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On the Contribution of Mother's Education to Children's Nutritional Capabilities in Mozambique

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Abstract. *This paper examines the role of mother's education in expanding children's nutritional capabilities in Mozambique, a country where both educational and nutritional deprivations are dramatic. The econometric results, based on data from the 2003 DHS survey, suggest that mother's schooling is a key determinant of children's nutrition, but its direct marginal contribution is declining after completion of primary education. Children whose mothers have completed primary education are far more likely to be well nourished than children whose mothers have lower or no educational attainments. Primary education works through the increase of mother's general knowledge and, to a less extent, of her nutrition knowledge. Mother's secondary schooling, instead, contributes only indirectly, by increasing household wealth. A further empirical analysis shows that there is no substantial difference in the benefits of mother's education depending on whether she resides in urban or rural areas. Finally, the paper provides empirical evidence that female education is essential to improve children's wellbeing in Mozambique, and that only a small part of this influence works through the traditional economic channel.*

Keywords: Development economics; capability approach; nutrition; women's education; Mozambique.

JEL Codes: J13; O15; I20; R20; O55.

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1. Introduction

This paper aims at examining the role of mother's education in enhancing children's nutritional capabilities in contexts of large food deprivations. The problem is addressed from the perspective of the capability approach (Sen, 1999), which takes people's life achievements (*functionings*) and their substantial freedoms (*capabilities*) to be the ultimate concerns of development. Following this approach, children's nutrition is considered as a valuable development goal while women's education is both a goal *per se* and a means to expand other capabilities. In particular, the capability approach provides interesting insights to analyze to what extent (female) education can improve children's nutrition and to investigate the multiple, social and economic, mechanisms through which such relationship works (Sen, 1997; Robeyns, 2006).

Based on the Demographic and Health Surveys (DHS) household data, the paper aims at answering four core questions: 1) *How relevant* is mother's schooling for children's nutrition?; 2) *Up to which level* of mother's education should governments in low-income countries invest in order to promote children's nutrition?; 3) What are the main *channels* whereby mother's education affects children's nutrition? 4) Do results differ whether children live in rural or urban areas? To our knowledge, no work has tried to address the issue outlined in question 2) and only very few works have attempted to investigate the channels of influence.

The research focuses on Mozambique due to its large deprivations in both educational and nutritional capabilities. With regard to education, Mozambique is ranked at the 172nd position out of 177 countries using the Education Index adopted by UNDP (2007). Moving to food security, it was estimated that nearly 45% of the total population is undernourished (FAO, 2006). On the one hand, the high incidence of children's long-run malnutrition justifies an urgent intervention in this field in Mozambique; on the other hand, the low levels of educational achievements leave an open space (where the suitability is confirmed by empirical studies) for the adoption of mother's education as a means to improve children's nutrition. Thus, Mozambique seems a good case-study; however, further comparatives studies will be required to have a broader understanding of the relationships between the two basic capabilities in low-income countries.

The paper is structured as follows. Section two contains the literature review; section three illustrates the conceptual framework on which the quantitative analysis is based; the following section explains the dataset and shows descriptive statistics;

section five presents the estimation results; finally, conclusions are drawn in the last part of the paper.

2. Literature review

There is abundant empirical literature on the contribution of mother's schooling to children's malnutrition or health.[1] Most of the results were achieved applying the following methodology. First, the broad impact of mother's schooling was estimated, controlling just for exogenous factors at the level of children, households and communities. Among these factors, biologists suggest including parents' nutritional indicators: omitting this set of variables risks to lead to an overestimation of the effect of mother's education on children's nutritional status (Barrera, 1990). After considering this set of variables, mother's education was still a key determinant of children's nutrition (Barrera, 1990; Glewwe, 1999; Morales *et al.*, 2004).

Since many scholars (rightly) argued that education could just reflect the impact of household economic welfare on child health, most of the authors have controlled also for economic factors. The result, in many cases, is that the positive effect of mother's education still remains significantly different from zero (see Strauss and Thomas, 1995). Thomas *et al.* (1991) have found that in North-East Brazil mother's schooling has a significant influence on child health, even after controlling for household income. In Mozambique, Garrett and Ruel have concluded that mother's education provides a positive contribution to child food security and child nutrition "above and beyond the income effect" (Garrett and Ruel, 1999, p. 1971).

Finally, to our knowledge, only few studies have tried to estimate the channels through which mother's schooling affects children's nutrition. It is improbable that schooling, understood as the subjects studied in the classroom, reflects the whole relationship. It is reasonable to think that it is mediated by some other factors. Thomas *et al.* (1991) have been the first scholars addressing the problem of channels. They have considered four channels: 1) Income generation; 2) Access to mass media, which is likely to influence children's nutrition as long as media provide information concerning nutrition and health; 3) Literacy (general capacity to read and write); 4) Numeracy (general capacity to count and deal with numbers). While with the addition of the income variable the coefficient of mother's education falls by only a small proportion, with the further addition of mother's access to media mother's education loses

[1] Both are usually measured by their nutritional attainments.

significance. The variables indirectly reflecting nutrition knowledge are jointly significant and also jointly significant with mother's schooling. Concluding from the case-study of North-East Brazil, schooling does not account for a substantial part of the impact of mother's education on child health, economic resources only account for a small proportion, and nutrition knowledge explains almost the whole influence of mother's education (Thomas *et al.*, 1991).

Glewwe (1999) and Webb and Block (2003) have improved this methodology, by using variables more directly reflecting mother's nutrition and health knowledge. Glewwe (1999) has used a dataset for Morocco with further information on health and general knowledge, obtained through specific tests submitted to interviewees. He has concluded that mother's schooling does not have a direct influence on child health, but through income (one third of the total contribution) and, primarily, through mother's health knowledge (Glewwe, 1999).

Finally, Webb and Block (2003) in Java have used questionnaires where women were asked about the potential benefits of vitamin A: the number of correct answers was treated as a proxy for overall nutrition knowledge. Their main finding was that mother's nutrition knowledge is more relevant than her education for children's short-run nutritional status, while in the long run mother's education and economic factors are more adequate predictors of children's nutrition (Webb and Block, 2003).

