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# Monetary and multidimensional child poverty:
## Why they differ

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# Monetary and multidimensional child poverty: Why they differ

## Abstract

We investigate the effect of parental education on the concordance/discordance between monetary and multidimensional child poverty. First, in a simple model of parental investment in child outcomes, we demonstrate that the misalignment between household income and parental education is a predictor of the mismatch between monetary and multidimensional child poverty. Indeed, a match between these two poverty measurements occurs whenever household income and parental education are correlated. Second, using Tanzania NPS data, we find that parental education has a negative effect on the probability that a monetarily non-poor child suffers some basic deprivations, and a positive effect on the likelihood that a monetarily poor child suffers no basic deprivations.

**JEL Classifications:** I32, J13, O12

**Keywords:** Monetary child poverty, Multidimensional child deprivation, Maternal education, Heckman selection model.

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# 1 Introduction

The poverty measurement literature (e.g., Roelen et al. (2012); Roelen and Gassmann (2014); Alkire et al. (2015); Tran et al. (2015)) holds that there is a mismatch between monetary and non monetary multidimensional measures of poverty, particularly in reference to child poverty (e.g., Roelen et al. (2012)); and that monetary poverty indicators are inadequate reflections of children's poverty status (White et al. (2003)). Yet why there is a mismatch between monetary and multidimensional child poverty remains unclear. This paper examines this question both theoretically and empirically.[1]

Addressing this question is both timely and policy relevant. First, while it is often assumed that households that are not monetarily poor possess the purchasing power necessary to avoid basic child deprivations such as malnutrition and illiteracy (Thorbecke (2007)), recent evidence shows that this is not always the case for children who live in such households (Menchini et al. (2012)). Second, the recently released UN's Sustainable Development Goals (SDGs) list the fight against poverty in all its forms as one the priorities of international cooperation. The very first SDG aims to "eradicate extreme (monetary) poverty for all people" and to "reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions". Yet around the globe, 836 million people still live in extreme monetary poverty, among whom nearly half are children (Olinto et al. (2013)), while one in four children under the age of five suffers from stunted growth, and 57 million children remain out of school (Nations (2015)). These facts suggest that achieving SDG 1 may not be possible without a clear and practical understanding of the links between monetary and (non-monetary) multidimensional poverty.

In this paper we advance the idea that turning household monetary resources into catalysts for improving children's multidimensional well-being requires that parents be sufficiently

[1] In what follows, and for simplicity of exposition, we use the term 'multidimensional poverty' to refer to non-monetary poverty dimensions.

endowed with complementary non-monetary resources such as education. We first articulate this idea in a simple model of parental investment in child well-being. We model a child's multidimensional well-being as a composite of nutritional status and level of education. Our focus on child nutrition and level of education as constituents of child multidimensional well-being stems from the fact they comprise two of the three dimensions underlying the multidimensional poverty index (MPI), which was developed jointly by the United Nations Development Programme and the Oxford Poverty and Human Development Initiative in 2010. Moreover, of the three dimensions of the MPI, education and health (of which nutrition is an indicator) are the only ones that embody aspects of deprivation specifically relevant for children.

Our modeling of child outcomes draws from the literature on parental investment in child outcomes (e.g., Thomas et al. (1991); Glewwe (1999); Currie and Moretti (2003); Currie and Moretti (2007); Chevalier et al. (2013); Currie et al. (2007)). We link parental socioeconomic characteristics, in particular maternal education and household income, to a household's ability to adequately invest in the multidimensional well-being of its children. The link between household income and child outcomes is straightforward, as many of the constituents of a child's well-being, such as food and school fees, must be purchased. The link between parental education and child outcomes works through two important channels: *in utero* experiences and investment decisions for a growing child. Our theoretical model of child outcomes captures these two channels.

The model generates four mains testable predictions. First, parental education and household income have a significant influence on children's educational achievement and nutritional status (P1). Second, for a given household consumption expenditure quintile, the probability that a child suffers deprivations (education and nutrition) is lower, the higher parental education (P2). Third, a child's multidimensional poverty status is influenced by both household income (a proxy for the child's monetary poverty status) and parental education (P3). Fourth, the misalignment between household income and parental education is a predictor of the mismatch between monetary and multidimensional child poverty. Indeed, a match between these two poverty measurements occurs if and only if household income and parental education are closely correlated (P4).

We test these predictions using the 2012/2013 Tanzania National Panel Survey (NPS), which samples 5,010 households containing $25,412$ individuals. The survey gathers information at national and regional levels on education, health, household characteristics, living conditions and anthropometrics for children of all ages. Our analysis focuses on the population of children aged 7-15, which yields a sample of 4,346 children. We face three main potential identification problems. First, an identification issue arises in isolating the causal effect of a mother's education on her children's outcomes, due to the possibility of educational externalities within the household. We consider that not taking into account the level of education of other household members would potentially give rise to an omitted variable bias. Thus to identify the causal effect of a mother's education on her children's outcomes, we control for the father's own education, as well as that of other members of the household, as these may impact children's outcomes and especially their schooling achievements.

Second, the main challenge in estimating the causal effect of household income on children's education outcomes is the possible joint determination of household expenditure decisions with household decisions on the allocation of children's time between labor supply and schooling. To deal with this identification issue, we instrument household consumption expenditures, using a set of exogenous variables (instruments) that are correlated with household consumption expenditures but not with the error term of the schooling equation. We use the following variables to instrument household consumption expenditure: the average consumption expenditure of other households in the same cluster; other income of the household (including rental payments and pensions); ownership of land; remittances or cash transfer received by the household; economic shocks affecting the household over the past years; average profit of business assets; and, amount received from assistance.

Third, in order to identify the determinants of the mismatch between monetary and multidimensional child poverty, we use *Heckman's selection models* to correct for selection bias. We use the same set of instruments as those applied to deal with the second identification issue.

To test P1, we use linear probability models (LPM) of the probability that a child is school-deprived and nutritionally deprived respectively, to gauge the influence of household income (a proxy of child's poverty status) and parental education. The associated regressions are adjusted for potential confounders, including household characteristics (number of children, household head characteristics and parental education), child's own characteristics (age, gender, labor), and the characteristics of the community in which the child lives (rural/urban, access to services, etc.). For P2, we use the same model as in for P1, while also allowing for the interaction between household income quintile and parental education. Both these predictions are validated empirically. In particular, monetary child poverty is not the only significant predictor of a child's multidimensional poverty status.

We test P3 by empirically assessing the relative contribution of each factor in our linear probability models using the *Shorrocks-Shapley decomposition* method. Indeed, application of this method reveals that a child's monetary poverty status explains only about 7% of the variability of her/his enrollment status, and approximately 5% of her/his schooling progression status. Parental characteristics also have a substantial relative contribution. Indeed, mother's and father's characteristics account for, respectively, 14.34% and 15.3% of the variability of a child's enrollment status. When we measure child school deprivation using grade progression, we find that mother's and father's characteristics account for, respectively, 13.4% and 8.1% of the variability in child's deprivation. The Shorrocks-Shapley decomposition results show that household income plays an even less important role in explaining child nutritional deprivation. Household income explains only 1.2% of the variability in child thinness status and around 9.46% of the variability in child stunting status. These results imply that monetary and multidimensional child poverty are different, but related, phenomena, which makes it highly important to explain this non-concordance.

We conclude our empirical exercise with the testing of P4, which states that parental education influences the concordance/non-concordance between monetary and multidimensional child poverty. P4 suggests that, conditional on other factors, the occurrence or non-occurrence of a mismatch between a child's monetary and multidimensional poverty is governed by the extent of the association between household income and parental education. Given the possible sample selection bias arising in a study of deprivation among monetary poor households, we use Heckman selection models to explain (i) why a significant share of children living in monetarily non-poor households suffers from deprivation, and (ii) why a significant share of children living in monetarily poor households do not suffer from deprivations. Results confirm our model's prediction of the influence of parental education on the mismatch between monetary and multidimensional child poverty. In particular, parental education is a negative predictor of the probability that a monetarily non-poor child suffers some basic deprivations, particularly in education, and a positive predictor of the likelihood that a monetarily poor child suffers no basic deprivation.

Our study bridges the literatures on child poverty measurement and on parental investments in children. Roelen et al. (2010), Roelen et al. (2012), Roelen and Notten (2013), and Roelen and Gassmann (2014) all propose case studies of the mismatch between monetary and multidimensional child poverty. Others have analyzed potential explanations of this mismatch (e.g., Perry (2002); Bradshaw and Finch (2003); Hulme and Shepherd (2003); Rendtel et al. (2004); Cancian and Meyer (2004); Alessio et al. (2011); Menchini et al. (2012); Roelen (2015)). Roelen (2015) highlights measurement error and lagged effects as two potential explanations. Bradshaw and Finch (2003) identify differences in the reliability and validity of the two types of measures to explain their non-concordance. Some of these papers highlight the role of household characteristics, but only in relation to measurement issues. For example, the fact that income (or consumption) is almost always measured at the household level and so does not capture intra-household allocation of resources (Hulme and McKay (2008)). Furthermore, children are generally unable to influence this allocation or sustain their own livelihood (White et al. (2003)) to address their various deprivations. We contribute to this literature by highlighting parental education as a potential explanation in a context where altruistic parents invest in their children.

The link between income (and thus monetary poverty) and specific dimensions of child deprivation has also been widely studied. Using data on anthropometric status and reported illness in Uganda, Lawson and Appleton (2007) highlight the importance of household income for child health. Singh and Sarkar (2015) find that children from chronically poor households suffer a much higher number of deprivations than those in less poor households in India. Using longitudinal data from 25 European countries, Alessio et al. (2011) finds that long-term housing deprivation is negatively associated with long-term income. All these studies find that variations in income only partially explain variations in deprivation and point to other factors as potential determinants of the non-concordance between monetary and multidimensional child poverty. We contribute to this literature by investigating the potential role of parental education.

Parental education, especially maternal education, is widely recognized as an important determinant of various forms of child deprivation. Lawson and Appleton (2007) find that parental education improves the health of Preschoolers in Uganda. In India, Imai et al. (2014) highlight the role of mother's empowerment, in particular her education relative to the father, in improving the nutritional status of children. Gunes (2015) also finds that, in Turkey, mother's primary school completion improves infant health. Cavatorta et al. (2015) find that large disparities in anthropometric measurements among Indian states are attributable to wealth and maternal education. We contribute to this literature by linking parental education to the extent of the mismatch between monetary and multidimensional child poverty.

Other socioeconomic factors are also found in the literature to explain child deprivation. Using data from Kenya and Malawi, Kennedy and Peters (1992) suggest that food security and preschooler nutritional status are influenced not only by household income, but also by the gender of the head of household. Handa (1996) also finds gender of the household head to be associated with higher share of household budget allocated to children. Spears (2013) finds that access to sanitation explains a large share of height differences in India and Africa. We contribute to this literature by empirically modeling various child, household and community characteristics as potential determinants of the non-concordance of monetary and multidimensional child poverty.

The rest of the paper is organized as follows. In the next section we present a model of parental investment in children. Section draws on the predictions of the model to develop and estimate a bivariate probit model that we use to explore various determinants of the mismatch between monetary and multidimensional child poverty in Tanzania. Section 4 concludes.

## 2 A Model of Parental Investment in Child's Outcomes

In this section, we describe a simple model of parental investment in child's outcomes that generates predictions about the causes of a mismatch between child monetary and multi-dimensional poverty. Our model has two fundamental conceptual underpinnings. First, an individual experiencing monetary poverty has insufficient income to lead a decent life. Second, an individual experiencing multidimensional poverty lacks the nutrition and education required to enjoy a minimum standard of living and to fully participate in society. Therefore, if money were all a family needs to ensure that their children enjoy an adequate standard of living, one would expect a match between the monetary and the multidimensional poverty status of a child. Our model explores the causes of the observed mismatch between these two child poverty measurements.

The basic idea underlying our analytical model is that, while a household's budget constraint determines the quantity of inputs it can purchase to produce child outcomes, the efficiency with which it produces these outcomes is determined by parental education. Let a household consists of an altruistic decision-making parent and a unique child. The parent has characteristics $e$ (education) and $y$ (income), all of which are exogenously given. Our model links these characteristics to the child's well-being.

