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How Parental Education Affects Child Human Capital: Evidence From Mozambique[1]

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Summary. *This paper analyses how paternal education affects child human capital outcomes, using household survey data from Mozambique. Four indicators of human capital are examined: height-for-age of children below 5 years of age, children's rate of survival, children's education, and total fertility of adult women. Using a sequential regression approach, it is investigated how mothers' and fathers' education impacts on child human capital outcomes through higher incomes, literacy and changes in fertility knowledge and preferences. Education of the parents, and especially of the mother, is found to impact in a strong and significant manner on human capital outcomes. The effect of education seems to work through cognitive skills (such as literacy) to a large extent, but income, health knowledge and fertility preferences also play a role. The results are robust to controlling for community fixed effects (which purge the estimates of all differences in infrastructure and prices), and there seems to be little difference in the determinants of human capital outcomes between rural and urban areas. For education, gender of the child matters: Mothers' schooling and literacy has a stronger effect on girls' education, and fathers' schooling and literacy has a larger impact on the education of boys. It is concluded that programs to expand literacy, especially of women, are likely to have a high payoff in terms of improved human capital and reduced fertility.*

JEL codes: D1, I1, O1.
Keywords: Human capital , fertility, education, health, Africa, Mozambique.

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1. Introduction

Low levels of human capital are both a cause and a consequence of persistent underdevelopment and poverty. Strategies to alleviate poverty through targeted interventions to improve human capital are at the forefront of much international development policy and cooperation. Nowhere are human capital levels as low as they are in Sub-Saharan Africa, where a declining trend is present in several countries.

Well-informed policy interventions are needed to help raise the human capital levels of children, *i.e.* their health, nutrition, education and skills. Policies should aim to increase the general level of human capital as well as improve its distribution across income groups and gender. Such interventions need to be based on a profound understanding of the determinants of human capital.

Most of the factors leading to adverse human capital outcomes are associated with poverty: Low income in conjunction with credit constraints, parents' own lack of knowledge and education, lack of nearby school and health facilities, low quality of services provided, and unhealthy environments. There are also strong inter-generational aspects of human capital, with positive correlations between parental endowments of human capital and child outcomes. Therefore, one of the consequences of neglecting children's human capital is that upward social mobility is hard to achieve in poor countries, and poverty is reinforced through generations.

Increased emphasis on female education is a solution often advocated. This study adds to a growing literature demonstrating that parental education (especially mothers' education) has a large and positive impact on a range of demographic and economic variables (see for example the survey by Behrman and Deolalikar, 1988). Yet, few studies have documented why parental schooling has such beneficial effects. The aim of this paper is to investigate the mechanisms through which parental education affects children's human capital using a joint framework for four different human capital outcomes.

The outline of this paper is as follows. The conceptual framework is introduced in the next section, and the Mozambican data set used for the empirical analysis is described in Section 3. The basic results, in which boys and girls and rural and urban areas are pooled, is presented in Section 4. Various refinements and robustness checks of the results are discussed in Section 5, while conclusions and policy implications are summarised in Section 6.

2. Conceptual framework

2.1 Schematic framework

A schematic framework (inspired by Glewwe, 1999) gives a basic illustration of the channels through which parental education may affect investments in children's human capital (*i.e.* child nutrition and mortality, schooling and total fertility) is provided in Figure 1.

Please insert Figure 1 here

Outcomes are ultimately influenced by three sets of factors: (i) household behavior, including nutrition provided to children; other health inputs such as medicine, care, hygiene, and water quality; investments in education; and fertility; (ii) community characteristics, e.g. health and education infrastructure, pollution, local norms and values; and (iii) the child's own characteristics and endowments (ability, inherent skills etc). Parental education affects human capital investments through multiple pathways. Parental education improves income and therefore demand for children's human capital. Education also changes the values, knowledge and preferences of parents. Better parental health knowledge, for example, is likely to lead to improved child health outcomes for any given level of income. A key result of education is improvement in cognitive skills such as literacy, numeracy and language skills. Cognitive skills may help raise incomes, lead to improved knowledge and can also directly affect human capital related behavior, for example through better ability to process information. Parental schooling likewise may have a residual impact on child outcomes over and above the previously mentioned channels.

2.2 Research approach and hypotheses

In line with common practice in the literature on child health, we estimate reduced form models of human capital outcomes where the regressors are exogenous characteristics of the individual, its household and the community in which it lives. Income may also be included provided it is instrumented to account for possible endogeneity. This reduced form can be derived from a household utility function (defined over consumption, leisure and the number and quality of children), which is maximized subject to a budget constraint and a technology (or "production function") that relates human capital inputs to health and education outcomes. A variety of models of the household's decision-making support the same reduced form specification (Thomas, 1994).

As a starting point, human capital outcomes (denoted *HC*) are regressed on years of schooling of the mother and the father (*EDUC*) and a vector of exogenous controls, *Z*, such as age of the child and the mother (where relevant) and sector of residence:

$$HC = \alpha + \beta_1 EDUC^{female} + \beta_2 EDUC^{male} + \delta ' Z + \varepsilon$$

The "total education effect" of the mother and the father's schooling is defined as the estimates of β_1 and β_2. There is, however, a potential problem with this interpretation. The education variable may not capture a treatment effect, but merely unobserved parental characteristics such as ability, intelligence etc. Unfortunately, we have no way to control for idiosyncratic variation in ability, which, if important, would cause an upward bias in estimates of the effect of education. It is also possible that paternal education is correlated with observable or unobservable community characteristics, for example due to easy access to health or education facilities, local norms regarding child human capital and so on. Section 5 addresses such potential problems.

We try to quantify the mechanisms - income augmenting, literacy, and fertility knowledge and preferences - through which education may affect human capital outcomes by sequentially adding explanatory variables that capture each of these mechanisms. The importance of each mechanism for explaining the "total education effect" is assessed from the ensuing reduction in the estimates of β_1 and β_2. Thomas, Strauss, and Henriques (1991) and Glewwe (1999) have previously applied a similar procedure.

The following channels are hypothesised:

Income augmenting. Education improves the job opportunities and productivity of parents, and thereby raises their demand for child human capital to the extent that this is a normal good. Evidence from around the world suggests that income has a small but positive effect on child human capital (see for example Von Braun and Kennedy, 1994). Decisions regarding the allocation of time to child rearing and to income earning activities are likely to be jointly endogenous, and we therefore use instruments (such as exogenous assets and community variables) to account for the endogeneity of income.

$$HC = \alpha + \beta_1^{'} EDUC^{female} + \beta_2^{'} EDUC^{male} + \gamma_1 INCOME + \delta ' Z + \varepsilon.$$

The estimates of $\beta_1^{'}$ and $\beta_2^{'}$ show the component of the "total education effect" that remains once the income-augmenting effect of education is controlled for. Many studies have found a positive impact of education conditional on income, meaning that educated parents, for a given level of income, are more efficient producers of human capital.

