What Explains Vietnam's Exceptional Performance in Education Relative to Other Countries? Analysis of the Young Lives Data from Ethiopia, Peru, India and Vietnam

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Abstract

Vietnam's strong performance on the 2012 and 2015 PISA assessments has led to interest in what explains the strong academic performance of Vietnamese students. Analysis of the PISA data has not shed much light on this issue. This paper analyses a much richer data set, the Young Lives data for Ethiopia, India (Andhra Pradesh), Peru and Vietnam, to investigate the reasons for the strong academic performance of 15-year-olds in Vietnam. The (preliminary) analysis thus far indicates that the Young Lives data can "explain" about two thirds of the gap between Vietnamese and Ethiopian 15-year-olds, about half of the gap between Vietnamese and Indian 15-year-olds, and about 40% of the gap between Vietnamese and Peruvian 15-year-olds.

I. Introduction

Vietnam's rapid economic growth in the last 30 years has transformed it from one of the world's poorest countries to a middle income country (World Bank, 2013). While Vietnam's economic achievements have attracted much attention, in more recent years its accomplishments in education have also generated a great deal of international interest. Most striking is its performance on the 2012 and 2015 PISA assessments: In 2012 Vietnam ranked 16th in math and 18th in reading out of 63 countries and territories,[1] ahead of both the US and the UK and much higher than that of any other developing country (OECD, 2014). Its 2012 PISA mathematics and readings scores (at 511 and 508), for example, were more than one standard deviation higher than those of Indonesia (375 and 396), another Southeast Asian country, which is most similar to Vietnam among all the 2012 PISA participating countries in terms of GDP per capita.[2] While its performance on the 2015 was slightly lower, ranking 21st in math and 31st in reading out of 68 countries, it still outperformed all other developing countries and still outperformed the US and the UK in math (but not in reading).

Vietnam's achievements in education are particularly notable given that it is a lower middle income country. This is shown in Figures 1 and 2 (taken from Dang, et al., 2019), which plot PISA scores in math and reading by the log of per capita GDP for all 63 countries. Vietnam is in the upper left in both figures, higher than any other country above the line that shows the expected test score given per capita GDP. Vietnam is also the largest positive outlier (relative to

[1] Throughout this paper we consider only countries, and thus we exclude Shanghai, China, which is obviously not representative of China as a whole, and the territory of Perm, which is unlikely to be representative of Russia. Also, for convenience we refer to Hong Kong, Macao and Taiwan as countries, although Hong Kong and Macao are territories of China, and Taiwan's status is a matter of international dispute.

[2] The GDP per capita for Indonesia was \$US 3,347 in 2015, which is about 50 percent higher than that of Vietnam (\$US 2,110) in the same year (World Bank, 2017).

the fitted line) when PPP (purchasing power parity) per capita GDP is used and when the 2015 PISA data are used (see Dang et al., 2019).

Dang et al. (2019) used the 2012 and 2015 PISA data to try to understand Vietnam's unusually high performance on those assessments of student learning. However, the PISA data have some limitations that should be kept in mind when interpreting the results. First, the PISA data exclude children who are not in school, and about one third of Vietnam's 15-year-olds are not in school (Dang et al., 2019). Second, the student-level data from the PISA are collected only when those students are age 15, and not at any earlier age. Third, the school-level data are collected only for the schools that the students are currently attending, not the schools that they attended in earlier years. Fourth, the school-level data are somewhat limited. For example, the question on teacher absence simply asks the school principal the extent to which teacher absence hinders student learning, the possible responses being: a) Not at all; b) Very little; c) To some extent; or d) A lot. Fifth, the Vietnamese government appears to have "prepped" students for the PISA exam, which could explain, at least in part, its strong performance.

This paper examines the nature and underlying determinants of Vietnam's apparent exceptional performance using a different data source: the Young Lives data collected from Ethiopia, India (Andhra Pradesh and Telangana), Peru and Vietnam.[3] While the number of countries in the Young Lives data (4) is much smaller than the number in the PISA data (63), the Young Lives data have several advantages over the PISA data. First, the test score data when the Young Lives children were 15 years old include *all* 15-year-old children, regardless of whether they were in school. Second, the Young Lives data were collected from the children over 14 years, when they were 1, 5, 8, 12 and 15 years old, and include much more detailed information than the data collected from the PISA student questionnaire. Third, the Young Lives data

[3] For further information on the Young Lives data see: https://www.younglives.org.uk/.

include very detailed data from the primary schools attended by the Young Lives children (at the age when they were in grade 4 or 5), as well as very detailed data from the secondary school that they attended, if any, when they were about 14 years old. Fourth, relative to the PISA data, the Young Lives data collected from the schools are much richer, including school, principal and teacher questionnaires, and school observation data. Fifth, the Young Lives data do not attract any media attention and thus there is little reason to think that the Vietnamese government "prepped" the 15-year-olds who participated in the Young Lives' academic assessments.

At best, the analysis of the PISA data by Dang et al. (2019) explains only one third of the gap between Vietnam's strong performance on that assessment and the performance that one would expect given its income level. The Young Lives data, which are much more detailed than the PISA data, may be able to explain a larger proportion of the gap between Vietnam and the three other developing countries in the Young Lives data. This paper investigates what more can be learned about Vietnam's exceptional performance in education from an analysis of the Young Lives data. It does so by focusing on the performance on the mathematics tests given at age 15, since comparisons of language abilities across different languages can be confounded by linguistic differences in those languages.

The following (preliminary) conclusions can be drawn. First, the Young Lives data are able to "explain" about two thirds of the gap in test scores between Vietnam and Ethiopia. Second, the Young Lives data can explain about hald of the gap in test scores between Vietnam and India. Third, these data can explain about 40% of the gap in test scores between Vietnam and Peru.

II. Vietnamese Children's Performance on the Young Lives Tests, and Possible Explanations

Dang et al. (2019) show that Vietnam outperformed all other developing countries (and many developed countries) on the 2012 and 2015 PISA assessments. The same is true for the four countries in the Young Lives data: Vietnam easily outperforms the other three countries on the mathematics test. This is shown in Table 1, for young people who were about 15 years old (data were collected in 2016).

More specifically, in the fifth round of data collection, which took place in 2016, mathematics tests were administered to the younger cohort of the Young Lives children, who were about 15 years old at that time. These tests varied somewhat across the four countries, but there were 23 mathematics questions that were used in all four countries. For these 23 questions, the mean number of questions correct was 5.5 for Ethiopia; 6.9 for India, 9.1 for Peru and 12.3 for Vietnam. In terms of standard deviations of the test score (for the combined distribution across all four countries), henceforth denoted by σ, the average mathematics scores in Vietnam were 1.4σ higher than those in Ethiopia, 1.1σ higher than those in India, and 0.7σ higher than those in Peru. While it is not particularly surprising that Vietnamese youth outperform those in Ethiopia given that income per capita is slightly over three times higher in Vietnam ($1,950 **[why slightly different from number in footnote 1?]** vs. $600), this explanation cannot explain the gaps with India and Peru, since India has an average income per capita only slightly lower than that of Vietnam ($1,600) and Peru's average income per capita is more than three times higher than that of Vietnam ($6,160).

A similar result holds if IRT (item response theory) is used to compare the latent mathematics ability of the 15-year-olds in the Young Lives data. This was done using a 2-parameter IRT model. IRT analysis has the advantage that it uses *all* questions in the mathematics test in each country, rather than being limited to the 23 questions that appeared on the math tests in each of the four Young Lives countries. Further, it accounts for the fact that some questions are more difficult than others, and that some questions have more discriminating power than others. The latent mathematics skill for the sample of Young Lives 15-year-olds is shown in the third column of Table 1. (Note that the mean of this variable for the entire sample is set to zero, and the standard deviation is set to about one.) The ranking is similar for all four countries, and indeed the gaps between pairs of countries are quite similar. In particular, in terms of the standardized score for the 23 mathematics questions, Vietnam is 0.67 standard deviations ahead of Peru, 1.12 standard deviations ahead of India, and 1.41 standard deviations ahead of Ethiopia, and in terms of the latent IRT score, Vietnam is 0.655 standard deviations ahead of Peru, 0.899 standard deviations ahead of India, and 1.278 standard deviations ahead of Ethiopia.

Another way to see the disparity in these mathematics scores is to examine the density functions for each of the four countries. This is done in Figure 3 for the scores on the 23 questions that are the same for all four countries. The distributions for Ethiopia and India are concentrated on the left side of the diagram, peaking at a score of about 5 answers correct (out of 23). Note that 17 of the 23 questions were multiple choice questions with four possible responses (for one question there were 5 possible responses), so that by randomly guessing a test taker could get a score of 4.2; this implies that roughly one third of Ethiopian 15-year-olds and one third of Indian 15-year-olds performed no better than someone who randomly guessed for all of the multiple choice answers. In contrast, relatively few Vietnamese 15-year-olds had a score of 5 or less. Fifteen-year-olds from Peru do somewhat better, with a distribution that peaks around 8 questions correct. Perhaps the starkest contrast is in terms of 15-year-olds with a score of 15 or higher. About 36% of Vietnamese 15-year-olds score in this range, while only 0.8% of Ethiopian 15-year-olds, and 4.0% of Indian 15-year-olds, score in this range. Even for Peru, the wealthiest of the four Young Lives countries only 9.8% of 15-year-olds score in this range.