A child's well-being is usually conceived of as a composite of different dimensions, including physical, emotional, psychological, social and economic. For the purpose of this study, we focus on two core aspects of child well-being: nutritional status (a constituent of her/his health status) and educational attainment. Nutrition directly contributes to the physical and emotional dimensions of child well-being, for example through its impacts on the child's weight, height, and susceptibility to morbidity. A child's level of education is seen as contributing to social, psychological, and economic dimensions of child well-being, for example by reducing the likelihood of a child's involvement in crimes (Lochner and Moretti (2004)). We model child well-being using a Cobb-Douglas aggregator function of her/his level of nutrition, $n_c$, and educational attainment, $e_c$:

$$b_c = (n_c)^{\beta} (e_c)^{1-\beta} \tag{1}$$

where $\beta \in (0, 1)$. Given some critical level of well-being, $\underline{b}$, a child is multidimensionally poor if and only if her/his level of well-being, as defined in (1), is less than $\underline{b}$.

A child's nutritional status is influenced by the level of household expenditures on her/his nutrition, $x_n$, as well as by his parent's level of education, $e$. There are two channels through which parental education can impact a child's nutritional status. The first channel is through *in utero* experiences, as the parent's education may influence the dietary and behavioral choices made prior to and during pregnancies, which in turn affect the child's birth weight (Chevalier and O'Sullivan (2007); Parlee and MacDougald (2014)). The second is a *post utero* channel, as a parent's education influences his knowledge of the basic nutrients required for the normal physical and emotional development of a child. Our modeling of child nutritional status $n_c$ incorporates these two channels as follows:

$$n_c = A\left(x_n - \delta_n e\right)^{\alpha}\left(1 + e\right)^{\mu} \tag{2}$$

where $A$ is a parameter capturing the effect of omitted factors (e.g., characteristics of the physical environment in which the child lives), $\delta_n > 0$, and $\alpha + \mu < 1$ to reflect omitted factors. The term $\delta_n e$ captures the parent's ability to assess her/his child's nutritional needs. It represents her/his perception of the minimum dietary requirement for child's nutrition, as influenced by her/his level of education, $e$. In other words, how much education a parent has affects her/his ability to choose the best nutrition inputs s/he can afford for her/his child. The higher the parent's level of educational attainment, the better her/his assessment of a child's nutritional needs, which translates into a higher level of $\delta_n e$. Thus the term $x_n - \delta_n e$ captures the fact that the beneficial effects of parental education are only significant for child nutrition when household monetary resources are sufficiently high (REED et al. (1996)). The term $(1 + e)^{\mu}$ captures the *in utero* channel for the impact of parent's education. Below, we establish conditions under which a child's nutritional status, $n_c$, rises with the parent's level of education, $e$.

Next, we follow the human capital literature (e.g., Chevalier et al. (2013)) in modeling a child's educational attainment as determined by parental education, $e$, and the level of monetary resources invested in child's schooling, $x_e$:

$$e_c = D\left[(x_e - \delta_e e)^{\alpha}(1+e)^{\mu}\right] \tag{3}$$

where $D > 0$ is an efficiency parameter measuring the quality of the schooling system and the effect of omitted factors, hence $\alpha + \mu < 1$. The term $\delta_s e$ captures the parent's perception of the minimum level of monetary resources required to create a cognitively stimulating environment for the child, as mediated by his level of education, $e$. This is consistent with (Kremer and Chen, 1999) who argue that better educated parents are more able to create a cognitively stimulating for their offspring. The term $x_e - \delta_e e$ thus captures the fact that the beneficial effect of parental education are only significant for child's education when household monetary resources are sufficiently high. The second term, $(1+e)^{\mu}$ captures the effect a parent's own education has on the child's innate learning ability, for example through *in utero* experiences. Below, we establish necessary and sufficient conditions for a child's schooling outcome to rise with parental education.

## 2.1 Household's Problem

The parent has preferences over own-consumption of a numeraire, $c$, and, altruistically, over her/his child's level of well-being, $b_c$. The utility function representing these preferences is given by

$$U_i = \ln(c - \underline{c}) + \gamma \ln b_c \tag{4}$$

where $\underline{c}$ denotes a subsistence requirement for the parent's own consumption, and $\gamma > 0$, the altruism parameter measuring the utility weight the parent assigns to the child's well-being.

All households are credit-constrained and thus finance all their expenditures out of parental income, $y$. The budget constraint faced by a household with parental characteristics, $(e, y)$, is given by

$$c + x_e + x_n \leq y. \tag{5}$$

Expression (5) implies that the levels of household expenditures on child nutrition and schooling are both measured in units of the numeraire. Given the properties of the utility function in (4), and using (1)-(5), we can express a typical household's problem as follows:

$$\max_{\langle n_c, s \rangle} U\left(x_e, x_n; e, y\right) \tag{6}$$

where

$$U\left(x_e, x_n; e, y\right) := \ln\left(y - x_e - x_n - \underline{c}\right) + \lambda_n \ln\left(x_n - \delta_n e\right) + \lambda_s \ln\left(x_e - \delta_e e\right) + R(e)$$

with

$$\begin{aligned} R(e) \quad &: \quad = \gamma \ln\left(1 + e\right)^{\mu} + \gamma\beta \ln A + \left(1 - \beta\right)\gamma \ln D \\ \lambda_n \quad &: \quad = \alpha\gamma\beta \\ \lambda_s \quad &: \quad = \alpha\gamma\left(1 - \beta\right). \end{aligned}$$

The first order necessary and sufficient conditions for an interior solution to this problem lead to the following household's expenditure allocation choices:

$$c = \frac{1}{1+\lambda_e+\lambda_n}\left[y-(\delta_e+\delta_n)\,e+(\lambda_e+\lambda_n)\,\underline{c}\right] \equiv C\,(e,y) \tag{7}$$

$$x_e = \frac{1}{1+\lambda_e+\lambda_n}\left[\lambda_e\,(y-\underline{c})+(\delta_e+\delta_e\lambda_n-\delta_n\lambda_e)\,e\right] \equiv X^e\,(e,y) \tag{8}$$

$$x_n = \frac{1}{1+\lambda_e+\lambda_n}\left[\lambda_n\,(y-\underline{c})+(\delta_n+\delta_n\lambda_e-\delta_e\lambda_n)\,e\right] \equiv X^n\,(e,y) \tag{9}$$

Observe that the functions $C\,(.)$, $X^e\,(.)$, and $X^n\,(.)$ are all strictly increasing in $y$, suggesting that households with more monetary resources should exhibit better household and child outcomes. However, given any pair of parents with similar or identical monetary resources, differences in parental education can lead to differences in child outcomes. Indeed, one can see from (7) that the function $C$ is strictly decreasing in $e$ (i.e., $\partial C/\partial e < 0$), implying that education induces altruistic parents to sacrifice more for the well-being of their children. Indeed, if

$$\frac{\lambda_n}{1+\lambda_e} < \frac{\delta_n}{\delta_e} < \frac{1+\lambda_n}{\lambda_e}, \tag{10}$$

then it holds that better educated parents invest more in their child's nutrition (i.e., $\partial X^n/\partial e > 0$) and schooling (i.e., $\partial X^e/\partial e > 0$). These results are consistent with the literature on parental investments in children (e.g.,(Burchi, 2010); (Glewwe, 1999)). Condition (10) is purely technical, but can easily obtain, for example, by setting $\delta_e = \delta_n$.

For the rest of this study, and without loss of generality, let us set $\bar{c} = 0$, and assume for all $(e, y)$, the condition

$$y > (\delta_e+\delta_n)\,e \tag{11}$$

holds. Condition (11) implies that how much a parent is willing to sacrifice for the well-being of her/his child does not violate her/his own subsistence requirement. This condition ensures that the positive effect of parental education on child outcomes is significant only when her/his monetary resources are sufficient. From (2), substituting in (9) yields:

$$n_c^* = \kappa \left[y - (\delta_e + \delta_n) e\right]^{\alpha} (1+e)^{\mu} \equiv N(e, y) \tag{12}$$

where

$$\kappa = A \left( \frac{\lambda_n}{1 + \lambda_e + \lambda_n} \right)^{\alpha}.$$

Likewise, from (3), substituting in (8), rearranging terms yields:

$$e_c^* = \sigma \left[y - (\delta_e + \delta_n) e\right]^{\alpha} (1+e)^{\mu} \equiv E(e, y) \tag{13}$$

where

$$\sigma = D \left( \frac{\lambda_e}{1 + \lambda_e + \lambda_n} \right)^{\alpha}.$$

Clearly, from (12) and (13), we have that a child's health status and level of educational attainment both increase with parental income, $y$, suggesting that children whose parents have more monetary resources tend to suffer fewer basic deprivations like malnutrition and low educational attainments. What about children whose parents lack or have less education?

**Proposition 2.1** *For all parents, if the pair* $(e, y)$ *satisfies the inequality*

$$y > (\delta_e + \delta_n) \left[ e + (1+e) \frac{\alpha}{\mu} \right], \tag{14}$$

*then raising a parent's level of education,* $e$*, raises her/his child's nutritional status* ($\partial N/\partial e > 0$)*, as well as her/his level of education (* $\partial E/\partial e > 0$*).*

Condition (14) has a similar interpretation to condition (11) above. Proposition 2.1 is consistent with empirical evidence stating that a parent's education is an important determinant of her/his child's educational attainment (e.g., Chevalier et al. 2013). Indeed, the following further crystallizes this idea:

**Proposition 2.2** *Suppose that for all households, the pair* $(e, y)$ *satisfies condition (11) hold. Then*

*(i) the effect on a child's health status of raising household income is higher, the higher her/his parent's level of education (i.e.,* $\partial^2 h_c^*/\partial y \partial e$*);*

*(ii) the effect on a child's level of education of raising household income is higher, the higher her/his parent's level of education (i.e.,* $\partial^2 e_c^*/\partial y \partial e$*).*

Proposition 2.2 implies that parental education and household income reinforce each other in enhancing child outcomes.

## 2.2 Parental Education and the Poverty Measurements' Mismatch Puzzle

In this sub-section, we provide a theoretical explanation for the observed mismatch in the identification of monetary and multidimensional child poverty. We start with a characterization of a child's optimal level of multidimensional well-being—a measure of her/his multidimensional poverty status—, as determined by household socioeconomic characteristics, including income, $y$, and parental education, $e$.

From (1), substituting in (12) and (13), rearranging terms, yields a child's level of well-being as follows:

$$b_c^* = \phi \left[ y - (\delta_s + \delta_n) e \right]^{\alpha} (1 + e)^{\mu} \equiv B(e, y) \tag{15}$$

where

$$\phi := \kappa^{\beta} \sigma^{1-\beta}.$$

Observe then that if condition (11) is violated, $b_c^* = 0$, implying that parental education yields benefits in terms of child's outcomes only when household income is sufficiently high. Recall that we interpret an increase (respectively, a decrease) in the level of $y$ as a decrease (respectively, an increase) in a child's level of monetary poverty, and an increase (respectively, a decrease) in the level of $b_c^*$ as a reduction (respectively, an increase) in a child's level of multidimensional poverty.

**Proposition 2.3** *If, for all households, the pair $(e, y)$ satisfies the inequality*

$$y > (\delta_s + \delta_n)\left[\alpha + (1+\alpha)\, e\right], \tag{16}$$

*then,*

*(i) reducing a child's level of monetary poverty (an increase in $y$) reduces her/his level of multidimensional poverty: $\partial b_c^* / \partial y > 0$;*

*(ii) increasing parents' level of education, $e$, reduces his child's level of multidimensional poverty: $\partial b_c^* / \partial e > 0$;*

*(iii) the effect on a child's level of multidimensional poverty of improving her/his monetary poverty status is higher, the higher the parent's level of education (i.e., $\partial^2 b_c^* / \partial y \partial e$).*

Condition (16) has a similar interpretation to that of conditions (14) and (11) above. Proposition 2.3-(i) suggests that monetary poverty and multidimensional poverty are related phenomena. The question of interest however, is whether a child's monetary poverty status uniquely determines her/his multidimensional poverty status. Proposition 2.3 -(ii) and (iii) state that a child's monetary poverty status is not the only determinant of her/his multidimensional poverty status; parental education is another such determinant, and even influences the magnitude of the effect an exogenous change in a child's monetary poverty status has on her/his multidimensional poverty status. We argue in what follows that this strategic complementarity between household income ($y$) and parental education ($e$) in a child multidimensional poverty status is a key that unlocks the child poverty measurements' mismatch puzzle.