3. Conceptual framework

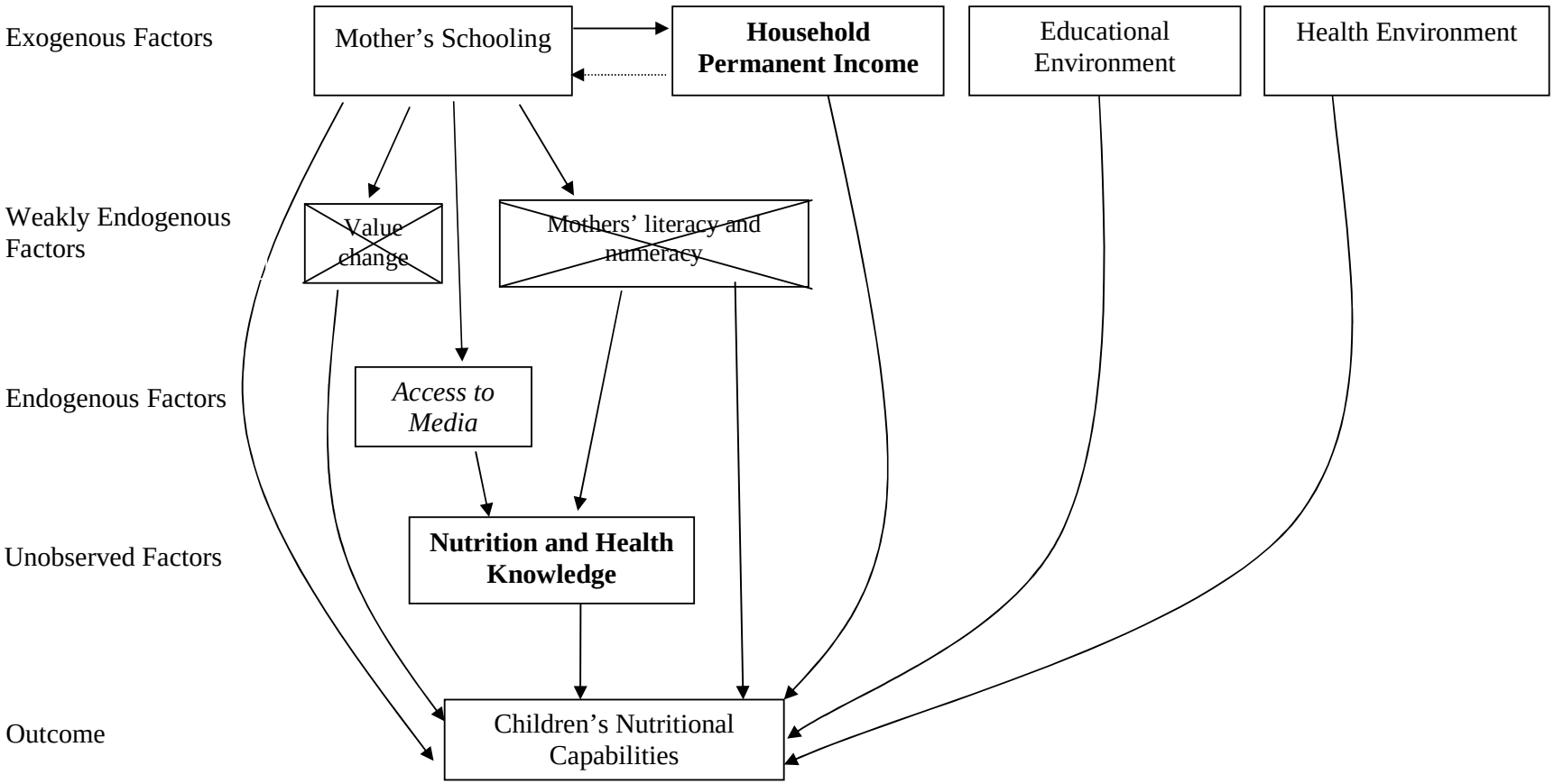
The diagram below (Figure 1) illustrates the conceptual framework on which the quantitative analysis is based. On the top-left side there is one of the key variables of interest, mother's schooling. Mother's schooling – counting for information directly acquired in school and, more generally, for knowledge – is assumed to provide a direct contribution to child nutrition (bottom side of Figure 1). However, it is unlikely to directly account for the whole positive influence of her education on child nutrition.

Following Glewwe (1999), five main channels could be enclosed: literacy, numeracy, values' shift, health knowledge, and income generation. However, the DHS dataset, used for this research, does not contain information concerning values and numeracy, and literacy data do not add much to educational data because literacy is only tested on people that do not have completed primary education. Thus, the effect of mother's schooling on children's nutrition mediated by these three channels is incorporated in its direct effect.

Therefore, the final estimations have included the income generation and nutrition knowledge mechanisms (bold in Figure 1). The economic channel is the traditional one: mother's formal education is seen as human capital, which raises productivity and household income, which, in turn, allows to allocate more resources to children's nutrition. The nutrition knowledge effect, instead, is indirectly measured, through the use of regressors for mother's access to information via media: radio, television and the press (in italics). The rationale is that these media are used also by national and international institutions to disseminate messages concerning nutrition and health practices. More educated mothers are likely to catch and process better this information, especially that coming from written sources, and use it to improve the nutrition of their children, being the amount of accessible food the same. In the food security literature it is referred to as the *utilization* dimension, which integrates the *access* dimension. Being aware of the importance of a diversified diet, knowing the basic hygienic practices and how to cook properly in order to get the right properties from the food are key aspect, besides the amount of food that the child can receive. Food utilization is crucial to move from food security to nutrition security (Maxwell and Frankenberger, 1992).

In brief, the assumption is that mother's education promotes children's nutrition directly, through an 'economic production' channel (income generation), and through a 'social change' channel (here represented by nutrition knowledge) (Sen, 1997, p. 1960). The direct contribution of schooling and the two indirect channels are not mutually exclusive: for example, a mother might have acquired information regarding nutrition also in school. Finally, the diagram should be interpreted specifically in view of the aim of this paper since, for example, the variable 'access to media' clearly does not depend only on mother's education.

Figure 1. Direct and indirect relationships between mother's schooling and children's nutritional capabilities.



Source: Author's elaboration based on Glewwe (1999).