What explains the strong performance of 15-year-olds in Vietnam? Table 2 provides some possibilities given the rich data collected by the Young Lives Study. First, there is a large amount of evidence that malnutrition in the first few years of life will cause children to perform poorly in school (see Alderman et al., 2017, for a recent summary). The first two rows of Table 2 show that Vietnamese children are better nourished, as measured at age 5 by average height-for-age and percent of children who are stunted, than children in the three other Young Lives countries. However, the differences are not very large; for example, about 25% of 5-year-old children in Vietnam are stunted, compared to 33-36% in the other three countries.

Large family size is often negatively associated with children's educational outcomes, while family wealth is typically positively correlated. The next two rows of Table 2 indicate that Vietnamese children have fewer siblings, and that they are wealthier (in terms of an index of household durable goods and housing characteristics), than the children in the other three Young Lives countries. Yet here again the differences are not dramatic, except that Ethiopian children have many more siblings and much less wealth than the children in the other three countries.

Another possible reason for Vietnamese 15-year-olds' strong education performance is that their parents are highly educated, and may be more able to help their children with their schoolwork. This is examined in the next four rows of Table 2. Vietnamese parents have clearly completed much more years of schooling than parents in Ethiopia and India; on average, Vietnamese mothers have completed 6.2 years of education, compared to 2.4 and 3.1 years in Ethiopia and India, respectively, and Vietnamese fathers have completed 7.0 years of education, compared to 3.5 and 4.7 years in Ethiopia and India. On the other hand, mothers and fathers in Peru have completed 1.5-1.9 more years of schooling than their Vietnamese counterparts. Regarding parental assistance with schoolwork, at age 12 about 22% of Vietnamese 15-year-olds received assistance from their parents (as reported by the child's caregiver), which is a higher rate than among parents in Ethiopia (14%) and India (16%), but less likely than parents in Peru (35%). Yet by age 15 Vietnamese parents were less likely to help their children (4%) than were parents in the other three countries (10-15%). Overall, relative to Vietnamese parents, Peruvian parents appear to be better prepared, and more willing, to help their children with their homework, while Ethiopian and Indian parents seem less prepared and help less when their children are age 12, but more when their children are age 15.

There is also a general perception for East Asia as a whole, and thus for Vietnam in particular, that East Asian children spend longer hours in school, and spend more time studying outside of school. The next six rows in Table 2 show that this is only half correct. Vietnamese children of school age spend *less* time in school than children of the same age in the other three Young Lives countries, although the differences with Ethiopia are very small. This is true at ages 8, 12 and 15; for example, at age 12 Vietnamese children spent, on average, 5.4 hours per day in school, which is slightly lower than in Ethiopia (5.6 hours) and Peru (6.1 hours) and much lower than in India (8.0 hours). In contrast, it is correct that Vietnamese children spend more hours per day studying at home, between 2.6 and 2.9 hours per day from age 8 to age 15, while children in the other countries spend between 1.0 and 2.1 hours per day. **[Verify that this includes children not currently in school. Also check data on tutoring.]**

A final parental variable is parental aspirations for their children's education. Another common perception is that parents in East Asian value education more, and thus have higher aspirations for their children's education, than do parents in other countries. The next two lines in Table 2 examine whether this is true. Somewhat surprisingly, in all four Young Lives countries the majority of parents expect their children to complete a university-level or other post-secondary education. which for all countries is much higher than actual post-secondary completion. These questions were asked of the parents when the child was only five years old. While 79% of Vietnamese parents hope that their child will complete a university level or other post-secondary degree, Peruvian parents were even more likely (87%) to express this desire, and Ethiopian parents were not far behind (72%); only Indian parents had much lower aspirations, with a figure of 58%. These parents were also asked (when the child was five years old) whether they thought that their child would achieve this ambitious expectation. For the three countries other than Vietnam, the parents were very optimistic, with 89-91% opining that their child would obtain this goal. While Vietnamese parents were also optimistic, they were somewhat less so, with 79% reporting that they thought that their child could attain university or post-secondary schooling.

It is also possible that the strong academic performance of Vietnamese 15-year-olds is due to their going to better schools. This is examined in the last nine rows of Table 2. In almost all respects, Vietnamese schools appear to be of higher quality. In particular: 1. Almost all (94%) of Vietnamese primary school teachers have a general (non-education) university degree, compared to 5% for Ethiopia, 79% for India and 84% for Peru; 2. Vietnamese primary school principals have 10.4 years of experience, on average, which is less than in Peru (12.7 years) but much higher than Ethiopia (4.0) and India (6.3) **[for India, maybe distinguish between public and private]**; 3. Reported teacher absence is lower in Vietnam than in all the other countries (but there are several problems with this variable, as explained below);[4] 4. All Vietnamese primary schools have electricity, which is higher than in the other three Young Lives countries (53% for Ethiopia, 86% for India and 94% for Peru); 5. Vietnamese schools are much more likely to have a library, which is the case for 79% of Vietnamese schools, but only 62% of Ethiopian, 21% of Indian and 44% of Peruvian schools; and 6. Vietnamese schools are more likely to have computers for students' use (32%) than schools in Ethiopia (20%) and India (30%), but less likely than in Peru (58%).

Finally, in three of the four countries (India, Peru and Vietnam), primary school mathematics teachers took a test designed to measure their pedagogical skills in mathematics. The tests varied over the three countries, but for each of the three pairs of countries there are between 4 and 9 common test items. The last four rows show that Vietnamese mathematics teachers outperformed their counterparts in India and Peru. More specifically, for the four test questions given to both Indian and Vietnamese mathematics teachers, the average number correct was higher in Vietnam (3.13) than in India (2.53). The gap is even larger when comparing Peru and Vietnam; of the eight test questions taken by mathematics in both Peru and Vietnam, on average Peruvian teachers answered only 3.27 correctly while Vietnamese teachers answered 5.74 correctly. Finally, the last row in Table 2 applies IRT analysis to *all* of the teacher math ability questions used in the three countries that administered this exam to the mathematics teachers (India, Peru and Vietnam). The latent mathematical pedagogical ability of Vietnamese mathematics teachers is about 0.71 standard deviations higher than their counterpart teachers in India, and an astonishing 1.52 standard deviations higher than their counterparts in Peru.

[4] **To be done. Zoe suggests checking the child questionnaire for questions such as "my teacher is often absent". Perhaps use this as an IV to address measurement error?**

Overall, the data in Table 2 show that Vietnamese 15-year-olds have several advantages relative to 15-year-olds in the other three Young Lives countries that could lead to higher learning outcomes, including better nutritional status, fewer siblings and greater wealth, better educated parents (although Peruvian parents are even more educated), longer hours spent studying at home, and generally better schools (including mathematics teachers with better pedagogical skills). On the other hand, they are at a disadvantage in terms of parental assistance with homework at age 15, length of the school day, and parental confidence that they will complete university or other post-secondary education. The next question is, which of these child, parent and school characteristics have explanatory power for the learning of 15-year-olds in these four countries. This is examined in the next section.

III. What Observed Variables Explain the Differences across the Young Lives Countries?

In theory, the differences in the mathematics scores across the four Young Lives countries are due to underlying differences across those four countries in the causal factors that determine learning of mathematics. To the extent that those causal factors are observed in the Young Lives data, they can be used to explain the differences across these four countries. This section explains how this can be done, and presents estimates that investigate the extent to which the Young Lives data can explain these differences.

A. Regression Methodology. It is convenient to undertake this exercise using standard multiple regression analysis. This is because such a regression can start by replicating the differences in the mean test scores across the four countries. More specifically, the following regression replicates the differences in the (normalized) mathematics scores across the four countries:[5]

$$\text{Test Score}_i = \beta_1\text{Ethiopia}_i + \beta_2\text{India}_i + \beta_3\text{Peru}_i + \beta_4\text{Vietnam}_i + u_i \qquad (1)$$

where Ethiopia_i is a dummy variable that equals 1 for Ethiopian 15-year-olds in the data (and is 0 otherwise), and India_i, Peru_i and Vietnam_i are analogously defined. Notice that there is no constant term in equation (1); this ensures that an OLS regression of the Test Score on these four dummy variables will produce estimates of the associated β terms that exactly equal to the standardized scores shown in Table 1. As such, this regression is not an estimate of any causal relationship; it simply provides the mean values of the dependent variable (the math test score) for each of the four countries.

Recall that there exists, in principle, a causal process that determines test scores. This can be expressed as follows for all four countries:

$$\text{Test Score}_i = \boldsymbol{\beta}'\mathbf{x}_i + u_i \qquad (2)$$

where $\mathbf{x}_i$ includes *all* variables that determine test scores, which implies that u_i is simply random measurement error in the test scores, so there is little reason to expect u_i to be correlated with the **x** variables. This linear approximation is not particularly restrictive as long as the **x** variables include interactions between combinations of **x** variables (including squares and other powers of the **x** variables). If one had accurate data for all variables that have a causal impact on test

[5] Such a regression can also replicate the differences in the non-normalized mathematics scores; the normalized scores are used in this paper for ease of interpretation. Note also that in this section the skills of the mathematics teachers are not used because that variable is not available for Ethiopia; this variable is used in Section IV.

scores, one could estimate equation (2) by ordinary least squares (OLS) and obtain the causal impacts of all of those variables. Unfortunately, it is virtually impossible to obtain data on all causal factors, in which case OLS estimates of equation (2) that use only observed variables could produce biased estimates of the causal impacts of the $\mathbf{x}$ variables (biased estimates of the $\boldsymbol{\beta}$ parameters in equation (2)) because the unobserved variables are relegated to the error term and are likely to be correlated with the observed variables. However, on average, the more $\mathbf{x}$ variables in the regression (the greater the proportion of the causal factors that are observed) the less bias in the OLS estimates.