Since we established above that monetary and multidimensional child poverty are related phenomena, we base our theoretical exploration of the causes of the mismatch between these two measurements on the characterization of the elasticity of a child's multidimensional poverty status with respect to her/his monetary poverty status. The question of interest is: by how much will a child's multidimensional poverty status improve following a 10% improvement in her/his level of monetary poverty status?

To address this question, we first derive the elasticity of a child's multidimensional poverty status with respect to her/his monetary poverty status using (15). To do so, we interpret $B(e, y)$ as a measure of the multidimensional poverty status of a child born in a household with socioeconomic characteristics $(e, y)$. As mentioned above, we also interpret $y$ as a measure of the child's monetary poverty status. Then, since the function $B(e, .)$ is strictly increasing in $y$, we can define this elasticity as follows:

$$\varepsilon_{b/y} := \frac{y}{B(e, y)} \frac{\partial B}{\partial y}. \tag{17}$$

A necessary and sufficient condition for a child's multidimensional poverty status to match her/his monetary poverty status thus is that $\varepsilon_{b/y} = 1$, implying that a 10% improvement in her/his monetary poverty status yields a 10% improvement in her/his multidimensional poverty status. In other words, if household monetary resources were all that matters for a child well-being, then one would expect the elasticity of her/his multidimensional poverty status with respect to her/his monetary poverty status to equal unity, irrespective of other household socioeconomic characteristics. From (17), substituting in (15), and rearranging terms, yields a reformulation of this elasticity as follows:

$$\varepsilon_{b/y} = \frac{\alpha}{1 - f(e, y)}, \tag{18}$$

where

$$f(e, y) := \frac{(\delta_s + \delta_n) e}{y} \in (0, 1) \tag{19}$$

by virtue of *condition (11)*. Recall that, by assumption, $\alpha \in (0, 1)$. Then, observe from (18) and (19) that for a household where the mother has no education (i.e., $e = 0$),

$$\varepsilon_{b/y} = \alpha < 1.$$

More generally, a necessary and sufficient condition for $\varepsilon_{b/y} = 1$ is that $f(e, y) = 1 - \alpha$, which, from ((19)), implies that

$$e = \frac{(1-\alpha)}{\delta_s + \delta_n} y.$$

We have just established the following results:

**Proposition 2.4** *Let condition (11) holds.*

*Then there is a match between monetary and multidimensional child poverty if and only if household income and parental education are correlated.*

Proposition 2.4 suggests that a mismatch between monetary and multidimensional child poverty is likely to occur whenever household income and parental education are misaligned or uncorrelated. We test this theoretical prediction against the data, adjusting our empirical model for potential confounders that may mask the causal effect of parental education on the mismatch between these two poverty measurements.

## 2.3 Testable Predictions

In this sub-section, we summarize the testable predictions of our theoretical model. Our empirical model is devoted to the testing of these predictions:

P1. Household income and parental education each have a positive effect on child's nutritional status and level of educational attainment (Proposition 2.1)

P2. The effect of household income on a child's (i) nutritional status and (ii) level of education is higher, the higher her/his parent's level of education (Proposition 2.2)

P3. A child's multidimensional poverty status is influenced by both her/his monetary poverty status and parental education (Proposition 2.3 -(ii) and (iii))

P4. The misalignment between household income and parental education is a predictor of the mismatch between monetary and multidimensional child poverty. Indeed, a match between these two poverty measurements occurs whenever household income and parental education are correlated (Proposition 2.4).

Our first prediction (P1) comes from our intermediate results (12) and (13) and Proposition 2.1. These results show that parental education and household income have a significant influence on children's educational achievement and nutritional status.

Our second prediction (P2) comes from Proposition 2.2. This result states that parental education and household income reinforce each other in enhancing child outcomes. We test this prediction by allowing interaction between household income and parental education.

The third prediction (P3) comes from Proposition 2.3. The first empirical implication of this prediction is that household income has a significant effect on child deprivations. The second implication is that household income is not the only significant determinant of child deprivation. Therefore, we need to identify all other factors, including parental education, that influence child deprivations.

Our prediction (P4) suggests that, conditional on other factors, the occurrence or non-occurrence of a match between child's monetary and multidimensional poverty is governed by the extent of the association between household income and parental education. Second, our theoretical model is not explicit about the weight of other factors in the occurrence or non-occurrence of this match. This means that our empirical analysis must identify and include these remaining factors as potential confounders of the predictive effect of this association between parental socioeconomic characteristics.

# 3 Empirical Analysis

Our model provides testable predictions on the determinants of the probability that a child is both monetary poor and multidimensionally deprived. In this section we test the predictions of our theory. However, before embarking on our empirical analysis, two facts are worth mentioning. First, our theory suggests that, conditional on other factors, the occurrence of a match between a child's monetary and multidimensional poverty is governed by the nature of the association between household income and parental education. Second, although our model captures the weight of other factors in the occurrence or non-occurrence of this match, it does so only implicitly. This means that our empirical analysis must identify and include these remaining factors as potential confounders of the predictive effect of this association between parental socioeconomic characteristics.

## 3.1 Data and Summary Statistics

The data used in this study come from the 2012/2013 Tanzania National Panel Survey (NPS). The 2012/2013 Tanzania NPS is the third round in a series of nationally-representative household panel surveys that collect information on a wide range of topics, including consumption expenditures and a wealth of other socioeconomic characteristics. All three rounds of the NPS have been implemented by the Tanzania National Bureau of Statistics (NBS).

The 2012/2013 Tanzania NPS samples $5,010$ households including $25,412$ individuals and contains information at national and regional levels on education, health, household characteristics, living conditions and, anthropometric data on children of all ages. This allows us to examine education and nutritional deprivations simultaneously. Information is collected by through a household questionnaire. Our analysis focuses on the population of children aged $7-15$, which yields a sample of $4,346$ children.

Table 1 reports descriptive statistics of our sample of children.

| Children aged 7-15 | | |
|---|---|---|
| Child characteristics | Number | Percent |
| Male | 2,095 | 48.21 |
| Female | 2,251 | 51.79 |
| Urban | 1,101 | 25.33 |
| Rural | 3,245 | 74.67 |
| Age 7 | 599 | 13.78 |
| Age 8 | 540 | 12.43 |
| Age 9 | 504 | 11.60 |
| Age 10 | 508 | 11.69 |
| Age 11 | 462 | 10.63 |
| Age 12 | 495 | 11.39 |
| Age 13 | 457 | 10.52 |
| Age 14 | 409 | 9.41 |
| Age 15 | 372 | 8.56 |
| Source: Authors' own calculations from Tanzania's 2012/2013 NPS | | |

Table 1: Sample Information

In our sample, 48% percent of children are male, implying a male/female sex ratio of 0.931, which is slightly lower when compared to the overall male/female sex ratio of 1.02 for Tanzanian children in the age group $0-14$.[2] The geographical distribution of the sample shows that approximately 75% of children aged $7-15$ live in rural areas, with the remainder living in urban areas.

## 3.2 Child Poverty Measurements

Our focus is on two important dimensions of child deprivation – education and nutrition. We use two indicators to measure education deprivation, namely school enrollment and schooling-for-age (SAGE). A school-aged child is identified as education deprived with respect to enrollment if s/he was not enrolled in school at the time of the survey. A child is identified as education deprived with respect to *SAGE*, if her/his grade progression at school occurs at a rate below normal. In other words, this indicator measures school deprivation as an

[2]World Fact Book Tanzania, 2016, available online at https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html

age-grade distortion (Psacharopoulos and Yang (1991)):

$$SAGE = \left(\frac{Years\ of\ schooling}{Age - E}\right) \times 100$$

where $E$ represents the normal schooling entry age, which is 7 in Tanzania. $A$ child is identified as below normal progression if $SAGE < 100$.

We measure children's nutritional status by their BMI-for-age z-score (thinness) and height-for-age z-score (stunting). A child is identified as thin (stunted) if his/her BMI-for-age z-score<-2SD (height-for-age z-score<-2SD).

| Dimension of poverty | Indicator | Definition. A child is identified as poor if: |
|---|---|---|
| Monetary | Real consumption | his household's monthly real consumption per adult equivalent is below the poverty line |
| Education | Enrollment | s/he is not enrolled in school |
| | Progression | his/her score SAGE <100 |
| Nutrition | Thinness | his/her BMI-for-age z-score is <-2 SD |
| | Stunting | his/her height-for-age z-score is <-2 SD |

Source: Tanzania national poverty line in 2012-13; and World Health Organization (WHO)

Table 2: Normative criteria for poverty measurement

On the basis of the measurement criteria defined in Table 2, we present in Table 3 rates of monetary and multidimensional child poverty by geography, gender and wealth quintile. Overall, 26.16% of children live in monetarily poor households. Corresponding figures for children suffering some form of basic deprivation are, respectively, 21.79% not enrolled in school, around 54% of enrolled children are below normal progression, 8.16% are thin and 33.14% are stunted. Figures broken down by regions show a large degree of heterogeneity. In particular, the rural area exhibits the highest rates of both monetary poverty and school deprivation for children in our sample, whereas the Zanzibar region has the highest rate of thinness.

Figure 1 reports the total consumption expenditure quintile-group rates of deprivation. It

| | Monetary | Education | | Nutrition | |
|---|---|---|---|---|---|
| | | Enrollment | Progression | Thinness | Stunting |
| Total | 26.16 | 21.79 | 53.55 | 8.16 | 33.14 |
| **Region** | | | | | |
| Dar es Salaam | 0.90 | 12.65 | 30.08 | 6.30 | 26.15 |
| Rest of urban | 11.59 | 11.39 | 34.46 | 7.04 | 23.24 |
| Rural | 30.61 | 24.64 | 58.60 | 8.26 | 35.51 |
| Zanzibar | 16.72 | 8.25 | 65.78 | 14.01 | 26.87 |
| **Gender** | | | | | |
| Male | 25.16 | 23.97 | 58.34 | 8.68 | 37.24 |
| Female | 27.08 | 19.78 | 49.35 | 7.67 | 29.35 |
| **Wealth Quintile** | | | | | |
| 1st quintile | - | 32.24 | 63.20 | 10.08 | 39.99 |
| 2nd quintile | - | 24.75 | 58.91 | 6.34 | 33.23 |
| 3rd quintile | - | 16.96 | 54.09 | 10.12 | 36.42 |
| 4th quintile | - | 17.93 | 51.98 | 7.70 | 31.64 |
| 5th quintile | - | 13.73 | 38.63 | 6.07 | 21.77 |