The econometric strategy is based on the estimation of a set of models gradually including more variables, with mother's schooling always kept in the model in order to check the variation of its coefficient with the addition of other covariates. Firstly, the paper tries to assess the overall contribution of mother's education to children's nutrition. In equation (1) a functioning/capability production function (e.g. Klasen, 2000; Kuklys, 2005) was formalized, with children's nutritional capabilities – measured by the height-for-age Z-score (HAZ) indicator – as basic capabilities:

$$ChildHAZ_i = \alpha + \sum_{h=1}^{H}\sum_{i=1}^{I}\beta_h Child_{hi} + \sum_{w=1}^{W}\sum_{i=1}^{I}\delta_w Moth_{wi} + \sum_{p=1}^{P}\sum_{i=1}^{I}\phi_p Fath_{pi} + \\ + \sum_{j=1}^{J}\sum_{i=1}^{I}\gamma_j HH_{ji} + \sum_{q=1}^{Q}\sum_{i=1}^{I}\lambda_q Comm_{qi} + \varepsilon_i \quad (1)$$

In equation (1) α is the constant; $Child_{hi}$ is the h-th characteristic of the i-th child, where child characteristics are sex and age. $Moth_{wi}$ and $Fath_{pi}$ are respectively the w-th mother's and the p-th father's characteristic for the i-th child. These include, for example, age, education and nutrition. HH_{ji} is the j-th characteristic of the household in which the i-th child lives, such as its size and the proportion of members below the age of five. $Comm_{qi}$ is the q-th community characteristic where the i-th child lives: this set of variables includes education and health environment, and variables for province and place of residence. In particular, community variables are very important since they show also the quality side of parents' education, in addition to some other aspects that directly affect children's life and nutrition. Finally, ε_i is the disturbance term for child i.

In all the models estimated, mother's schooling is specified as exogenous. The reason is the same given by Glewwe (1999) in the case of Morocco: parents' mean years of schooling are very low. Data from the DHS show that in Mozambique the average years of schooling is 2.2 for mothers and 4 for fathers. Furthermore, with respect to mother's schooling the values are fairly homogenous: the standard deviation is not very high, and almost half of them have zero years of formal education. Thus, the hypothesis of exogeneity of mother's schooling in Mozambique seems reasonable.

The other point the paper aims at addressing concerns the channels whereby mother's schooling affects children's nutrition. In equation (2), the first channel – household permanent income (*Inc*) – is added.

$$ChildHAZ_i = \alpha + \sum_{h=1}^{H}\sum_{i=1}^{I}\beta_h Child_{hi} + \sum_{w=1}^{W}\sum_{i=1}^{I}\delta_w Moth_{wi} + \sum_{p=1}^{P}\sum_{i=1}^{I}\phi_p Fath_{pi} + \\ + \sum_{j=1}^{J}\sum_{i=1}^{I}\gamma_j HH_{ji} + \sum_{q=1}^{Q}\sum_{i=1}^{I}\lambda_q Comm_{qi} + \sum_{x=1}^{X}\sum_{i=1}^{I}\eta_x Inc_{xi} + \varepsilon_i \quad (2)$$

Household permanent income is one of the most controversial variables because it is not clear whether it should be treated as endogenous or exogenous. Since the number of endogenous variables must be minimized in order to estimate a model, it is necessary to discuss which variable should be included among the endogenous ones.

The dominant literature on child health considers household expenditures as a good proxy for household permanent income. Since it is assumed that the expenditures are an endogenous variable, they are instrumented by an indicator of household wealth, based on the ownership of assets. Household wealth is treated as exogenous under the assumption that it is the result of unearned income. This reasoning has two main shortcomings. The first one is that in low-income countries data on consumption and expenditures are not reliable, and do not well reflect permanent income, which is not a variable measured in a given time, but the result of wealth accumulation of a household in the long run. A wealth index based on assets' ownership, available in the DHS surveys, seems to better reflect permanent income. The second shortcoming is that household wealth is not the result of unearned income: "nonlabor income is the return to assets built up with previous labor earnings" (Strauss and Thomas, 1995, p. 1900), thus the wealth index is a poor instrument for household expenditures (Strauss and Thomas, 1995). If one accepts this reasoning, she or he also accepts that inadequate instrumental variables undermine the validity of the results of the Wu-Hausman test, often applied to verify the endogeneity of household expenditures.[2]

[2] The Wu-Hausman test verifies whether OLS and 2SLS estimates are statistically different: if this difference exists, the variable is not exogenous and 2SLS estimates are preferable.

The most important argument, however, concerns the lack of data on income. Data from the 2003 DHS survey in Mozambique do not contain information on household consumption or expenditures, but only on the assets owned by the households, finally aggregated into an indicator of wealth. Since it is very hard to find reliable instruments for wealth, this paper cannot report together results of ordinary least squares (OLS) and two-stage least squares (2SLS) estimations and apply the Wu-Hausman test. Thus, the wealth index will be treated as exogenous.

Equation (3) includes also the set of *L* variables concerning mothers' access to media (*Media*).

$$ChildHAZ_i = \alpha + \sum_{h=1}^{H}\sum_{i=1}^{I}\beta_h Child_{hi} + \sum_{w=1}^{W}\sum_{i=1}^{I}\delta_w Moth_{wi} + \sum_{p=1}^{P}\sum_{i=1}^{I}\phi_p Fath_{pi} +$$

$$+ \sum_{j=1}^{J}\sum_{i=1}^{I}\gamma_j HH_{ji} + \sum_{q=1}^{Q}\sum_{i=1}^{I}\lambda_q Comm_{qi} + \sum_{x=1}^{X}\sum_{i=1}^{I}\eta_x Inc_{xi} + \sum_{l=1}^{L}\sum_{i=1}^{I}\eta_l Media_{li} + \varepsilon_i \quad (3)$$

Regarding the newly added variables, the same arguments of Thomas *et al.* (1991) are proposed. Since the data used here are not experimental, mother's access to media is taken as proxy for something that cannot be observed, nutrition knowledge. This choice is valid behind the assumption that these media disseminate relevant information about nutrition and health practices, which seems quite realistic in the case of Mozambique.[3] Thus, due to omitted variables, OLS estimates can be inconsistent and mother's access to information should be specified as endogenous. This assumption will be tested by the Wu-Hausman statistic.

Finally, an attempt is made in order to understand the mechanisms underlying the influence of mother's schooling on children's nutritional capabilities by adding the interaction terms between: a) mother's schooling and household permanent income; and b) mother's schooling and her access to information. As shown in Figure 1, the relationship between mother's schooling and household permanent income is bidirectional; however, one arrow is dotted, to indicate a weaker relationship. In order to influence child HAZ, it is more mother's schooling affecting income than *vice versa*. Interaction terms are labeled *Inter* in equation (4):

[3] Detailed information concerning which mass media is more likely to disseminate nutrition messages is given in section four.

$$ChildHAZ_i = \alpha + \sum_{h=1}^{H}\sum_{i=1}^{I}\beta_h Child_{hi} + \sum_{w=1}^{W}\sum_{i=1}^{I}\delta_w Moth_{wi} + \sum_{p=1}^{P}\sum_{i=1}^{I}\phi_p Fath_{pi} + \sum_{j=1}^{J}\sum_{i=1}^{I}\gamma_j HH_{ji} +$$

$$+ \sum_{q=1}^{Q}\sum_{i=1}^{I}\lambda_q Comm_{qi} + \sum_{x=1}^{X}\sum_{i=1}^{I}\eta_x Inc_{xi} + \sum_{x=1}^{X}\sum_{i=1}^{I}\eta_x Media_{xi} + \sum_{z=1}^{Z}\sum_{i=1}^{I}\sigma_z Inter_{zi} + \varepsilon_i \quad (4)$$

4. Dataset and data description

This paper uses DHS data from the 2003 survey in sample areas of Mozambique. The sample consists of 7,000 children in the age group 0-5, alive at the time of the survey. In the next paragraphs some of the key variables are described.