Note that the $\boldsymbol{\beta}$ parameters in equation (2) are assumed to be the same for all four countries. One could object to this assumption – for example, the impact of an additional hour in school would be smaller in countries where schools or teachers are less effective in improving children's academic skills. Yet this could be accounted for in equation (2) by including interaction terms between the number of hours that a child spends in school and indicators of school or teacher quality. Thus the assumption that the $\boldsymbol{\beta}$'s are the same for all four countries is, in principle, reasonable, yet care must be taken on interpreting results when some variables are not contained in the data, which is virtually inevitable, as will now be discussed.

Given the assumption that $\boldsymbol{\beta}$ is the same for all four countries, equation (2) can also be expressed as follows:

$$\text{Test Score}_i = \boldsymbol{\beta}'\mathbf{x}_{iE} + \boldsymbol{\beta}'\mathbf{x}_{iI} + \boldsymbol{\beta}'\mathbf{x}_{iP} + \boldsymbol{\beta}'\mathbf{x}_{iV} + u_i \qquad (3)$$

where, using the same country dummy variables used in equation (1), $\mathbf{x}_{iE} = \mathbf{x}_i \times \text{Ethiopia}_i$, $\mathbf{x}_{iI} = \mathbf{x}_i \times \text{India}_i$, $\mathbf{x}_{iP} = \mathbf{x}_i \times \text{Peru}_i$, and $\mathbf{x}_{iV} = \mathbf{x}_i \times \text{Vietnam}_i$.

To see the usefulness of this expression of equation (2), consider (without loss of generality) the term for Ethiopia. It can be expressed as follows:

$$\begin{aligned} \boldsymbol{\beta}'\mathbf{x}_{iE} &= \boldsymbol{\beta}_o'\mathbf{x}_{iE,o} + \boldsymbol{\beta}_u'\mathbf{x}_{iE,u} \qquad (4) \\ &= \boldsymbol{\beta}_o'\mathbf{x}_{iE,o} + \boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u} + \boldsymbol{\beta}_u'(\mathbf{x}_{iE,u} - \bar{\mathbf{x}}_{E,u}) \end{aligned}$$

The first line of equation (4) simply divides the **x** variables for Ethiopia into two sets, those that are observed, which are denoted by $\mathbf{x}_{iE,o}$, and those that are unobserved, which are denoted by $\mathbf{x}_{iE,u}$. The $\boldsymbol{\beta}$ vector is similarly divided into $\boldsymbol{\beta}_o$ for the observed variables and $\boldsymbol{\beta}_u$ for the unobserved variables.

The second line in equation (4) divides the set of unobserved variables into two parts, the mean of those variables for Ethiopia, multiplied by their associated $\boldsymbol{\beta}$'s, and the deviation of those variables from the mean for Ethiopia as a whole. Note that the first term, $\boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u}$, does not vary over observations from Ethiopia and thus it is essentially a dummy variable for Ethiopia. More precisely, it can be replaced by the dummy variable for Ethiopia, Ethiopia_i, the coefficient of which is simply $\boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u}$.

The $\boldsymbol{\beta}'\mathbf{x}_{iE}$ term in equation (4) has two "extreme" cases. First, if all variables are observed then $\boldsymbol{\beta}'\mathbf{x}_{iE}$ equals $\boldsymbol{\beta}_o'\mathbf{x}_{iE,o}$, in which case equation (3), or equivalently equation (2), includes all causal variables and OLS regressions produce unbiased estimates of $\boldsymbol{\beta}$. Second, if none of the variables is observed then $\boldsymbol{\beta}'\mathbf{x}_{iE}$ becomes the sum of: 1. A dummy variable for Ethiopia multiplied by the coefficient on that dummy variable, which is equal to $\boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u}$; and 2. The (unobserved) variation from the means for each variable, $\boldsymbol{\beta}_u'(\mathbf{x}_{iE,u} - \bar{\mathbf{x}}_{E,u})$, and those deviations are uncorrelated with the dummy variable for the simple reason that the dummy variable does not vary. The more plausible cases are between these two extremes, where some variables are observed and others are unobserved. In general, adding more observed variables to the regression has two effects. First, the means of those variables are implicitly moved from $\boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u}$ to $\boldsymbol{\beta}_o'\mathbf{x}_{iE,o}$, the latter of which accounts for both the means of those variables and their variation within Ethiopia. In general, this will lead to a reduction in the size of $\boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u}$, the coefficient associated with the Ethiopia dummy variable, so that as one adds observed variables to equation (1) the estimated coefficients for the country dummy variables in that equation will diminish. In other words, as more observed variables are added they will increasingly explain the differences in test scores across the four countries, and the dummy variables will explain less and their coefficients will diminish. Second, this removal of the unobserved variables from the regression removes from the residual factors that could be correlated with the observed variables, which reduces the correlation of the error term with the observed variables and thus reduces bias in OLS estimates of equation (2).

Of course, it is possible that moving a given variable from unobserved to observed will increase the coefficient on the Ethiopia dummy variable rather than decrease it. For example, the teacher absence variable is likely to have a negative impact on student learning, so that the associated β will be negative, which implies that removing the associated $\beta_u'\bar{x}_{E,u}$ for teacher absence will increase $\boldsymbol{\beta}_u'\bar{\mathbf{x}}_{E,u}$. The best approach is to redefine all variables so that increases in them are likely to increase test scores; in this particular case teacher absence can be redefined as teacher presence, which should have a positive effect. **[Not done yet]**

The above discussion leads to the following regression equation:

$$\text{Test Score}_i = \boldsymbol{\beta}_o'\mathbf{x}_{i,o} + \beta_1\text{Ethiopia}_i + \beta_2\text{India}_i + \beta_3\text{Peru}_i + \beta_4\text{Vietnam}_i + u_i \qquad (5)$$

where u_i represents both measurement error in the test score variable and unobserved variation within each of the four countries of the unobserved determinants of test scores. The goal of the regressions based on this equation is to investigate the extent to which the dummy variables for the four countries decrease (more precisely, converge, since there is no constant term) as more observed variables are added to the regression equation.

B. Results. Tables 3 and 4 show estimates of equation (5), starting with no observed variables other than the country dummy variables and then adding additional child and household level variables. Table 3 does this when the normalized score on the 23 mathematics questions is used as the dependent variable, while Table 4 uses the latent mathematics skills of each student obtained from the IRT analysis. For both tables, the first column simply shows that the OLS estimate of equation (1) reproduces the (normalized) mean test scores shown in Table 1. That is, the first column in Table 3 shows that Vietnamese 15-year-olds score about 1.4σ higher than their counterparts in Ethiopia, 1.1σ higher than those in India, and about 0.7σ higher than those in Peru. Similarly, the first column in Table 4 shows that Vietnamese 15-year-olds score about 1.3σ higher than their counterparts in Ethiopia, 0.9σ higher than those in India, and about 0.7σ higher than those in Peru. These gaps, which are shown in brackets immediately to the right of the column of parameter estimates in both tables, are very large; explaining them is the goal of this paper.

Recall that Vietnamese 15-year-olds are less likely to be stunted, come from wealthier homes (as measured by a wealth index), have fewer siblings, and (except for Peru) have more educated parents than 15-year-olds of the same age in the three other countries. The second column of estimates in Tables 3 and 4 adds those variables as additional explanatory variables in equation (5). As expected, 15-year-olds from wealthier households, with more educated mothers, and with better nutrition (as indicated by higher height-for-age Z-scores) have higher test scores, and 15-year-olds with more siblings have lower test scores. More interesting from the point of view of this paper is that the gaps between the Vietnam dummy variable and the Ethiopia and India country dummy variables have decreased. More specifically, in Table 3 (Table 4) the gap between Ethiopia and Vietnam dropped from 1.41σ to 0.92σ (from 1.28σ to 0.76σ), the gap between India and Vietnam and India dropped from 1.12σ to 0.85σ (from 0.90σ to 0.63σ). In contrast, the gap between Peru and Vietnam increased slightly, from 0.67σ to 0.68σ (from 0.66σ to 0.68σ). Thus, these variables alone can "explain" about one third of the gap between Ethiopia and Vietnam and about one fourth of the gap between India and Vietnam, but they offer no explanatory power for the gap between Peru and Vietnam.

The last column of estimates in Tables 3 and 4 examines whether hours spent in school and hours studying at home can explain any more of the gap in test score between Vietnam and the other three countries. As expected, at all ages (8, 12 and 15) both of these variables have positive predictive power for test scores. Regarding the gaps, adding these variables does not reduce them; this likely reflects the fact that Vietnamese students time in schools in generally lower than that in the other countries. Turning to Table 3, the gap relative to Ethiopia increases slightly, from 0.92σ to 0.93σ, while the gap relative to India increases to 1.07σ (not very different from the unconditional gap in column 1 of 1.12σ) and the gap relative to Peru drops only slightly, from 0.68σ to 0.67σ. Similar results are shown in Table 4

The potential role played by school and teacher variables to explain the gaps between Vietnam and the other three Young Lives countries is examined in Tables 5 and 6. The first four columns reproduce the first two columns and last two columns of Table 3 (for Table 5) and

Table 4 (for Table 6), although the sample size is smaller because observations with missing school variables are excluded. Yet with this smaller sample size the overall findings from Tables 3 and 4 are unchanged; for Table 5 household variables can explain about one third of the gap between Vietnam and Ethiopia, less than one tenth of the gap between Vietnam and India, and none of the gap between Vietnam and Peru, and similar results hold for Table 6.