Literacy and other cognitive skills. The ability to read and write is probably the most important result of education, closely followed by numeracy and language skills. Literacy and other cognitive skills of the parents may affect human capital outcomes through the ability to process information and to understand simple messages as well as through higher self-esteem and a changed outlook on life. Dummies for female and male literacy and for the ability to speak Portuguese, the national language in Mozambique, are added to the regressions to measure the impact of cognitive skills:[1]

$$HC = \alpha + \beta_1^{''} EDUC^{female} + \beta_2^{''} EDUC^{male} + \gamma_1 INCOME + \gamma_2 LITERACY^{female} + \gamma_3 LITERACY^{male} + \gamma_4 PORTUGUESE + \delta ' Z + \varepsilon$$

Preferences and knowledge regarding fertility. Education of girls may change their attitudes to fertility by improving their knowledge of contraceptive techniques, by challenging their perceptions of the size of an 'ideal' family, and in other ways. We control for this effect by including regressors that capture the mother's contraceptive knowledge and desired number of children:[2]

$$HC = \alpha + \beta_1''' EDUC^{female} + \beta_2''' EDUC^{male} + \gamma_1 INCOME + \gamma_2 LITERACY^{female} + \gamma_3 LITERACY^{male}$$
$$+\gamma_4 PORTUGUESE + \gamma_5 PLANNING + \gamma_6 \#CHILDREN + \delta' Z + \varepsilon$$

Residual effect. Direct acquisition of basic health knowledge in school may enable future mothers and fathers to better treat their children's health problems, maintain hygiene, provide healthy foods and so on. Moreover, having received schooling may increase parents' preferences for schooling for their kids, for example by inducing a higher valuation of education *per se.* Also, any unobserved variables that jointly affect parental education and child human capital outcomes (such as genetic endowments and area characteristics) will be picked up as the estimated residual effects of education, β_1''' and β_2'''. This is therefore likely to remain positive even after controlling for the other channels of influence.

2.3 Human capital and fertility

Human capital, HC, measures child height, the rate of child survival, education and total fertility. The first three indicators are clearly important child human capital outcomes in their own right. They are intricately linked to fertility in several ways. For example, malnutrition and high perceived mortality risk may weaken parents' incentives to invest in the education and health of their children. Similarly, high fertility strains household resources and may worsen human capital outcomes. Thus, there is often thought to exist a fertility-human capital trade-off, whereby large families are associated with lower health and education investment per child. High fertility may cause adverse human capital outcomes for individual children to the extent it reduces income per capita. High fertility also reduces maternal caring time available per child, at least until older siblings are old enough to assist with domestic tasks. Montgomery, Kouamé and Oliver (1995) find limited evidence for the existence of a trade-off between number of children and child schooling in Côte d'Ivoire and Ghana. The trade-off can be observed at the national level since fertility reductions in most countries have gone hand-in-hand with improved survival, health and education of children.

The causality of the fertility-human capital trade-off is hard to pinpoint. One would ideally wish to investigate the links between mother's total fertility and child human capital outcomes, but since these two variables are jointly endogenous they cannot be used as regressors for one another. Thus, including family size as a regressor, which has been done by many researchers, is fraught with endogeneity problems. Instrumental variable techniques can rarely resolve the situation since there are few, if any, plausible instruments that are correlated with fertility but not determinants of human capital investments. Nevertheless, our results can throw light on the existence of this trade-off in a somewhat indirect manner. If the regressors have the opposite sign in the fertility equation relative to the health and education equations, it would suggest the existence of a trade-off, in the sense that the factors causing improved health and education are associated with declining fertility.

3. Data and variables

The data set employed for this study is a 1997 household survey from Mozambique, a country with very low levels of health, education and general economic development, even by the standards of Sub-Saharan Africa. Civil war, economic mismanagement and collapse, and Portuguese colonial policies are some of the reasons for this. Yet, Mozambique has demonstrated a fairly strong policy commitment to improving living standards and human capital outcomes, and appears sensitive to distributional issues

The *'Inquérito nacional aos agregados familiares sobre as condicões de vida'* (IAF), meaning 'National household survey on living standards' was carried out by the Mozambican National Statistics Institute in 1996-97. In addition to data on individual health and education, the survey contains information on household expenses and assets as well as family characteristics. The survey, which is nationally representative, covered a total of 8,273 households in both rural and urban areas. The survey is, in many respects, comparable to the World Bank sponsored Living Standard Measurement Surveys (LSMS) in scope and quality. Sampling weights, or inflation factors, that are inverse to the sampling probability are employed throughout this paper except where explicitly noted. We work with the following four endogenous variables, capturing distinct (but interrelated) aspects of human capital.

The *height-for-age z-score* is a measure of long-run nutritional status and is available for children 0-4 years old. The *z*-score is the difference (measured in standard deviations) between the actual height of the child and the median height of children of the same age and sex in a healthy reference population. Low height-for-age *z*-scores are caused by prolonged malnutrition, extended illness, or the interaction of both. As can be seen from Table 1, the mean height-for-age *z*-score in Mozambique is around –1.6 to –1.8, depending on choices regarding exclusion of outliers and missing variables. Stunting, normally defined as *z*-scores below –2 (corresponding to a height below 90% of the median height of children of same age in the reference population) is associated with a rapidly rising risk of mortality and has long-term negative consequences for adult health, height and work capacity. At the national level, the incidence of stunting is around 42%. Stunting rates are higher in rural than in urban areas, and they are highest in the under-developed Northern part of the country. Mozambique's incidence of stunting is at the high end of stunting rates found in other Sub-Saharan African countries, but well below those of South Asia.

Please insert Table 1 here

Using the same data set, Garrett and Ruel (1999) analysed the extent to which the determinants of height-for-age *z*-scores (and calorie availability) differ between rural and urban areas. They found very little difference. Since they did not analyse any other human capital outcomes, nor consider the channels of influence of education, there is little overlap between their study and ours.

The survival rate is defined, for all women in the sample aged 15 or above, as the proportion of children ever born to them that are still alive. Observations span from 0-1 with a mean of 0.82.

This figure matches quite closely the under-5 mortality rate of 20% that can be calculated from the Demographic and Health Survey (DHS), an alternative data set (DHS, 1998).

The education index is a measure of each child's schooling attainment relative to the national average. Inspired by a formula used by Rosenzweig (1978), it is computed as

$$Education\ index_i = \frac{S_{ixk}}{\overline{S_{xk}}}$$

where S_{ixk} is the number of years of schooling of individual *i* of age *x* and sex *k,* and $\overline{S_{xk}}$ is the average number of years of schooling attained by children aged *x* of sex *k* in the sample. The index takes values from zero to infinity and by construction its mean is 1. The data necessary for the computation is available for children 7-18 years old. As the index is normalized with respect to age and gender, these variables need not be included among the controls in this case.

Fertility is measured as the number of children ever born to a woman. We use data for all sampled women above age 14; observations span from 0 to 19 children.

3.1 Sample size and missing observations

Due to missing observations and extreme values, some of the observations had to be excluded from the sample used for regressions. In the case of height-for-age *z*-scores, roughly 24% of the observations were excluded because either the child's height or age was missing. In addition, *z*-scores less than -5 and greater than 3 were omitted (6% of the observations on *z*-scores), because they can be considered biologically implausible. To some extent this problem is caused by low levels of literacy and numeracy in rural Mozambique, low penetration of medical facilities and, consequently, a large number of children for whom there is no written document recording the date of birth. Many mothers therefore may not know the exact age of their infants. However, although measurement error in the *z*-scores appears to be substantial, there is no reason to believe the measurement error to be systematically correlated with the regressors. Parameter estimates should therefore not be biased.