Source: Authors' own calculations from Tanzania's 2012/2013 NPS

Table 3: Child monetary and Deprivation Rates

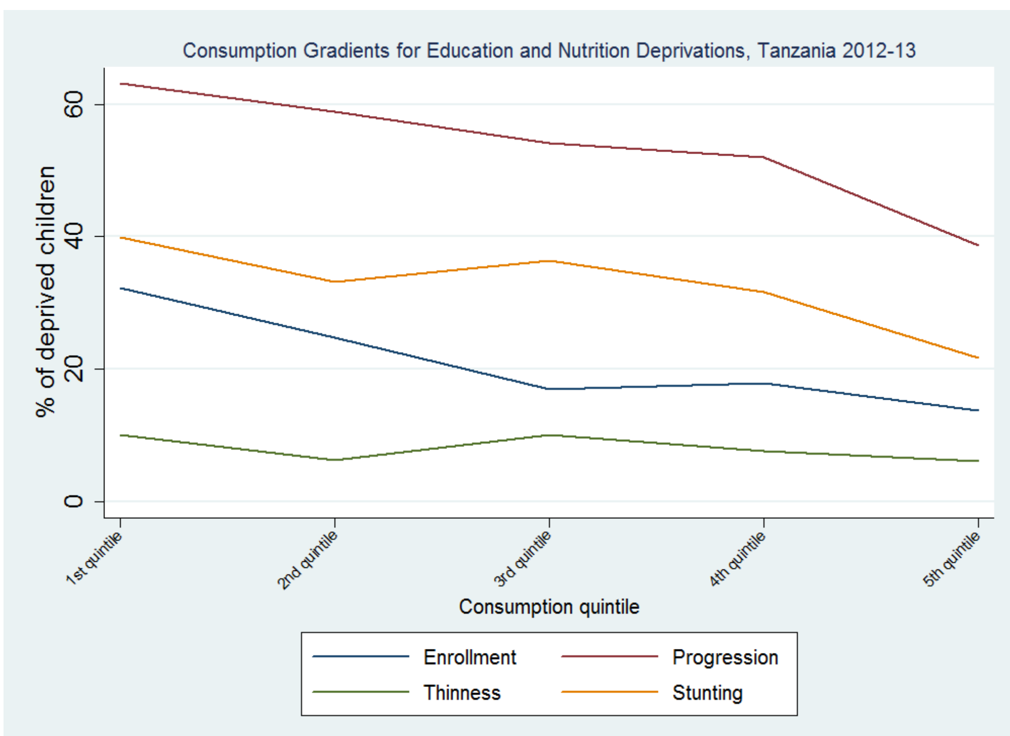


Figure 1: Consumption Gradients for Education and Nutrition Deprivations

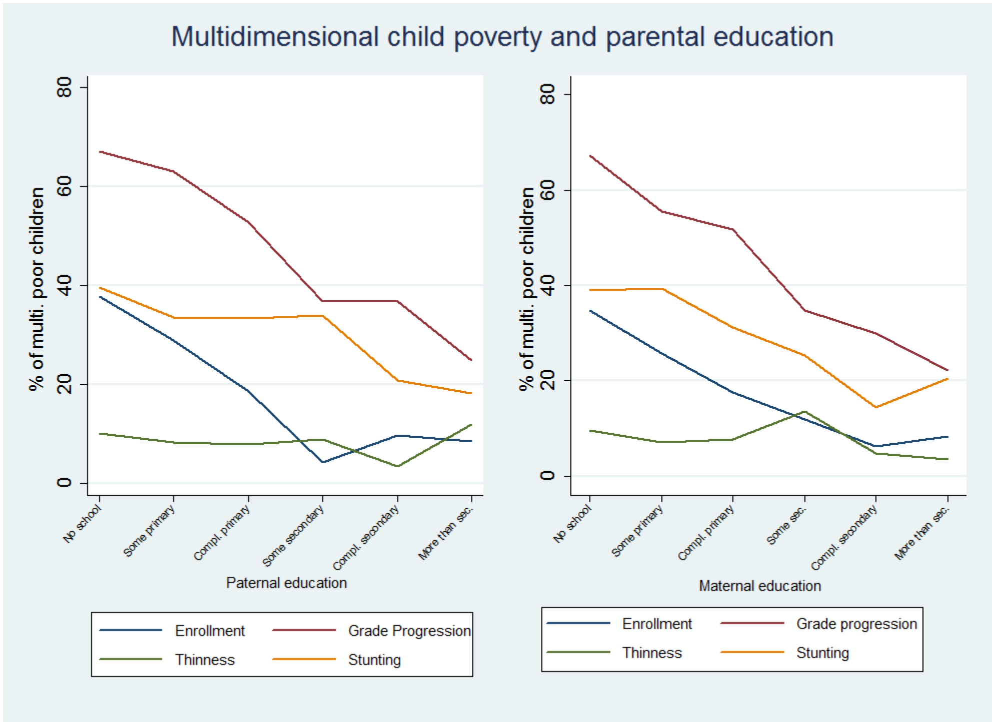


Figure 2: Multidimensional child poverty and parental education

shows that the gradients for each of the four deprivation for Tanzania. Figure 1 shows that the poorest is more deprived than the richer quintiles. Therefore, we conclude that there is an obvious pro-rich gradient of deprivation in Tanzania. Figure 2 plots rates of multidimensional child poverty by parental educational level. Figure 2 shows that children having parents (father and mother) with no education are more deprived than those with educated parents.

### 3.3 Patterns of Mismatch between monetary and multidimensional child poverty

In this sub-section we present a descriptive picture of the degree of mismatch between multidimensional and monetary child poverty in Tanzania. We first sort children in our sample into groups identified as poor by (i) the monetary criterion, (ii) the education criterion, (iii) the nutrition criterion, and (iv) the multidimensional criterion. Next, we measure the extent of the mismatch between the two poverty measurement approaches by characterizing the intersection between the group of children identified as monetary poor and the group of those suffering some form of deprivation (Table 4).

| Dimension | Indicator | Group A | Group B | Group AB | Group C | Total |
|---|---|---|---|---|---|---|
| Education | Enrollment | 18.15 | 13.78 | 8.01 | 60.06 | 100 |
| | Progression | 8.71 | 39.06 | 14.50 | 37.74 | 100 |
| Nutrition | Thinness | 23.73 | 5.70 | 2.44 | 68.12 | 100 |
| | Stunting | 16.41 | 18.67 | 9.76 | 55.15 | 100 |

*Source:* Authors' own calculations from Tanzania's 2012/2013 NPS

Table 4: Patterns of mismatch

Group **A** in Table 4 consists of children who are identified as monetarily poor; Group **B**, those identified as multidimensionally poor; Group **AB** consists of those who are identified as both monetarily and multidimensionally poor (school deprivation and nutritional deprivation); and Group **C** consists of children who are neither. For example, we observe, from Table 4, that 18.15% of children in our sample are identified as being only monetarily poor, 13.73% are not enrolled in school, while 8.01% are identified as both monetarily poor and school-deprived, and 60.06% are neither.

The Venn diagrams presented in Figure 3 give summary pictures of the observed patterns of mismatch between the types of child poverty in Tanzania. Figure 3$a$ shows that roughly 32% of children in our sample are either monetarily poor or school-deprived (enrollment) $(A + B)$, but only 8.01% are identified as both monetarily poor and school-deprived $(AB)$. Figure 3$b$ shows the mismatch between monetary poverty and child deprivation in education using grade progression indicator. It shows that 14.50% of children are identified as both monetarily poor and below normal progression at school, while 39.06% are identified as living in monetarily non-poor household but below normal progression at school. Figure 3$c$ shows the mismatch between monetary poverty and child deprivation in nutrition using thinness indicator. It shows that only 2.44% of children are identified as both monetarily poor and thin (see $AB$ in Figure 1$c$), given that a total of 29.44% of children are either monetarily

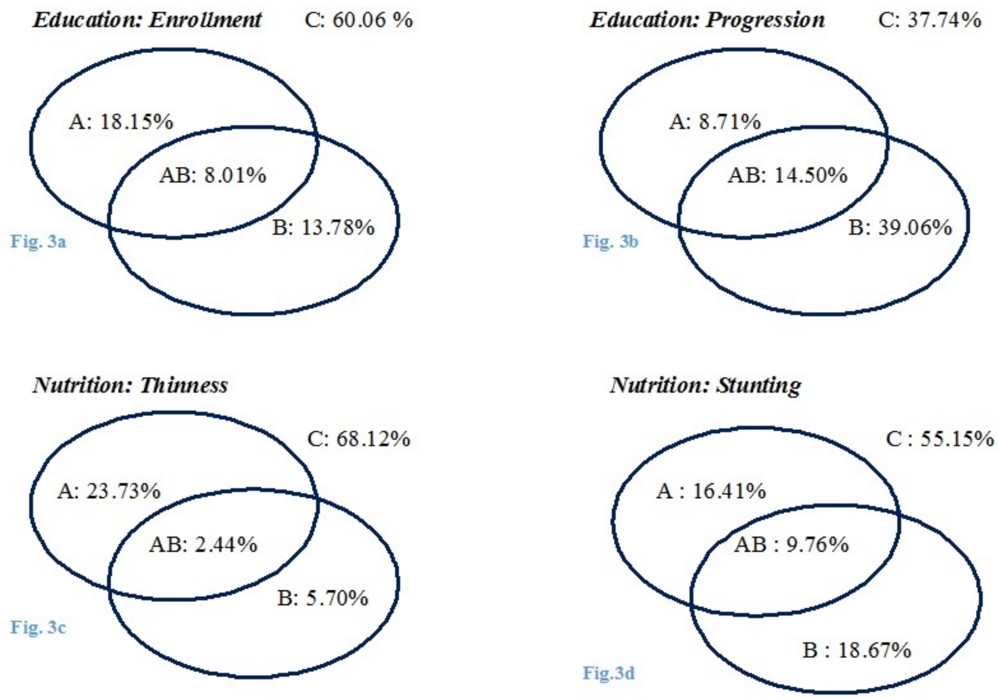


Figure 3: Patterns of mismatch between child monetary and multidimensional poverty

poor or thin $(A + B)$. Figure 3$d$ shows the mismatch between monetary poverty and child deprivation in nutrition using the stunting indicator. It shows that 9.76% of children are identified as both monetarily poor and stunted, 9.76% of children are identified as only stunted while 16.41% of children are identified as only monetarily poor. Clearly, in all these figures, there is little matching between the two types of poverty, echoing findings in the literature (e.g., Roelen et al. (2012)).

We now turn to our empirical strategy for testing our theoretical predictions and identifying factors that explain the mismatch between child monetary and multidimensional poverty in Tanzania.

## 3.4 Estimation Strategy and Results

In this sub-section, we detail the steps of our empirical strategy and present results associated with each step.

### 3.4.1 Identification Strategy

We face three main potential identification problems.

First, an identification issue arises in isolating the causal effect of a mother's education on her children's outcomes due to the possibility of educational externalities within the household (Burchi (2012)). We consider that not taking into account the level of education of other household members would potentially give rise to an omitted variable bias. Thus to identify the causal effect of a mother's education on her children's outcomes, we control for the father's own education, as well as that of other members of the household, as these may impact children's outcomes and especially their educational attainment.

Second, some studies focusing on the relation between household income and child's schooling have addressed the issues of the endogeneity of household total consumption expenditures in the schooling equation (e.g. Tansel (1997), Montgomery and Kouame (1993)). Therefore, the main challenge in estimating the causal effect of household income on children's education outcomes is the possible joint determination of household expenditure decisions with household decisions on the allocation of children's time between labor supply and schooling. To deal with this identification issue we instrument household consumption expenditures, through a set of exogenous variables (instruments) that are correlated with household consumption expenditures, but not with the error term of the schooling equation. To examine the validity of this identification strategy, we perform three statistical tests. We perform *Hausman* exogeneity test to assess the validity of the null hypothesis of exogeneity of household consumption expenditures in the schooling equation. We perform the *Stock-Yogo* test for weak identification of our instruments. Lastly, we perform the *Sargan* test to assess the overidentification of all instruments used.

Third, in order to identify the determinants of the mismatch between monetary and multidimensional child poverty, we use *Heckman*'s selection models to correct for selection bias. We use the same set of instruments as those applied to deal with the second identification issue.

### 3.4.2 The Effects of Household Income and Parental Education on Children's Outcomes

We test the first prediction of our theoretical model (P1) that a child's nutritional status and level of education are positively affected by household income and parental education. In order to estimate the effects of household income and parental education on child deprivations (school deprivation and nutritional deprivation) we estimate the two linear probability models (LPM), denoted as M1 and M2, respectively. The main advantage of the LPM is that the parameter estimates can be directly interpreted as the mean marginal effect of covariates on the outcome. However, we are aware that the predicted probability from the LPM can be below 0 or above 1 and the errors terms are heteroskedastic. We therefore use heteroskedasticity robust standard errors when estimating the linear probability model to deal with the issues of the violation of the homoskedasticity and normality of errors assumptions.

#### 3.4.2.1 Determinant of Child Education

We use a linear probability model to estimate a regression based-model of the form:

$$D\_Educ_{ih} = \beta_0 + \beta_1 I_h + \beta_2 X_{ih} + \beta_3 Z_h + \epsilon_{ih} \qquad \text{M1} \qquad (20)$$

where $D\_Educ_{ih}$ equals to 1 if a child $i$ living in household $h$ suffers from education deprivation; $I_h$ denotes household $h$'s income measured by the natural log of real per adult equivalent consumption expenditure, $X_{ih}$ is a vector of child $i$'s own characteristics (age, gender, labor ), as well as other household characteristics (numbers of children, household head characteristics and parental education), and $Z_h$, is a vector of characteristics of the community in which the child lives (rural versus urban, and access to basic public services such as hospitals, healthcare centers and primary schools). We use two indicators to measure a child's level of education deprivation. The first one is school enrollment, equal to 1 if child is not enrolled in school, and 0 otherwise. The second indicator measures schooling progress, and is denoted as $SAGE$; it's equal to 1 if $SAGE < 100$, and 0 otherwise.