The last two columns in Tables 5 and 6 add the six school level variables shown in Table 2.[6] In Tables 5 and 6, five of the six variables have the expected sign, but their statistical significance is generally low;[7] indeed, the only variable significant at the 5% level, electricity in Table 5, has an unexpected negative sign, although it is not significant in Table 6. For comparisons of Vietnam with Ethiopia and India, adding these school variables in both tables reduces the difference between the coefficients on their dummy variables and that of the Vietnam dummy variable, and thus increases the proportion of the "raw" gap that can be explained by the observed variables. More specifically, in Table 5 (Table 6) the original gap for Ethiopia of 1.41σ decreases to 0.78σ (decreases from 1.30σ to 0.64σ), so that 45% (51%) of the gap is explained, while for India the original gap of 1.12σ falls to 0.95σ (0.91 falls to 0.88), so that only about 15% (4%) of the gap is explained. In contrast, in both Tables 5 and 6 adding the school variables slightly increases the difference between the coefficient on the Peru dummy variable and the coefficient on the Vietnam dummy variable, and thus cannot explain any of the gap.

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[6] The school level variables are community (site) level averages over all schools in the community. In the next draft of this paper the 15-year-olds will be linked to their individual schools (or the schools they would be mostly likely to have attended if they are not in school).

[7] The teacher absence variable has several problems that could explain its weak explanatory power. First, it is not measured directly but is obtained as self-reports from teachers (who are likely to underestimate it) or from their school principals (which could also be inaccurate). Second, the recall periods vary over countries **[explain more]**. Third, for India the school principal is asked how many days one or more teachers were absent **[explain more what was done.]**

IV. Oaxaca-Blinder Decompositions

The methodology in the previous section assumes that the impacts of all variables, observed and unobserved, should be the same for all four countries. While in principle this assumption may be correct, it may be unrealistic to impose it given the data available. For example, the impact of an additional year of parental education on a child's learning could vary across countries if school quality varies across countries. While in theory this should be controlled for by interacting years of parental schooling with accurate indicators of school quality (for the years that the parents were in school), such data may simply not be available.

A. The Oaxaca-Blinder Decomposition. An alternative approach for understanding the learning gaps between Vietnam and the other three Young Lives countries is to estimate an Oaxaca-Blinder decomposition of that gap. This can be done separately for each of the three other Young Lives countries. To see how this can be done, consider a comparison of Vietnam with Ethiopia. The starting point is to allow the impacts of the observed variables on test scores to vary by country:

$$S_{i,vn} = \boldsymbol{\beta}_{vn}'\mathbf{x}_{i,vn} + u_{i,vn} \quad \text{(Vietnam)} \qquad (6)$$

$$S_{i,e} = \boldsymbol{\beta}_{e}'\mathbf{x}_{i,e} + u_{i,e} \quad \text{(Ethiopia)} \qquad (7)$$

Taking the mean of both sides of these two regression equations gives the following:

$$\overline{S}_{vn} = \boldsymbol{\beta}_{vn}'\overline{\mathbf{x}}_{vn} \qquad (8)$$

$$\overline{S}_{e} = \boldsymbol{\beta}_{e}'\overline{\mathbf{x}}_{e} \qquad (9)$$

The standard Oaxaca-Blinder decomposition uses these two equations to express the difference in the mean test scores between Vietnam and Ethiopia in the Young Lives data as follows:[8]

$$\bar{S}_{vn} - \bar{S}_e = \boldsymbol{\beta}_{vn}'\bar{\mathbf{x}}_{vn} - \boldsymbol{\beta}_e'\bar{\mathbf{x}}_e \qquad (10)$$

$$= \boldsymbol{\beta}_{vn}'\bar{\mathbf{x}}_{vn} - \boldsymbol{\beta}_e'\bar{\mathbf{x}}_e + \boldsymbol{\beta}_e'\bar{\mathbf{x}}_{vn} - \boldsymbol{\beta}_e'\bar{\mathbf{x}}_{vn}$$

$$= \boldsymbol{\beta}_e'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_e) + (\boldsymbol{\beta}_{vn} - \boldsymbol{\beta}_e)'\bar{\mathbf{x}}_{vn}$$

However, this decomposition has a shortcoming: the differences in ($\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_e$) are "weighted" by the coefficients for Ethiopia, while the differences in ($\boldsymbol{\beta}_{vn} - \boldsymbol{\beta}_3$) are weighted by the means of the $\mathbf{x}$ variables for Vietnam. It would be better if both sets of "weights" were based on data from both countries.

To avoid this shortcoming, one could use the following decomposition:

$$\bar{S}_{vn} - \bar{S}_e = \boldsymbol{\beta}_{vn}'\bar{\mathbf{x}}_{vn} - \boldsymbol{\beta}_e'\bar{\mathbf{x}}_e \qquad (11)$$

$$= \boldsymbol{\beta}_{vn}'\bar{\mathbf{x}}_{vn} - \boldsymbol{\beta}_e'\bar{\mathbf{x}}_e + \bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_e) - \bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_e)$$

$$= \bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_e) + [(\boldsymbol{\beta}_{vn} - \bar{\boldsymbol{\beta}})'\bar{\mathbf{x}}_{vn} + (\bar{\boldsymbol{\beta}} - \boldsymbol{\beta}_e)'\bar{\mathbf{x}}_e]$$

where $\bar{\boldsymbol{\beta}} = (\boldsymbol{\beta}_{vn} + \boldsymbol{\beta}_e)/2$.[9] Intuitively, the first term weights the differences in the $\mathbf{x}$ variables by the simple average of the two $\boldsymbol{\beta}$ coefficients, and the second term accounts for differences in $\boldsymbol{\beta}_{vn}$ and $\boldsymbol{\beta}_e$ by splitting that difference into: 1. The difference between $\boldsymbol{\beta}_{vn}$ and $\bar{\boldsymbol{\beta}}$, weighted by $\bar{\mathbf{x}}_{vn}$; and 2. The difference between $\boldsymbol{\beta}_e$ and $\bar{\boldsymbol{\beta}}$, weighted by $\bar{\mathbf{x}}_e$.

[8] An alternative decomposition is: $\bar{S}_{vn} - \bar{S}_e = \boldsymbol{\beta}_{vn}'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_e) + (\boldsymbol{\beta}_{vn} - \boldsymbol{\beta}_e)'\bar{\mathbf{x}}_e$. This decomposition suffers from the same criticisms as the decomposition in equation (10).

[9] Note that equation (11) holds for *any* definition of $\bar{\boldsymbol{\beta}}$, but the definition used here is the most "natural" one for decomposition purposes.

B. Results. Before presenting the Oaxaca-Blinder decompositions, it is useful to review the means of all of the observed variables in the regression. This is shown in Table 7. Vietnam compares favorably to the three other countries in terms of number of siblings, nutritional status (as measured by the height-for-age Z-score), hours spent studying at home, proportion of teachers with a general university degree, teacher absence, principle years of experience, proportion of schools with electricity and proportion of schools with a library. In addition, it also compares favorably with Ethiopia and India, but not Peru, in terms of family wealth, mother's years of schooling, parental hope that their child will obtain a university degree, and principal's years of experience. Another apparent advantage the Vietnam has over India and Peru (and perhaps Ethiopia, except that no data are available) is in terms of teachers' pedagogical skills for mathematics. The one dimension in which the other three countries compare favorably to Vietnam is the length of the school day, which is (on average) shorter in Vietnam than in all the other three Young Lives countries.[10]

The first country to compare with Vietnam using the Oaxaca-Blinder decomposition is Ethiopia. The results are shown in Table 8 (standardized score on 23 math questions) and Table 9 (latent math skill from IRT analysis). Turning to Table 8, there is a very large gap in the (normalized) test scores between the two countries: 1.41σ. The overall decomposition of this gap into the differences in the mean values of the observed variables and the differences in the $\boldsymbol{\beta}$ coefficients is shown in the last line of the table: almost two thirds (63.5%) of the gap is due to differences in the means of the (observed) $\mathbf{x}$ variables across the two countries, while slightly more than one third (36.5%) is due to the differences in the estimated $\boldsymbol{\beta}$'s of those variables for the two countries. In Table 9, nearly three fourths (72.8%) of the gap between Ethiopia is

[10] This time in school variable includes travel time, which is generally a small amount of time in Vietnam, but could be a larger amount of time in the other three countries **[Need to check more]**.

explained by the (observed) **x** variables. For both tables, it is likely that the explanatory power would be even higher if data were available on teacher's pedagogical skills in mathematics.

The second to last column in Tables 8 and 9 disaggregates the contribution of the differences in the means of the **x** variables across the two countries into the analogous contributions from each observed variable. The largest impact that is statistically significant is due to the difference in wealth, which in Table 8 (Table 9) accounts for about 0.21σ (0.22σ) of the gap. (The proportion of teachers with a university degree has a slightly higher contribution, about 0.24σ (0.27σ), but this is not statistically significant because the impact of this variable is imprecisely estimated for both countries.) The only other observed variables that have statistically significant impacts are mothers' education, which explains 0.08σ (0.07σ) of the gap, and three variables that measure time spent studying at home at different ages, which together explain about 0.19σ (0.22σ) of the gap.