A substantial proportion of observations on fertility are also missing, since more than 20% of women older than 15 years did not answer the survey questions on pregnancy and childbirth. By contrast, the education index could be computed for a full 98% of sample children. Finally, in the case of survival rates one cannot say how many observations are lost since the true number of mothers in the survey is unknown. In addition, in all cases, around 10% of observations are lost due to missing observations of the exogenous variables.

3.2. Explanatory variables

The explanatory variables are the following:

EDUC. The number of years of schooling completed for the mother and the father is meant to catch the effect of formal education. Mean schooling is 1.84 years for the females and 3.53 years for males, but this overestimates the gender difference in education: Since the questionnaire does not link fathers to children, we use the information on the adult male in the household with the most years of schooling. For simplicity of exposition, we often refer to this variable as "father's education", even though it will not, in all cases, refer to the actual father. Likewise, for children aged 5 and above, one cannot match sampled children to sample mothers, and we therefore use information on the adult woman in the household with the most years of schooling as the regressor for the education index.

INCOME. Total expenditures per capita per day are used as a measure of income. Its mean is 5061 Meticais, corresponding to USD 0.46 at the time of the survey. As already mentioned, labor supply and hence income is determined simultaneously with allocation of time for nursing and childrearing. Expenditures therefore need to be considered endogenous and should be instrumented. Instruments are household demographics and assets, area characteristics, regional dummies, and prices.

LITERACY. A dummy variable coded 1 when the parent is able to read and write and 0 otherwise represent literacy. Among women, 34% are literate, while 67% of households contain a literate male. The distinction between literacy and illiteracy can be somewhat blurred, and since this is a self-reported variable, it cannot be ruled out that literacy has been defined in somewhat varying ways by different people.

Family planning enters into the regressions through two variables. PLANNING indicates the number of contraceptive techniques known to each woman (the mean is 0.7), and #CHILDREN is the desired number of children, expressing the fertility preference (mean 5.7). The inclusion of these variables is justified by the observation that family size preferences, to a substantial extent, are shaped by forces of culture and education, and therefore are largely exogenous to the individual. A large number of women respond that they never thought about how many children to have, or that they want the number of children that God sends. In these cases the preference variable is coded 0 and a separate dummy variable is set to 1. This way, all observations can be retained in the sample used for regression. The parameter for the preference variable is thus estimated conditional on a preference being articulated.

Control variables. Finally, a group of background variables, or controls, are included in the *Z*-vector. These controls are specific to the individual child (age, age squared, gender dummy); to the mother (her age and age squared; unfortunately, information on parents' height was not collected, and we are therefore unable to control for genetics); or to the sector (a dummy for urban households). In addition, dummies for missing information on the mother or the father, respectively, were added in order to raise the number of observations used in the regressions.

3.3. Estimation procedure

The estimation procedure varies between regressions. For the *z*-score, the education index and fertility, ordinary-least-squares (OLS) is appropriate as long as expenditure is not among the explanatory variables. Two-stage-least-squares (2SLS) is used when expenditure is included. For the survival rate, a generalized linear model (GLM) with a binomial distribution is adopted. In this model, the number of surviving children is the dependent variable, and the number of children ever born to the woman is the binomial parameter that describes the number of 'trials'. Age of the oldest child is added in order to control for the number of years of mortality risk. Standard errors throughout are based on a robust estimator, which corrects for the survey nature of the data and uses sampling weights. The only exception is that the GLM estimates of survival probability do not take survey design and weighting into account, implying that the significance of the estimates may be somewhat over-estimated in this case.

4. Results for the full sample

In this section, the results for the full sample are discussed, pooling boys and girls and rural and urban areas. Additional robustness tests (for example for splitting the sample into boys and girls and into rural and urban areas) appear in Section 5.

4.1 The total effect of education

Tables 2-5 present the results from regressing the four endogenous variables on parental schooling and a set of control variables (the results for the controls are discussed in Section 4.5 below). As expected, increases in mother and father's education are associated with significantly better human capital outcomes. Maternal schooling seems to have the largest impact, presumably because mothers spend more time on child rearing. The exception is for child survival, where father and mother's education have equal impact.

Please insert Tables 2-5 here

Each additional year of mother's schooling raises the *z*-score by 0.071 units or around 4.4%, corresponding to 0.22 cm in the case of a 24 month old boy. The impact of father's education is less than half of this. Parental schooling has a large impact on the rate of child survival – each additional year of schooling (same for both mother and father) increases the survival probability by around 6 percentage-points. Parents' education also impacts in a positive and significant manner on children's education. One additional year of mother's education raises the education index by around 16%, while the corresponding figure for father's education is half that. Converting into years of schooling, these estimates imply that increasing both parents' schooling by one year would add an additional 0.9 years of schooling for an average boy. For fertility, maternal schooling is found to impact in a negative and significant manner, whereas paternal education has an unexpected positive, but insignificant, parameter. Each additional year of female schooling is associated with having 0.1 less children at the time of the survey. Note that this figure is different from (and less than) the lifetime cumulative impact of education on fertility. We conclude that female education is important, but no panacea, for reducing the current fertility rate of 5.6 (DHS, 1998).

4.2 The income effect of education

In the second columns of Tables 2-5, instrumented expenditures are introduced. The excluded instruments are highly significant in all four regressions. Thus, the χ^2 test statistics for joint significance of the identifying instruments are: 8.34 (height); 10.36 (education index); 15.69 (survival); and 16.51 (fertility). Expenditure has the expected positive impact on height, and negative impact on fertility, both significant. Expenditure has a positive but insignificant parameter in the education equation, while, surprisingly, it is negative and significant for survival.

The largest impact of household expenditure occurs for fertility – 10% income growth would reduce fertility by 0.1 children. The estimated effect of income on the other human capital outcomes is very small. The size of the estimated impact of income does depend, to some extent, on the instrumentation. Thus, OLS regressions without instruments for income lead to lower absolute parameters in the regressions for height, survival and fertility, and a higher (and significant) parameter for education.

The impact of education falls once it is conditioned on income, as can be easily seen from Table 6. This table summarizes what happens to the magnitude of the parameter estimate for parental education (from Tables 2-5), as additional explanatory variables are included. In each of the four columns, the parameter for the total effect of mother's education is normalized to 100. The table shows how much remains of the total education effect after inclusion of additional regressors, with an asterisk denoting significance of the education parameter in the relevant regression.

Please insert Table 6 here

The extent to which controlling for income affects the education parameter differs widely. Looking first at mother's education, controlling for income reduces its effect on height and fertility by 43% and 64%, respectively, while its impact on the education index is unaffected. The large role of the income channel for fertility is in line with theory and evidence stressing the importance of female opportunity cost of time. For the survival rate, adding income leads to an increase in the education parameters (both mother's and father's), and this is hard to explain. For paternal education, including expenditures among the regressors does not reduce much the effect of education (in fact, the parameter increases for both survival rate and for fertility, where it has an unexpected sign). This is surprising. Since women tend do most of the childcare in Africa, education of mothers is likely to work through several channels, while the effect of father's education is normally thought to result mostly from its income effect (Glewwe, 1999). This assumption is not born out by our findings. Male education appears to enhance children's human capital outcomes (and increase fertility) for reasons other than income.

