# The Role of Maternal Education in the Cognitive Development of Young Children: A Nonparametric Approach in four Developing Countries

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**Abstract**

There is extensive evidence suggesting that cognitive development during early childhood has several consequences on adult life outcomes. This implies that understanding the determinants of skills formation during the first years of life is a matter of great importance. In this article I explore how maternal education shapes the process of cognitive development in young children. The literature has provided a considerable amount of evidence on this relationship but it has not dealt successfully with the endogeneity of maternal education and is highly concentrated in the context of a developed economy. In an attempt overcome this limitations I will implement the Monotone Treatment Response and Monotone Instrumental Variables methodologies proposed by C. Manski (1997) and C. Manski and Pepper (2000) using data from Ethiopia, India, Peru and Vietnam.

## 1 Introduction

During the last two decades the literature has provided overwhelming evidence stressing out the importance of the construction of cognitive and non-cognitive skills during the first ten years of life. There seems to be a consensus on the fact that the way this process is driven has several consequences in a wide variety of adult life outcomes such as health status, wages and schooling attainment (Heckman, Stixrud, & Urzúa, 2006). Moreover, it is well understood that cognitive abilities are malleable only during the first ten years of

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life due to biological reasons. This implies that remediating policies after childhood are not only more costly but their scope is limited. Thus, understanding the determinants of the process of skill formation is a matter of economic relevance.

One of the determinants of the process of skills formation is maternal education. In principle we could expect maternal education to modify the way children are raised both because more educated parents have more resources to invest in their children and also because of systematic differences in behaviors: more educated parents are aware of which investments are more productive to generate cognitive skills, have wider social networks and are more open to media. However, in order to get estimates on how maternal education shapes cognitive development in young children we have to take into account the possible endogeneity in the empirical exercise. There is a series of unobserved characteristics affecting children's cognitive development, such as parental motivation or innate cognitive and non-cognitive ability, that might be related with maternal education as well. Ignoring this fact in the empirical implementation will yield biased estimates.

This article contributes to the existing literature in two important aspects. First of all, it is to my knowledge the first article implementing the methodology proposed by C. Manski and Pepper (2000) and C. Manski (1997) to get bounds on the impact of maternal education on children's cognitive skills. Most of the studies try to deal with the endogeneity via an instrumental variables approach, using quasi-experimtal data or by getting estimates of a fully structural model. All these methodologies have a series of limitations: there is always room for the debate on the validity of any instrument; estimates from natural experiments lack external validity in general; and the strong assumptions implied in fully structural models make their estimates sensitive to specific parametric forms. In an attempt to overcome this limitations I weaken the strong assumptions used in the instrumental variables approach. However, dropping this assumptions comes at a cost as I no longer get point estimates but bounds on the impact of maternal education on children's cognitive skills.

The second contribution of this article is explained by the dataset used. Most of the existing literature analyzing the relationship between maternal education and cognitive skills of young children use data from developed countries (mostly from the US). In such cases the conclusions can be hardly used as policy recommendations for developing countries. Children born in developing countries are raised in a radically different context than those in developed economies. As pointed out by Helmers and Patnam (2011), this implies that the process of skill formation in the two contexts should be analyzed separately. More-

over, education services differ significantly in these two contexts and one year of maternal education might not be comparable in both societies. By using data from Ethiopia, India, Peru and Vietnam I extend the existing evidence in to a context that has not been fully explored so far.

The results of the paper have several implications for the design of public policy in developing countries. Identifying maternal education as a powerful tool for enhancing the process of cognitive development among young children contributes to the existing literature on the importance of policies expanding educational coverage in developing countries. In the subsequent sections of the article I will present a brief literature review on the importance of maternal education on Early Childhood Development (Section 2); I will describe the dataset in Section 3; in Section 4 I simultaneously describe the methodology implemented and report the results; in Section 5 I analyze where next steps should be taken in this research; and in Section 6 I Conclude.

## 2 Literature Review

There is a consensus in the literature on the positive relationship between maternal education and children's cognitive achievement regardless of the methodology implemented. For instance, Cunha, Heckman, Lochner, and Masterov (2006) develop a fully structural model for the technology of skill formation in young children taking into account two important facts: self productivity and dynamic complementarity. The first one refers to the fact that skills acquired in one stage of childhood will not only increase the stock of skills but will also increase the marginal productivity of further investments. The latter is related to the fact that one type of skills will increase the productivity of different type of skills (for example, non-cognitive skills make investments in cognitive skills more productive). By analyzing gaps in the PIAT math test scores for children in the NLSY79[1] between 6 and 10 years of age, the authors find that racial and income gaps in the test are virtually non-existent once parental education is included as a control. Interestingly, they find the same for non-cognitive skills, which recently have been found to be also a good predictor of adult life outcomes (Heckman et al., 2006).

Using the same data, Carneiro, Meghir, and Parey (2013) find a positive link between maternal education and children's cognitive test scores. In order to deal with the endogene-

[1] National Longitudinal Survey of the Youth 1979

ity of maternal education the authors instrument this variable with schooling costs when mother was adolescent. They find that an additional year of schooling improves the PIAT math and reading test scores by between 0.05 to 0.12 standard deviations. Oreopoulos, Page, and Stevens (2006) use variations in schooling policies in the United States between the 1960's and 1980's as a source for a natural experiment. By having quasi experimental data, the authors argue that their estimates can be interpreted as a causal relationship between parental schooling and children's human capital accumulation. They find that a 1-year increase in education of either of the parents reduces the probability of grade repetition of their children by 2-4% in the United States. Rosenzweig and Wolpin (1994) develop an identification strategy where they analyze mothers who continue their education after having their first child. In order to identify the impact of maternal education the authors analyze the performance on the PPVT[2] and PIAT examinations of siblings of these mothers. They find that one additional year of education increases the PPVT and PIAT test scores by 0.13 standard deviations.

The evidence in developing countries also support the hypothesis of the positive impact of maternal education on children's cognitive outcomes. Schady (2011) uses data from Ecuador to perform reduced form-nonparametric estimates of the impact of maternal education on children's test scores [3]. The author finds a positive and statistically significant relationship between maternal education children's scores. In addition, he provides evidence suggesting that the level of cognitive skills remains stable after age 8, highlighting the importance of early interventions. Paxson and Schady (2007) use the same data as Schady (2011) in order to analyze the socioeconomic status (SES) gradients in test scores for children between 3 and 6 years of age. This gradients refer to the fact that when children are 3 years old they all seem to have the same level of cognitive skills regardless of their socioeconomic background but when they turn six there SES seems to determine the stock of such skills. The authors find that find that variation in parental education is one of the reasons why this gaps emerge and suggest channels through which this might be operating such as parental investments and family environment.

Helmers and Patnam (2011) use the Young Lives dataset for the Indian region of Andhra Pradesh in order to understand the process of skill formation in the context of a developing country. The authors basically get reduced form estimates of a technology of

[2] A test of verbal IQ that will be described in the next section

[3] The tests analyzed were the Peabody Picture Vocabulary Test, Woodcok-Johnson-Munoz of Memory, Visual Integration, Math and Numeric Series

skill formation that allows for some of the empirical findings in Cunha et al. (2006) such as dynamic complementarities and self productivity. One of the channels the authors analyze is education of the children's primary caretaker which in more than 90% of the cases is the biological mother. In a variance decomposition analysis they find that around 86.5% of the possible measurement error on children's cognitive development is explained by this variable.

Despite there being substantive evidence suggesting a positive relation between maternal education and children's cognitive ability, there is some evidence pointing out that this relationship might not exist. Black, Devereux, and Salvanes (2005) use changes in educational policies in Norway in order to instrument parental education and asses the relationship between this variable and children's schooling. They find only a modest effect of mother's education on their son's schooling level but they consider it to be irrelevant.

In their influential study, Behrman and Rosenzweig (2002) find a negative effect of maternal education on children's educational level but a positive and statistically significant effect of father's schooling. The authors use data on monozygotic twins in order to control for any possible heritable traits. Although in both cases there is no evidence of positive correlation between maternal and child's schooling it is not evident how this maps directly to effects on cognitive ability, and there is much debate about the reliability of their estimates (Antonovics & Goldberger, 2005).

It seems that regardless of the methodology implemented there is a positive relationship between maternal education and cognitive skills in young children. This fact seems to hold in both, developed and developing countries. For the purpose of this study I will solely focus on the impact of maternal education rather than taking information on fathers also. This is a common approach in the literature (Rosenzweig and Wolpin (1994), Carneiro et al. (2013)) and studies analyzing the effect of mothers' and fathers' education on children's cognitive achievement have found that once controlling for maternal education, father's years of schooling becomes irrelevant Schady (2011). This is due to the fact that in most of the cases it the primary caretaker. Alternatively, due to assortative mating the estimated results can be interpreted as the total of parental education.

# 3 Data

I will use the Young Lives dataset. Young Lives is a project intended to follow and study children living in poverty in four different developing countries: Peru, India (Andhra Pradesh)[4], Ethiopia and Vietnam. The baseline survey was taken in 2002 for children when they were approximately 1 year old. Subsequent waves were taken in 2006 and 2009. The surveys contain detailed information on household members demographics, dwelling characteristics and children's cognitive development. For the purpose of this study I will use the 2006 wave as this was the first one to implement the Peabody Picture Vocabulary Test (PPVT), the instrument I will use to asses children's cognitive development.