Children's nutritional capabilities were measured by the height-for-age Z-score (HAZ) of children below five of age. The Z-score was adjusted for child's sex and age, and measures how close the child is to the World Health Organization reference population. A child is considered "moderately stunted" when her or his Z-score is minus two or below, and "severally stunted" when it is minus three or below.

The height-for-age measure is an indicator that reflects children's nutritional capabilities. The influential work by Amartya Sen (e.g. Sen, 1981; Dreze and Sen, 1989) in the field of famine and hunger had relevant repercussions on the indicators of nutrition and food security adopted. The "entitlement approach", developed by Sen (1981), caused a shift in the focus of the studies on hunger from the aggregate level of food availability to the capacity of people to access food at the micro level. Moreover, the relevant contribution of Dreze and Sen (1989) went further, moving from people's means to have command over food – entitlements – to their nutritional capabilities, which depend on the way food is utilized, and on the inter-temporal choices made by the individuals.[4] Nutritional capabilities should be the ultimate concern of the studies on hunger and food security, and the height-for-age measure is an "outcome" indicator of long-run nutritional status (Maxwell and Frankenberger, 1992).

Among the other child characteristics, child's sex and child's age were included although child HAZ incorporates age and sex differentials. This is because they can

[4] During food crisis, some individuals, for example, can have access to sufficient nutritious food in the short-term, by selling productive assets such as land. However, they could decide to reduce their food consumption for a short period, in order not to undermine their capacity to go back to their pre-crisis conditions, thus pointing on long-run nutritional status.

reflect gender-related and age-related influence of non-observed covariates on nutrition (Morales *et al.*, 2004).

Moving to the other policy variables, mother's schooling was measured by mother's educational attainments, further split up in four dummy variables, expressing whether or not the mother has achieved a specific level of education. The variables are: "incomplete primary education", "complete primary education", "incomplete secondary education", and "complete secondary education or higher".[5] The use of these variables permits to answer the second research question: up to which level of maternal education is it convenient to invest in order to improve children's nutritional capabilities?

Two variables were selected for mother's nutrition: the height-for-age Z-score, which is calculated with the same rationale used for children, and the body mass index (BMI), which is given by her weight divided by the square of her height. Mother's access to information, instead, was measured by one indicator, constructed aggregating the original variables indicating whether or not mothers listen to radio, watch TV, or read newspapers at least once a week. The DHS dataset provides information concerning the capacity of mass media to increase people's knowledge on a range of social and health issues. In particular, these data show that most of the information concerning HIV/AIDS and family planning in Mozambique is obtained primarily through radios, much less through televisions, and ultimately through newspapers.[6] Moreover, governmental programs for the dissemination of nutrition and health knowledge are channeled through the most used instruments, which in both rural and urban areas of Mozambique are radios.[7] Thus, since the largest information concerning nutrition is obtained primarily through radios, much less through televisions, and ultimately through newspapers, it was assumed that a woman frequently listening to radio is more likely to acquire this type of knowledge than another woman frequently watching TV or, finally, reading newspapers. The final index, *AccessMedia*, was built on this assumption: it takes a higher value if the woman has only access to radio rather than having access to both TV and newspapers.

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[5] In Mozambique primary school lasts seven years, while secondary education lasts five years.

[6] More precisely, nearly 78% of mothers answered that they received information on HIV/AIDS through radio, 12% through television, 3.5% through newspapers, and the remaining through other sources. With respect to family planning the percentages are respectively 49%, 12%, and 7%.

[7] For the recurrent use of radios as a dissemination tool of nutrition and health information within national and international programs in Mozambique, see among others Pridmore and Yates, 2005; Low *et al*., 2005; Low *et al.*, 2007.

A deeper explanation is needed for the variable household permanent income. In the DHS surveys there are no questionnaires on household consumption or expenditures, and the wealth index was taken as proxy for permanent income. The reason is that in middle and low-income countries an asset-based measure of wealth reflects a more permanent economic status than a measure based on consumption or expenditures (Rutstein and Johnson, 2004; Wall and Johnston, 2008). Some authors have also showed that a wealth index might perform better, especially in explaining children's outcomes (Filmer and Pritchett, 1999; Montgomery *et al.*, 2000; Sahn and Stifel, 2000).

The DHS wealth index was constructed applying the principal components technique on qualitative variables such as the type of flooring, the ownership of land, car, bicycle, or refrigerator, and the use of public utilities (such as water, public well, and public sewerages), and on a quantitative variable, number of rooms, adjusted for household size and age (Rutstein and Johnson, 2004). After performing the principal component analysis, each household was assigned a standardized score for each asset, depending on whether or not the household owned that asset, or depending on the number of people per room. The final household wealth index, obtained by summing all the indicator values, is a standardized score with mean equal to zero and standard deviation equal to one; thus, poor households have negative values because they lack several sources of wealth (Rutstein and Johnson, 2004).

All community variables were calculated at the level of "clusters", which are the secondary sampling unit in the DHS surveys.[8] The "functionings" mothers' literacy rate and children's mortality rate at community level were used as proxies for educational environment and for (bad) health environment.[9] They were preferred to variables related to "commodities" such as the number of schools and the number of hospitals. The last two community variables reflect the proportion of households that within each community own a basic good such as water and a more complex one such as electricity.

Table 1 presents the descriptive statistics. The nutritional status of children (HAZ) is very diverse, ranging from a minimum value far below the threshold for severe stunting (-6) to an extremely high value (4.780). Looking at the mean (-1.678),

[8] There are 299 clusters in the case of the survey realized in Mozambique.
[9] Being healthy and being educated are commonly defined as basic functionings.

however, we can argue that more than one out of three children is at least at risk of being moderately stunted.