Regarding the contributions to explaining the gap of the differences in the **β** coefficients for specific variables, there are several that have statistically significant explanatory power, as seen in the last column of Tables 8 and 9. In all cases except one, the impact reflects that the coefficient for Vietnam is larger than that for Ethiopia. The stronger impact of mother's years of schooling in Vietnam, relative to the impact for Ethiopia, in Table 8 (Table 9) explains about 0.11σ (0.10σ) of the overall gap, which may reflect that Vietnamese mothers learn more per year of schooling than Ethiopian mothers. An even stronger (relative) effect is found for the height-for-age Z-score variable,[11] which accounts for 0.27σ (0.33σ) of the gap. It is unclear why child malnutrition has a much smaller effect on mathematics skills in Ethiopia than in Vietnam. Another variable with strong (relative) explanatory power is hours studying at home at age 15,

[11] While the mean of this variable is negative for both countries in Table 5, that variable has been rescaled so that it takes only positive values (by adding to all observations the absolute value of the lowest observed values for all countries), which is a standard transformation for interpreting the results of Oaxaca-Blinder decompositions.

which suggests that Vietnamese children are more efficient in their use of their study time. Somewhat contradictory results are found in the hours per day at school variable, which seems to be more effective in Ethiopia at age 12 while more effective in Vietnam at age 15 (significant only in Table 8). Finally, parental hope that their child will obtain a university degree has a stronger effect on mathematics skills in Vietnam than in Ethiopia, but the interpretation of this is not clear. **[Could mention that constant term is big, but not significant. If electricity has a positive effect in Vietnam, this would decrease the constant term for Vietnam, leading to an even larger gap between the 2 constant terms.]**

Turn next to the Oaxaca-Blinder decomposition results that compare Vietnam to India, which are shown in Tables 10 and 11. There is again a very large gap in the (normalized) tests scores between the two countries: 1.12σ in Table 10 and 0.97 in Table 11. The overall decomposition of this gap into the differences in the mean values of the observed variables and the differences in the **β** coefficients is shown in the last lines of the two tables. In Table 10, slightly less than one half (44.0%) of the gap is due to differences in the means of the (observed) **x** variables across the two countries, while slightly more than one half (56.0%) is due to the differences in the estimated **β**'s for the two countries. In Table 11, slightly more than one half (52.2%) of the gap is due to differences in the means of the (observed) **x** variables across the two countries, while slightly less than one half (47.8%) is due to the differences in the estimated **β**'s for the two countries.

The contributions of the differences in the means across the two countries for each of the individual observed variables is shown in the second to last column in Tables 10 and 11. Most of the effects that are statistically significant are positive, which indicates that, on average, Vietnam has higher levels of several variables that contribute to acquiring mathematics skills. In particular, relative to India, Vietnamese households are wealthier, have more educated mothers, have better nourished children, who in turn study more at home, have more hopeful parents, and have schools with more experienced principals and teachers with higher skills for teaching mathematics. The main contributing factor where Vietnam falls short is in the length of the school day, as mentioned above.

Turning to explanations of the gap that are due to differences in the impacts of the **x** variables (observed variables) across the two countries, shown in the last columns of Tables 10 and 11, there is only one child or household variable that has significant explanatory power in both tables: hours spent in school at age 12 seem to be more productive in India than in Vietnam, but the two countries reverse roles for the same variable at age 15. It is difficult to explain this result, including why this difference is found at age 12 but not at age 15.

There are also three school characteristic variables that have significantly (5% level) different effects on mathematics skills across the two countries, but these effects are not easy to interpret. First, both tables show that Vietnamese 15-year-olds have higher math skills than India 15-year-olds because school electricity and computers for students' use have significantly *negative* effects on student learning in India. Perhaps this reflects the fact that providing computers to students can, in some cases, lead to an erosion of students' skills (see Glewwe and Muralidharan, 2016), and the availability of electricity could exacerbate this problem. Lastly, the impact of a school library is much stronger in India than in Vietnam, which counteracts some of the above-mentioned variables that favor Vietnamese students. Why this is effect is so much stronger in Vietnam is difficult to determine.

Finally, Tables 12 and 13 show the Oaxaca-Blinder decomposition results that compare Vietnam with Peru. The gap between the two countries is smaller than was the case for Ethiopia and India, only about 0.58 standard deviations (of the distribution of scores) for the (normalized) score based on the 23 questions (Table 12), and only 0.64 standard deviations for the latent skill variable generated by the IRT analysis (Table 13). The overall decomposition of this gap into the differences in the mean values of the observed variables and the differences in the **β** coefficients is shown in the last lines of Tables 12 and 13, and between 36% (Table 13) and 45% (Table 12) of the gap can be explained by differences in the means of the (observed) **x** variables across the two countries; thus 55-64%% of the gap is due to the differences in the estimated **β**'s across the two countries.

Turning to contributions of the differences in the means across the two countries, in Table 12 the main contributing factors are increased time studying at ages 12 and 15 (which together explain about 0.09σ of the gap), a longer school day at those same ages in Peru (which "un-explains" about 0.13σ of the gap), and the much higher pedagogical skills of Vietnamese teachers (which explains about 0.42σ of the gap). The results in Table 13 are quite similar.

Explanations of the gap between learning of Peruvian and Vietnamese 15-year-olds that are due to differences in the impacts of the (observed) **x** variables across the two countries do not shed much light on this gap. None of these is significant at the 1% level, and the one that is significant at the 5% level in Table 12 is not significant in Table 13, and the one that is significant at the 5% level in Table 13 is significant only at the 10% level in Table 12. Overall, the main finding from Tables 12 and 13 is that the gap in teachers' pedagogical skills explains between 59.9% (Table 13) and 72.5% (Table 12) of the gap in test scores between Peru and Vietnam.

V. Conclusion (tentative)

Vietnam's economic achievements in the past 30 years have attracted much attention, yet in more recent years its accomplishments in education, especially its performance on the 2012 and 2015 PISA assessments, have also generated international interest. This paper investigates the nature and underlying determinants of Vietnam's apparent exceptional performance using a different data source: the Young Lives data collected from Ethiopia, India (Andhra Pradesh), Peru and Vietnam. While the number of countries in the Young Lives data is much smaller than the number in the PISA data, the Young Lives data have several advantages over the PISA data.

The following (preliminary) conclusions can be drawn. First, the Young Lives data are able to "explain" between two thirds and three fourths of the gap in mathematics test scores between Vietnam and Ethiopia. Second, the Young Lives data can explain about half of the gap in test scores between Vietnam and India. Third, these data can explain about 40% of the gap in test scores between Vietnam and Peru. Particularly interesting is that more than half of the gap in the test scores between Peru and Vietnam appears to be due to the much higher pedagogical skills of Vietnamese mathematics teachers.

[To be continued!]

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Figure 1. Mean Age 15 Math Scores in 2012 PISA, by 2010 Log Real GDP/capita