In this wave children were approximately 5 years old and there are a total of 7,360 children in the sample (1,861 in Ethiopia, 1,851 in India, 1,745 in Vietnam and 1,903 in Peru). In Figure 1 I present the distribution of ages for each country. As can be seen, most of the children are between 55 and 70 months of age averaging 63, conforming a relatively homogeneous group. This is an important feature of the data as the process of skill formation varies with age. Information on maternal education can be found on Tables 1 and 2. As can be seen, maternal levels of education are very low in India and Ethiopia: more than 50% of the sample have no education at all and no more than 10% of the sample have more than secondary schooling. The case is less dramatic in Vietnam, where 11% have no education at all and 11% of the sample have done some post-secondary education. Peru has the best situation in terms of maternal years of education: only 8% of the sample have no education at all and 40% have completed secondary education.

As stated previously, I will use the PPVT as an instrument to measure cognitive development. The PPVT is a test trying to asses the level of verbal intelligence and is a strong predictor of general cognitive skills in young children Heckman, Pinto, and Savelyev (2012) and of adult life outcomes such as labor market opportunities, health status and engagement in risky behaviors[5]. It has been widely used in several studies in developed and in developing countries[6]. The test consists of a series of slides shown to the child. Each slide contains four different pictures. The person administering the test mentions one

[4]The survey in India was taken only in state of Andhra Pradesh. Even though it was taken in this region, throughout the article I will refer to this sample as the Indian survey

[5]See for example Currie and Thomas (1999), Carneiro, Crawford, and Goodman (2003)

[6]for the case of developed countries see for example Cunha, Heckman, and Schennach (2010) and Heckman et al. (2012), Rosenzweig and Wolpin (1994). In developing countries see Helmers and Patnam (2011), Schady (2011), Paxson and Schady (2007), Paxson and Schady (2010) and also an extensive list of studies can be in the Young Lives Website

word that corresponds to only one of the pictures in the slide and the child has to choose the picture he thinks suites the best for the word. In Figure 2 the first slide is presented. The child should identify the word "doll" and point at it. There are two warm-up items before the test begins and it stops after six consecutive mistakes. The total raw score is the number of correct answers in the test. Figure 3 reports the distribution of this test-scores in the sample. Evidently, older children have higher levels of verbal intelligence. In order to control for this, I standardize the test for each age group and country. The score should be interpreted as the amount of standard deviations each child scores above/below the mean of it's age group (in months) for each country, a practice that has been previously used (Schady et al. (2012) and Rosenzweig and Wolpin (1994)).

## 4 Maternal education and children's cognitive development

The main question I try to answer in this article is what can we say about the relationship between maternal education and children's cognitive development and how this inference varies as we make different assumptions. First of all, it is important to point out that in the sample most of the children's primary caregiver are their mothers: 90.95% in Ethiopia, 97.44% in India, 95.06% in Peru and 92.23% in Vietnam. Now, as a preliminary exercise I divide the sample between those children whose mother completed primary education and those whose mother have no formal education at all. Figure 4 reports kernel density estimates for the distribution of the PPVT scores between these two groups. In each of the four countries it is evident that the distribution of mothers with complete primary or more first order stochastically dominates that of mothers with no education at all. In Tables 3 and 4 I extend this preliminary evidence by reporting mean PPVT scores by level of maternal education. It is evident that there is an increasing trend.

Even though these evidence suggests a positive relationship between maternal education and children's cognitive development we have to be careful in the analysis: mothers with more education are systematically different in unobserved manners that might also affect children's cognitive outcomes. In order to control for this issue I will use the methodology proposed by C. Manski (1997) and C. Manski and Pepper (2000). Of course if I want to deal with the endogeneity by using weaker assumptions, I have to incur a cost that comes in terms of identification: I no longer get point estimates on the impact of maternal education on children's cognitive outcomes but rather bounds on these impacts. The analysis I will perform consists on making a set of assumptions, from the weakest to the

strongest, and see the identifying power of each of them [7]. I begin by defining the relevant variables for the analysis. Given observations of $j = 1...J$ children, we have:

$$
\begin{aligned}
z_j &: \text{Realized years of maternal education for individual } j \\
t &: \text{Level of treatment-years of maternal schooling education} \\
T &: \text{Set of possible treatment levels-possible maternal years of education} \\
y_j(.) : T \to Y &: \text{Response function of cognitive development as a function of maternal years of schooling} \\
y_j &: \text{Realized level of cognitive development } y_j = y_j(z_j) \\
x = (w, v) &: \text{Other covariates such as gender, SES, migration, among others}
\end{aligned}
$$

Where $(w, v) \in W \times V$. We are interested in the function $E[y(t)]$ and also on $\Delta(s,t) = E[y(t)] - E[y(s)]$ where $s < t$. The main problem with obtaining estimates for this functions that we do not observe the counterfactual $y_j(t)$ whenever $t \neq z_j$. That is, we do not observe how the cognitive development of a child would be had his mother had $t$ years of schooling instead of $z_j$. Note that:

$$E[y(t)] = E[y(t)|z = t]P(z = t) + E[y(t)|z \neq t]P(z \neq t) \tag{1}$$

from the data we can observe everything relevant to equation (1) except for $E[y(t)|z \neq t]$. Then, the first assumption I will make is to assume boundedness on the response function, $y(t)$.

**Assumption B1.** Bounded response

$$y(t) \in [K_0, K_1]; \forall t \in T$$

for $K_0 \neq -\infty; K_1 \neq \infty$. As bounds in this case I will assume that test scores can't be more than 3 standard deviations from the mean: $[K_0, K_1] = [-3, 3]$. In all of the four countries more than 98% of the sample have scores within these bounds. In all the studies revised, the highest impact of a year of schooling on a test score is of 0.13 standard deviations (Carneiro et al., 2013). This is similar to the case of Gonzalez (2005) where

[7] This is an exercise very similar to that of Gonzalez (2005) where the author analyzes the labor market returns of language skills for a sample of immigrant workers in the US

a bound on the outcome is imposed for practical reasons. Assuming then that a child whose mother have no education scores three standard deviations below the mean, and interpreting the estimates of 0.13 as a causal effect of maternal schooling on children's test, the mother will need 50 years of education so that the child scores three standard deviations above the mean. Then, if anything, the bounds between -3 and 3 are generous on the possible impact of maternal education on test scores. This is consistent also with the preliminary evidence on the distribution of PPVT scores reported in Tables 1 and 2 and in Figure 1. Thus, by omitting scores outside these bounds I am basically taking out outliers and measurement errors[8].

Assumption B1 is weak but yet it provide some useful information on the function $E[y(t)]$. The lowest possible estimate for $E[y(t)]$ is assuming everybody except people with $z = t$ have an impact of $K_0$, the upper bound is given by the assumption that everyone except those with $z = t$ have an impact equivalent to $K_1$:

$$\begin{aligned} & E[y(t)|t = z]P(t = z) + K_0 P(t \neq z) \\ & \leq E[y(t)] \leq \\ & E[y(t)|t = z]P(t = z) + K_1 P(t \neq z) \end{aligned} \tag{2}$$

This is what C. Manski (1997) calls the worst case bounds. If no further assumptions are imposed this is all we can say about $E[y(t)]$ which, in general, is not very informative. In table 5 I report the estimates for this case. Although the width of the bounds are very large, we can see that for low education these bounds are skewed to the left while for higher levels they are to the right. This is some emerging evidence of the positive correlation between maternal education and children's cognitive development. In Table 6 I report 95% confidence intervals for these bounds obtained via bootstrap. In table 7 I report estimates of the worst case bounds by categories of maternal education. This simplifies the analysis and makes it easier to see that amongst those with lowest education the bounds are shifted to the left, contrary to those with higher education. Table 8 reports the 95%

[8] In addition, although there are no physical bounds on the possible test scores the practice of assuming reasonable bounds on these sort of scenarios have been also implemented. For instance Gonzalez (2005) imposes bounds on the log of wages for immigrant workers.

confidence interval for these categories

An intuitive lower bound for $\Delta(s,t)$ is given by the difference when $E[y(s)]$ is set at it's upper bound and $E[y(t)]$ at it's lower bound. Similar analysis for the upper bound and so we get.

$$E[y(t)|t=z]P(t=z) + K_0 P(t \neq z) - E[y(s)|s=z]P(s=z) - K_1 P(s \neq z)$$

$$\leq \Delta(s,t) \leq$$

$$E[y(t)|t=z]P(t=z) + K_1 P(t \neq z) - E[y(s)|s=z]P(s=z) - K_0 P(s \neq z)$$

These estimates can be found in Table 9 and it's 95% confidence intervals in Table 10.

As stated previously, these bounds are in general not very informative. Now, to get more information on the impact of maternal education on children's cognitive development I will begin to make some assumptions. First of all, I wil assume Monotone Treatment Response (MTR) as introduced by C. Manski (1997):

**Assumption MTR.** Monotone Treatment Response

$$t_2 \geq t_1 \rightarrow y_j(t_2) \geq y_j(t_1)$$

This basically states that the outcome $y$ is weakly increasing in the treatment $t$ at all points. In this case, assumption MTR is equivalent to say that parental education does not reduce the stock of cognitive abilities of children. This is a fairly intuitive assumption as there is no reason to suppose more educated parents will have disadvantaged children in terms of cognitive outcomes. Now, note that we can get a more descriptive bound on $E[y(t)]$ under this assumption. In order to get a lower bound, we will use the information of those with $z < t$ and for the upper bound we will use the information of those with $z \geq t$:

$$K_0 P(t < z) + E[y|t \geq z]P(t \geq z)$$

$$\leq E[y(t)] \leq$$

$$K_1 P(t > z) + E[y|t \leq z]P(t \leq z) \tag{3}$$

Part, but not all the derivation, is reported in corollary M1.2 in C. Manski (1997). For the sake of the clarity of how to get the bounds I will proof that under MTR we get the bounds implied in equation 3. Define:

$$y_{o,j}(t) = \begin{cases} y_j \text{ if } t \geq z_j \\ K_0 \text{ otherwise} \end{cases}$$

$$y_{1,j}(t) = \begin{cases} y_j \text{ if } t \leq z_j \\ K_1 \text{ otherwise} \end{cases}$$

And so:

$$y_{0,j}(t) \leq y_j(t) \leq y_{1,j}(t)$$

$$\sum_t P(t) y_{0,j}(t) \leq \sum_t P(t) y_j(t) \leq \sum_t P(t) y_{1,j}(t) \tag{4}$$

Where $P(t)$ represents the probability of receive treatment level $t$. $P(t) = P(z = t)$.