On average, Mozambican women give birth at the age of eighteen and nearly one third of them before the age of seventeen. This is likely to be one of the major causes of their very low educational attainments beyond primary school, with less than 0.5% of mothers completing secondary education. However, mothers have also poor educational achievements at primary level - more than half of them did not even attend one year of primary education – and the causes should be found elsewhere, in other social, cultural and economic factors.

Table 1. Descriptive statistics

	Mean	St. Dev.	Min.	Max.
Child height-for-age Z-score (HAZ)	-1.678	1.415	-6	4.780
Child's age (in months)	27.986	17.164	0	59
Child's sex (1=female)	0.502	0.500	0	1
Mother's age at 1st birth (in years)	18.396	3.429	10	39
Mother's current age (in years)	28.689	7.199	15	49
Mother's marital status (1=currently married)	0 .904	0.294	0	1
Mother's incomplete primary education	0.571	0.494	0	1
Mother's complete primary education	0.069	0.253	0	1
Mother's incomplete secondary education	0.042	0 .201	0	1
Mother's complete secondary or higher education	0.004	0.064	0	1
Mother's height-for-age Z-score (HAZ)	-1.374	1.013	-5.320	4.230
Mother's body mass index (BMI)	22.037	3.058	13.15	49.76
Mother's access to media	1.558	1.605	0	4.500
Father's years of schooling	3.992	3.205	0	19
Household size	7.082	3.508	2	30
Proportion of household members in the age group 0-5	0.324	0.121	0.066	0.750
Household wealth (z-score)	-0.127	0.843	-0.755	4.715

Community availability of electricity (proportion of households)	0.092	0.160	0	1
Community availability of toilet facilities (proportion of households)	0.527	0.354	0	1
Mothers' literacy rate in the community	0.281	0.256	0	1
Children's mortality rate in the community	0.113	0.065	0	0.428
Place of residence (1=rural area)	0.673	0.468	0	1

Sample size = 7,000.

The wealth index, as previously outlined, takes both positive and negative values; the mean is -0.12. Since the final value is a result of a standardization procedure applied to the whole households' sample, a negative mean outlines that the sample of households with children below five of age is relatively poorer than the full households' sample. Finally, children's mortality rate varies significantly, ranging from zero to 42% according to the communities.

The following step consists in the correlation analysis implemented on the covariates more interesting for this research. Table 2 reports Pearson's coefficients.

Child HAZ is highly correlated with mother's height and household wealth, father's years of schooling and with the indicator of mother's access to media. The linear relationship between child food security and the first two covariates of mother's schooling, "some" and "complete" primary education, is fairly high, while it sensitively lower with mother's "incomplete secondary education" and "complete secondary education or higher". Also the correlation between mother's educational attainments and household wealth is high, but it follows a different pattern. The wealth index is more correlated with "incomplete secondary education", then with "complete secondary education", thirdly with "incomplete primary education", and finally with "complete secondary education or higher". Therefore, it seems that the form of the relationship between mother's education and wealth, on the one hand, and mother's education and child HAZ on the other, is different. A further analysis, through scatter plots, might help to examine more in depth such relationships.

Table 2. Correlation matrix

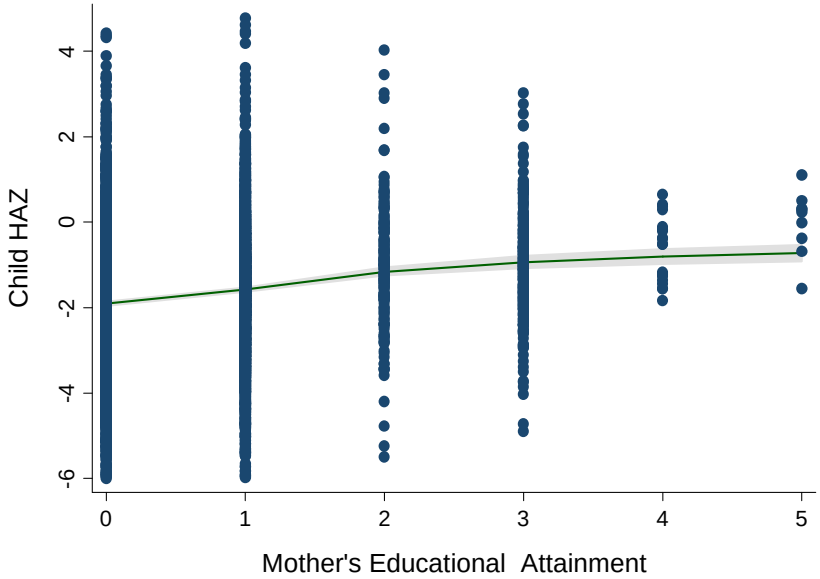
	Child HAZ	Mother's HAZ	Mother's Incomplete primary	Mother's Complete Primary	Mother's Incomplete secondary	Mother's Complete Sec/Higher	Wealth index	Father's Schooling	Mother's Access to Media
Child HAZ	1.000								
Mother's HAZ	0.251	1.000							
Mother's Incomplete primary	0.136	0.122	1.000						
Mother's Complete Primary	0.129	0.097	0.235	1.000					
Mother's Incomplete secondary	0.104	0.090	0.182	0.774	1.000				
Mother's Complete Sec/Higher	0.055	0.052	0.055	0.237	0.306	1.000			
Wealth index	0.232	0.195	0.365	0.496	0.481	0.274	1.000		
Father's Schooling	0.177	0.128	0.435	0.401	0.372	0.183	0.535	1.000	
Mother's Access to Media	0.123	0.085	0.228	0.227	0.209	0.087	0.406	0.312	1.000

Note: all coefficients are statistically significant at the 0.01-level.

The scatter plot in Figure 2 shows the relationship between child HAZ and the original covariate ‘educational attainment’, which has the following modalities: 0 = ‘no education’, 1 = ‘incomplete primary’, 2 = ‘complete primary’, 3 = ‘incomplete secondary’, 4 = ‘complete secondary’, and 5 = ‘tertiary’. The curve represents the fractional polynomial prediction plot of the distribution with child HAZ as dependent variable. The slope of the curve in the interval between ‘incomplete primary’ and ‘complete primary’ is higher than in the interval between ‘no education’ and ‘incomplete primary’: this suggests that the marginal contribution of an additional level of education is large and rising until the woman completes primary school. Beyond that level, any further educational attainment does not seem to provide a significant additional contribution to child nutrition.