4.3 Education and cognitive skills

Dummy variables for parents' ability to read and write as well as for mothers' ability to speak Portuguese are introduced in the third column of Tables 2-5. Mother's literacy and ability to speak Portuguese both have significant positive impact on children's health and education. The effects on fertility are not significant, though. Literate mothers, on average, have children with *z*-scores that are higher by 12%, have a 17 percentage-point higher survival probability, and receive

18% more schooling. The mother's ability to speak Portuguese affects children's human capital outcomes in a similar manner (although just below the significance threshold for height). By contrast, father's literacy is not significant for children's health and education, although it is positive and significant for fertility.

Cognitive skills turn out to be the single most important channel through which parent's education affects children's human capital. When one asks why education matters for human capital once income is controlled for, it appears that literacy and language skills provide a large part of the answer. Thus, the impact of maternal schooling on all four human capital outcomes is reduced by a substantial amount once cognitive skills are controlled for. This suggests that the ability to read and write is of paramount importance for the ability of the mother (but less so for the father) to efficiently transform health inputs into reduced child morbidity and mortality. Once income and cognitive skills are introduced in the equations, the effect of years of schooling on height and fertility becomes insignificant.

Literacy is the most important outcome of formal education, especially where schooling levels are low. It takes 3-4 years of completed schooling before the ability to read and write is achieved. In Mozambique, many children begin school but do not complete lower primary school, *i.e.* grade 5 (Heltberg, Simler and Tarp, 2001). Making sure children complete at least basic primary education, which should enable them to remain literate through adulthood, would help improve the country's human capital record. Adult literacy programs are also called for, and preferably with a focus on women.

4.4 The knowledge and preference effects of education

In the fourth column of Tables 2-5, the three variables related to family planning enter the regressions. The number of contraceptives known to the mother has a positive impact on children's health (significant for survival probability). This finding may reflect the fertility impact of contraceptive knowledge, or it may be that the number of contraceptives known to a woman is a proxy for more general health knowledge, which helps improve child health. In fact, Glewwe (1999) found health knowledge to be the single most important factor for explaining height-for-age in Morocco. Better data on general health knowledge would be desirable. Surprisingly, fertility is positively associated (in a significant manner) with the number of known contraceptives. This puzzling finding may be interpreted in various ways. For example, it is possible that the effect on fertility may not stem from knowledge of contraception *per se*; instead contraceptive knowledge may be correlated with some omitted variable which is itself positively related to fertility. This would be the case if visitors to maternity clinics, health centres and hospitals are given information about contraceptive techniques. Number of children born to a woman, and the number of such visits she has ever made (and hence amount of advice received), is likely to be correlated. Unfortunately, we have no way to control for the amount of advice and training given and are therefore unable to estimate the true impact of contraceptive knowledge on fertility.

The number of desired children has a positive and significant effect on the number of children born. The estimated coefficient is 0.2. When interpreting this coefficient it has to be kept in mind that the women surveyed are of varying age and that many have not yet completed their fertile age; hence the exact magnitude of the estimated parameter will depend on the age distribution of the sample. This finding suggests a certain, albeit imperfect, ability of the women to make fertility choices, although biological factors, economic constraints and the preferences of male partners obviously also shape realised fertility. The dummy variable for not having an explicit preference for the number of desired children is positive and significant. Women with no independent opinion about desired family size have one additional child, and the survival rates of their children are substantially lower. Programs that help women to consider how many children to have may thus help reduce both fertility and child mortality.

Inclusion of the family planning variables leads to a reduction in the importance of mothers' education for fertility and survival rate (see Table 6). Hence, for those outcomes, the effect of mothers' education also works through changes in fertility knowledge and preferences.

4.5 The control variables

As already mentioned, a varying set of controls or background variables are included in all the regressions in order to account for factors that are important, yet unrelated to education. A dummy for urban residence is employed in all four regressions. Its parameters show that families in urban areas have significantly better health and education outcomes, presumably reflecting differences in the availability of public services. There is little difference in fertility between rural and urban areas. Dummies are included for absent father (in all regressions) and for absent mother (in height and education); they are generally insignificant except for child education, where there are positive effects.

In the height regression, age, age squared, and sex of the child are included. Data from many countries show that height *z*-scores tend to decline with the age of the child until around two years, where they stabilize and in some cases rise again (e.g. Thomas and Strauss, 1992). The decline in *z*-score between 6 months and two years of age is due to the special dietary needs in that age, where children are weaned. The usual staples (cereals, legumes) are not very appropriate for toddlers, but foods with higher concentrations of calories and micronutrients are more expensive. The parameter estimates of the age variables confirm that this stylised fact also applies to Mozambique: the average *z*-score is falling during the first 30 months or so, after which it slowly recovers. Female children have significantly higher *z*-scores than male children.

4.6 Discussion

As already mentioned, Table 6 reports how much of the 'total' effect of parental education that remains after controlling for the hypothesised channels of influence. Generally, the most important channel appears to be literacy and language, followed by income, which is very important for fertility and child height. Fertility knowledge and preferences play a lesser role.

The parameter for years of schooling remains substantial and significant in two cases (education and survival), indicating that parental schooling also works through other channels that have not been captured. In part, this may be due to the omission of parental preference for education, which is unobserved. It is likely that parents with schooling put substantially more emphasis on the necessity of education, irrespective of its economic benefits.

The results point, in an indirect fashion, to the existence of a trade-off between fertility and human capital: important explanatory variables have the effect of simultaneously improving health and education outcomes and lowering fertility. This is most pronounced for female education, but is also observed for income. In addition, not having considered how many children to have is associated with significantly higher fertility and higher mortality risk.

5. Interaction effects: geography and gender

In this section, the extent to which the basic results for the pooled sample in the previous section are robust to controlling for a host of other factors is tested. These factors relate, first, to the community (urban-rural residence; community fixed effects; and average education in the community) and, second, to the individual (gender of the child). Although the basic results of Section 4 appear robust, the regressions in this section reveal a number of additional and interesting findings.

5.1 Rural- urban differences

Many features of the local environment influence human capital decisions: Prices of food and other health inputs, distance and quality of health and education facilities, availability of clean water, pollution, labor market conditions and local customs and culture. The most dramatic difference in such community factors undoubtedly occurs between rural and urban areas, and it is therefore common practice in much of the literature to split samples into rural and urban households. Although Garrett and Ruel (1999) found little difference in the determinants of height-for-age *z*-scores and calorie availability between rural and urban areas of Mozambique, it is appropriate to test the robustness of the results to splitting the sample by sector.

This is done by interacting a dummy variable for urban residence with each of the explanatory variables. Subsequently, insignificant interaction terms were dropped, resulting in parsimonious models that allow easy comparison with the results in Section 4. Results are shown in Table 7 for all four endogenous variables, and are generally not very different from those in Section 4. Mother's education interacted with the urban dummy was nowhere significant, and was hence excluded. Father's education interacted with urban residence has a significant negative effect on education and fertility. This means that father's schooling is less important for children's education in urban, as compared to rural, areas (but remains positive) and that it has a negative impact on fertility in urban areas. In contrast, mother and father's literacy both have a higher impact on education in urban areas. Ability to speak Portuguese, surprisingly, is associated with higher fertility in urban areas. Knowledge of contraceptive methods reduces fertility in urban areas relative to rural areas, possibly due to better availability of contraceptives in the towns. In addition, a few of the control variables have a significantly different impact in urban areas – the most interesting result here is that boys' shortfall in height (relative to girls) is larger in urban areas. The urban dummy remains included in non-interacted form (*i.e.* allowing the intercept to differ between urban and rural areas), and this was retained whether significant (*i.e.* height and survival, both better in urban areas), or not.