Table 6 reports the results of our first specification (M1). This table reports the coefficients from the regression of school enrollment and the coefficients from the regression of the $SAGE$ dummy to capture grade repetition or below normal progression. We find that household income, other household characteristics (such as: number of children, household head characteristics and parental education), child characteristics, parents' characteristics and place of residence all have significant effects on a children's educational outcomes. The results reported in the two first columns of Table 6 rely on the assumption that all covariates are exogenous, especially the key variable of income (total consumption expenditure). We recognize that household total consumption expenditure may be correlated with the error term, which may potentially bias the estimated coefficients. We discuss in the next section the endogeneity of household total consumption expenditure and our strategy to identify its causal effect.

More specifically, we find that the coefficient of household consumption expenditure (monthly per adult equivalent expenditures) has negative and significant effects on the probability that a child suffers education deprivation. This result suggests that a 1% increase in household income causes the probability that a child suffers education deprivation to decrease by 0.062 (or 6.2%), while it causes the probability that a child has a normal progression through school grades to increase by 0.058 (5.8%). These results imply that the higher household income, the lower the probability that a child is education deprived. This finding is similar to the result often found in most empirical studies that higher levels of income are associated with low levels of child deprivation (Singh and Sarkar (2015)).

We also find that all of parental education coefficient estimates have significant effects on the probability that a child suffers education deprivation. We observe that father's education has a more significant impact on the school enrollment decision than does mother's education. Similar evidence showing that father's education has a greater influence on child's schooling than mother's education can be found in Tansel (1997). In contrast, for those enrolled in school, we observe that when it comes to a child's normal progression through school grades, the coefficients for mother's education are larger than those for father's education (not significant). The intuition behind these two results is that in a context of African societies, most household decisions (including schooling enrollment for children) are made by the household head; but mothers matter more for a child's grade progression than fathers.

Finally, results in Table 6 also show that a child own characteristics are significant determinants of her/his schooling outcomes. Indeed, we find that, compared to girls, boys are more at risk of dropping out of school or facing a slow rate of grade progression. Another important determinant of children's deprivation in education is child labor. We find that child labor increases the probability of dropping out of school by 0.065 (or 6.5%), but has no significant effect on a child's grade progression.

#### 3.4.2.2 Endogeneity of Total Consumption Expenditure

Some studies on the relation between household income and children's schooling have addressed the issues of endogeneity of household total consumption expenditure (e.g. Tansel (1997); Montgomery and Kouame (1993)). This endogeneity may arise from two sources. The first is reverse causality from household consumption expenditure and child labor decisions. As discussed in Benefo and Schultz (1994), and Behrman and Knowles (1999), if households make expenditure decisions simultaneously with schooling decisions there may be a bias. Behrman and Knowles (1999) argue that households may lower their consumption expenditures when they have school-age children in order to invest in child schooling. The second potential source of endogeneity arises from child labor. As discussed in Montgomery and Kouame (1993), if children work (chores in the home, in household enterprises or outside the household) and make a contribution to household income this could simultaneously affect household consumption and school enrollment. Therefore, the assumption of exogeneity of all covariates is not verified for household total consumption expenditure.

To correct for this potential endogeneity, we use instrumental variables, and identify a set of exogenous variables (instruments) that is correlated with household consumption expenditure and not correlated with the error term in the schooling equation. We use the following variables to instrument household consumption expenditure: the average consumption expenditure of other households in the same cluster; other income of the household (including rental payments and pensions); ownership of land; remittances or cash transfer received by the household; economic shocks affecting he household over the past years; average profit of business assets; and, amount received from assistance.

To examine the validity of this identification strategy, we undertake three statistical tests: *i)* the *Hausman* exogeneity test to test the null hypothesis of exogeneity of the household consumption expenditure in schooling equation; *ii)* the *Sargan* test for overidentification of all instruments; and *iii)* the *Stock-Yogo* test, which tests weak identification. The results of these tests are reported in Appendix B.

The last two columns of Table 6 report the results of the instrumental variable regressions for school enrollment and progression. We find that when we control for child labor, the Hausman test of the null hypothesis that household consumption expenditures are exogenous could not be rejected at the 95% confidence level. Therefore, if household consumption expenditures are indeed exogenous, our linear probability model specification is more consistent than the instrumental variables specification.

#### 3.4.2.3 Determinants of Child Nutrition

In the second model (denoted as M2):

$$D\_Nutri_{ih} = \beta_0 + \beta_1 I_h + \beta_2 X_{ih} + \beta_3 Z_h + \epsilon_{ih} \qquad \text{(M2)} \qquad (21)$$

where $D\_Nutri_{ih}$ equals 1 if a child $i$ living in household $h$ suffers from nutritional deprivations (thinness or stunting) with all other covariates defined as before.

Table 7 reports the estimates of the determinants of children's nutrition. We find that, household consumption has a significant and negative effect on a child's probability of being stunted but has no significant effect on his/her probability of being thin. We also find that both parents' body mass indices (BMI) have significant effects on a child's thinness status, but only mother's BMI has a significant effect on her/his stunting status. We also find that girls generally have better nutritional status than boys.

### 3.4.3 The Effects on Children' Outcomes of the Interaction between Household Income and Parental Education

We test the second prediction of our theoretical model (P2) that the effect of household income on a child's (i) nutritional status and (ii) level of education is higher, the higher her/his parent's level of education. For this purpose, we modify our two specifications (M1 and M2) to allow for the interaction between household consumption quintiles and parents' level of education. The results are presented in Table 8. Since our results in the previous sub-section show that household consumption has no significant effect on a child's thinness status, we report only for stunting status as a measure of nutritional deprivation. For a child's enrollment status, we allow interactions between household's quintile of consumption expenditure and father's level of education because of our previous finding that father's education has a more significant impact on the school enrollment decision than does mother's education. However, when using $SAGE$ as a measure of a child school deprivation status, we consider the interactions between household's quintile of consumption expenditure and mother's level of education. We find that, for a given household consumption expenditure quintile, the probability that a child suffers education deprivation (based on school enrollment or grade progression rate) is lower the higher is her/his parents' level of education. However, for a child nutritional status, we find that, the probability that a child suffers nutritional deprivation (stunting) is lower the higher is her/his parents' level of education only from the second to the fifth quintiles. These results imply that household income and parental education reinforce each other in enhancing child outcomes in education and nutrition.

#### 3.4.4 Assessing the Relative Contribution of Household Income and Parental Education on Children's Outcomes

We next test the third prediction of our theoretical model (P3) that household income is not the only significant determinant of child deprivation. Therefore, we need to assess the relative contribution of each factor in our previous specifications. To do so, we perform a Shorrocks-Shapley decomposition of the R-squared of our previous specifications M1 and M2. The main objective of this decomposition is to evaluate the role played by household income (consumption expenditure) in securing children's needs in education and nutrition. Table 5 summarizes the Shapley decomposition results for different dimensions of deprivation considered in this study.

The results show that household income (measured by the natural log of real per adult equivalent consumption) explains approximately 7% of the variability of a child's enrollment status, and approximately 5% of her/his schooling progression status. We find that most of the variability in deprivation in education is explained by child characteristics (namely, gender, age, and child labor status), respectively 37% for schooling enrollment, and 52.3% for grade progression. Parental characteristics also have a substantial relative contribution.

Indeed, mother's and father's characteristics account for respectively 14.34% and 15.3% of the variability of a child' enrollment status. When we measure child school deprivation using $SAGE$, we find that mother's and father's characteristics account for respectively 13.4% and 8.1% of the variability in child's deprivation.

The Shorrocks-Shapley decomposition results for nutrition show that household income plays an even less important role in explaining child nutritional deprivation. Household income explains only 1.2% of the variability in child thinness status and around 9.46% the variability in child stunting status. For child thinness status, we find that child characteristics accounts for 27.5% of the $R-squared$, while the contribution of her/his mother's (respectively father's) characteristics account for about 23.8% (20.1%). For a child stunting status, we find that child characteristics accounts for 34.6% of the $R-squared$, while the contribution of his/her mother's (respectively father) characteristics account for about 18.1% (11.2%). These results imply that child monetary and multidimensional poverty are different, but related, phenomena.

#### 3.4.5 Explaining the Mismatch between Monetary and Multidimensional Child Poverty

Finally, we test the fourth prediction of our theoretical model (P4), that parental education influences the concordance/non-concordance between monetary and multidimensional child poverty. Our prediction P4 suggests that, conditional on other factors, the occurrence or non-occurrence of a mismatch between a child's monetary and multidimensional poverty is governed by the extent of the association between household income and parental education. Given the possible sample selection bias arising in a study of deprivation among monetary poor households, to test prediction P4 we use *Heckman selection models* to explain: (i) why a significant share of children living in monetarily non-poor households suffers from deprivation and, (ii) why a significant share of children living in monetarily poor households does not suffer from deprivations.

A *Heckman selection model* follows a two-stage approach. The first stage estimates a probability model of the monetary poverty status of a household (i.e. the likelihood of being monetarily poor) with the application of a probit regression model as follows:

$$y_h^* = \beta_h X_h + \epsilon_h$$

where $y_h^*$ is a latent variable denoting the probability that a household $h$ is monetarily poor, and $X_h$ is the vector of explanatory variables, and $\epsilon_h \sim N(0, \sigma^2)$

The dependent variable $y_h$ is observed if the latent variable $y_h^*$ is greater than zero:

$$y_h = \begin{cases} 1 & \text{if } y_h^* > 0 \\ \\ 0 & \text{if } y_h^* \leq 0 \end{cases} .$$

While estimating the first stage probit model, the inverse *Mill's ratio* is calculated for each household. To correct the selection bias, this *Mill's ratio* is incorporated as an explanatory variable in the second stage.

The results of the second stage of the *Heckman models* are presented in Tables 9, 10, 11, and 12.

We first focus on deprived children in monetarily non-poor households. With respect to deprivation in school enrollment (Table 9), we find that low levels of parental education and education of other household members constitute the main explanation of why we find deprived children in monetarily non-poor households. We also find that number of offspring and child labor increase a child's probability of being out of school even if the household is identified as monetarily non-poor.

With respect to deprivation measured by grade progression (Table 9), we find that the average level of education of other household members, parental education and the fact that a child's biological mother is living in the household are the main determinants of the mismatch between household monetary poverty and a child deprivation in schooling progression. We find that living in a household severely affected by negative shocks affects negatively a child normal progression in school. In summary, a sub-normal school progression of children from monetarily non-poor households is explained by (i) the lack of parental and other household members' education, (ii) the absence of the biological mother in the household, (iii) negative shocks affecting the household, and (iv) living in a household headed by a female and in rural area.

With respect to thinness status (Table 10), we find that parental BMI and fathers' education are the main drivers of the mismatch between household monetary poverty and children deprivation in nutrition (thinness). For stunting status, we find that girls in monetarily non-poor households have better nutritional status than boys. We also find that, (i) living in urban area decreases the likelihood that a child's growth will be stunted, and (ii) children whose mothers have higher BMI are less likely to be stunted.

Tables 11, and 12 focus on non-deprived children in monetarily poor households. With respect to schooling participation for children in poor households (Table 11), we find that paternal education and average level of education of other household members increase a child's likelihood of school participation. We also find that being a girl and having the biological mother living in the household increase the chance of being enrolled in school even if the household is monetarily poor. Likewise, living in a household receiving remittances or cash transfer increases a child likelihood of being enrolled in school. In essence, if we observe children from monetarily poor households enrolled in school it's mainly because of (i) father's education, (ii) the presence of the biological mother in the household, and (iii) remittances or cash transfer received by the household.

With respect to normal progression in schooling for children in poor households (Table 11), we find that being a girl in a monetarily poor households and tolerance of child labor decrease the likelihood of having a normal progression in school. We also find that having the biological mother living in the household increases the likelihood of a child's having a normal progression in school.

With respect to thinness status (Table 12), we find that parental BMI (mother's BMI for thinness and father's BMI for stunting), parental self-employment and education are the main drivers of the mismatch between household monetary poverty and children deprivation in nutrition. With respect to stunting status (Table 12), we find no significant effect of covariates.

# 4 Conclusion

At a time when the development community is entering a critical period in the fight to eradicate extreme monetary poverty by 2030, empirical evidence documenting the non-concordance of monetary and multidimensional child poverty measures challenge for the targeting of poverty alleviation policies to the appropriate populations. Investigating the determinants of the non-concordance between these two approaches to child poverty measurement is therefore of paramount in clarifying importance. This paper contributes to this objective in two ways.