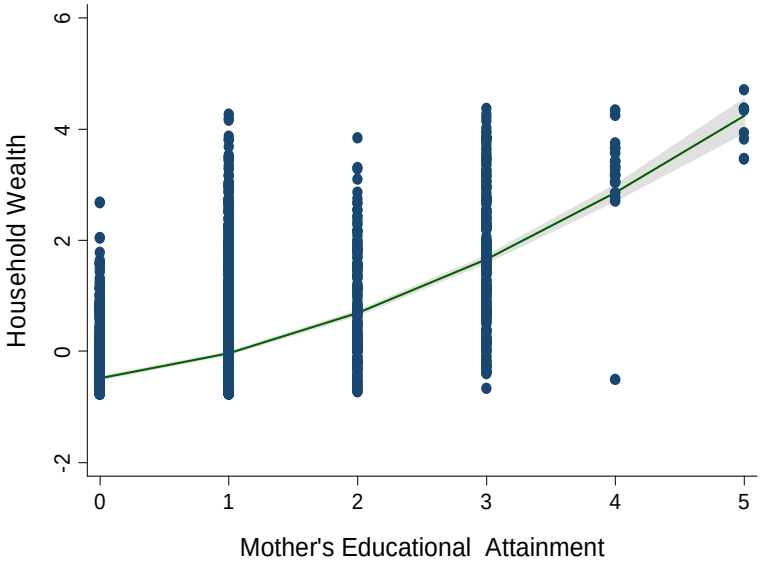
Figure 3, instead, shows that mothers’ education has an increasing marginal influence on household wealth, for any level of education attained. Although these are very preliminary results, obtained without including control variables, the two graphs seem to indicate that the form of the relationship between mothers’ education and wealth on the one hand, and mothers’ education and child HAZ on the other, are very different. This suggests that the ‘human capital’ dimension, i.e. the traditional economic channel, does not explain the whole contribution of mothers’ education to children’s nutritional capabilities.

Figure 2. Mother’s education and child HAZ



0= No Education; 1= Incomplete primary; 2= Complete Primary; 3= Incomplete secondary; 4= Complete Secondary; 5= Tertiary

Figure 3. Mother's education and household wealth



0= No Education; 1= Incomplete primary; 2= Complete Primary; 3= Incomplete secondary; 4= Complete Secondary; 5= Tertiary

5. Econometric results

5.1 Results without interaction terms

Column (a) of Table 3 presents the estimation results of equation (1).[10] Two variables for mother's education are highly significant: children of mothers with incomplete primary education, and, even more, with complete primary education are likely to be better nourished than children whose mothers have no education. On the contrary, further levels of education do not provide a statistically significant additional contribution to child nutrition. Both the coefficients associated to mother's nutrition are highly significant (p-value = 0.000), which shows that mother's nutrition is a key determinant of child nutritional capabilities. However, mother's nutrition does not capture a very high proportion of the influence of mothers' incomplete and complete primary education.[11]

In column (b) the estimation results of equation (2) are reported. First, the variance of the model now explains 16.9% of the total variance, while before only 16.4%: this is

[10] For seek of simplicity the coefficients for the Provinces of residence were not reported.
[11] The magnitude of the effect falls respectively by 25% and 15% compared to the model without mother's nutrition (results not reported).

in line with other OLS estimations of child nutrition models (Barrera, 1990; Glewwe, 1999). The new variable – household wealth – is largely significant and positively correlated with child HAZ, but its influence cannot be quantified since it is not expressed in a comparable unit of measurement.

The addition of household wealth causes a decline in the influence of mother's schooling, especially for mother's complete primary education; its coefficient falls by 30% (from 0.249 to 0.174) and it is now significant only at the 0.1-level. The model (b) presents an unexpected outcome: mother's incomplete secondary education is now significant even at the 0.05-level, but highly negative. The finding is counterintuitive: a child of a mother with some years of secondary education has nearly 0.26 height-for-age Z-scores less than a child of a mother who left school after completing primary education. This anomaly appears not to be due to the presence of outliers.[12] A possible explanation is that mothers with higher education are more likely to search for and find a job away from home, which reduces their time spent in child care, and finally lowers children's nutrition. Although not much information is available to verify this assumption, it is interesting to stress that the more educated mothers are the more they tend to delegate the care of the child to someone else (usually the husband or other relatives).[13] If a causal relationship does exist between these two variables, it might be that women with higher education can obtain better jobs, sometimes even far from home. Following this reasoning, results could be interpreted in the sense that the benefit of increasing household income is offset by the decrease of time spent in child care, resulting in lower child nutritional status. The addition of interaction terms helps to address the issue (see section 5.2).

Father's schooling slightly decreases with the inclusion of the wealth index, but it still has a largely significant influence. A similar decrease, small in both significance and magnitude, occurs to mother's HAZ and mother's BMI, while the coefficient of the only community variable significant in model (a) – availability of electricity - declines remarkably and becomes non-significant once household wealth is introduced. This means that household economic conditions are a good proxy for the socio-economic

[12] The Cook's D test detected the presence of 365 possible outliers. In all the regressions run after dropping gradually the most suspected observations, mother's incomplete secondary education was still significant, negative and its coefficient very close to that reported in column (b) of Table 3.

[13] In our sample, 49% of mothers with no education take directly care of their child, while this statistic falls to nearly 33% and 24% respectively for mothers with complete primary education and mothers with a minimum of one year of secondary education.

environment where they live. The dummy for gender of the child shows that girls have better nutritional levels than boys, which is consistent with the results of other studies in Sub-Saharan Africa (Svedberg, 1990; Sahn and Alderman, 1997; Svedberg, 2002). Finally, *ceteris paribus*, children living in rural areas have a lower nutritional status than children living in the cities.

Finally, column (b) presents the results of the Wald tests for joint significance of mother's educational levels and household wealth. All tests are significant at 0.01-level, which means that also mother's complete secondary education, alone non-significant, becomes significant jointly with household wealth.

The following step concerns the estimation of equation (3). Since mother's access to media (AccessMedia) might be endogenous, it was instrumented by the non-self community means of households owning at least one radio, i.e. the mean for each community calculated for each household excluding itself (Christiaensen and Alderman, 2001). This calculation allows to minimize the correlation between the instrument and the disturbance term in the structural equation. The results of the first stage of the 2SLS regression show that the community availability of radios is a good instrumental variable since it is correlated with the assumed endogenous variable (see Table 4). Then, the Wu-Hausman test was run on the model in order to verify whether AccessMedia is endogenous. The result, showed in Table 5, is that the null hypothesis of exogeneity of AccessMedia cannot be rejected, with the p-value being far above 0.1. Accordingly, particular attention will be given to the OLS estimates (reported in column (d)).