In addition, the impact of water source on survival is tested by including dummies for the type of water supply available to the household. These variables are highly significant, and indicate that the availability of tap water has a large positive impact on child survival whereas water supplied from rivers or lakes is detrimental to child health. In the long run water supply may be partly endogenous, but for practical purposes the choice of water supply can be considered exogenous as it is strongly influenced by community factors.

5.2 Community fixed effects

It is conceivable that part of the estimated effect of education is caused by unobserved factors correlated with both education and human capital outcomes (for example if educated parents were more likely to reside in places with good health and education infrastructure, or with different norms, even after controlling for income). Including community fixed effects, essentially a dummy variable for each community, controls for this possibility. This way, estimates are purged of the influence of all community-level factors such as infrastructure and prices (see for example Skoufias, 1998). Community fixed effects are included for each *bairro* (in urban areas) and *localidade* (in rural areas). These are small administrative units that served as primary sampling units for the *IAF*. To avoid multi-collinearity, the urban dummy has to be excluded in this case. Controlling for community fixed effects (see Table 8) leads to a modest increase in the influence of expenditure on education and a doubling of the expenditure effect on fertility. There are also changes in some of the other regressors, for example a fall in the effect of tap water (unsurprising in light of the correlation between water source and community of residence). We conclude from this that the estimated positive effects of schooling, literacy and income on human capital outcomes are not caused by correlation between those variables and omitted community characteristics.

5.3 External effects of education and fertility

Sometimes, it is argued that education has important external effects beyond the benefits it provides to the individuals and households receiving it. Well-educated neighbors, for example, may help improve parental health knowledge, or even substitute for it. Norms and patterns of behavior in the community may influence parents' norms and preferences regarding schooling and fertility (Dasgupta, 1995). Such external effects can be tested for by including the average education level of sampled men and women in the community, and – in the case of fertility only – the average number of children born to all women in the community. These variables are all constructed as "non-self averages" (*i.e.* excluding the person under consideration) defined over the community ("*bairro/localidade*"). Other external effects could be included, but the ones chosen here were a priori considered the most interesting.

The regressions with community external effects are shown in Table 9. Interestingly, average female schooling in the community has positive and highly significant effects on children's education and survival. The positive externalities of educating a woman therefore appear to extend beyond her own household to the community in which she resides. Surprisingly, average female schooling is associated with higher fertility, and this is significant, but hard to explain. Average female schooling is not significant in the regression for height. Average male education is significant only in the education equation, where it has a small positive effect, corresponding to the previously mentioned importance of educational norms. Another interesting finding concerns average female fertility in the community, which has a positive and significant effect on the number of children ever born to sample women. The effect is fairly substantial – when the non-self community mean increases by one child (a standard deviation), individual fertility rises by 0.24 when other factors are controlled for.

5.4 Gender-based differences in outcomes

Do the determinants of children's human capital outcomes depend on the gender of the child? This would be the case if the incentives and constraints affecting girls' education and health differ from those facing boys. This is investigated by interacting the regressors with a dummy variable indicating the gender of the child (coded 1 when the child is male, 0 otherwise). The analysis is carried out for *z*-scores and the education index, where each observation of the endogenous variable corresponds to an individual child (fertility and survival rates are observed at the level of the mother and therefore cannot be broken down by gender). The procedure used is that only significant interactions are retained. For height-for-age *z*-scores, very few significant differences in the regression parameters for boys as compared to girls could be detected (see Table 10). Specifically, none of the variables for parental education had significant interaction effects, implying that separate regressions for boys' and girls' height give nearly the same parameter estimates as a pooled regression with a gender dummy.

For children's education, all interactions related to schooling and literacy are highly significant. Maternal schooling, while good for the education of both boys and girls, has the strongest positive impact on the schooling of female children. Paternal schooling appears to benefit boys the most. For literacy, the same pattern is observed: Mother's ability to read and write is positively and significantly associated with child schooling for both genders, but girls enjoy the greatest effect of maternal literacy. Literacy of the father has a mixed impact – it raises the schooling of males and reduces that of females, both in a significant manner. The magnitudes of these gender effects are substantial, suggesting that the way human capital is distributed between the parents has a large impact on the gender distribution of children's education. This reinforces the findings of Thomas (1994) who reported similar gender asymmetries from parental education using data for the US, Brazil, and Ghana.

Several possible explanations can be offered for the observed gender asymmetries in the relationship between father and mother's education and children's access to education. Bargaining position and influence exerted by parents on decisions regarding investment in children's education is likely to depend on their own education, and combined with some degree of same-sex preference this can produce the observed gender asymmetry. Educated mothers treat their daughters better, not because they try to harm their sons, but possibly because they want to equalize access to education by boys and girls. Differences in the returns to boys and girls' education may also play a role. Girls spend more time helping their mothers with domestic tasks and field work and hence, in the short run, the opportunity cost to the mothers of their daughters going to school are relatively high. Educated mothers may attach more importance to long-term benefits of girls' education. This evidence of self-preserving inequalities in the gender distribution of education implies that efforts to equalize the educational attainment of male and female children have permanent effects, thereby stressing the need for policies aimed at establishing equal access to education.

5.5 Fertility, mother's education, and age

Education can affect fertility in three ways: it can alter the costs and benefits of having children, for example by changing the opportunity cost of children; it may enable parents to better achieve desired fertility through health and contraceptive knowledge; and it may simply lead women to postpone childbearing. Above it was established that once income, literacy, and fertility preferences are controlled for, years of schooling of women has no effect on fertility. This shows that education works mostly through changes in opportunity costs and health knowledge; if it worked by postponing first pregnancy, an effect would remain after controlling for other factors. We also interacted mother's schooling and age in the fertility regression (not shown). The interaction has a significant negative impact on fertility, meaning that the fertility-reducing effect of education accumulates through life. Education does not reduce fertility only for the young. The effect does not 'wear out'.

6. Conclusions and policy implications

This paper has demonstrated, using household survey data from Mozambique, that mothers' education has a large and significant impact on important human capital outcomes such as child health (height and survival probability), education and fertility. The channels through which paternal schooling impacts on child human capital were investigated, using a recursive framework. The most important channel was found to be the basic cognitive skills acquired at school (literacy and language). Income also appears important (for fertility and child height), while fertility knowledge and preferences play a lesser role.

Thus, parents' basic cognitive skills are very important for their children's human capital development. Although the analysis carried out in this paper does not pin-point the exact reason behind the strong effect of parents' literacy and language skills (which could arise from ability to access or to process information, status, self esteem, or changes in preferences), it appears safe to conclude that investing in improved cognitive skills would have a high payoff. The importance of basic cognitive skills appears to be robust, and persists after inclusion of a variety of controls for rural/urban location, omitted community factors, etc. Improved levels of literacy are required, and can be achieved through higher primary school enrolment, better school completion performance and adult literacy programs.

There is evidence, albeit indirect, of a trade-off between fertility and human capital: Mothers' education (and income to some extent) improves child human capital and reduces fertility at the same time. Human capital outcomes depend not only on parents' education, but also on the education of other adults in the community. Likewise, fertility depends on the fertility of other women within the community. This demonstrates the importance of community externalities for human capital generation. It is also evidence of the crucial impact that educated women can have on norms and values within their community.