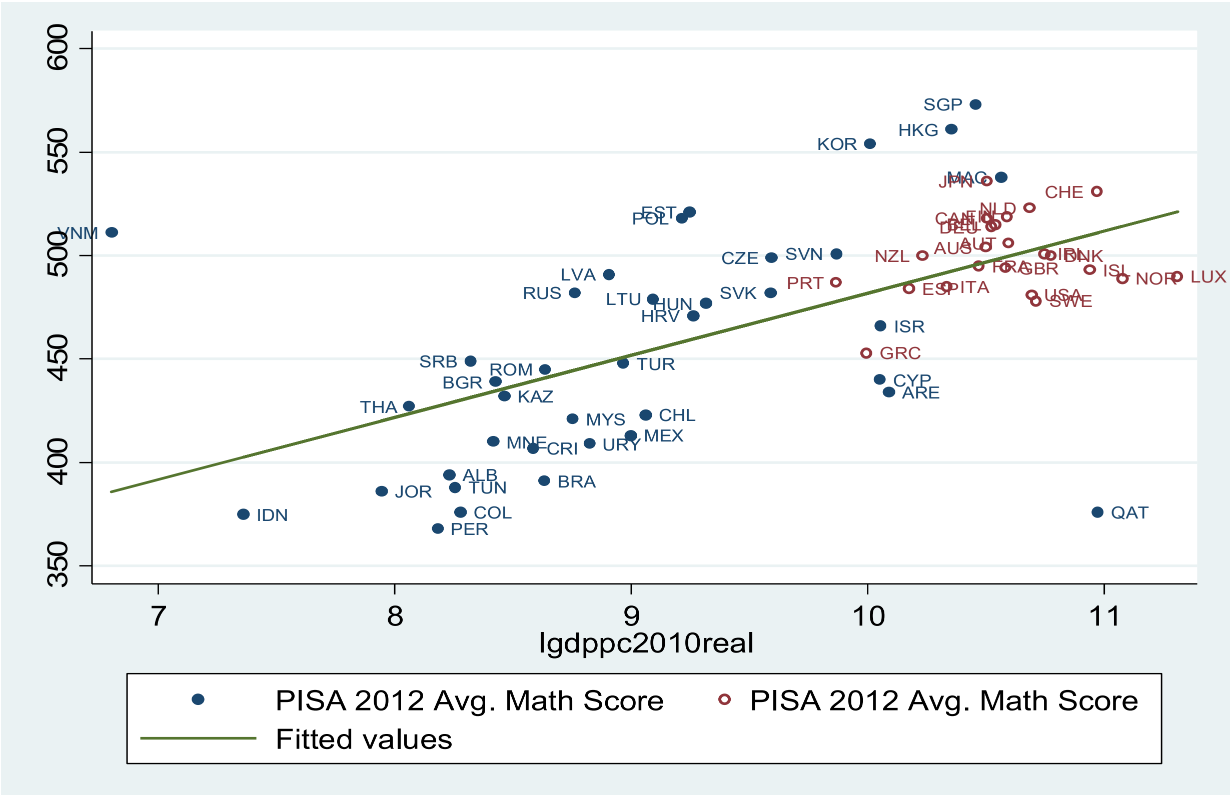

Figure 2. Mean Age 15 Reading Scores in 2012 PISA, by 2010 Log Real GDP/capita

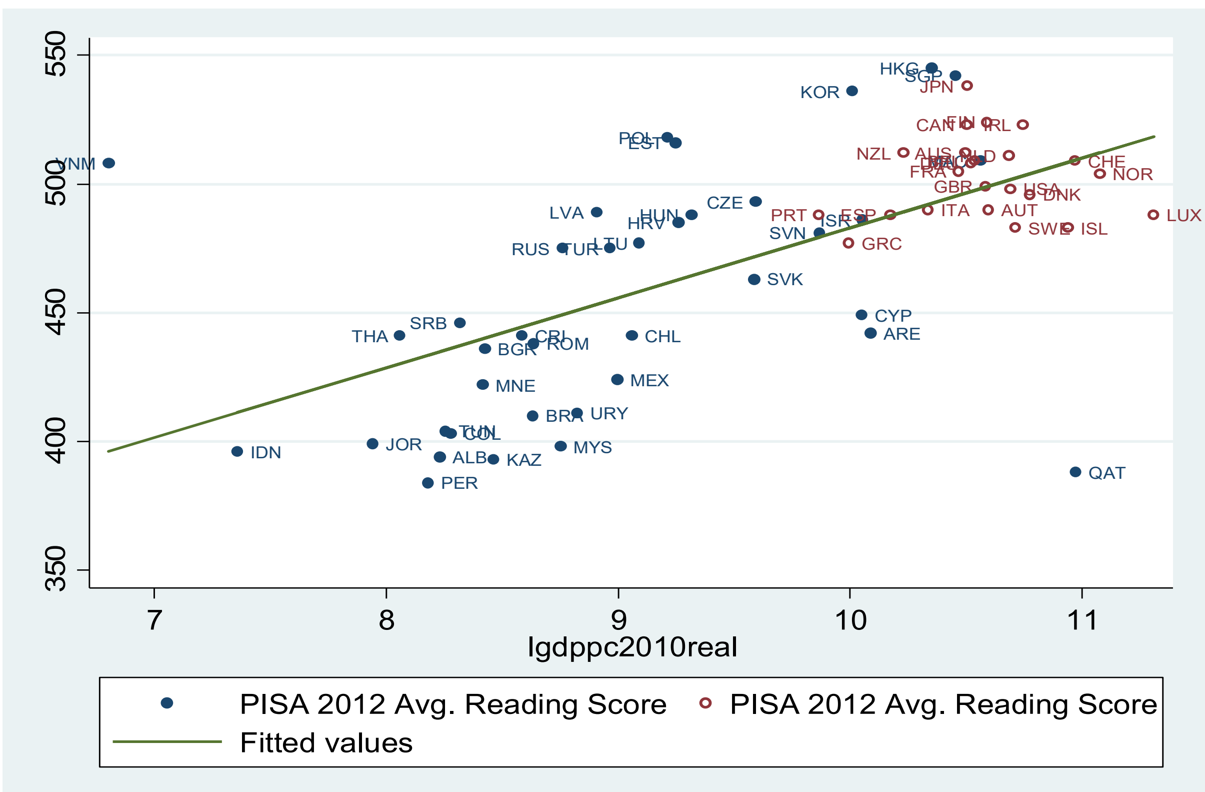

Figure 3: Kernel Density Estimates of Mathematics Test Scores in All Four Countries

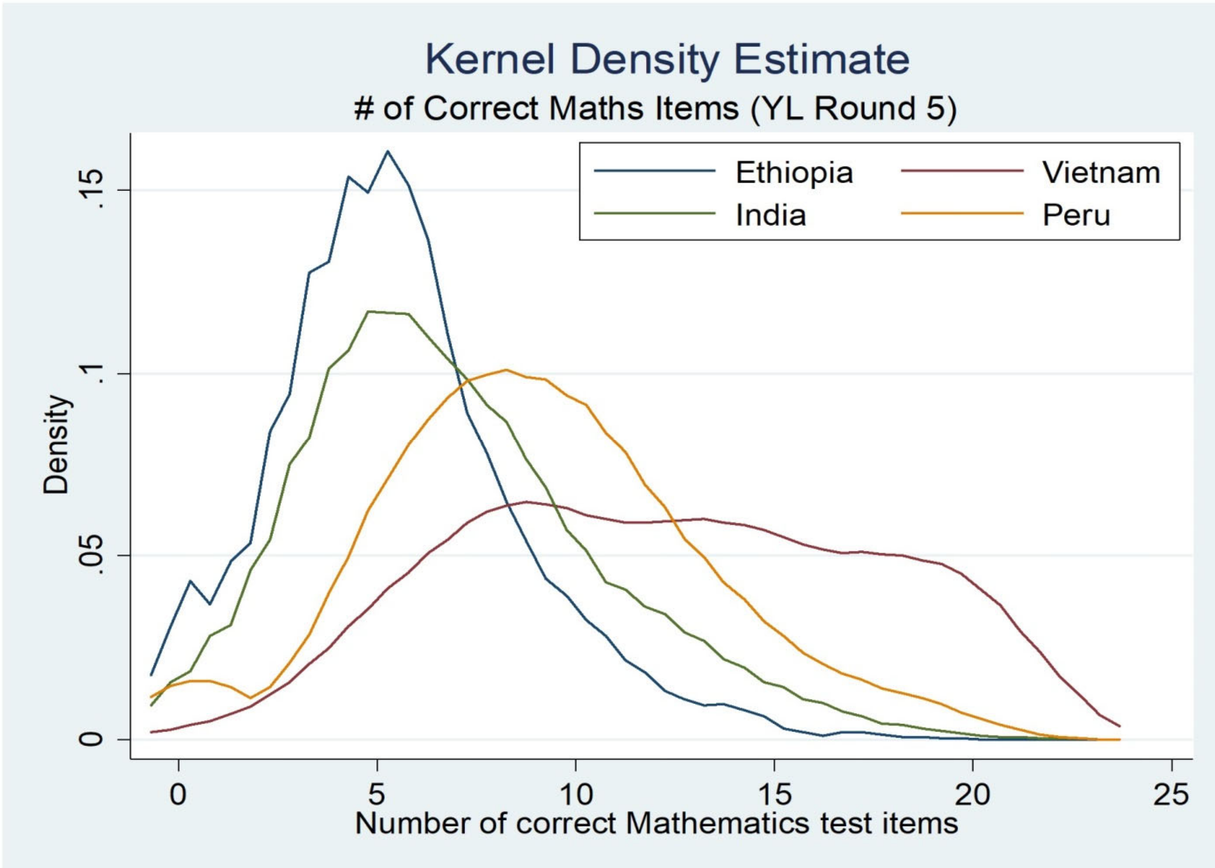

Table 1. Number of Math Questions Correct and Estimated Latent Skill in All 4 Countries (includes all 15-year old children, including those not in school)

Country	Number of Questions Correct (out of 23)	Standardized Score	Latent Skill (IRT)	GNI/Capita (2015)
Ethiopia	5.5	1.13	-0.590	$600
India	6.9	1.42	-0.211	$1,600
Peru	9.1	1.87	0.033	$6,160
Vietnam	12.3	2.54	0.688	$1,950

Notes: The standardized score divides the "raw" score by 4.8618, which is the standard deviation of the "raw" score over all four countries.

Table 2. Potential Explanations for Strong Performance of Vietnamese 15-year-olds

	Ethiopia	India	Peru	Vietnam
Nutritional Status				
Average height-for-age Z-score, age 5	-1.45	-1.65	-1.54	-1.35
Percent of children who are stunted (Z-score < -2), age 5	31.3%	35.7%	33.2%	25.3%
Family Size and Wealth				
Number of siblings, age 8	3.0	1.5	1.7	1.3
Wealth index (when child was 12 years old)	0.32	0.52	0.62	0.63
Parental Education and Support to Education				
Average father's years of education	3.5	4.7	8.9	7.0
Average mother's years of education	2.4	3.1	7.7	6.2
Mother or father helps child with homework:				
Age 12	14.3%	15.6%	34.9%	21.6%
Age 15	10.3%	9.6%	14.6%	4.3%
Hours Devoted to Education				
Hours/day in school (includes travel time):				
Age 8	4.9	7.7	6.0	4.9
Age 12	5.6	8.0	6.1	5.4
Age 15	5.3	7.8	6.9	5.0
Hours/day studying at home:				
Age 8	1.0	1.8	2.0	2.9
Age 12	1.5	1.9	1.8	2.6
Age 15	1.8	2.1	2.1	2.6
Parental Aspirations (when child was 5 years old)				
Finish university or other post-sec. educ.	71.8%	57.9%	87.2%	78.6%
% of parents who think child will attain this	90.8%	88.7%	91.4%	78.9%
Teacher & School Level Variables (site averages)				
% tchrs w/ general (non-ed.) univ. degree	5.4%	78.6%	84.2%	94.4%
Principal's years of exper. as a principal	4.0	6.3	12.7	10.4
Tchr days absent per month	0.63	0.71	0.48	0.26
School has electricity	52.8%	85.8%	94.1%	100.0%
School has a library	62.4%	20.7%	43.9%	79.2%
School has computers for student use	20.1%	29.5%	58.2%	32.3%
Teacher mean score on math pedagogy test:				
9 test items common to India and Peru	--	6.05	5.41	--
4 test items common to India and Vietnam	--	2.53	--	3.13
8 test items common to Peru and Vietnam	--	--	3.27	5.74
Latent ability estimated by IRT	--	0.021	-0.786	0.734