Table 3. Determinants of children's nutritional capabilities

Dependent variable: Child Height-for-Age Z-score (HAZ)	(a) OLS Overall education effect	(b) OLS Add the Wealth Index	(c) 2SLS Add endogenous *AccessMedia*	(d) OLS Add exogenous *AccessMedia*	(e) 2SLS Add Interactions	(f) OLS Add Interactions
Constant	-2.477***	-2.213***	-1.970***	-2.237***	-2.019***	-2.237***
CHILD CHARACTERISTICS						
Child's age	-0.018***	-0.018***	-0.018***	-0.018***	-0.018***	-0.018***
Child's sex (1=female)	0.110***	0.111***	0.109***	0.111***	0.109***	0.111***
MOTHERS' CHARACTERISTICS						
Mother's age at 1st birth	-0.005	-0.007	-0.006	-0.006	-0.004	-0.006
Mother's current age	0.008***	0.008***	0.008***	0.008***	0.008***	0.008***
Mother is currently married	0.181***	0.152***	0.113*	0.142***	0.125**	0.143***
Mother's incomplete primary education	0.098**	0.090**	0.073*	0.086**	0.265	0.116**
Mother's complete primary education	0.249*	0.174*	0.169*	0.173*	0.178*	0.162*
Mother's incomplete secondary education	-0.166	-0.266**	-0.267**	-0.266**	-0.042	-0.033
Mother's complete sec. education or higher	0.056	-0.195	0.141	-0.181	0.057	0.053
Mother's height-for-age Z-score (HAZ)	0.307***	0.301***	0.299***	0.300***	0.298***	0.300***
Mother's body mass index (BMI)	0.045***	0.040***	0.039***	0.040***	0.039***	0.039***
Mother's access to media (*AccessMedia*)	—	—	0.087	0.021**	0.163	0.035**
FATHERS' CHARACTERISTICS						
Father's years of schooling	0.033***	0.025***	0.021***	0.024***	0.021***	0.023***
HOUSEHOLD CHARACTERISTICS						
Household size	-0.015***	-0.018***	-0.018***	-0.018***	-0.020***	-0.019***
Household members in the age group 0-5	0.101	0.178	0.210	0.186	0.203	0.190
Household wealth	—	0.215***	0.156**	0.200***	0.217***	0.234***

COMMUNITY CHARACTERISTICS						
Community availability of electricity	0.272*	0.012	0.025	0.015	0.061	0.045
Community availability of toilet facilities	-0.040	-0.101	-0.122	-0.106	-0.147	-0.117
Mothers' literacy rate in the community	0.014	-0.008	-0.006	-0.007	-0.003	-0.017
Children's mortality rate in the community	-0.402	-0.423	-0.473*	-0.436	-0.442	-0.433
Place of residence (1=rural area)	-0.147**	-0.098*	-0.094	-0.097*	-0.085	-0.084
Incompl. secondary education * wealth	—	—	—	—	-0.142**	-0.155***
Incompl. primary education * *AccessMedia*	—	—	—	—	-0.146	-0.025
R-squared	0.164	0.169	—	0.170	—	0.171
Wald Test (F-statistic):						
Incomplete secondary – wealth		25.97***	4.62***	21.97***		
Complete secondary – wealth	—	25.15***	2.34*	21.02***	—	—
Incomplete primary – *AccessMedia*		—	3.33**	5.08***		
Complete primary – *AccessMedia*		—	2.06	3.74**		

Note: *** = significant at the 0.01-level; ** = significant at the 0.05-level; * = significant at the 0.1-level.
Sample size = 7,000.
Robust standard errors in parenthesis. Heteroskedasticity detected in initial models by White and Breusch-Pagan/Cook-Weisberg tests.

In the estimates presented in column (d), mother's access to media is significant at the 0.05-level. Mother's schooling is an important determinant of child HAZ: coefficients are about the same of those in the model without *AccessMedia*. Only the variable "incomplete primary education" provides a slightly lower contribution.[14] This would partly suggest that mother's access to information through media is important, but it is not a key channel through which mother's education affects child nutrition. However, the removal of "incomplete primary education" from the model in column (d) causes a raise in the coefficient associated to *AccessMedia* by nearly 7% and a remarkable increase in its significance, with the p-value moving from 0.043 to 0.031 (model not reported). This means that the two covariates interact to affect child nutrition, as it is also confirmed by the Wald tests. Adding the interaction terms helps to understand better the issue.

Table 4. First stage of 2SLS estimations

Model	**Dependent variable**	**Regressors (Instruments)**	**Coefficient**	**Std. Err.**	**P-value**
Without interactions: Column (c) of Table 3	*AccessMedia*	Community availability of radios	1.260	0.129	0.000
With interactions: Column (e) of Table 3	*AccessMedia*	Community availability of radios	0.639	0.090	0.000

Table 5. Wu-Hausman tests of endogeneity

Model	**Endogenous variable**	**Instruments**	**Degrees of freedom**	**F-Statistic**	**P-value**
Without interactions: Column (c) of Table 3	*AccessMedia*	Community availability of radios	1, 6967	0.479	0.488
With interactions: Column (e) of Table 3	*AccessMedia*	Community availability of radios	1, 6965	0.455	0.499

[14] Note that the 2SLS estimates, showed in column (c), present similar results regarding the educational variables to those obtained with the OLS estimator. The only difference concerns the coefficient for the assumed endogenous variable, *AccessMedia*, which is non-significant in column (c), probably stressing that non-self means of radios available in the community is a good instrumental variable.

5.2 Results with interaction terms

The Wald tests in column (c) of Table 3 show that mother's schooling interacts with her capacity to process information and with her contribution to household permanent income in order to improve children's nutrition. Thus, in the model (d) some key interaction terms were added for the purpose of analyzing more deeply whether these regressors are complementary. Following the significance of the Wald tests, it was chosen to include the interactions between mother's "incomplete primary education" and her access to media, and between mother's "incomplete secondary education" and household wealth. These cross-products provide additional means to study the pathways of influence of mother's education on child HAZ. It is reasonable to assume that some years of primary school affect mother's ability to access nutrition information and mother's secondary education affects household wealth. The reverse causal relationships, in both cases, are much weaker.

Table 5 reports also the results of the Wu-Hausman test run in the model incorporating the interactions. The instrumental variable – availability of radios in the communities – is correlated with AccessMedia (see Table 4). Finally, as well as before, the null hypothesis of exogeneity of AccessMedia cannot be rejected at the 0.1-significance level. As well as for the estimation of equation (3), the OLS estimator is more consistent.