Large and striking gender asymmetries were found in the factors determining access to education. Schooling and literacy of the mother is more beneficial for girls' schooling than it is for boys'. The father's education is especially good for boys' schooling. This demonstrates that gender inequality in access to education can be self-preserving. Shortfalls in female education are repeated in the next generation. Yet the opposite also holds - educating one generation of women will have a lasting impact on human capital and its gender distribution. Policies should aim to establish equal access to education.

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Table 1: Summary statistics for the endogenous variables

	z-score		Survival rate		Educational index		Fertility	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
All observations	-1.83	2.36	0.82	0.25	1.00	1.02	3.23	3.10
After exclusion of extremes	-1.61	1.60	0.82	0.25	1.00	1.02	3.23	3.10
In the final regression	-1.59	1.61	0.83	0.25	1.02	1.03	3.24	3.10

Note: Means are weighted averages using sampling weights.

Table 2: Height-for-age z-score	**1**	**2**	**3**	**4**
Mother's schooling in years	0.071	0.043	-0.004	0.002
	(3.06)**	(1.54)	(0.12)	(0.07)
Father's schooling in years	0.030	0.020	0.031	0.026
	(2.05)*	(1.37)	(1.67)	(1.39)
Log expenditures/person/day		0.473	0.430	0.308
		(1.75)	(2.63)**	(2.47)*
Mother literate			0.187	0.126
			(1.57)	(1.01)
Father literate			-0.147	-0.158
			(1.19)	(1.25)
Mother speaks Portuguese			0.221	0.247
			(1.88)	(2.03)*
Desired number of children				-0.004
				(0.17)
No fertility preference				-0.084
				(0.54)
# contraceptives known				0.047
				(1.89)
Missing father	-0.103	-0.054	-0.119	-0.204
	(0.73)	(0.41)	(0.84)	(1.38)
Missing mother	-0.411	-0.683	-0.575	-0.384
	(0.76)	(1.07)	(0.85)	(0.28)
Age of child	-0.070	-0.070	-0.071	-0.068
	(9.11)**	(9.19)**	(9.45)**	(8.84)**
Age of mother	0.029	0.032	0.033	0.038
	(1.73)	(1.89)	(1.98)*	(1.99)*
Age of mother squared	0.000	0.000	0.000	0.000
	(1.25)	(1.23)	(1.29)	(1.39)
Age of child squared	0.001	0.001	0.001	0.001
	(7.02)**	(7.15)**	(7.34)**	(6.80)**
Sex of child	-0.150	-0.168	-0.166	-0.168
	(2.15)*	(2.40)*	(2.44)*	(2.32)*
Urban dummy	0.439	0.468	0.393	0.334
	(4.96)**	(5.15)**	(4.14)**	(3.29)**
Constant	-1.528	-5.385	-5.046	-4.079
	(4.82)**	(3.77)**	(3.66)**	(2.86)**
Observations	4094	4071	4058	3875
R-squared	0.10	0.09	0.10	0.10

Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level.

Table 3: Education index	**1**	**2**	**3**	**4**
Mother's schooling in years	0.158	0.154	0.118	0.121
	(22.44)**	(20.85)**	(12.99)**	(12.66)**
Father's schooling in years	0.088	0.085	0.072	0.069
	(13.19)**	(12.45)**	(8.54)**	(7.97)**
Log expenditures/person/day		0.081	0.108	0.095
		(1.62)	(2.10)*	(1.79)
Mother literate			0.180	0.189
			(3.77)**	(3.90)**
Father literate			0.069	0.048
			(1.69)	(1.15)
Mother speaks Portuguese			0.096	0.104
			(2.64)**	(2.92)**
Desired number of children				-0.007
				(0.97)
No fertility preference				-0.024
				(0.43)
# contraceptives known				-0.001
				(0.11)
Missing father	0.323	0.313	0.317	0.277
	(6.68)**	(6.38)**	(6.17)**	(5.23)**
Missing mother	0.179	0.146	0.058	0.035
	(2.72)**	(2.14)*	(0.78)	(0.41)
Urban dummy	0.123	0.122	0.108	0.130
	(3.05)**	(3.10)**	(2.72)**	(3.14)**
Constant	0.226	-0.412	-0.676	-0.545
(10.03)** (1.03)	(1.67)	(1.29)		
Observations	13177	13045	12970	12162
R-squared	0.34	0.35	0.35	0.36

Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level.

Table 4: Survival probability	1	2	3	4
Mother's schooling in years	0.057 (5.72)**	0.088 (8.28)**	0.056 (3.72)**	0.051 (3.37)**
Father's schooling in years	0.063 8.39)**	0.070 (9.26)**	0.068 (6.79)**	0.066 (6.60)**
Log expenditures/person/day		-0.519 (9.28)**	-0.532 (9.49)**	-0.606 (10.60)**
Mother literate			0.136 (2.02)*	0.077 (1.14)
Father literate			-0.011 (0.22)	-0.011 (0.22)
Mother speaks Portuguese			0.097 (2.05)*	0.077 (1.63)
Desired number of children				-0.010 (1.00)
No fertility preference				-0.171 (2.17)*
# contraceptives known				0.078 (5.81)**
Missing father	-0.081 (1.46)	-0.065 (1.17)	-0.079 (1.37)	-0.100 (1.72)
Age of oldest child	-0.065 (11.78)**	-0.068 (12.06)**	-0.066 (11.87)**	-0.064 (11.46)**
Urban dummy	0.421 (9.85)**	0.499 (11.36)**	0.464 (10.17)**	0.381 (8.13)**
Age of mother	0.023 1.65)	0.017 (1.15)	0.014 (0.92)	0.008 (0.55)
Age of mother squared	0.000 (2.03)*	0.001 (2.46)*	0.001 (2.60)**	0.001 (2.80)**
Constant	0.842 3.60)**	5.084 (9.75)**	5.243 (9.99)**	6.066 (11.14)**
Observations	6330	6223	6223	6223

Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level.

Table 5: Fertility	1	2	3	4
Mother's schooling in years	-0.099	-0.037	-0.036	-0.025
	(8.40)**	(2.29)*	(1.68)	(1.17)
Father's schooling in years	0.026	0.060	0.024	0.022
	(1.89)	(3.66)**	(1.14)	(1.07)
Log expenditures/person/day		-0.995	-0.974	-0.962
		(6.84)**	(6.77)**	(6.64)**
Mother literate			-0.004	-0.034
			(0.04)	(0.29)
Father literate			0.320	0.284
			(2.41)*	(2.14)*
Mother speaks Portuguese			-0.020	-0.022
			(0.22)	(0.24)
Desired number of children				0.202
				(9.26)**
No fertility preference				1.038
				(8.74)**
# contraceptives known				0.083
				(3.19)**
Missing father	-0.122	-0.029	0.064	0.049
	(1.14)	(0.24)	(0.50)	(0.37)
Age of mother	0.447	0.446	0.447	0.433
	(24.44)**	(24.50)**	(24.65)**	(23.30)**
Age of mother squared	-0.003	-0.003	-0.003	-0.003
	(10.55)**	(10.42)**	(10.52)**	(10.11)**
Urban dummy	-0.025	-0.041	-0.014	-0.047
	(0.29)	(0.40)	(0.14)	(0.43)
Constant	-6.184	1.773	1.506	0.584
	(27.44)**	(1.47)	(1.26)	(0.46)
Observations	9245	9185	9143	9025
R-squared	0.58	0.56	0.57	0.58

Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level.