Now, note that the MTR assumption together with the boundedness of $y_j(t)$ imply that:

$$t < z_j \rightarrow K_0 \leq y_j(t) \leq y_j \tag{5}$$

$$t = z_j \rightarrow y_j(t) = y_j \tag{6}$$

$$t > z_j \rightarrow K_1 \geq y_j(t) \geq y_j \tag{7}$$

Then, using conditions 5-7 into 4 we get the expression described in 3. Table 11 reports the estimates of maternal schooling on children's test scores under this assumption. Note that we get more informative bounds. For instance, for mothers with no education the whole interval is pretty much on the negative part of the real line whereas for those mothers with 13 years of schooling or more it becomes evident that the impact is positive. Table 12 reports 95% confidence intervals for these bounds and Tables 13 and 14 report the bounds when we separate mothers by categories.

Under assumption MTR I can obtain a more precise bound on $\Delta(s,t) = E[y(t) - y(s)]$. The lowest possible difference occurs when $y(t) = y(s)$ as under the monotonicity assumption $y(s)$ can never exceed $y(t)$. Then, 0 is indeed a lower bound for $E[y(t) - y(s)]$. Now, the highest possible difference occurs when $y(t)$ attains its upper bound and $y(s)$ its lower bound. C. Manski (1997) formally proves that this bound is sharp:

$$0 \leq E[y(t) - y(s)] \leq$$

$$K_1 P(t > z) + E[y|t \leq z]P(t \leq z) - \{K_0 P(t < z) + E[y|t \geq z]P(t \geq z)\} \tag{8}$$

Tables 15 and 16 report bounds and 95% confidence intervals, respectively, for the difference in categories. It becomes every time more evident that there is indeed a positive correlation between maternal schooling and children's cognitive development.

Now, in order to get more descriptive bounds I will use the methodology of Monotone Instrumental Variables proposed in (C. Manski & Pepper, 2000). In principle, we call a covariate $v \in V$ an instrumental variable in the sense of mean-independence if, $\forall t \in T, \forall w$:

**Assumption IV.**

$$E[y(t)|w, v = u'] = E[y(t)|w, v = u]; \forall (u, u') \in (V \times V) \tag{9}$$

Now, the Monotone Instrumental Variable assumption proposed in C. Manski and Pepper (2000) is weaker than IV, it just assumes that the function $E[y(t)]$is non-decreasing in $v$ for any $w$:

**Assumption MIV.**

$$u_2 \geq u_1 \rightarrow E[y(t)|w, v = u_2] \geq E[y(t)|w, v = u_1] \tag{10}$$

A special case of MIV is given when the instrument selected is the amount of treatment received $z$. This is the so called Monotone Treatment Selection assumption:

(11)

**Assumption MTS.** Monotone Treatment Selection

$$u_2 \geq u_1 \rightarrow E[y(t)|z = u_2] \geq E[y(t)|z = u_1]$$

Assumption MTS states that the same level of parental schooling $t$ will not have a lower expected cognitive development among those children who have more educated parents. In other words, the function $E[y(t)]$ for children with higher levels of maternal education will never lie below that of children with lower levels of maternal education. I argue this is an unquestionable assumption as more educated parents have also higher levels of unobserved ability, more aware of the benefits of education, among many others, all factors that might affect positively the process of skill formation. Moreover, this is the whole issue of the endogeneity of maternal education: parents with more education differ in unobserved ways that do have a positive impact on children's cognitive skills. Under MTS C. Manski and Pepper (2000) show that we can bound $E[y(t)]$ as follows:

$$\begin{aligned} & K_0 p(z < t) + E[y|z = t]P(z \geq t) \\ & \leq E[y(t)] \leq \\ & K_1 P(z > t) + E[y|z = t]P(z \leq t) \end{aligned} \tag{12}$$

The estimates of the MTS assumption are found between tables 17 to 22. Note that in the case of the lower bounds for $\Delta(s,t)$ we no longer can bound this by zero because we are now allowing this to be negative, contrary to the case of MTR. Because of this, in Table 21 I include estimates of the lower bound of the difference together with its 95% confidence interval in Table 22.

Now, note that assumptions MTR and MTS are informative only if the outcome is bounded. However, when combined these assumptions are informative of the response

function $E[y(t)]$ even when the possible outcome is not bounded. As shown in Proposition 2, Corollary 2 in C. Manski and Pepper (2000), we can get bounds on $E[y(t)]$ when both MTR and MTS in the following way:

$$\sum_{u<t} E[y|z=u]P(z=u) + E[y|z=t)P(z \geq t)$$

$$\leq E[y(t)] \leq$$

$$\sum_{u>t} E[y|z=u]P(z=u) + E[y|z=t)P(z \geq t) \tag{13}$$

In addition, we might be interested in how counterfactuals of the form:

$$\Delta(s,t) = E[y(t)] - E[y(s)] \tag{14}$$

Under the pair of assumptions MTR-MTS we can get an upper bound on $\Delta(s,t)$ by setting $E[y(t)]$ to be at its lower bound and $E[y(s)]$ at its upper bound.

As we know:

$$E[y(t)] \geq \sum_{u<t} E[y|z=u]P(z=u) + E[y|z=t)P(z \geq t) \tag{15}$$

and

$$E[y(s)] \leq \sum_{u>s} E[y|z=u]P(z=u) + E[y|z=s]P(z \geq s) \tag{16}$$

Thus, combining (15) and (16) we can get a lower bound for (14):

$$\Delta(s,t) \geq \left[\sum_{u<t} E[y|z=u]P[z=u] + E[y|z=t]P[z\geq t]\right] - \left[\sum_{u>s} E[y|z=u]P[z=u] + E[y|z=s]P[z\leq s]\right] \quad (17)$$

The estimates can be found in tables 23-28. As can be seen, compared to the worst case, MTR or MTS bounds these are much more informative. There is indeed a pronounced difference on the impact of schooling for lower levels and higher of maternal education. As shown by C. Manski and Pepper (2000), the MTR-MTS assumptions are testable as long as $E[y|z]$ is increasing in $z$. This can be seen in tables 3 and 4 as PPVT scores are increasing with maternal education.

## 5 Further steps

So far we have analyzed the identifying power of the different assumptions presented in C. Manski (1997) and C. Manski and Pepper (2000) in the context of how maternal education might affect the process of construction of cognitive skills. In order to proceed with this research it is necessary to incorporate certain methodological aspects.

First of all, I should allow for heterogeneous effects of maternal education. It is a well established fact that the process of skill formation depends not only on the age of the child but also on it's gender (Cunha et al., 2006). For instance, Carneiro et al. (2013) find that the relationship between children's cognitive skills and maternal educational attainment is stronger in girls than in boys and this heterogeneity is stronger in non-minority groups (i.e. excluding black and hispanics in the NLSY97 dataset). Black et al. (2005), on the other hand, find that the relationship between maternal education and children's educational attainment is stronger in boys than in girls. Although years of schooling is not a direct measure of cognitive ability, it might indeed suggest that there is some sort of heterogeneous effects according to gender. Even though these two results suggest opposite effects, this is indeed evidence that inputs into the production function of cognitive skills have heterogeneous impacts according to genders.

In addition to this, I should also allow for more covariates. It might be the case that the effect of education on children's cognitive skills disappears once we control for

wealth level. This would imply that the only channel through which maternal education modifies the process of skill formation is via having more resources to invest on children. In terms of policy design, it implies that in order to raise children's cognitive achievement it is probably more efficient to give direct monetary transfer to households rather than to develop aggressive policies intended to increase maternal education. In his influential study, Sacerdote (2002) finds in a sample of adoptees children that once a control for Socio-Economic-Status indicator is included father's education has virtually no effect on children's educational outcomes. The results could potentially indicate that the channel through which education affects children's outcome is only through resources. This should be further analyzed by including more sociodemographic covariates.

Even though we explored the identifying power of most of the assumptions suggested in C. Manski and Pepper (2000) and C. Manski (1997), there are still some that I didn't include in the analysis. For instance, monotone concavity is an assumption made in C. Manski (1997) and basically states that there are diminishing marginal returns to the treatment. In the context of this paper it will imply that a year of education increases children's cognitive achievement but the marginal increase decreases with education. This is a stronger assumption than MTR and thus it's identifying power is stronger[9].

In this specific point it is not evident that the monotone concavity is an assumption one is willing to make. There is some evidence suggesting that marginal returns to education might possibly be linear in several outcomes (see Heckman and Polachek (1974), Card and Krueger (1992) and Card (1995)).However, even if this assumption does not hold, the exercise of assuming monotone concavity might give some insights on it's identification power even when one does not suggest to assume it in this context. The exercise estimating parameters when an assumption rarely holds in the data is commonly used in the literature of identification analysis in order to provide some idea on the gains of identification of such assumption. Examples of this can be found in C. F. Manski and Pepper (2009) analyzing the Homogeneous Linear Response assumption (HLR) and in Aradillas-Lopez and Tamer (2008) when analyzing level-$k$ rationality.