Table 3. Regressions of Standardized Math Scores on Country Dummy Variables and Household/Child Variables

Ethiopia dummy variable	1.131***	[-1.406]	0.876***	[-0.915]	0.115	[-0.931]
	(0.069)		(0.049)		(0.088)	
India dummy variable	1.416***	[-1.120]	0.946***	[-0.845]	-0.023	[-1.068]
	(0.055)		(0.061)		(0.131)	
Peru dummy variable	1.865***	[-0.671]	1.109***	[-0.682]	0.380***	[-0.666]
	(0.063)		(0.077)		(0.113)	
Vietnam dummy variable	2.537***	[0.000]	1.791***	[0.000]	1.046***	[0.000]
	(0.103)		(0.093)		(0.101)	
Wealth index	--		0.890***		0.593***	
			(0.111)		(0.087)	
Mother's years of education	--		0.046***		0.030***	
			(0.004)		(0.003)	
Number of siblings	--		-0.017**		-0.008	
			(0.008)		(0.006)	
Height-for-age Z-score	--		0.072***		0.056***	
			(0.012)		(0.011)	
Hours/day study at home, age 8	--		--		0.023	
Hours/day study at home, age 12	--		--		0.064***	
Hours/day study at home, age 15	--		--		0.088**	
Hours/day in school, age 8	--		--		0.016	
Hours/day in school, age 12	--		--		0.024***	
Hours/day in school, age 15	--		--		0.051***	
Hope child will go to university	--		--		0.079***	
Observations/R-squared	7,297/0.824		7,008/0.854		6,957/0.869	

Standard errors, clustered at site level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Relative to Vietnam dummy in brackets.

Table 4. Regressions of Math Skill (IRT Estimates) on Country Dummy Variables and Household/Child Variables

Ethiopia dummy variable	-0.590***	[-1.278]	-0.852***	[-0.761]	-1.843***	[-0.827]
	(0.086)		(0.055)		(0.083)	
India dummy variable	-0.211***	[-0.899]	-0.719***	[-0.628]	-2.003***	[-0.987]
	(0.061)		(0.072)		(0.129)	
Peru dummy variable	0.033	[-0.655]	-0.771***	[-0.680]	-1.717***	[-0.701]
	(0.058)		(0.083)		(0.112)	
Vietnam dummy variable	0.688***	[0.000]	-0.091	[0.000]	-1.016***	[0.000]
	(0.108)		(0.093)		(0.112)	
Wealth index	--		1.000***		0.612***	
			(0.123)		(0.088)	
Mother's years of education	--		0.046***		0.027***	
			(0.004)		(0.003)	
Number of siblings	--		-0.023***		-0.011**	
			(0.008)		(0.005)	
Height-for-age Z-score	--		0.078***		0.056***	
			(0.012)		(0.011)	
Hours/day study at home, age 8	--		--		0.029*	
Hours/day study at home, age 12	--		--		0.076***	
Hours/day study at home, age 15	--		--		0.093***	
Hours/day in school, age 8	--		--		0.030***	
Hours/day in school, age 12	--		--		0.046***	
Hours/day in school, age 15	--		--		0.055***	
Hope child will go to university	--		--		0.077***	
Observations/R-squared	7,349/0.245		7,055/0.405		6,995/0.495	

Standard errors, clustered at site level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Relative to Vietnam dummy in brackets.

Table 5. Regressions of Standardized Math Scores on Country Dummies, Household/Child & School Variables

Ethiopia dummy variable	1.112***	[-1.413]	0.123	[-0.928]	0.134	[-0.777]
	(0.068)		(0.091)		(0.107)	
India dummy variable	1.419***	[-1.116]	-0.008	[-1.060]	-0.042	[-0.952]
	(0.055)		(0.135)		(0.186)	
Peru dummy variable	1.960***	[-0.574]	0.414***	[-0.638]	0.256	[-0.655]
	(0.074)		(0.117)		(0.180)	
Vietnam dummy variable	2.535***	[0.000]	1.051***	[0.000]	0.910***	[0.000]
	(0.102)		(0.104)		(0.169)	
Prop. tchrs with general univ. degree	--				0.151	
					(0.167)	
Rate of teacher absenteeism	--		adds child &		-0.067	
					(0.041)	
Principal years of experience	--		household		0.012*	
					(0.007)	
Primary school had electricity	--		variables		-0.220**	
					(0.108)	
Primary school had a library	--		--		0.079	
	--		--		(0.117)	
Prim. sch. had computers for students	--		--		0.108	
	--		--		(0.090)	
Observations/R-squared	6,425/0.826		6,425/0.869		6,425/0.871	

Coefficients not shown for hhold/child variables. Std. errors, clustered at the site level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1. Country dummy variables relative to Vietnam in brackets.

Table 6. Regressions of Math Skill (IRT Estimates) on Country Dummies, Household/Child & School Variables

Ethiopia dummy variable	-0.599***	[-1.302]	-1.837***	[-0.819]	-1.826***	[-0.636]
	(0.085)		(0.084)		(0.092)	
India dummy variable	-0.209***	[-0.912]	-1.996***	[-0.978]	-2.068***	[-0.878]
	(0.061)		(0.131)		(0.183)	
Peru dummy variable	0.123*	[-0.580]	-1.698***	[-0.680]	-1.882***	[-0.692]
	(0.066)		(0.116)		(0.176)	
Vietnam dummy variable	0.703***	[0.000]	-1.018***	[0.000]	-1.190***	[0.000]
	(0.105)		(0.113)		(0.169)	
Prop. tchrs with general univ. degree	--				0.166	
					(0.154)	
Rate of teacher absenteeism	--		adds child &		-0.077*	
					(0.041)	
Principal years of experience	--		Household		0.009	
					(0.007)	
Primary school had electricity	--		Variables		-0.114	
					(0.111)	
Primary school had a library	--		--		0.043	
	--		--		(0.116)	
Prim. sch. had computers for students	--		--		0.121	
	--		--		(0.086)	
Observations/R-squared	6,463/0.273		6,463/0.508		6,463/0.513	

Coefficients not shown for hhold/child variables. Std. errors, clustered at the site level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1. Country dummy variables relative to Vietnam in brackets.

Table 7: Means of Regression Variables, for All Four Young Lives Countries, 2016

Variable (x)	Vietnam	Ethiopia	India	Peru
Math test score (number correct), age 15	12.332	5.498	6.885	9.068
Math test score (normalized), age 15	2.535	1.122	1.419	1.960
Latent math skill (IRT estimated)	0.668	-0.590	-0.211	0.033
Wealth index (adjusted), age 12	0.635	0.324	0.525	0.638
Mom years schooling	6.332	2.415	3.211	8.162
Number of siblings, age 8	1.292	3.032	1.532	1.571
Height-for-age Z-score, age 5	-1.337	-1.415	-1.644	-1.435
Hours of study at home per day, age 8	2.922	1.019	1.855	2.095
Hours of study at home per day, age 12	2.688	1.534	1.959	1.896
Hours of study at home per day, age 15	2.608	1.915	2.181	2.126
Hours of in school per day, age 8	4.945	5.038	7.732	6.029
Hours of in school per day, age 12	5.491	5.699	8.116	6.121
Hours of in school per day, age 15	5.139	5.464	8.047	6.857
Parents hope child will go to university, age 5	0.809	0.761	0.612	0.956
Proportion of teachers with general university degree	0.941	0.053	0.786	0.842
Days teacher was absent in last 30 days	0.263	0.635	0.710	0.464
Principal years of experience as a principal	10.409	3.983	6.235	12.774
School has electricity	1.000	0.527	0.857	0.945
School has a library	0.789	0.623	0.206	0.446
School has computers for students to use	0.312	0.199	0.290	0.596
Teacher mean score on math pedagogy test:				
9 test items common to India and Peru	--	--	6.05	5.41
4 test items common to India and Vietnam	3.13	--	2.53	--
8 test items common to Peru and Vietnam	5.74	--	--	3.27
Latent ability estimated by IRT	0.734	--	0.021	-0.786
Sample size	1,793	1,650	1,804	1,178

Table 8: Oaxaca-Blinder Decomposition for Normalized Math Score, Age 15, Vietnam and Ethiopia
(diff = 2.535– 1.122 = 1.413)

Variable	β_{vn}	$\bar{x}_{vn}$	β_{e}	$\bar{x}_{e}$	$\bar{\beta}$	$\bar{\beta}'(\bar{x}_{vn}-\bar{x}_{e})$	$(\beta_{vn}-\bar{\beta})'\bar{x}_{vn} + (\bar{\beta}-\beta_{e})'\bar{x}_{e}$
Wealth index (adjusted), age 12	0.800***	0.635	0.537***	0.324	0.669	0.208***	0.126
Mom years schooling	0.033***	6.332	0.008	2.415	0.021	0.080***	0.111***
Number of siblings, age 8	-0.007	1.292	-0.001	3.032	-0.004	0.007	-0.012
Height-for-age Z-score,	0.082***	-1.337	0.021	-1.415	0.052	0.004	0.267**
Hours study at home, age 8	0.030	2.922	0.032*	1.019	0.031	0.059**	-0.003
Hours study at home, age 12	0.072***	2.688	0.056***	1.534	0.064	0.073***	0.034
Hours study at home, age 15	0.097***	2.608	0.040*	1.915	0.069	0.048***	0.130**
Hours/day in school, age 8	0.017	4.945	0.018**	5.038	0.018	-0.002	-0.008
Hours/day in school, age 12	0.004	5.491	0.044***	5.699	0.024	-0.005	-0.221**
Hours/day in school, age 15	0.069***	5.139	0.039**	5.464	0.054	-0.002	0.163*
Parents hope child go to university	0.163***	0.809	0.004	0.761	0.084	0.004	0.124**
Prop. tchrs with general univ. degree	0.400	0.941	0.146	0.053	0.273	0.243	0.126
Days teacher absent	-0.072	0.263	-0.131	0.635	-0.102	0.038	0.026
Principal years of experience	0.028**	10.409	0.011	3.983	0.020	0.127	0.106
School has electricity	0.000	1.000	-0.004	0.527	-0.002	-0.001	0.003
School has a library	0.159	0.789	0.003	0.623	0.081	0.013	0.109
School has computers for students	0.122	0.312	0.178*	0.199	0.150	0.017	-0.014
Constant	-0.451	1.000	0.101	1.000	-0.175	0.000	-0.551
						0.897***	0.516**