First, we develop a theoretical model of parental investment in child outcomes to generate testable predictions about factors that influence the observed mismatch between monetary and multidimensional child poverty. We link child outcomes such as nutritional status and schooling achievements to parental and household characteristics including household income and parental education. Two important results emerge from this theoretical model: (a) we demonstrate that the effect, on a child's nutritional status and schooling achievements, of raising household income is higher, the higher parental education (Proposition 2); (b) correlation between household income and parental education is necessary and sufficient for a match between monetary and multidimensional child poverty.

Second, we test our model's prediction using the third round of the National Panel Survey (NPS) conducted in Tanzania between 2012 and 2013, which focuses on children aged $7-15$. We do this in two steps. In the first step, we use linear probability models (LPM) to identify factors that influence the probability that a child is deprived in terms of education and nutrition, respectively. For both these LPM, the regression is adjusted for potential confounders, and appropriate identification strategies are applied. This allows us to empirically validate our theoretical predictions P1, P2 and P3, respectively. In particular, application of the Shorrocks-Shapley Decomposition methodology shows that a child's monetary poverty status explains only about 7% of the variability in her/his enrollment status, and approximately 5% in her/his schooling progression status. In contrast, mother's and father's characteristics account for respectively 14.3% and 15.3% of the variability in a child's enrollment status. These results imply that monetary and multidimensional child poverty are different, but related phenomena, which makes it highly important to explain their non-concordance.

In the second step, we test our fourth theoretical prediction, stating that parental education influences the concordance/non-concordance between monetary and multidimensional child poverty. In particular, parental education is a negative predictor of the probability that a monetarily non-poor child suffers some basic deprivations, particularly in education, and a positive predictor of the likelihood that a monetarily poor child suffers no basic deprivation. These results suggest that misalignment between household income and parental education is an important predictor of the mismatch between monetary and multidimensional child poverty, and put parental education at the center of the fight against child poverty.

# Appendix A

| | Education | | | | Nutrition | | | |
|---|---|---|---|---|---|---|---|---|
| | Enrollment | | Progression | | Thinness | | Stunting | |
| Regressor | Shapley v. | % | Shapley v. | % | Shapley v. | % | Shapley v. | % |
| HH monthly expend. | 0.0144 | 6.81 | 0.0149 | 4.91 | 0.0009 | 1.18 | 0.0101 | 9.46 |
| Other HH charact. | 0.0439 | 20.76 | 0.0502 | 16.61 | 0.0179 | 24.11 | 0.0193 | 18.19 |
| Child charact. | 0.0788 | 37.21 | 0.1581 | 52.29 | 0.0204 | 27.49 | 0.0368 | 34.55 |
| Mother charact. | 0.0304 | 14.34 | 0.0406 | 13.43 | 0.0177 | 23.83 | 0.0192 | 18.06 |
| Father charact. | 0.0323 | 15.26 | 0.0246 | 8.14 | 0.0149 | 20.07 | 0.0119 | 11.21 |
| Locational charact. | 0.0119 | 5.62 | 0.0139 | 4.63 | 0.0025 | 3.31 | 0.0091 | 8.52 |
| $R^2$ | 0.2119 | 100 | 0.3024 | 100 | 0.0742 | 100 | 0.1064 | 100 |

Table 5: Shorrocks-Shapley decomposition

| | LPM | | | | IV | |
|---|---|---|---|---|---|---|
| | Enrollment | | Progression | | Enrollment | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. | Coef. | Std. Err. |
| ***HH characteristics*** | | | | | | |
| HH monthly expend. | -0.062*** | 0.018 | -0.058*** | 0.023 | -0.138** | 0.063 |
| Number of kids | 0.012*** | 0.004 | 0.003 | 0.005 | 0.012*** | 0.004 |
| Av. schooling others | -0.022*** | 0.004 | -0.021*** | 0.006 | -0.019*** | 0.004 |
| HH head is female | -0.018 | 0.063 | 0.134 | 0.092 | -0.020 | 0.063 |
| Cash transfer: yes | -0.049** | 0.024 | -0.001 | 0.031 | - | - |
| Negative shocks: yes | -0.016 | 0.023 | 0.080*** | 0.028 | - | - |
| Month of survey fixed effect | Yes | | Yes | | Yes | |
| ***Child characteristics*** | | | | | | |
| Child is female | -0.035** | 0.017 | -0.063*** | 0.022 | -0.038** | 0.017 |
| BMI of child | 0.036*** | 0.010 | -0.060*** | 0.012 | 0.039*** | 0.010 |
| Age of child | -0.353*** | 0.034 | 0.315*** | 0.038 | -0.347*** | 0.034 |
| Age of child squared | 0.017*** | 0.002 | -0.011*** | 0.002 | 0.017*** | 0.002 |
| Child work | 0.065*** | 0.019 | -0.018 | 0.025 | 0.068*** | 0.020 |
| ***Mother characteristics*** | | | | | | |
| Mother's age | -0.000 | 0.001 | 0.001 | 0.002 | -0.001 | 0.001 |
| Mother living in HH | -0.060** | 0.027 | -0.057 | 0.036 | -0.065** | 0.027 |
| Mother has primary | -0.097*** | 0.025 | -0.137*** | 0.030 | -0.095*** | 0.025 |
| Mother has secondary | -0.120*** | 0.041 | -0.235*** | 0.054 | -0.081* | 0.049 |
| Self employed | -0.055 | 0.050 | -0.148** | 0.061 | -0.046 | 0.051 |
| Unpaid family worker | -0.062 | 0.053 | -0.100 | 0.064 | -0.058 | 0.053 |
| Own farm | -0.075 | 0.053 | -0.109* | 0.064 | -0.076 | 0.053 |
| ***Father characteristics*** | | | | | | |
| Father's age | 0.003** | 0.001 | 0.003** | 0.001 | 0.002** | 0.001 |
| Father living in HH | -0.017 | 0.028 | -0.040 | 0.036 | -0.010 | 0.028 |
| Father has primary | -0.115*** | 0.033 | 0.045 | 0.040 | -0.104*** | 0.033 |
| Father has secondary | -0.145*** | 0.041 | -0.039 | 0.052 | -0.125*** | 0.045 |
| Self employed | 0.015 | 0.028 | -0.010 | 0.040 | 0.013 | 0.028 |
| Unpaid family worker | 0.073* | 0.042 | -0.080 | 0.057 | 0.063 | 0.042 |
| Own farm | 0.007 | 0.025 | -0.042 | 0.036 | -0.013 | 0.030 |
| ***Other characteristics*** | | | | | | |
| Gov. primary school | 0.037 | 0.028 | -0.002 | 0.045 | 0.030 | 0.029 |
| HH is located in urban area | -0.053* | 0.032 | 0.014 | 0.046 | -0.058* | 0.034 |
| HH is located in rural area | -0.019 | 0.032 | 0.112** | 0.045 | -0.031 | 0.037 |
| HH is located in Zanzibar | -0.142*** | 0.048 | 0.116* | 0.070 | -0.160*** | 0.054 |
| Intercept | 2.844*** | 0.284 | -0.976*** | 0.353 | 3.660*** | 0.734 |
| Number of obs. | 1992 | | 1546 | | 1969 | |
| R-squared | 0.212 | | 0.302 | | 0.200 | |

Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Determinants of child education

| | LPM | | | |
|---|---|---|---|---|
| | Thinness | | Stunting | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. |
| ***HH characteristics*** | | | | |
| HH monthly expend. | -0.005 | 0.014 | -0.077*** | 0.026 |
| Number of kids | -0.005** | 0.002 | -0.006 | 0.005 |
| Av. schooling others | 0.003 | 0.004 | -0.009 | 0.007 |
| HH head is female | -0.022 | 0.055 | -0.010 | 0.115 |
| Cash transfer: yes | -0.029 | 0.019 | 0.023 | 0.034 |
| Negative shocks: yes | -0.014 | 0.017 | 0.032 | 0.032 |
| Month of survey fixed effect | Yes | | Yes | |
| ***Child characteristics*** | | | | |
| Child is female | 0.001 | 0.013 | -0.106*** | 0.024 |
| Age of child | 0.028 | 0.025 | 0.092** | 0.044 |
| Age of child squared | -0.001 | 0.001 | -0.003 | 0.002 |
| Child work | 0.012 | 0.016 | 0.001 | 0.028 |
| ***Mother characteristics*** | | | | |
| Mother's age | -0.002 | 0.001 | -0.003 | 0.002 |
| Mother's BMI | -67.515*** | 15.807 | -117.698*** | 28.753 |
| Mother living in HH | 0.005 | 0.021 | -0.016 | 0.039 |
| Mother has primary | -0.021 | 0.017 | -0.026 | 0.032 |
| Mother has secondary | 0.025 | 0.037 | 0.013 | 0.061 |
| Self employed | 0.050 | 0.037 | 0.061 | 0.069 |
| Unpaid family worker | 0.013 | 0.036 | 0.092 | 0.072 |
| Own farm | 0.019 | 0.036 | 0.054 | 0.071 |
| ***Father characteristics*** | | | | |
| Father's age | 0.002** | 0.001 | -0.000 | 0.002 |
| Father's BMI | -58.541*** | 21.653 | -12.666 | 37.129 |
| Father living in HH | -0.017 | 0.022 | -0.042 | 0.040 |
| Father has primary | -0.016 | 0.023 | -0.050 | 0.039 |
| Father has secondary | -0.042 | 0.029 | -0.027 | 0.057 |
| Self employed | 0.038 | 0.026 | 0.036 | 0.047 |
| Unpaid family worker | 0.006 | 0.032 | -0.079 | 0.057 |
| Own farm | -0.003 | 0.021 | 0.052 | 0.044 |
| ***Other characteristics*** | | | | |
| Water | -0.004 | 0.015 | 0.024 | 0.028 |
| Sanitation | 0.000 | 0.016 | 0.003 | 0.029 |
| Gov. hospital | 0.022 | 0.027 | 0.032 | 0.048 |
| Gov. Health center | -0.007 | 0.014 | -0.021 | 0.024 |
| HH is located in urban area | -0.053* | 0.031 | -0.107** | 0.052 |
| HH is located in rural area | -0.035 | 0.033 | -0.010 | 0.053 |
| HH is located in Zanzibar | -0.066 | 0.055 | -0.129 | 0.088 |
| Intercept | 0.255 | 0.195 | 1.150*** | 0.387 |
| Number of obs. | 1526 | | 1526 | |
| R-squared | 0.074 | | 0.106 | |

Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$



Table 7: Determinants of child nutrition

| | Education | | | | Nutrition | |
|---|---|---|---|---|---|---|
| | Enrollment | | Progression | | Stunting | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. | Coef. | Std. Err. |
| ***Interaction Effects*** | | | | | | |
| 1st quintile*Primary | -0.102* | 0.060 | -0.168*** | 0.040 | -0.039 | 0.059 |
| 1st quintile*Secondary | -0.255** | 0.103 | -0.020 | 0.066 | 0.382*** | 0.092 |
| 2nd quintile*Noschooling | -0.086 | 0.081 | -0.057 | 0.049 | -0.023 | 0.069 |
| 2nd quintile*Primary | -0.114* | 0.060 | -0.115*** | 0.042 | -0.082 | 0.060 |
| 2nd quintile*Secondary | -0.237*** | 0.081 | -0.371*** | 0.129 | -0.362*** | 0.120 |
| 3rd quintile*Noschooling | -0.032 | 0.081 | -0.052 | 0.046 | -0.097 | 0.071 |
| 3rd quintile*Primary | -0.217*** | 0.059 | -0.159*** | 0.042 | -0.107* | 0.060 |
| 3rd quintile*Secondary | -0.184** | 0.084 | -0.386*** | 0.115 | 0.212 | 0.151 |
| 4th quintile*Noschooling | -0.022 | 0.088 | -0.116** | 0.058 | -0.105 | 0.080 |
| 4th quintile*Primary | -0.191*** | 0.060 | -0.203*** | 0.042 | -0.078 | 0.059 |
| 4th quintile*Secondary | -0.210*** | 0.070 | -0.243** | 0.108 | -0.207** | 0.104 |
| 5th quintile*Noschooling | -0.062 | 0.116 | -0.083 | 0.073 | -0.090 | 0.101 |
| 5th quintile*Primary | -0.199*** | 0.062 | -0.245*** | 0.046 | -0.163** | 0.066 |
| 5th quintile*Secondary | -0.241*** | 0.065 | -0.302*** | 0.065 | -0.140* | 0.085 |
| ***Child characteristics*** | | | | | | |
| Child is female | -0.034** | 0.017 | -0.067*** | 0.019 | -0.108*** | 0.024 |
| BMI of child | 0.033*** | 0.010 | -0.044*** | 0.010 | - | - |
| Age of child | -0.351*** | 0.034 | 0.364*** | 0.032 | 0.092** | 0.044 |
| Age of child squared | 0.017*** | 0.002 | -0.013*** | 0.001 | -0.003 | 0.002 |
| Child work | 0.067*** | 0.020 | -0.020 | 0.022 | -0.004 | 0.028 |
| Controls | YES | YES | YES | YES | YES | YES |
| Month of survey fixed effect | YES | YES | YES | YES | YES | YES |
| Number of obs. | 1992 | | 1546 | | 1526 | |
| R-squared | 0.216 | | 0.306 | | 0.110 | |
| Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ | | | | | | |

Table 8: Interaction effects between household income and parental education

| Heckman (the outcome models): Deprived children in non-poor household | | | | |
|---|---|---|---|---|
| | Enrollment | | Progression | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. |
| ***HH characteristics*** | | | | |
| Number of kids | 0.017*** | 0.004 | 0.004 | 0.006 |
| Av. schooling others | -0.019*** | 0.005 | -0.024*** | 0.006 |
| HH head is female | -0.033 | 0.072 | 0.166* | 0.093 |
| Cash transfer: yes | -0.028 | 0.027 | -0.047 | 0.035 |
| Negative shocks: yes | -0.009 | 0.023 | 0.071** | 0.031 |
| Month of survey fixed effect | Yes | | Yes | |
| ***Child characteristics*** | | | | |
| Child is female | -0.017 | 0.018 | -0.052** | 0.024 |
| BMI of child | 0.032*** | 0.010 | -0.063*** | 0.013 |
| Age of child | -0.318*** | 0.034 | 0.277*** | 0.048 |
| Age of child squared | 0.015*** | 0.002 | -0.010*** | 0.002 |
| Child work | 0.054** | 0.021 | 0.020 | 0.028 |
| ***Mother characteristics*** | | | | |
| Mother's age | 0.001 | 0.001 | 0.001 | 0.002 |
| Mother's BMI | | | | |
| Mother living in HH | -0.019 | 0.028 | -0.117*** | 0.038 |
| Mother has primary | -0.088*** | 0.025 | -0.132*** | 0.036 |
| Mother has secondary | -0.123*** | 0.045 | -0.237*** | 0.060 |
| Self employed | -0.060 | 0.049 | -0.131** | 0.066 |
| Unpaid family worker | -0.061 | 0.051 | -0.092 | 0.068 |
| Own farm | -0.073 | 0.051 | -0.074 | 0.068 |
| ***Father characteristics*** | | | | |
| Father's age | 0.003*** | 0.001 | 0.003* | 0.002 |
| Father's BMI | | | | |
| Father living in HH | -0.043 | 0.028 | -0.031 | 0.039 |
| Father has primary | -0.142*** | 0.032 | 0.055 | 0.048 |
| Father has secondary | -0.184*** | 0.043 | -0.046 | 0.061 |
| Self employed | 0.019 | 0.032 | -0.039 | 0.042 |
| Unpaid family worker | 0.109** | 0.043 | -0.060 | 0.061 |
| Own farm | 0.007 | 0.030 | -0.050 | 0.040 |
| ***Other characteristics*** | | | | |
| Gov. primary school | 0.037 | 0.035 | -0.053 | 0.045 |
| HH is located in urban area | -0.038 | 0.036 | 0.011 | 0.047 |
| HH is located in rural area | -0.012 | 0.037 | 0.101** | 0.048 |
| HH is located in Zanzibar | -0.109* | 0.060 | 0.101 | 0.076 |
| Intercept | 1.823*** | 0.198 | -1.390*** | 0.275 |
| lnsig_1 | -1.055*** | | -0.862*** | |
| atanhrho_12 | 0.097 | | 0.276* | |
| Number of obs. | 2737 | | 2119 | |
| Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ | | | | |

Table 9: Estimates of the Heckman model for deprived children in education in non-poor household

| Heckman (the outcome models): Deprived children in non-poor household | | | | |
|---|---|---|---|---|
| | Thinness | | Stunting | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. |
| ***HH characteristics*** | | | | |
| Number of kids | -0.004 | 0.003 | -0.006 | 0.006 |
| Av. schooling others | 0.003 | 0.004 | -0.007 | 0.007 |
| HH head is female | -0.000 | 0.069 | 0.067 | 0.126 |
| Cash transfer: yes | -0.026 | 0.021 | 0.008 | 0.039 |
| Negative shocks: yes | -0.004 | 0.020 | 0.027 | 0.036 |
| Month of survey fixed effect | Yes | | Yes | |
| ***Child characteristics*** | | | | |
| Child is female | -0.012 | 0.014 | -0.078*** | 0.027 |
| BMI of child | | | | |
| Age of child | 0.008 | 0.027 | 0.102** | 0.050 |
| Age of child squared | 0.000 | 0.001 | -0.003 | 0.002 |
| Child work | 0.013 | 0.017 | 0.025 | 0.031 |
| ***Mother characteristics*** | | | | |
| Mother's age | -0.002* | 0.001 | -0.002 | 0.002 |
| Mother's BMI | -59.563*** | 17.050 | -147.840*** | 31.810 |
| Mother living in HH | 0.000 | 0.022 | -0.063 | 0.042 |
| Mother has primary | -0.004 | 0.021 | -0.057 | 0.039 |
| Mother has secondary | 0.043 | 0.036 | -0.053 | 0.069 |
| Self employed | 0.049 | 0.042 | 0.079 | 0.078 |
| Unpaid family worker | 0.023 | 0.043 | 0.089 | 0.081 |
| Own farm | 0.024 | 0.043 | 0.064 | 0.080 |
| ***Father characteristics*** | | | | |
| Father's age | 0.002** | 0.001 | -0.001 | 0.002 |
| Father's BMI | -64.822*** | 22.581 | 13.078 | 41.991 |
| Father living in HH | -0.007 | 0.023 | -0.021 | 0.043 |
| Father has primary | -0.046* | 0.025 | -0.034 | 0.047 |
| Father has secondary | -0.080** | 0.034 | -0.039 | 0.065 |
| Self employed | 0.033 | 0.027 | 0.018 | 0.050 |
| Unpaid family worker | -0.007 | 0.036 | -0.087 | 0.067 |
| Own farm | -0.003 | 0.025 | 0.031 | 0.047 |
| ***Other characteristics*** | | | | |
| Water | 0.003 | 0.017 | -0.008 | 0.031 |
| Sanitation | 0.006 | 0.017 | 0.004 | 0.032 |
| Gov. hospital | 0.018 | 0.028 | 0.011 | 0.052 |
| Gov. Health center | -0.002 | 0.015 | -0.023 | 0.028 |
| HH is located in urban area | -0.055* | 0.031 | -0.102* | 0.057 |
| HH is located in rural area | -0.039 | 0.031 | 0.002 | 0.057 |
| HH is located in Zanzibar | -0.066 | 0.053 | -0.099 | 0.098 |
| Intercept | 0.298* | 0.166 | 0.296 | 0.308 |
| lnsig_1 | -1.430*** | | -0.804*** | |
| atanhrho_12 | 0.015 | | 0.031 | |
| Number of obs. | 3304 | | 2732 | |
| Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ | | | | |

Table 10: Estimates of the Heckman model for deprived children in nutrition in non-poor household

| Heckman (the outcome models): Non-deprived children in poor household | | | | |
|---|---|---|---|---|
| | Enrollment | | Progression | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. |
| ***HH characteristics*** | | | | |
| Number of kids | -0.001 | 0.007 | -0.004 | 0.010 |
| Av. schooling others | 0.048*** | 0.014 | -0.003 | 0.016 |
| HH head is female | 0.045 | 0.151 | -0.070 | 0.170 |
| Cash transfer: yes | 0.118* | 0.060 | 0.083 | 0.061 |
| Negative shocks: yes | 0.009 | 0.062 | 0.111 | 0.069 |
| Month of survey fixed effect | Yes | | Yes | |
| ***Child characteristics*** | | | | |
| Child is female | 0.095** | 0.039 | -0.136*** | 0.043 |
| BMI of child | -0.043* | 0.022 | -0.062** | 0.027 |
| Age of child | 0.446*** | 0.073 | 0.450*** | 0.087 |
| Age of child squared | -0.021*** | 0.003 | -0.017*** | 0.004 |
| Child work | -0.036 | 0.045 | -0.115** | 0.050 |
| ***Mother characteristics*** | | | | |
| Mother's age | 0.003 | 0.003 | -0.001 | 0.003 |
| Mother living in HH | 0.147** | 0.061 | 0.190** | 0.076 |
| Mother has primary | 0.064 | 0.044 | -0.106** | 0.052 |
| Mother has secondary | 0.365 | 0.437 | 0.149 | 0.399 |
| Self employed | 0.002 | 0.265 | -0.400 | 0.288 |
| Unpaid family worker | 0.112 | 0.211 | -0.314 | 0.218 |
| Own farm | 0.111 | 0.210 | -0.345 | 0.217 |
| ***Father characteristics*** | | | | |
| Father's age | -0.004* | 0.002 | 0.004 | 0.003 |
| Father living in HH | -0.026 | 0.065 | -0.129 | 0.081 |
| Father has primary | 0.095* | 0.052 | 0.042 | 0.064 |
| Father has secondary | 0.188 | 0.155 | 0.214 | 0.154 |
| Self employed | -0.072 | 0.150 | 0.254 | 0.168 |
| Unpaid family worker | 0.072 | 0.138 | -0.066 | 0.153 |
| Own farm | 0.017 | 0.119 | -0.104 | 0.130 |
| ***Oher characteristics*** | | | | |
| Gov. primary school | -0.226* | 0.123 | 0.350*** | 0.119 |
| HH is located in urban area | 0.223 | 0.256 | -0.129 | 0.269 |
| HH is located in rural area | 0.128 | 0.254 | 0.082 | 0.267 |
| HH is located in Zanzibar | 0.402 | 0.301 | 0.138 | 0.313 |
| Intercept | -2.096*** | 0.609 | -2.235*** | 0.717 |
| lnsig_1 | -0.883*** | | -0.984*** | |
| atanhrho_12 | 0.150 | | -0.243 | |
| Number of obs. | 2720 | | 2107 | |
| Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ | | | | |

Table 11: Estimates of the Heckman model for non-deprived children in education in poor Household

| Heckman (the outcome models): Non-deprived children in poor household | | | | |
|---|---|---|---|---|
| | Thinness | | Stunting | |
| Variables | Coef. | Std. Err. | Coef. | Std. Err. |
| ***HH characteristics*** | | | | |
| Number of kids | 0.008 | 0.008 | 0.020 | 0.014 |
| Av. schooling others | 0.007 | 0.010 | 0.030* | 0.016 |
| HH head is female | 0.156 | 0.137 | 0.353 | 0.233 |
| Cash transfer: yes | 0.021 | 0.044 | -0.014 | 0.072 |
| Negative shocks: yes | 0.027 | 0.045 | -0.105 | 0.073 |
| Month of survey fixed effect | Yes | | Yes | |
| ***Child characteristics*** | | | | |
| Child is female | -0.038 | 0.028 | 0.165*** | 0.048 |
| Age of child | -0.089* | 0.053 | -0.056 | 0.089 |
| Age of child squared | 0.004 | 0.002 | 0.001 | 0.004 |
| Child work | -0.021 | 0.034 | 0.070 | 0.057 |
| ***Mother characteristics*** | | | | |
| Mother's age | 0.001 | 0.002 | 0.005 | 0.004 |
| Mother's BMI | 122.339** | 48.579 | 6.921 | 82.594 |
| Mother living in HH | -0.045 | 0.048 | -0.175** | 0.081 |
| Mother has primary | 0.021 | 0.033 | -0.044 | 0.055 |
| Mother has secondary | 0.058 | 0.272 | -0.269 | 0.461 |
| Self employed | -0.418* | 0.221 | 0.201 | 0.373 |
| Unpaid family worker | 0.008 | 0.181 | -0.379 | 0.300 |
| Own farm | 0.002 | 0.178 | -0.297 | 0.296 |
| ***Father characteristics*** | | | | |
| Father's age | -0.002 | 0.002 | -0.001 | 0.003 |
| Father's BMI | 68.512 | 60.647 | 299.922*** | 103.183 |
| Father living in HH | 0.043 | 0.051 | 0.084 | 0.086 |
| Father has primary | -0.051 | 0.039 | 0.106 | 0.067 |
| Father has secondary | -0.091 | 0.131 | -0.252 | 0.223 |
| Self employed | 0.003 | 0.120 | -0.539*** | 0.203 |
| Unpaid family worker | -0.044 | 0.109 | -0.277 | 0.183 |
| Own farm | 0.004 | 0.096 | -0.490*** | 0.163 |
| ***Other characteristics*** | | | | |
| Water | 0.030 | 0.038 | -0.110* | 0.062 |
| Sanitation | -0.019 | 0.044 | -0.005 | 0.075 |
| Gov. hospital | -0.031 | 0.091 | -0.074 | 0.150 |
| Gov. Health center | 0.044 | 0.032 | 0.009 | 0.054 |
| HH is located in urban area | 0.029 | 0.087 | 0.069 | 0.112 |
| Intercept | 1.050** | 0.415 | 0.825 | 0.681 |
| lnsig_1 | -1.366*** | | -0.831*** | |
| atanhrho_12 | -0.070 | | 0.116 | |
| Number of obs. | 3292 | | 3292 | |
| Note:. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ | | | | |

Table 12: Estimates of the Heckman model for non-deprived children in nutrition in poor household

# Appendix B

To examine the validity of the instrumental variables strategy, we undertake three statistical tests. First, we test whether the household total consumption expenditure need to be considered endogenous in schooling equation (M1). We test the null hypothesis of exogeneity of the household total consumption expenditure in schooling equation. On basis of the test results reported in Table 13, we cannot reject the null hypothesis that household total consumption expenditure may be treated as exogenous. The Hausman test indicates that we can consider household total consumption expenditure as an exogenous variable in schooling equation. Second, we perform the Sargan test for overidenfication of all instruments. The Sargan statistic, in Table 13, implies that the test of overidentifying restrictions cannot reject its null hypothesis.

| Test | test statistic | p-value |
|---|---|---|
| Hausman | 0.964 | 0.3262 |
| Sargan | 2.829 | 0.5868 |

Table 13: Hausman and Sargan tests results

Third, we perform the Stock-Yogo test, which tests weak identification of instruments. The weak instrument problem arises when the correlation between endogenous the regressor and the set of instrumental variables is small. It tests the null hypothesis of weak instruments. Table 14, reports the first type of the Stock-Yogo test based on the ratio of the bias of the estimator to the bias of OLS. At a significance level of 5%, the null hypothesis is rejected if $F > \kappa_{10}(k)$. The Cragg-Donald Wald F-statistic is equal to 20.17. Results show that we reject the null hypothesis of weak identification of instrument. Thus, it is unlikely that our estimated are biased by weak instruments.

| Stock-Yogo weak identification test | |
|---|---|
| Weak identification test (Cragg-Donald Wald F statistic): | 20.168 |
| Stock-Yogo weak ID test critical values: | |
| 5% maximal IV relative bias | 18.37 |
| 10% maximal IV relative bias | 10.83 |
| 20% maximal IV relative bias | 6.77 |
| 30% maximal IV relative bias | 5.25 |

Table 14: Stock-Yogo test results

# References


Alessio, F., G. Anne-Catherine, and M. Eric (2011). "Income poverty and material deprivation in European countries," LISER Working Paper Series 2011-04, LISER.

Alkire, S. and J. Foster (2011). "Counting and multidimensional poverty measurement," *Journal of Public Economics*, 95, 476 – 487.

Alkire, S., J. Foster, S. Seth, M. E. Santos, J. M. Roche, and P. Ballon (2015). *Multidimensional poverty measurement and analysis*, Oxford University Press, USA.

Behrman, J. R. and J. C. Knowles (1999). "Household income and child schooling in Vietnam," *The World Bank Economic Review*, 13, 211–256.

Benefo, K. D. and T. P. Schultz (1994). *Determinants of fertility and child mortality in Cote d'Ivoire and Ghana*, vol. 103, World Bank Publications.

Berenger, V. and A. Verdier-Chouchane (2007). "Multidimensional Measures of Well-Being: Standard of Living and Quality of Life Across Countries," *World Development*, 35, 1259–1276.

Bradshaw, J. and N. Finch (2003). "Overlaps in dimensions of poverty," *Journal of Social Policy*, 32, 513–525.

Burchi, F. (2010). "Child nutrition in Mozambique in 2003: The role of mother's schooling and nutrition knowledge," *Economics & Human Biology*, 8, 331–345.

——— (2012). "Whose education affects a child's nutritional status? From parents' to household's education," *Demographic Research*, 27, 681–704.

Cancian, M. and D. R. Meyer (2004). "Alternative measures of economic success among TANF participants: Avoiding poverty, hardship, and dependence on public assistance," *Journal of Policy Analysis and Management*, 23, 531–548.

Cavatorta, E., B. Shankar, and A. Flores-Martinez (2015). "Explaining Cross-State Disparities in Child Nutrition in Rural India," *World Development*, 76, 216–237.

Chevalier, A., C. Harmon, V. O'Sullivan, and I. Walker (2013). "The Impact of Parental Income and Education on the Schooling of Children," Papers WP468, Economic and Social Research Institute (ESRI).

Chevalier, A. and V. O'Sullivan (2007). "Mother's education and birth weight," Working Papers 200724, Geary Institute, University College Dublin.

Currie, A., M. Shields, and S. W. Price (2007). "The child health/family income gradient: Evidence from England," *Journal of Health Economics*, 26, 213–232.

Currie, J. and E. Moretti (2003). "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings," *The Quarterly Journal of Economics*, 118, 1495–1532.

——— (2007). "Biology as Destiny? Short- and Long-Run Determinants of Intergenerational Transmission of Birth Weight," *Journal of Labor Economics*, 25, 231–264.

fei Lee, L., M. R. Rosenzweig, and M. M. Pitt (1997). "The effects of improved nutrition, sanitation, and water quality on child health in high-mortality populations," *Journal of Econometrics*, 77, 209 – 235.

Fusco, A. (2015). "The relationship between income and housing deprivation: A longitudinal analysis," *Economic Modelling*, 49, 137–143.

Glewwe, P. (1999). "Why Does Mother's Schooling Raise Child Health in Developing Countries? Evidence from Morocco," *The Journal of Human Resources*, 34, 124–159.

Gunes, P. M. (2015). "The role of maternal education in child health: Evidence from a compulsory schooling law," *Economics of Education Review*, 47, 1–16.

Handa, S. (1996). "Expenditure behavior and children's welfare: An analysis of female headed households in Jamaica," *Journal of Development Economics*, 50, 165–187.

Hulme, D. and A. McKay (2008). "Identifying and Measuring Chronic Poverty: Beyond Monetary Measures," in *The Many Dimensions of Poverty*, ed. by N. Kakwani and J. Silber, Palgrave-Macmillan.

Hulme, D. and A. Shepherd (2003). "Conceptualizing Chronic Poverty," *World Development*, 31, 403 – 423, chronic Poverty and Development Policy.

Imai, K. S., S. K. Annim, V. S. Kulkarni, and R. Gaiha (2014). "Women's Empowerment and Prevalence of Stunted and Underweight Children in Rural India," *World Development*, 62, 88 – 105.

Kennedy, E. and P. Peters (1992). "Household food security and child nutrition: the interaction of income and gender of household head," *World Development*, 20, 1077 – 1085.

Kremer, M. and D. Chen (1999). "Income-distribution dynamics with endogenous fertility," *The American Economic Review*, 89, 155–160.

Lawson, D. and S. Appleton (2007). "Child Health in Uganda: Policy Determinants and Measurement," *The European Journal of Development Research*, 19, 210–233.

Lochner, L. and E. Moretti (2004). "The effect of education on crime: Evidence from prison inmates, arrests, and self-reports," *The American Economic Review*, 94, 155–189.

Menchini, L., Y. Chzhen, G. Main, B. Martorano, C. De Neubourg, and J. Bradshaw (2012). "Child Deprivation, Multidimensional Poverty and Monetary Poverty in Europe," Innocenti working papers.

Mirza, S. and T. Knighton (2002). "Postsecondary participation: the effects of parents' education and household income," *Education Quarterly Review*, 8.

Moestue, H. and S. Huttly (2008). "Adult education and child nutrition: the role of family and community," *Journal of Epidemiology and Community Health*, 62, 153–159.

Montgomery, M. R. and A. Kouame (1993). "Fertility and child schooling in Cote dIvoire: is there a tradeoff?" [Unpublished] 1994. Presented at the Annual Meeting of the Population Association of America Miami Florida May 5-7 1994.

Nations, U. (2015). "Sustainable Development Goals," .

Olinto, P., K. Beegle, C. Sobrado, H. Uematsu, et al. (2013). "The State of the Poor: Where Are The Poor, Where Is Extreme Poverty Harder to End, and What Is the Current Profile of the World's Poor?" *Economic Premise*, 125.

Parlee, S. D. and O. A. MacDougald (2014). "Maternal nutrition and risk of obesity in offspring: the Trojan horse of developmental plasticity," *Biochimica et Biophysica Acta (BBA)-Molecular Basis of Disease*, 1842, 495–506.

Permanyer, I. (2014). "Assessing individuals' deprivation in a multidimensional framework," *Journal of Development Economics*, 109, 1 – 16.

Perry, B. (2002). "The mismatch between income measures and direct outcome measures of poverty," *Social Policy Journal of New Zealand*, 101–127.

Psacharopoulos, G. and H. Yang (1991). "Educational attainment among Venezuelan youth: An analysis of its determinants," *International Journal of Educational Development*, 11, 289–294.

REED, B. A., J.-P. HABICHT, and C. NIAMEOGO (1996). "The Effects of Maternal Education on Child Nutritional Status Depend on Socio-Environmental Conditions," *International Journal of Epidemiology*, 25, 585–592.

Rendtel, U., L. Nordberg, M. Jäntti, J. Hanisch, and E. Basic (2004). "Report on quality of income data," *CHINTEX WP*.

Roelen, K. (2015). "Reducing all Forms of Child Poverty: The Need for Comprehensive Measurement," *IDS Policy Briefing*, 98.

Roelen, K. and F. Gassmann (2014). "Beyond averages: Child well-being in Kazakhstan," *Journal of Children and Poverty*, 20, 91–110.

Roelen, K., F. Gassmann, and C. de Neubourg (2012). "False positives or hidden dimensions: What can monetary and multidimensional measurement tell us about child poverty in Vietnam?" *International Journal of Social Welfare*, 21, 393–407.

Roelen, K., F. Gassmann, and C. Neubourg (2010). "Child Poverty in Vietnam: Providing Insights Using a Country-Specific and Multidimensional Model," *Social Indicators Research*, 98, 129–145.

Roelen, K. and G. Notten (2013). "The Breadth of Child Poverty in Europe: An Investigation into Overlap of Deprivations," *Poverty & Public Policy*, 5, 319–335.

Singh, R. and S. Sarkar (2015). "Children's experience of multidimensional deprivation: Relationship with household monetary poverty," *The Quarterly Review of Economics and Finance*, 56, 43 – 56.

Spears, D. (2013). "How much international variation in child height can sanitation explain ?" Policy Research Working Paper Series 6351, The World Bank.

Tansel, A. (1997). "Schooling attainment, parental education, and gender in Cote d'Ivoire and Ghana," *Economic Development and Cultural Change*, 45, 825–856.

Thomas, D., J. Strauss, and M.-H. Henriques (1991). "How Does Mother's Education Affect Child Height?" *Journal of Human Resources*, 26, 183–211.

Thorbecke, E. (2007). *The Many Dimensions of Poverty*, London: Palgrave Macmillan UK, chap. Multidimensional Poverty: Conceptual and Measurement Issues, 3–19.

Tran, V. Q., S. Alkire, and S. Klasen (2015). *Static and Dynamic Disparities between Monetary and Multidimensional Poverty Measurement: Evidence from Vietnam*, chap. 15, 249–281.

White, H., J. Leavy, and A. Masters (2003). "Comparative Perspectives on Child Poverty: A review of poverty measures," *Journal of Human Development*, 4, 379–396.