In addition to this it will be also important to analyze the identifying power of combinations of assumptions. In a preliminary exercise I tried to analyze the the combination of MTS and monotone concavity but when imposed together, my conclusion is that the identifying power is the same as that as imposing MTR and MTS together. An additional

[9]Figure 3 in C. Manski (1997) gives a neat explanation on how the identifying power of monotone concavity is superior to that of MTR.

exercise in this point is to impose MTR-MTS and MIV. Although MTS is a special case of MIV, we can impose the three of them altogether when a monotone instrumental variable different to the treatment is used. The three assumptions have extra identifying power than the pair MTR-MTS and has been previously done in the literature (Gonzalez, 2005).

# 6 Conclusions

In this article I try to answer the question on how maternal education and children's cognitive development are related. Even though this question has been addressed previously I make two important contributions to the existing literature. On the one hand, I estimate this relationship using a methodology that has never been used in this context. The assumptions made throughout the article are much weaker than the usual restrictions imposed in existing studies. However, the cost of having weaker conditions translates into expanding the identification region. Second, I use data from developing countries, a fact that is not common in this type of research.

Even though I do not get point estimates on the relationship between maternal education and children's cognitive development, the bounds I get are consistent with previous findings in the literature. First of all, it becomes evident that there is indeed a positive correlation between these two variables: more educated mothers have indeed children with a higher stock of cognitive abilities. In addition to this, the point estimates found in the literature, equivalent to an increase between 0.05 and 0.12 standard deviations on the test score, are included in all the identification regions developed in this article. We should be careful on how to interpret these results: even though we estimate bounds on the relationship between maternal education and children's cognitive development we should not interpret these as the causal effect of maternal education on children's skills, as is often interpreted in the literature.

Future research should focus on the mechanisms through which maternal education might modify the process of skill formation. It is evident that there is a positive relationship between both variables but we need to identify the causal relationship between both and the fundamental causes of this behavior. Similarly, heterogenous impacts should be considered: it might be the case that boys benefit less from maternal education when compared to girls, for example.

Econometric theory provides new methodologies and estimators and in many cases we lack applications of such innovations.The pace of new developments in econometric theory

exceeds the rate at which these methodologies are being implemented in empirical applications. In this article I develop an empirical application for the methodologies proposed in C. Manski (1997) and C. Manski and Pepper (2000), giving new econometric techniques an empirical application.

# 7 Figures and Tables

Figure 1: Distribution of ages in months

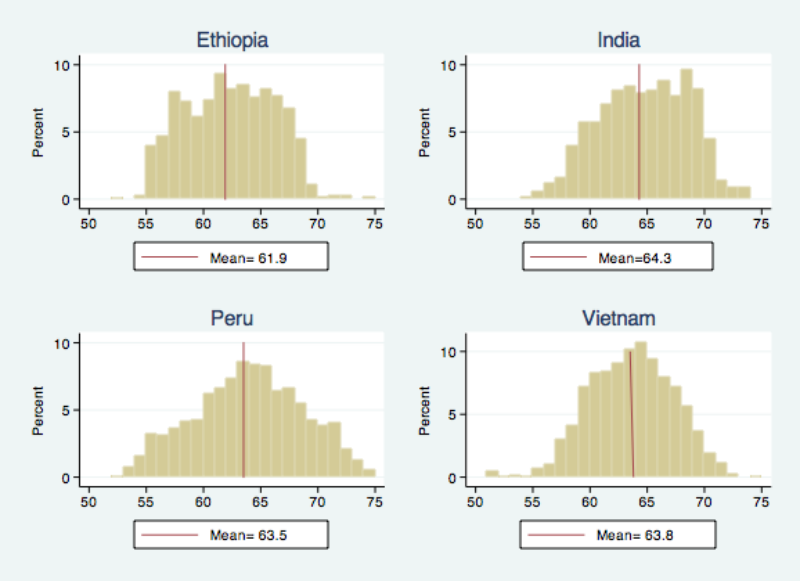

Figure 2: First slide of the test (PPVT)

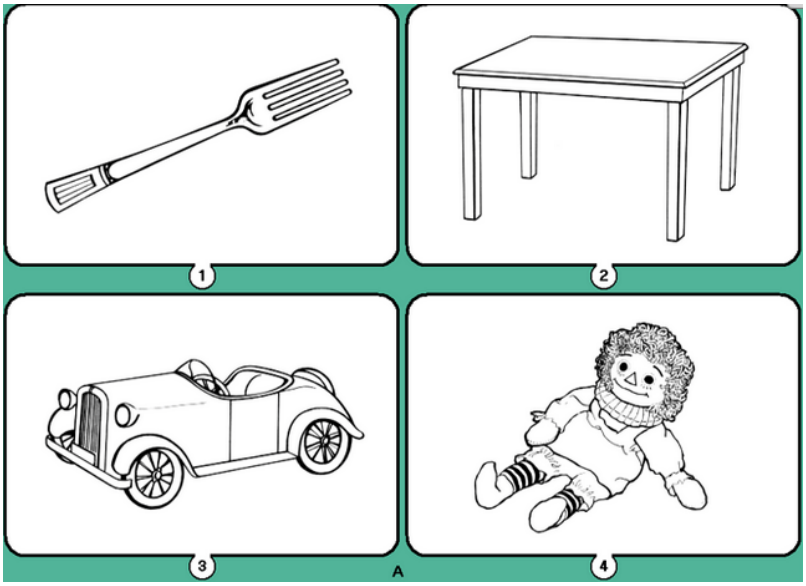


Figure 3: Distribution of PPVT raw score in sample

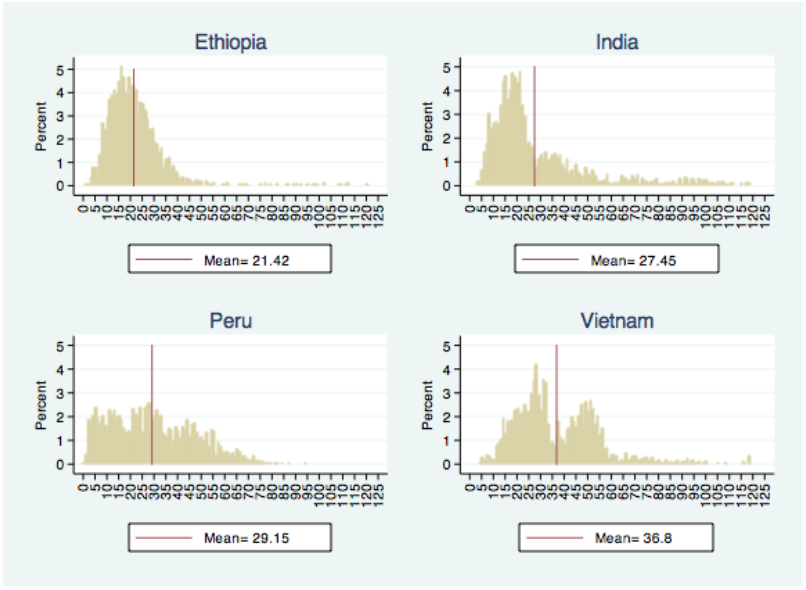

Figure 4: Distribution of scores and Maternal education

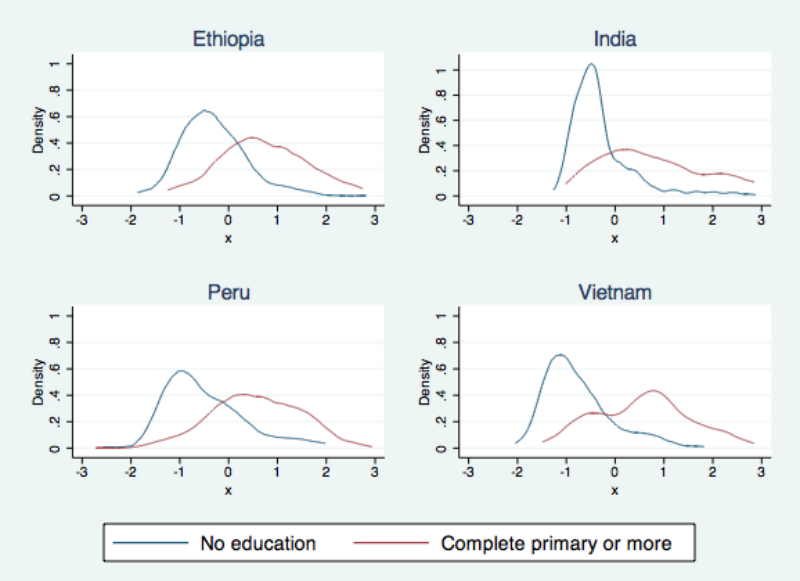

Table 1: Distribution of maternal years of schooling (%)

| **Years of schooling** | **Ethiopia** | **India** | **Peru** | **Vietnam** |
|---|---|---|---|---|
| 0 | 56.90 | 53.01 | 7.86 | 10.96 |
| 1 | 1.64 | 0.27 | 2.48 | 1.03 |
| 2 | 3.45 | 2.06 | 3.64 | 3.10 |
| 3 | 4.55 | 2.23 | 5.54 | 3.04 |
| 4 | 3.83 | 2.44 | 4.12 | 5.34 |
| 5 | 3.61 | 7.55 | 3.75 | 12.05 |
| 6 | 4.38 | 2.55 | 14.88 | 9.06 |
| 7 | 3.50 | 5.92 | 3.06 | 8.15 |
| 8 | 4.60 | 1.47 | 4.43 | 4.88 |
| 9 | 2.19 | 4.40 | 5.91 | 21.63 |
| 10 | 2.79 | 10.43 | 3.54 | 1.84 |
| 11 | 0.22 | 0.16 | 18.36 | 1.78 |
| 12 | 3.40 | 2.61 | 5.12 | 6.43 |
| 13 | 1.31 | 0.54 | 8.18 | 2.87 |
| 14 | 0.60 | 2.77 | 1.79 | 4.13 |
| 15 | 0.00 | 0.00 | 3.27 | 0.00 |
| 16 | 0.00 | 0.00 | 0.11 | 0.00 |
| 17 | 0.00 | 0.00 | 0.16 | 0.00 |
| NA | 3.01 | 1.58 | 3.80 | 3.80 |

Table 2: Maternal education by category (%)

| **Category** | **Ethiopia** | **India** | **Peru** | **Vietnam** |
|---|---|---|---|---|
| None | 56.90 | 53.01 | 7.86 | 10.96 |
| Incomplete Primary | 24.97 | 7.01 | 19.53 | 12.51 |
| Complete Primary | 4.60 | 7.55 | 14.88 | 12.05 |
| Incomplete Secondary | 5.20 | 24.93 | 16.94 | 47.33 |
| Complete Secondary | 3.40 | 2.61 | 18.36 | 6.43 |
| Post-Secondary | 4.93 | 4.89 | 22.43 | 10.73 |

Categories of education by years of schooling are: 1. Primary schooling (Ethiopia: 8, India: 5, Peru: 6 and Vietnam: 5). 2. Secondary schooling (Ethiopia, India and Vietnam: 12; Peru: 11).