Model (f) shows the estimates with exogenous AccessMedia. The inclusion of interaction terms has important repercussions on education variables: first, the coefficient associated to the interaction term between secondary schooling and wealth is highly significant (and negative), and now mother's incomplete secondary education does not alone provide a contribution. Also the size of influence of the wealth index rises. The negative sign of the coefficient of the cross-product is likely to indicate that secondary schooling and wealth are not highly complementary in the promotion of child nutrition. Mother's secondary schooling works as a proxy for household income and the inclusion of both the variables might cause multicorrelation in the models: that is why moving from model (b) to model (c) of table 3 the coefficient of mother's incomplete secondary school becomes significantly negative. What data cannot show is up to which point having higher education allows women to work and earn more or whether, conversely, the economic status of the household allows women to continue their education beyond primary school. The results seem to lean towards the latter

interpretation. On the contrary, mothers' incomplete and complete primary schooling are highly significant.

Concluding from the final model, a child whose mother has attended only some years of primary school has a better nutritional status than a child whose mother has no education by nearly 0.116 Z-scores. Then, if the mother attends school until the completion of primary studies, her child has 0.162 Z-scores more than a child of a mother with incomplete primary school. Mother's access to (nutrition) information is, again, significant and its coefficient larger than previously. The interaction with primary education, instead, is not significant.

These results suggest that joining formal education until the completion of primary education is fundamental for mothers aiming at improving their children's food security. With regard to the pathways of influence, primary schooling operates both directly and indirectly. The direct effect occurs because attending school, acquiring general knowledge and information about specific subjects in school are fundamental. Having attended only some years of primary education does not improve child nutrition by increasing household wealth, while only to a small extent through the acquisition of nutrition knowledge. That is also because listening to and elaborating information from radio, the most widespread mass media, does not require as much education as, say, reading newspapers. A further explanation is that part of the nutrition knowledge effect is embedded in the direct contribution of mother's schooling to children's nutrition since also basic nutrition information can be provided in class.

Access to levels of education beyond primary is not so crucial. The model with interactions emphasizes that whether or not mothers have accessed also secondary education does not alone influence children's nutrition, while affecting it when interacting with household wealth. This is perfectly coherent with the results of the preliminary analysis illustrated in section 4: mother's schooling has a decreasing marginal contribution to child HAZ and an increasing marginal contribution to wealth. However, since increasing wealth is only one of the pathways, the overall marginal effect of secondary education is minimal.

5.3 Rural vs. urban areas

The results of the final models have outlined that there is no significant difference in the likelihood of a child to be well-nourished whether he or she lives in rural or urban areas.

Now, it is interesting to analyze if size and significance of the impact of each predictor varies whether households live in urban or rural regions. First, each variable was multiplied by the dummy variable for place of residence (1=rural, 0=urban), and finally a regression with all the original variables and the cross-products as predictors of child HAZ was run. Table 6 presents only the output concerning education variables.

Mother's schooling does not have a different direct influence depending on her place of residence. Significance and size of the (negative) influence of the interaction term between mother's incomplete secondary education and household wealth, instead, are larger in rural areas. This means that in rural areas, even more than in urban areas, mother's secondary education is just a proxy for household economic resources. This analysis provides empirical evidence that there is no substantial difference in the contribution of the different levels of mother's education to child HAZ in Mozambique: the completion of primary schooling is a crucial determinant regardless of mother's place of residence.

Table 6. Determinants of child HAZ: rural-urban differences

Dependent variable: C*hild HAZ*	Coef.	Std. Err.
Mother's Incomplete Primary Education	0.052	0.100
Mother's Incomplete Primary Education*rural	0.033	0.114
Mother's Complete Primary Education	0.145	0.121
Mother's Complete Primary Education*rural	0.103	0.193
Mother's Incomplete Secondary Education	0.013	0.187
Mother's Incomplete Secondary Education*rural	-0.077	0.312
Mother's Complete Sec. Education/Higher	0.145	0.195
Mother's Complete Sec. Education/Higher*rural	0.393	0.360
Interaction Incompl. Secondary–wealth	-0.166	0.070
Interaction Incompl. Secondary–wealth*rural	-0.671***	0.252
Interaction Incompl. Primary–*AccessMedia*	-0.035	0.040
Interaction Incompl. Primary– *AccessMedia* *rural	0.031	0.048

*** = significant at the 0.01-level, ** = significant at the 0.05-level, * = significant at the 0.10-level.
Applied only to cross-products.

6. Concluding remarks

The paper aimed at answering four questions: 1) How relevant is mothers' education for children's nutritional capabilities in Mozambique? 2) Up to which level of mothers' education should policy-makers invest for the purpose of enhancing children's nutrition?; 3) What is the main pathway of influence? 4) Do results differ whether the household lives in urban or rural areas?

Regarding the first question, this work provides empirical evidence that investing in quality education of women could be an effective policy to expand long run children's nutritional capabilities in Mozambique. With respect to the level of education, direct returns - measured by children's nutrition - to mothers' schooling are clearly decreasing after their completion of primary school. Children are far more likely to be well-nourished if their mothers have completed the full cycle of primary school. Mothers' primary education plays a direct role: attending school, learning subjects in school and general knowledge are crucial. It also gives a partial indirect contribution, by making mothers more knowledgeable about nutrition and related aspects and, to a less extent, by increasing their economic opportunities. On the contrary, the marginal direct effect of mothers with incomplete secondary education on children's nutrition is not significant. The addition of interactions shows that secondary schooling affects children's nutritional status by increasing economic opportunities.

Finally, the rural-urban comparison shows that there is no statistical difference in the influence of mother's education whether she lives in urban or rural areas. This finding seems to be valid for all the levels of mother's education.

An interesting policy recommendation arising from this study is that, given the current conditions of the educational sector in Mozambique, an intervention aiming at reducing disparities in the access to primary education seems better than one pointing on enlarging access to more advanced levels of education for a small part of the (female) population. This is especially true in rural areas. Addressing it from a strictly economic perspective, given a limited budget, children's nutritional capabilities can be better promoted by giving incentive to one uneducated woman to join primary school rather than giving incentive to one woman with some years of secondary education to complete the full cycle of secondary studies. However, this study did not intend to undervalue the benefits of larger women's access to secondary or higher education in

low income countries; it only suggests that investing in quality primary education is more effective if the main goal of a policy maker in a country like Mozambique is improving children's nutrition.

Finally, more research is needed to study in depth the relationship between the two basic capabilities, possibly including additional social channels whereby mothers' schooling might affect children's nutrition. Further works in low-income countries with socio-economic features different from Mozambique are required to understand better the theoretical links between mother's education and children's nutritional capabilities.

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