Table 6: Decomposition of the effects of parental education

	z-scores	Education index	Survival rate	Fertility
Mother's education	100*	100*	100*	100*
- income	57	97*	151*	36*
- read and write	-21	75*	86*	24
- family planning	-10	77*	77*	15
- water			74*	
Father's education	49*	56*	116*	-24
- income	34	54*	128*	-59*
- read and write	51	46*	125*	-19
- family planning	43	44*	123*	-18
- water			105*	

Note: *indicates that education is significant at the 95% level. The numbers show the magnitude of the estimated effect of years of mother's and father's schooling. The parameter for mother's education in the regression with only years of schooling and controls included is set to 100, and all other parameters are measured relative to that.

Table 7: Interactions with urban dummy

	Height	Education	Survival rate	Fertility
Mother's schooling	-0.006	0.122	0.041	-0.010
	(0.17)	(12.60)**	(2.69)**	(0.45)
Father's schooling	0.026	0.081	0.060	0.053
	(1.39)	(8.58)**	(5.93)**	(1.96)
Father's schooling X urban		-0.037		-0.104
		(2.29)*		(3.06)**
Log expenditure/capita/day	0.225	0.096	-0.723	-0.964
	(1.28)	(1.84)	(12.06)**	(6.51)**
Mother literate	0.134	0.164	0.094	-0.147
	(1.05)	(3.18)**	(1.38)	(1.22)
Mother literate X urban		0.156		
		(1.97)*		
Father literate	-0.142	0.007	0.009	0.208
	(1.13)	(0.16)	(0.17)	(1.46)
Father literate X urban		0.204		
		(2.49)*		
Speak Portuguese	0.244	0.101	0.052	-0.133
	(2.04)*	(2.81)**	(1.10)	(1.36)
Speak Portuguese X urban				0.710
				(2.81)**
Desired number of children	0.010	-0.008	-0.005	0.192
	(0.54)	(1.01)	(0.53)	(9.04)**
Desired number of children X urban				0.079
				(2.99)**
Desired number of children missing	0.004	-0.026	-0.091	1.066
	(0.02)	(0.46)	(1.09)	(8.96)**
Desired number of children			-0.160	
				(1.96)*
# contraceptives known	0.055	-0.002	0.078	0.174
	(2.25)*	(0.26)	(5.93)**	(4.53)**
# contraceptives known X urban				-0.121
				(2.48)*
Age of oldest child			-0.020	
			(9.95)**	
Tap water			0.511	
			(6.81)**	
Water from rivers			-0.138	
			(3.68)**	
Mother's age			0.230	
			(44.01)**	
Father missing	-0.222	0.289	-0.084	0.170
	(1.55)	(5.33)**	(1.45)	(1.17)
Father missing X urban				-0.833
				(3.35)**
Mother missing	-0.547	0.026		
	(0.41)	(0.30)		
Age of child	-0.067			
	(8.71)**			
Age of child squared	0.001			
	(6.70)**			
Gender of child	-0.084			
	(0.98)			
Gender of child X urban	-0.328			
	(2.24)*			
Urban dummy	0.516	0.019	0.374	-0.108
	(3.78)**	(0.25)	(5.72)**	(0.34)
Constant	-3.869	-0.996	10.572	7.783
	(1.74)	(1.51)	(13.68)**	(4.02)**
Observations	3875	12162	6223	9025

R-squared	0.10	0.36		0.57

Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level; X urban indicates variable interacted with urban dummy.

Table 8: Controlling for community fixed effects

	Height-for-age	Education	Survival rate	Fertility
Mother's schooling in years	-0.006	0.104	0.044	-0.001
	(0.17)	(11.31)**	(2.71)**	(0.04)
Father's schooling in years	0.022	0.063	0.043	0.062
	(1.10)	(6.95)**	(3.86)**	(2.93)**
Log expenditures/person/day	0.248	0.139	-0.792	-1.939
	(1.13)	(2.10)*	(8.95)**	(9.27)**
Mother literate	0.086	0.167	0.052	-0.017
	(0.59)	(3.27)**	(0.70)	(0.12)
Father literate	-0.201	0.045	0.056	0.240
	(1.39)	(1.08)	(0.99)	(1.79)
Mother speaks Portuguese	0.236	0.083	0.076	-0.045
	(1.88)	(2.18)*	(1.44)	(0.45)
Desired number of children	0.013	-0.010	-0.008	0.178
	(0.57)	(1.25)	(0.71)	(7.77)**
No fertility preference	0.048	-0.050	-0.154	0.744
	(0.27)	(0.86)	(1.78)	(6.39)**
# contraceptives known	0.022	-0.012	0.049	0.095
	(0.67)	(1.02)	(2.88)**	(2.66)**
Missing father	-0.383	0.267	-0.083	0.121
	(2.21)*	(5.34)**	(1.32)	(0.87)
Missing mother	0.639	0.026		
	(0.64)	(0.29)		
Age of child	-0.068			
	(8.60)**			
Age of mother	0.037		-0.010	0.416
	(1.88)		(0.57)	(21.04)**
Age of mother squared	0.000		0.001	-0.003
	(1.40)		(3.15)**	(8.79)**
Age of child squared	0.001			
	(6.76)**			
Sex of child	-0.198			
	(2.54)*			
Age of oldest child			-0.060	
			(9.60)**	
River water			-0.154	
			(3.18)**	
Tap water			0.270	
			(2.73)**	
Constant	-3.551	-0.952	8.664	8.803
	(1.87)	(1.78)	(10.11)**	(5.12)**
Observations	3875	12162	6223	9025
R-squared	0.24	0.41		0.56

Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level

Table 9: External effects

	Height-for-age	Education	Survival rate	Fertility
Mother's schooling in years	0.045 (0.81)	0.101 (12.41)**	0.050 (3.21)**	-0.031 (1.43)
Father's schooling in years	-0.001 (0.03)	0.061 (9.40)**	0.047 (4.41)**	0.010 (0.51)
Average female schooling in community	0.052 (0.89)	0.081 (7.99)**	0.077 (4.07)**	0.098 (2.30)*
Average male schooling in community	0.073 (1.80)	0.020 (2.32)*	0.019 (1.27)	0.028 (0.85)
Average fertility in community				0.241 (5.79)**
Log expenditures/person/day	0.324 (1.23)	0.018 (0.43)	-0.769 (12.77)**	-1.015 (7.19)**
Mother literate	0.075 (0.40)	0.166 (4.83)**	0.039 (0.58)	-0.033 (0.28)
Father literate	0.039 (0.22)	0.045 (1.45)	-0.002 (0.04)	0.275 (2.12)*
Mother speaks Portuguese	0.003 (0.02)	0.086 (3.04)**	0.030 (0.64)	-0.074 (0.88)
Desired number of children	0.009 (0.29)	-0.006 (1.02)	-0.004 (0.41)	0.201 (9.20)**
No fertility preference	-0.009 (0.04)	-0.007 (0.16)	-0.106 (1.33)	1.025 (8.71)**
# contraceptives known	0.011 (0.24)	-0.007 (0.96)	0.064 (4.72)**	0.079 (3.04)**
Missing father	-0.264 (1.05)	0.267 (6.42)**	-0.137 (2.34)*	0.014 (0.11)
Missing mother	-1.747 (1.34)	0.041 (0.51)		
Age of child	-0.114 (8.30)**			
Age of child squared	0.002 (6.65)**			
Age of mother	0.066 (3.45)**		0.002 (0.14)	0.434 (23.03)**
Age of mother squared	-0.001 (3.31)**		0.001 (2.90)**	-0.003 (9.98)**
Sex of child	-0.216 (2.14)*			
Urban dummy	0.612 (2.78)**	-0.015 (0.51)	0.162 (3.09)**	-0.172 (1.35)
Age of oldest child			-0.062 (11.04)**	
Constant	-4.693 (2.19)*	-0.051 (0.15)	7.451 (13.06)**	0.124 (0.10)
River water			-0.101 (2.67)**	
Tap water			0.416 (5.47)**	
Observations	4213	12162	6220	9022
R-squared	0.12	0.37		0.58