Table 3: PPVT score by years of maternal education

| Years of schooling | Ethiopia | India | Peru | Vietnam |
|---|---|---|---|---|
| 0 | -0.30 | -0.28 | -0.49 | -0.76 |
| 1 | -0.15 | 0.59 | -0.75 | -0.55 |
| 2 | -0.02 | -0.19 | -0.51 | -0.56 |
| 3 | 0.09 | -0.24 | -0.56 | -0.41 |
| 4 | 0.09 | 0.17 | -0.33 | -0.17 |
| 5 | 0.12 | 0.07 | -0.58 | -0.11 |
| 6 | 0.28 | 0.13 | -0.36 | -0.04 |
| 7 | 0.39 | 0.24 | 0.03 | -0.07 |
| 8 | 0.66 | 0.01 | -0.06 | 0.02 |
| 9 | 0.82 | 0.23 | -0.04 | 0.22 |
| 10 | 0.68 | 0.55 | -0.15 | 0.19 |
| 11 | 0.83 | 1.80 | 0.32 | 0.44 |
| 12 | 1.30 | 0.52 | 0.57 | 0.32 |
| 13 | 0.71 | 0.78 | 0.84 | 1.18 |
| 14 | 1.81 | 1.50 | 1.04 | 1.00 |
| 15 | | | 1.20 | |

Table 4: PPVT scores by maternal education: categories

| Years of schooling | Ethiopia | India | Peru | Vietnam |
|---|---|---|---|---|
| **No education** | -0.30 | -0.28 | -0.49 | -0.76 |
| **Some primary** | 0.14 | -0.05 | -0.53 | -0.36 |
| **Complete primary** | 0.66 | 0.07 | -0.36 | -0.11 |
| **Some secondary** | 0.74 | 0.35 | -0.06 | 0.11 |
| **Secondary or more** | 1.21 | 1.00 | 0.58 | 0.71 |

Table 5: Worst case bounds estimates

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -1.41 | 1.07 | -1.53 | 1.23 | -2.79 | 2.71 | -2.75 | 2.58 |
| 1 | -2.95 | 2.95 | -2.99 | 2.99 | -2.94 | 2.90 | -2.98 | 2.97 |
| 2 | -2.89 | 2.89 | -2.94 | 2.93 | -2.91 | 2.87 | -2.92 | 2.88 |
| 3 | -2.86 | 2.86 | -2.94 | 2.93 | -2.86 | 2.80 | -2.92 | 2.89 |
| 4 | -2.88 | 2.88 | -2.92 | 2.93 | -2.89 | 2.86 | -2.84 | 2.82 |
| 5 | -2.89 | 2.89 | -2.76 | 2.78 | -2.91 | 2.86 | -2.64 | 2.61 |
| 6 | -2.85 | 2.88 | -2.92 | 2.93 | -2.59 | 2.48 | -2.72 | 2.71 |
| 7 | -2.88 | 2.91 | -2.81 | 2.84 | -2.90 | 2.91 | -2.75 | 2.74 |
| 8 | -2.83 | 2.89 | -2.96 | 2.96 | -2.86 | 2.86 | -2.85 | 2.85 |
| 9 | -2.91 | 2.95 | -2.86 | 2.88 | -2.82 | 2.81 | -2.27 | 2.37 |
| 10 | -2.89 | 2.93 | -2.62 | 2.74 | -2.90 | 2.88 | -2.94 | 2.95 |
| 11 | -2.99 | 3.00 | -2.99 | 3.00 | -2.37 | 2.49 | -2.94 | 2.95 |
| 12 | -2.85 | 2.94 | -2.91 | 2.93 | -3.00 | 3.00 | -2.78 | 2.82 |
| 13 | -2.95 | 2.97 | -2.98 | 2.99 | -2.81 | 2.87 | -2.88 | 2.95 |
| 14 | -2.97 | 2.99 | -2.87 | 2.96 | -2.67 | 2.82 | -2.83 | 2.91 |
| 15 | | | | | -2.92 | 2.96 | | |
| 16 | | | | | -2.86 | 2.94 | | |
| 17 | | | | | -3.00 | 3.00 | | |

Table 6: 95% CI worst case bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -1.47 | 1.13 | -1.59 | 1.30 | -2.82 | 2.75 | -2.78 | 2.62 |
| 1 | -2.97 | 2.96 | -3.00 | 3.00 | -2.96 | 2.93 | -2.99 | 2.98 |
| 2 | -2.92 | 2.92 | -2.96 | 2.95 | -2.92 | 2.89 | -2.94 | 2.91 |
| 3 | -2.88 | 2.89 | -2.95 | 2.95 | -2.88 | 2.83 | -2.94 | 2.92 |
| 4 | -2.90 | 2.91 | -2.94 | 2.95 | -2.91 | 2.88 | -2.87 | 2.85 |
| 5 | -2.91 | 2.92 | -2.80 | 2.81 | -2.92 | 2.89 | -2.68 | 2.65 |
| 6 | -2.88 | 2.90 | -2.94 | 2.94 | -2.63 | 2.53 | -2.76 | 2.75 |
| 7 | -2.90 | 2.93 | -2.84 | 2.86 | -2.92 | 2.93 | -2.79 | 2.78 |
| 8 | -2.86 | 2.91 | -2.97 | 2.97 | -2.89 | 2.88 | -2.87 | 2.88 |
| 9 | -2.94 | 2.97 | -2.88 | 2.90 | -2.85 | 2.84 | -2.33 | 2.42 |
| 10 | -2.92 | 2.95 | -2.67 | 2.77 | -2.92 | 2.91 | -2.96 | 2.96 |
| 11 | -3.00 | 3.00 | -3.00 | 3.00 | -2.42 | 2.53 | -2.95 | 2.97 |
| 12 | -2.88 | 2.96 | -2.93 | 2.95 | -3.00 | 3.00 | -2.81 | 2.85 |
| 13 | -2.97 | 2.98 | -2.99 | 2.99 | -2.84 | 2.89 | -2.91 | 2.96 |
| 14 | -2.99 | 3.00 | -2.90 | 2.97 | -2.71 | 2.84 | -2.86 | 2.93 |
| 15 | | | | | -2.95 | 2.97 | | |
| 16 | | | | | -2.89 | 2.95 | | |
| 17 | | | | | -3.00 | 3.00 | | |

Table 7: Worst case bounds estimates by categories

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -1.41 | 1.07 | -1.53 | 1.23 | -2.79 | 2.71 | -2.75 | 2.58 |
| Some primary | -2.19 | 2.27 | -2.99 | 2.99 | -2.94 | 2.90 | -2.98 | 2.97 |
| Complete primary | -2.83 | 2.89 | -2.94 | 2.93 | -2.91 | 2.87 | -2.92 | 2.88 |
| Some secondary | -2.80 | 2.88 | -2.94 | 2.93 | -2.86 | 2.80 | -2.92 | 2.89 |
| Secondary or more | -2.77 | 2.90 | -2.92 | 2.93 | -2.89 | 2.86 | -2.84 | 2.82 |

Table 8: Worst case bounds 95% CI

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -1.47 | 1.13 | -1.59 | 1.30 | -2.82 | 2.75 | -2.78 | 2.62 |
| Some primary | -2.25 | 2.32 | -3.00 | 3.00 | -2.96 | 2.93 | -2.99 | 2.98 |
| Complete primary | -2.86 | 2.91 | -2.96 | 2.95 | -2.92 | 2.89 | -2.94 | 2.91 |
| Some secondary | -2.83 | 2.90 | -2.95 | 2.95 | -2.88 | 2.83 | -2.94 | 2.92 |
| Secondary or more | -2.81 | 2.92 | -2.94 | 2.95 | -2.91 | 2.88 | -2.87 | 2.85 |

Table 9: Worst case bounds differences
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -3.26 | -3.89 | -3.86 | -3.83 | 3.68 | 4.30 | 4.29 | 4.31 |
| Some primary | | -5.09 | -5.06 | -5.03 | | 5.08 | 5.07 | 5.10 |
| Complete primary | | | -5.69 | -5.66 | | | 5.71 | 5.73 |
| Some secondary | | | | -5.65 | | | | 5.70 |

| **INDIA** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -4.02 | -4.00 | -3.39 | -3.99 | 4.31 | 4.31 | 3.86 | 4.41 |
| Some primary | | -5.55 | -4.94 | -5.54 | | 5.57 | 5.12 | 5.67 |
| Complete primary | | | -4.93 | -5.53 | | | 5.09 | 5.64 |
| Some secondary | | | | -5.09 | | | | 5.03 |

| **PERU** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -5.21 | -5.31 | -5.20 | -4.34 | 5.08 | 5.28 | 5.26 | 4.86 |
| Some primary | | -4.88 | -4.77 | -3.90 | | 4.98 | 4.96 | 4.57 |
| Complete primary | | | -4.96 | -4.10 | | | 5.05 | 4.66 |
| Some secondary | | | | -4.08 | | | | 4.55 |

| **VIETNAM** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -5.23 | -5.21 | -4.04 | -5.06 | 5.31 | 5.36 | 4.32 | 5.43 |
| Some primary | | -5.20 | -4.03 | -5.05 | | 5.27 | 4.23 | 5.34 |
| Complete primary | | | -4.08 | -5.09 | | | 4.21 | 5.32 |
| Some secondary | | | | -4.06 | | | | 4.15 |

Table 10: Worst case bounds differences 95% CI
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA** | | | **LB** | | | | **LB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -3.31 | -3.96 | 3.93 | -3.90 | 3.72 | 4.36 | 4.35 | 4.37 |
| Some primary | | -5.15 | -5.12 | -5.09 | | 5.14 | 5.13 | 5.16 |
| Complete primary | | | -5.73 | -5.70 | | | 5.74 | 5.77 |
| Some secondary | | | | -5.69 | | | | 5.74 |
| **INDIA** | | | **LB** | | | | **LB** | |
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -4.09 | -4.06 | -3.45 | -4.06 | 4.37 | 4.36 | 3.91 | 4.47 |
| Some primary | | -5.59 | -5.00 | -5.59 | | 5.61 | 5.18 | 5.70 |
| Complete primary | | | -4.99 | -5.58 | | | 5.15 | 5.68 |
| Some secondary | | | | -5.15 | | | | 5.10 |
| **PERU** | | | **LB** | | | | **LB** | |
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -5.27 | -5.36 | -5.25 | -4.41 | 5.14 | 5.33 | 5.31 | 4.92 |
| Some primary | | -4.94 | -4.83 | -3.98 | | 5.04 | 5.02 | 4.62 |
| Complete primary | | | -5.02 | -4.17 | | | 5.11 | 4.72 |
| Some secondary | | | | -4.15 | | | | 4.61 |
| **VIETNAM** | | | **LB** | | | | **LB** | |
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -5.29 | -5.27 | -4.11 | -5.12 | 5.36 | 5.41 | 4.38 | 5.47 |
| Some primary | | -5.26 | -4.10 | -5.12 | | 5.32 | 4.30 | 5.39 |
| Complete primary | | | -4.15 | -5.16 | | | 4.28 | 5.37 |
| Some secondary | | | | -4.13 | | | | 4.21 |

Table 11: MTR bounds: Levels

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -1.41 | 0.00 | -1.53 | 0.00 | -2.79 | 0.01 | -2.75 | 0.01 |
| 1 | -1.36 | 1.93 | -1.52 | 1.77 | -2.74 | 0.30 | -2.72 | 0.43 |
| 2 | -1.26 | 1.99 | -1.46 | 1.77 | -2.64 | 0.39 | -2.64 | 0.47 |
| 3 | -1.11 | 2.10 | -1.40 | 1.84 | -2.50 | 0.53 | -2.56 | 0.58 |
| 4 | -0.99 | 2.23 | -1.32 | 1.91 | -2.39 | 0.73 | -2.41 | 0.69 |
| 5 | -0.88 | 2.35 | -1.09 | 1.98 | -2.29 | 0.87 | -2.04 | 0.86 |
| 6 | -0.73 | 2.45 | -1.00 | 2.21 | -1.89 | 1.01 | -1.76 | 1.26 |
| 7 | -0.61 | 2.58 | -0.81 | 2.28 | -1.79 | 1.53 | -1.52 | 1.54 |
| 8 | -0.43 | 2.67 | -0.77 | 2.45 | -1.65 | 1.63 | -1.36 | 1.80 |
| 9 | -0.35 | 2.78 | -0.62 | 2.49 | -1.47 | 1.77 | -0.64 | 1.95 |
| 10 | -0.24 | 2.83 | -0.25 | 2.62 | -1.37 | 1.95 | -0.57 | 2.58 |
| 11 | -0.23 | 2.90 | -0.24 | 2.88 | -0.73 | 2.07 | -0.51 | 2.63 |
| 12 | -0.08 | 2.90 | -0.15 | 2.88 | -0.73 | 2.58 | -0.29 | 2.68 |
| 13 | -0.03 | 2.96 | -0.12 | 2.95 | -0.54 | 2.58 | -0.17 | 2.86 |
| 14 | 0.00 | 2.99 | 0.00 | 2.96 | -0.22 | 2.71 | 0.01 | 2.91 |
| 15 | | | | | -0.14 | 2.90 | | |
| 16 | | | | | 0.00 | 2.93 | | |
| 17 | | | | | 0.01 | 3.00 | | |

Table 12: MTR CI bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -1.47 | 0.04 | -1.59 | 0.04 | -2.82 | 0.05 | -2.78 | 0.05 |
| 1 | -1.42 | 1.99 | -1.58 | 1.83 | -2.77 | 0.35 | -2.75 | 0.48 |
| 2 | -1.31 | 2.05 | -1.52 | 1.84 | -2.68 | 0.44 | -2.68 | 0.52 |
| 3 | -1.17 | 2.15 | -1.46 | 1.90 | -2.54 | 0.58 | -2.60 | 0.64 |
| 4 | -1.04 | 2.28 | -1.38 | 1.97 | -2.43 | 0.79 | -2.45 | 0.74 |
| 5 | -0.93 | 2.40 | -1.14 | 2.04 | -2.34 | 0.93 | -2.10 | 0.92 |
| 6 | -0.78 | 2.50 | -1.06 | 2.26 | -1.94 | 1.07 | -1.82 | 1.32 |
| 7 | -0.66 | 2.61 | -0.87 | 2.34 | -1.84 | 1.59 | -1.57 | 1.60 |
| 8 | -0.48 | 2.71 | -0.82 | 2.49 | -1.71 | 1.68 | -1.42 | 1.86 |
| 9 | -0.39 | 2.81 | -0.67 | 2.54 | -1.53 | 1.82 | -0.69 | 2.01 |
| 10 | -0.28 | 2.86 | -0.29 | 2.66 | -1.42 | 2.01 | -0.63 | 2.62 |
| 11 | -0.27 | 2.92 | -0.28 | 2.90 | -0.79 | 2.12 | -0.56 | 2.67 |
| 12 | -0.12 | 2.92 | -0.19 | 2.90 | -0.79 | 2.62 | -0.34 | 2.72 |
| 13 | -0.07 | 2.97 | -0.16 | 2.96 | -0.59 | 2.62 | -0.21 | 2.88 |
| 14 | -0.04 | 3.00 | -0.04 | 2.97 | -0.26 | 2.74 | -0.03 | 2.93 |
| 15 | | | | | -0.18 | 2.91 | | |
| 16 | | | | | -0.04 | 2.95 | | |
| 17 | | | | | -0.03 | 3.00 | | |

Table 13: MTR bounds: categories

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -1.41 | 0.00 | -1.53 | 0.00 | -2.79 | 0.01 | -2.75 | 0.01 |
| Some primary | -0.61 | 1.93 | -1.32 | 1.77 | -2.29 | 0.30 | -2.41 | 0.43 |
| Complete primary | -0.43 | 2.67 | -1.09 | 1.98 | -1.89 | 1.01 | -2.04 | 0.86 |
| Some secondary | -0.23 | 2.78 | -0.24 | 2.21 | -1.37 | 1.53 | -0.51 | 1.26 |
| Secondary or more | 0.00 | 2.90 | 0.00 | 2.88 | 0.01 | 2.07 | 0.01 | 2.68 |

Table 14: MTR bounds 95% CI

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -1.47 | 0.04 | -1.59 | 0.04 | -2.82 | 0.05 | -2.78 | 0.05 |
| Some primary | -0.66 | 1.99 | -1.38 | 1.83 | -2.34 | 0.34 | -2.45 | 0.48 |
| Complete primary | -0.48 | 2.71 | -1.14 | 2.04 | -1.94 | 1.07 | -2.10 | 0.93 |
| Some secondary | -0.27 | 2.81 | -0.28 | 2.26 | -1.42 | 1.59 | -0.57 | 1.32 |
| Secondary or more | -0.04 | 2.92 | -0.04 | 2.90 | -0.03 | 2.12 | -0.03 | 2.72 |

Table 15: MTR upper bounds on differences
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
|---|---|---|---|---|
| **No education** | 3.35 | 4.08 | 4.19 | 4.31 |
| **Some primary** | | 3.28 | 3.39 | 3.51 |
| **Complete primary** | | | 3.21 | 3.33 |
| **Some secondary** | | | | 3.13 |

| **INDIA (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
|---|---|---|---|---|
| **No education** | 3.30 | 3.52 | 3.74 | 4.41 |
| **Some primary** | | 3.31 | 3.53 | 4.20 |
| **Complete primary** | | | 3.30 | 3.97 |
| **Some secondary** | | | | 3.12 |

| **PERU (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
|---|---|---|---|---|
| **No education** | 3.09 | 3.81 | 4.33 | 4.86 |
| **Some primary** | | 3.31 | 3.83 | 4.36 |
| **Complete primary** | | | 3.42 | 3.96 |
| **Some secondary** | | | | 3.44 |

| **VIETNAM (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
|---|---|---|---|---|
| **No education** | 5.31 | 5.36 | 4.32 | 5.43 |
| **Some primary** | | 5.27 | 4.23 | 5.34 |
| **Complete primary** | | | 4.21 | 5.32 |
| **Some secondary** | | | | 4.15 |