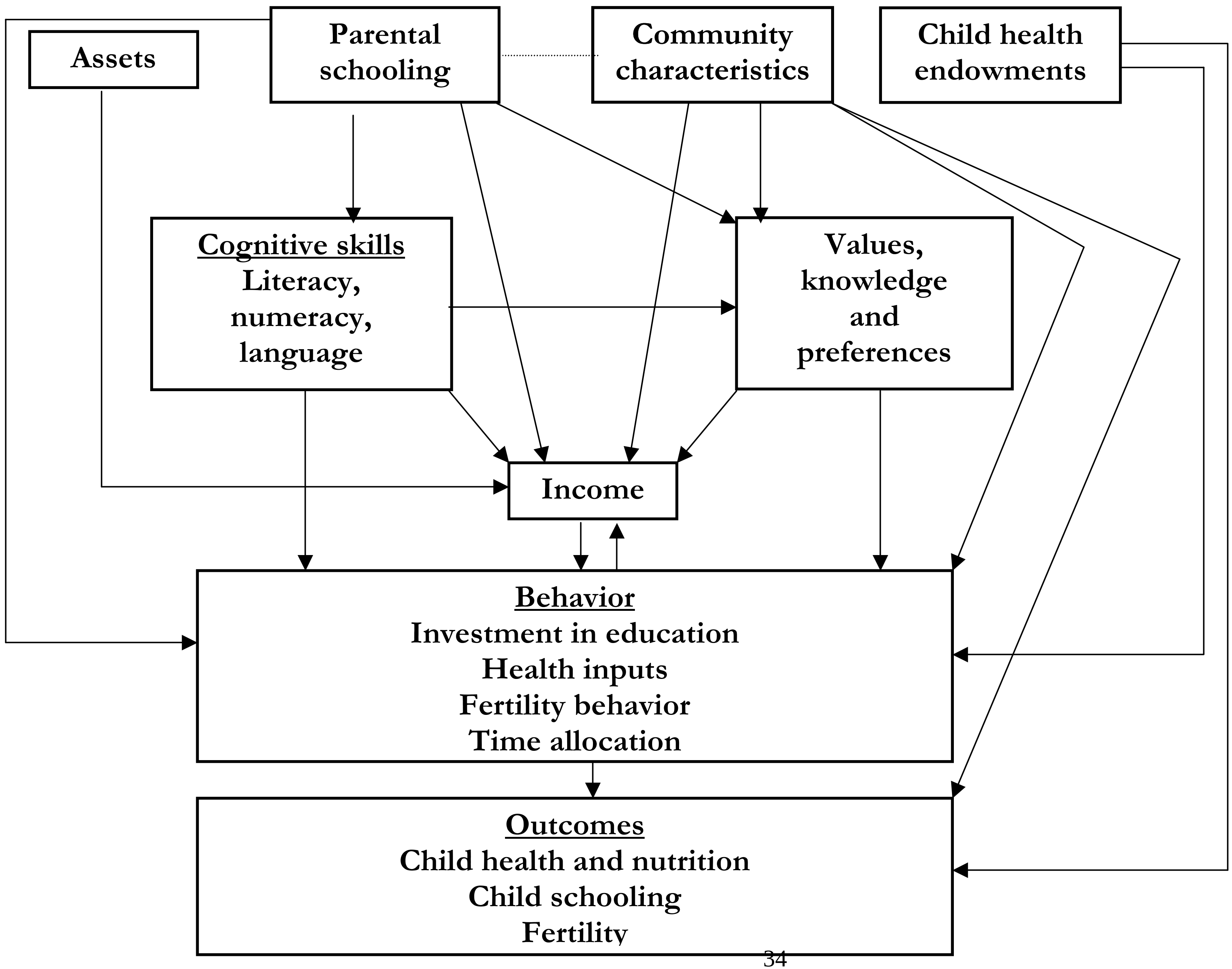
Note: t-statistics in parenthesis. ** Means estimate is significant at the 1% level, * indicates significance at the 5% level

Table 10: Interactions terms with gender of the child

	Height-for-age	Education
Mother's schooling in years	0.004	0.186
	(0.11)	(14.88)**
Mother's schooling X gender		-0.132
		(9.42)**
Father's schooling in years	0.024	0.038
	(1.29)	(4.12)**
Father's schooling X gender		0.066
		(5.10)**
Log expenditures/person/day	0.297	0.091
	(1.73)	(1.76)
Mother literate	0.125	0.315
	(0.98)	(5.13)**
Mother literate X gender		-0.222
		(3.17)**
Father literate	-0.151	-0.099
	(1.19)	(2.27)*
Father literate X gender		0.256
		(4.91)**
Mother speaks Portuguese	0.253	0.121
	(2.10)*	(3.62)**
Desired number of children	-0.004	-0.009
	(0.18)	(1.25)
No fertility preference	-0.087	-0.076
	(0.56)	(1.35)
No fertility preference X gender		0.069
		(2.14)*
# contraceptives known	0.101	-0.003
	(3.40)**	(0.33)
# contraceptives known X gender	-0.109	
	(3.08)**	
Missing father	-0.215	-0.034
	(1.44)	(0.64)
Missing mother	-0.256	0.194
	(0.18)	(1.68)
Father missing X gender		0.615
		(6.56)**
Mother missing X gender		-0.287
		(2.18)*
Urban dummy	0.326	0.126
	(3.27)**	(3.24)**
Age of child	-0.069	
	(8.90)**	
Age of child squared	0.001	
	(6.87)**	
Age of child X gender	0.129	
	(2.39)*	
Age of child squared X gender	-0.002	
	(2.38)*	
Age of mother	-0.056	
	(1.26)	
Age of mother squared	0.001	
	(1.58)	
Sex of child	-1.887	
	(2.38)*	
Constant	-2.741	-0.529
	(1.84)	(1.28)
Observations	3875	12162
R-squared	0.11	0.39

Note: t-statistics in parenthesis. ** indicates significant at the 1% level, * indicates significance at the 5% level. “X gender” refers to an interaction term between another variable and gender of the child.

Figure 1: Schematic framework



[1] Unfortunately we do not have information available on numeracy.

[2] Data on these variables is unfortunately not available for the male partners.