Table 16: MTR upper bounds on differences 95% CI
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
|---|---|---|---|---|
| **No education** | 3.38 | 4.14 | 4.25 | 4.37 |
| **Some primary** | | 3.31 | 3.43 | 3.56 |
| **Complete primary** | | | 3.25 | 3.38 |
| **Some secondary** | | | | 3.17 |
| **INDIA (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
| **No education** | 3.34 | 3.56 | 3.79 | 4.47 |
| **Some primary** | | 3.34 | 3.58 | 4.26 |
| **Complete primary** | | | 3.33 | 4.02 |
| **Some secondary** | | | | 3.16 |
| **PERU (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
| **No education** | 3.13 | 3.86 | 4.38 | 4.92 |
| **Some primary** | | 3.34 | 3.87 | 4.42 |
| **Complete primary** | | | 3.45 | 4.01 |
| **Some secondary** | | | | 3.47 |
| **VIETNAM (s/t)** | **Some primary** | **Complete primary** | **Some secondary** | **Secondary or more** |
| **No education** | 3.22 | 3.66 | 4.06 | 5.47 |
| **Some primary** | | 3.31 | 3.71 | 5.14 |
| **Complete primary** | | | 3.34 | 4.78 |
| **Some secondary** | | | | 3.23 |

Table 17: MTS bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -0.30 | 1.07 | -0.28 | 1.23 | -0.49 | 2.71 | -0.76 | 2.58 |
| 1 | -1.82 | 1.10 | -1.34 | 1.69 | -0.94 | 2.60 | -0.83 | 2.56 |
| 2 | -1.82 | 1.07 | -1.71 | 1.21 | -0.78 | 2.49 | -0.86 | 2.45 |
| 3 | -1.89 | 1.00 | -1.79 | 1.11 | -0.92 | 2.28 | -0.81 | 2.36 |
| 4 | -2.03 | 0.89 | -1.68 | 1.27 | -0.87 | 2.18 | -0.70 | 2.23 |
| 5 | -2.15 | 0.80 | -1.80 | 0.99 | -1.18 | 1.98 | -0.81 | 1.86 |
| 6 | -2.22 | 0.81 | -2.02 | 0.95 | -1.11 | 1.53 | -1.13 | 1.60 |
| 7 | -2.35 | 0.80 | -2.07 | 0.87 | -1.30 | 1.60 | -1.42 | 1.32 |
| 8 | -2.43 | 0.91 | -2.32 | 0.65 | -1.45 | 1.42 | -1.63 | 1.22 |
| 9 | -2.59 | 1.01 | -2.31 | 0.69 | -1.57 | 1.24 | -1.70 | 0.71 |
| 10 | -2.68 | 0.81 | -2.40 | 0.70 | -1.80 | 1.07 | -2.43 | 0.64 |
| 11 | -2.78 | 0.95 | -2.70 | 1.87 | -1.72 | 0.84 | -2.46 | 0.79 |
| 12 | -2.76 | 1.33 | -2.79 | 0.60 | -2.42 | 0.58 | -2.54 | 0.51 |
| 13 | -2.93 | 0.73 | -2.87 | 0.84 | -2.31 | 0.91 | -2.70 | 1.25 |
| 14 | -2.97 | 1.81 | -2.87 | 1.50 | -2.46 | 0.96 | -2.83 | 1.00 |
| 15 | | | | | -2.78 | 1.11 | | |
| 16 | | | | | -2.85 | 1.20 | | |
| 17 | | | | | -2.99 | 1.87 | | |

Table 18: MTS 95% CI bounds

| Years of schooling | Ethiopia | | India | | Peru | | Vietnam | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -0.33 | 1.13 | -0.31 | 1.30 | -0.60 | 2.75 | -0.84 | 2.62 |
| 1 | -1.93 | 1.24 | -1.77 | 2.34 | -1.07 | 2.64 | -1.07 | 2.62 |
| 2 | -1.92 | 1.22 | -1.82 | 1.35 | -0.91 | 2.54 | -0.97 | 2.50 |
| 3 | -1.97 | 1.11 | -1.87 | 1.20 | -1.02 | 2.34 | -0.97 | 2.43 |
| 4 | -2.10 | 1.00 | -1.81 | 1.46 | -1.01 | 2.25 | -0.82 | 2.29 |
| 5 | -2.21 | 0.92 | -1.88 | 1.10 | -1.31 | 2.06 | -0.90 | 1.93 |
| 6 | -2.31 | 1.04 | -2.12 | 1.15 | -1.19 | 1.60 | -1.22 | 1.68 |
| 7 | -2.41 | 0.95 | -2.14 | 1.00 | -1.42 | 1.70 | -1.51 | 1.41 |
| 8 | -2.49 | 1.13 | -2.40 | 0.90 | -1.55 | 1.52 | -1.72 | 1.33 |
| 9 | -2.64 | 1.36 | -2.38 | 0.86 | -1.66 | 1.34 | -1.77 | 0.80 |
| 10 | -2.73 | 1.08 | -2.46 | 0.84 | -1.89 | 1.19 | -2.50 | 0.81 |
| 11 | -2.82 | 1.33 | -2.80 | 3.00 | -1.79 | 0.91 | -2.52 | 1.02 |
| 12 | -2.81 | 1.63 | -2.82 | 0.85 | -2.46 | 0.63 | -2.59 | 0.66 |
| 13 | -2.95 | 1.05 | -2.91 | 1.70 | -2.37 | 1.05 | -2.74 | 1.53 |
| 14 | -2.99 | 2.98 | -2.90 | 1.78 | -2.51 | 1.07 | -2.86 | 1.24 |
| 15 | | | | | -2.81 | 1.38 | | |
| 16 | | | | | -2.88 | 1.37 | | |
| 17 | | | | | -3.00 | 2.20 | | |

Table 19: MTS bounds: categories

| Years of schooling | Ethiopia | | India | | Peru | | Vietnam | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -0.30 | 1.07 | -0.28 | 1.23 | -0.49 | 2.71 | -0.76 | 2.58 |
| Some primary | -1.70 | 0.59 | -1.64 | 1.14 | -0.73 | 2.00 | -0.66 | 2.19 |
| Complete primary | -2.43 | 0.91 | -1.80 | 0.99 | -1.11 | 1.53 | -0.81 | 1.86 |
| Some secondary | -2.59 | 0.87 | -1.95 | 0.51 | -1.35 | 1.12 | -1.03 | 0.51 |
| Secondary or more | -2.77 | 1.21 | -2.76 | 1.00 | -1.62 | 0.58 | -2.48 | 0.71 |

Table 20: MTS 95% bounds: categories

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -0.33 | 1.13 | -0.31 | 1.30 | -0.59 | 2.75 | -0.84 | 2.62 |
| Some primary | -1.77 | 0.66 | -1.72 | 1.24 | -0.80 | 2.06 | -0.74 | 2.25 |
| Complete primary | -2.49 | 1.13 | -1.88 | 1.10 | -1.19 | 1.60 | -0.90 | 1.92 |
| Some secondary | -2.64 | 1.08 | -2.02 | 0.60 | -1.42 | 1.20 | -1.11 | 0.57 |
| Secondary or more | -2.81 | 1.47 | -2.80 | 1.20 | -1.69 | 0.64 | -2.54 | 0.84 |

Table 21: MTS difference bounds
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -2.77 | -3.49 | -3.66 | -3.83 | 0.88 | 1.21 | 1.16 | 1.51 |
| Some primary | | -3.01 | -3.18 | -3.35 | | 2.62 | 2.57 | 2.92 |
| Complete primary | | | -3.50 | -3.68 | | | 3.30 | 3.64 |
| Some secondary | | | | -3.64 | | | | 3.81 |

| **INDIA** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -2.87 | -3.04 | -3.19 | -3.99 | 1.42 | 1.27 | 0.79 | 1.28 |
| Some primary | | -2.94 | -3.09 | -3.90 | | 2.63 | 2.15 | 2.64 |
| Complete primary | | | -2.94 | -3.75 | | | 2.31 | 2.80 |
| Some secondary | | | | -3.27 | | | | 2.95 |

| **PERU** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -3.45 | -3.82 | -4.06 | -4.34 | 2.48 | 2.01 | 1.61 | 1.07 |
| Some primary | | -3.11 | -3.34 | -3.62 | | 2.26 | 1.86 | 1.32 |
| Complete primary | | | -2.87 | -3.15 | | | 2.23 | 1.69 |
| Some secondary | | | | -2.74 | | | | 1.93 |

| **VIETNAM** | | | **LB** | | | | **UB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -3.23 | -3.39 | -3.61 | -5.06 | 2.95 | 2.62 | 1.27 | 1.47 |
| Some primary | | -3.00 | -3.22 | -4.67 | | 2.51 | 1.17 | 1.36 |
| Complete primary | | | -2.89 | -4.34 | | | 1.32 | 1.52 |
| Some secondary | | | | -2.99 | | | | 1.74 |

Table 22: MTS difference bounds 95% CI
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA** | | | **LB** | | | | **LB** | |
|---|---|---|---|---|---|---|---|---|
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -2.81 | -3.56 | -3.73 | -3.90 | 0.96 | 1.43 | 1.38 | 1.77 |
| Some primary | | -3.09 | -3.25 | -3.43 | | 2.85 | 2.79 | 3.18 |
| Complete primary | | | -3.73 | -3.90 | | | 3.52 | 3.91 |
| Some secondary | | | | -3.84 | | | | 4.07 |
| **INDIA** | | | **LB** | | | | **LB** | |
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -2.94 | -3.10 | -3.24 | -4.06 | 1.52 | 1.38 | 0.88 | 1.48 |
| Some primary | | -3.04 | -3.19 | -4.00 | | 2.75 | 2.27 | 2.86 |
| Complete primary | | | -3.04 | -3.86 | | | 2.43 | 3.02 |
| Some secondary | | | | -3.36 | | | | 3.17 |
| **PERU** | | | **LB** | | | | **LB** | |
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -3.51 | -3.90 | -4.14 | -4.41 | 2.61 | 2.14 | 1.74 | 1.19 |
| Some primary | | -3.17 | -3.41 | -3.69 | | 2.36 | 1.95 | 1.40 |
| Complete primary | | | -2.93 | -3.21 | | | 2.32 | 1.79 |
| Some secondary | | | | -2.80 | | | | 2.03 |
| **VIETNAM** | | | **LB** | | | | **LB** | |
| **s/t** | Some primary | Complete primary | Some secondary | Secondary or more | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | -3.31 | -3.47 | -3.68 | -5.13 | 3.05 | 2.72 | 1.37 | 1.62 |
| Some primary | | -3.08 | -3.28 | -4.74 | | 2.61 | 1.27 | 1.52 |
| Complete primary | | | -2.94 | -4.42 | | | 1.43 | 1.68 |
| Some secondary | | | | -3.04 | | | | 1.89 |

Table 23: MTR+MTS Bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -0.30 | 0.00 | -0.28 | 0.00 | -0.49 | 0.01 | -0.76 | 0.01 |
| 1 | -0.23 | 0.09 | 0.12 | 0.47 | -0.73 | -0.01 | -0.58 | 0.03 |
| 2 | -0.19 | 0.16 | -0.23 | 0.05 | -0.51 | 0.02 | -0.59 | 0.03 |
| 3 | -0.15 | 0.23 | -0.25 | 0.02 | -0.56 | 0.01 | -0.46 | 0.05 |
| 4 | -0.15 | 0.23 | -0.08 | 0.26 | -0.37 | 0.06 | -0.26 | 0.10 |
| 5 | -0.14 | 0.26 | -0.12 | 0.20 | -0.57 | -0.01 | -0.22 | 0.11 |
| 6 | -0.10 | 0.38 | -0.11 | 0.23 | -0.40 | 0.06 | -0.17 | 0.14 |
| 7 | -0.08 | 0.47 | -0.08 | 0.31 | -0.19 | 0.23 | -0.19 | 0.12 |
| 8 | -0.04 | 0.69 | -0.13 | 0.14 | -0.24 | 0.18 | -0.15 | 0.17 |
| 9 | -0.02 | 0.84 | -0.08 | 0.31 | -0.22 | 0.20 | -0.07 | 0.29 |
| 10 | -0.03 | 0.71 | -0.03 | 0.58 | -0.27 | 0.13 | -0.07 | 0.27 |
| 11 | -0.02 | 0.85 | 0.05 | 1.75 | -0.09 | 0.42 | -0.03 | 0.47 |
| 12 | 0.00 | 1.30 | -0.03 | 0.55 | -0.15 | 0.16 | -0.05 | 0.37 |
| 13 | -0.01 | 0.72 | -0.02 | 0.80 | -0.04 | 0.63 | 0.01 | 1.17 |
| 14 | 0.00 | 1.81 | 0.00 | 1.50 | 0.00 | 0.86 | 0.01 | 1.00 |
| 15 | | | | | 0.01 | 1.04 | | |
| 16 | | | | | 0.01 | 1.20 | | |
| 17 | | | | | 0.01 | 1.87 | | |

Table 24: MTR+MTS 95% Bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| 0 | -0.33 | 0.04 | -0.31 | 0.04 | -0.59 | 0.05 | -0.84 | 0.05 |
| 1 | -0.32 | 0.22 | -0.30 | 1.11 | -0.86 | 0.03 | -0.81 | 0.08 |
| 2 | -0.27 | 0.31 | -0.33 | 0.18 | -0.64 | 0.06 | -0.69 | 0.07 |
| 3 | -0.20 | 0.33 | -0.31 | 0.10 | -0.66 | 0.05 | -0.61 | 0.10 |
| 4 | -0.20 | 0.34 | -0.20 | 0.44 | -0.50 | 0.11 | -0.37 | 0.15 |
| 5 | -0.18 | 0.37 | -0.18 | 0.30 | -0.69 | 0.05 | -0.29 | 0.16 |
| 6 | -0.17 | 0.62 | -0.19 | 0.43 | -0.47 | 0.11 | -0.25 | 0.20 |
| 7 | -0.12 | 0.61 | -0.13 | 0.45 | -0.29 | 0.32 | -0.26 | 0.20 |
| 8 | -0.08 | 0.91 | -0.20 | 0.39 | -0.33 | 0.27 | -0.22 | 0.27 |
| 9 | -0.07 | 1.20 | -0.13 | 0.48 | -0.30 | 0.28 | -0.11 | 0.37 |
| 10 | -0.07 | 0.98 | -0.07 | 0.72 | -0.35 | 0.25 | -0.12 | 0.43 |
| 11 | -0.07 | 1.23 | -0.04 | 3.00 | -0.13 | 0.48 | -0.08 | 0.69 |
| 12 | -0.04 | 1.60 | -0.06 | 0.79 | -0.18 | 0.19 | -0.09 | 0.52 |
| 13 | -0.05 | 1.04 | -0.06 | 1.67 | -0.09 | 0.76 | -0.03 | 1.45 |
| 14 | -0.04 | 2.98 | -0.03 | 1.78 | -0.04 | 0.96 | -0.03 | 1.24 |
| 15 | | | | | -0.03 | 1.31 | | |
| 16 | | | | | -0.03 | 1.37 | | |
| 17 | | | | | -0.03 | 2.20 | | |

Table 25: MTR+MTS bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -0.30 | 0.00 | -0.28 | 0.00 | -0.49 | 0.01 | -0.76 | 0.01 |
| Some primary | -0.12 | 0.25 | -0.17 | 0.13 | -0.53 | 0.01 | -0.40 | 0.05 |
| Complete primary | -0.04 | 0.69 | -0.12 | 0.20 | -0.40 | 0.06 | -0.22 | 0.11 |
| Some secondary | -0.03 | 0.77 | -0.04 | 0.39 | -0.23 | 0.19 | -0.08 | 0.19 |
| Secondary or more | 0.00 | 1.21 | 0.00 | 1.00 | 0.01 | 0.58 | 0.01 | 0.71 |

Table 26: MTR+MTS 95%CI Bounds

| **Years of schooling** | **Ethiopia** | | **India** | | **Peru** | | **Vietnam** | |
|---|---|---|---|---|---|---|---|---|
| | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** | **LB** | **UB** |
| No education | -0.33 | 0.04 | -0.31 | 0.04 | -0.59 | 0.05 | -0.84 | 0.05 |
| Some primary | -0.15 | 0.32 | -0.23 | 0.21 | -0.59 | 0.05 | -0.48 | 0.09 |
| Complete primary | -0.08 | 0.91 | -0.18 | 0.30 | -0.47 | 0.10 | -0.29 | 0.16 |
| Some secondary | -0.07 | 0.98 | -0.07 | 0.47 | -0.29 | 0.25 | -0.12 | 0.24 |
| Secondary or more | -0.04 | 1.47 | -0.04 | 1.20 | -0.03 | 0.64 | -0.03 | 0.84 |

Table 27: MTR+MTS bounds differences
$\Delta(s,t) = E[y(t)] - E[y(s)]$

| **ETHIOPIA (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
|---|---|---|---|---|
| No education | 0.55 | 0.99 | 1.06 | 1.51 |
| Some primary | | 0.81 | 0.88 | 1.33 |
| Complete primary | | | 0.80 | 1.25 |
| Some secondary | | | | 1.24 |

| **INDIA (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
|---|---|---|---|---|
| No education | 0.40 | 0.47 | 0.66 | 1.28 |
| Some primary | | 0.37 | 0.56 | 1.17 |
| Complete primary | | | 0.51 | 1.12 |
| Some secondary | | | | 1.04 |

| **PERU (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
|---|---|---|---|---|
| No education | 0.49 | 0.54 | 0.68 | 1.07 |
| Some primary | | 0.59 | 0.72 | 1.11 |
| Complete primary | | | 0.59 | 0.99 |
| Some secondary | | | | 0.82 |

| **VIETNAM (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
|---|---|---|---|---|
| No education | 0.81 | 0.87 | 0.95 | 1.47 |
| Some primary | | 0.51 | 0.59 | 1.11 |
| Complete primary | | | 0.41 | 0.93 |
| Some secondary | | | | 0.79 |

Table 28: MTR+MTS 95% CI Difference categories

| **ETHIOPIA (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
|---|---|---|---|---|
| No education | 0.63 | 1.21 | 1.28 | 1.77 |
| Some primary | | 1.03 | 1.10 | 1.59 |
| Complete primary | | | 1.02 | 1.51 |
| Some secondary | | | | 1.50 |
| **INDIA (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | 0.50 | 0.58 | 0.76 | 1.48 |
| Some primary | | 0.49 | 0.66 | 1.38 |
| Complete primary | | | 0.61 | 1.33 |
| Some secondary | | | | 1.24 |
| **PERU (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | 0.61 | 0.66 | 0.80 | 1.19 |
| Some primary | | 0.66 | 0.80 | 1.20 |
| Complete primary | | | 0.68 | 1.07 |
| Some secondary | | | | 0.90 |
| **VIETNAM (s/t)** | Some primary | Complete primary | Some secondary | Secondary or more |
| No education | 0.91 | 0.97 | 1.05 | 1.62 |
| Some primary | | 0.60 | 0.69 | 1.26 |
| Complete primary | | | 0.50 | 1.07 |
| Some secondary | | | | 0.92 |

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