Table 9: Oaxaca-Blinder Decomposition for Latent Math Skill (IRT), Age 15, Vietnam and Ethiopia
(diff = 0.688–(-0.590) ≈ 1.302)

Variable	$\boldsymbol{\beta}_{vn}$	$\bar{\mathbf{x}}_{vn}$	$\boldsymbol{\beta}_{e}$	$\bar{\mathbf{x}}_{e}$	$\bar{\boldsymbol{\beta}}$	$\bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn}-\bar{\mathbf{x}}_{e})$	$(\boldsymbol{\beta}_{vn}-\bar{\boldsymbol{\beta}})'\bar{\mathbf{x}}_{vn} + (\bar{\boldsymbol{\beta}}-\boldsymbol{\beta}_{e})'\bar{\mathbf{x}}_{e}$
Wealth index (adjusted), age 12	0.689***	0.635	0.741***	0.324	0.715	0.220***	-0.025
Mom years schooling	0.031***	6.332	0.007	2.415	0.019	0.071***	0.103***
Number of siblings, age 8	-0.015	1.292	-0.003	3.032	-0.009	0.016	-0.028
Height-for-age Z-score,	0.099***	-1.337	0.023	-1.415	0.061	0.004	0.332***
Hours study at home, age 8	0.042*	2.922	0.033	1.019	0.038	0.070**	0.017
Hours study at home, age 12	0.083***	2.688	0.089***	1.534	0.086	0.096***	-0.012
Hours study at home, age 15	0.093***	2.608	0.066***	1.915	0.080	0.051***	0.060
Hours/day in school, age 8	0.027	4.945	0.024**	5.038	0.026	-0.003	0.013
Hours/day in school, age 12	0.052***	5.491	0.052***	5.699	0.052	-0.015	0.001
Hours/day in school, age 15	0.070***	5.139	0.035**	5.464	0.048	-0.022	0.180*
Parents hope child go to university	0.117**	0.809	0.031	0.761	0.074	0.003	0.068**
Prop. tchrs with general univ. degree	0.201	0.941	0.413	0.053	0.307	0.273	-0.105
Days teacher absent	-0.097	0.263	-0.154	0.635	-0.126	0.047	0.025
Principal years of experience	0.021**	10.409	0.008	3.983	0.015	0.094	0.077
School has electricity	0.000	1.000	0.114	0.527	0.067	0.027	-0.087
School has a library	0.050	0.789	-0.088	0.623	-0.019	-0.003	0.097
School has computers for students	0.157	0.312	0.216**	0.199	0.187	0.020	-0.015
Constant	0.154	1.000	0.500***	1.000	0.327	0.000	-0.347
						0.948***	0.355

Table 10: Oaxaca-Blinder Decomposition for Normalized Math Score, Age 15, Vietnam and India (diff = 2.535– 1.419 = 1.116)

Variable	$\boldsymbol{\beta}_{vn}$	$\bar{\mathbf{x}}_{vn}$	$\boldsymbol{\beta}_{i}$	$\bar{\mathbf{x}}_{i}$	$\bar{\boldsymbol{\beta}}$	$\bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn}-\bar{\mathbf{x}}_{i})$	$(\boldsymbol{\beta}_{vn}-\bar{\boldsymbol{\beta}})'\bar{\mathbf{x}}_{vn} + (\bar{\boldsymbol{\beta}}-\boldsymbol{\beta}_{i})'\bar{\mathbf{x}}_{i}$
Wealth index (adjusted), age 12	0.715***	0.635	0.445***	0.525	0.580	0.064***	0.156
Mom years schooling	0.034***	6.332	0.032***	3.211	0.033	0.104***	0.011
Number of siblings, age 8	0.001	1.292	-0.024	1.532	-0.012	0.003	0.035
Height-for-age Z-score,	0.073**	-1.337	0.054***	-1.644	0.064	0.019**	0.082
Hours study at home, age 8	0.015	2.922	0.033**	1.855	0.024	0.026*	-0.045
Hours study at home, age 12	0.066***	2.688	0.038*	1.959	0.052	0.038***	0.062
Hours study at home, age 15	0.102***	2.608	0.072***	2.181	0.087	0.037**	0.072
Hours/day in school, age 8	0.009	4.945	0.031	7.732	0.020	-0.055	-0.140
Hours/day in school, age 12	0.001	5.491	0.044***	8.116	0.023	-0.059***	-0.290***
Hours/day in school, age 15	0.067***	5.139	0.038***	8.047	0.053	-0.154***	0.192***
Parents hope child go to university	0.150**	0.809	0.092***	0.612	0.121	0.024***	0.041
Prop. tchrs with general univ. degree	0.228	0.941	0.039	0.786	0.134	0.021	0.164
Days teacher absent	-0.122	0.263	-0.040*	0.710	-0.081	0.036	-0.040
Principal years of experience	0.021*	10.409	0.008	6.235	0.015	0.060**	0.101
School has electricity	0.000	1.000	-0.440***	0.857	-0.220	-0.031**	0.409***
School has a library	-0.130	0.789	0.580***	0.206	0.225	0.131	-0.353**
School has computers for students	0.157	0.312	-0.329*	0.290	-0.086	-0.002	0.146**
Teacher latent math ability (IRT)	0.306**	1.934	0.333***	1.221	0.320	0.228***	-0.043
Constant	-0.389	1.000	-0.452	1.000	-0.037	0.000	0.063
						0.491***	0.626***

Table 11: Oaxaca-Blinder Decomposition for Latent Math Skill, Age 15, Vietnam and India (diff = 0.688 – (-0.211) ≈ 0.968)

Variable	$\boldsymbol{\beta}_{vn}$	$\bar{\mathbf{x}}_{vn}$	$\boldsymbol{\beta}_{i}$	$\bar{\mathbf{x}}_{i}$	$\bar{\boldsymbol{\beta}}$	$\bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn}-\bar{\mathbf{x}}_{i})$	$(\boldsymbol{\beta}_{vn}-\bar{\boldsymbol{\beta}})'\bar{\mathbf{x}}_{vn} + (\bar{\boldsymbol{\beta}}-\boldsymbol{\beta}_{i})'\bar{\mathbf{x}}_{i}$
Wealth index (adjusted), age 12	0.637***	0.635	0.414***	0.525	0.526	0.058***	0.129
Mom years schooling	0.033***	6.332	0.033***	3.211	0.033	0.102***	-0.000
Number of siblings, age 8	-0.005	1.292	-0.020	1.532	-0.012	0.003	0.021
Height-for-age Z-score,	0.080***	-1.337	0.049**	-1.644	0.065	0.020**	0.133
Hours study at home, age 8	0.019	2.922	0.047***	1.855	0.033	0.035**	-0.065
Hours study at home, age 12	0.061***	2.688	0.053**	1.959	0.057	0.042***	0.017
Hours study at home, age 15	0.092***	2.608	0.079***	2.181	0.086	0.036**	0.032
Hours/day in school, age 8	0.005	4.945	0.040*	7.732	0.023	-0.063	-0.217
Hours/day in school, age 12	0.009	5.491	0.048***	8.116	0.029	-0.074***	-0.268**
Hours/day in school, age 15	0.059***	5.139	0.049***	8.047	0.054	-0.157***	0.068
Parents hope child go to university	0.107**	0.809	0.084***	0.612	0.096	0.019***	0.017
Prop. tchrs with general univ. degree	0.200	0.941	-0.082	0.786	0.059	0.009	0.243
Days teacher absent	-0.141*	0.263	-0.038**	0.710	-0.090	0.040*	-0.051
Principal years of experience	0.015	10.409	0.013**	6.235	0.014	0.059**	0.013
School has electricity	0.000	1.000	-0.454**	0.857	-0.227	-0.032**	0.422***
School has a library	-0.156	0.789	0.777***	0.206	0.311	0.181*	-0.464**
School has computers for students	0.163	0.312	-0.404**	0.290	-0.120	-0.003	0.171**
Teacher latent math ability (IRT)	0.282**	1.934	0.366***	1.221	0.324	0.231***	-0.132
Constant	0.491	1.000	0.097	1.000	0.683	0.000	0.395
						0.505***	0.462***

Table 12: Oaxaca-Blinder Decomposition for Normalized Math Score, Age 15, Vietnam and Peru (diff = 2.535– 1.960 = 0.575)

Variable	$\boldsymbol{\beta}_{vn}$	$\bar{\mathbf{x}}_{vn}$	$\boldsymbol{\beta}_{p}$	$\bar{\mathbf{x}}_{p}$	$\bar{\boldsymbol{\beta}}$	$\bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn}-\bar{\mathbf{x}}_{p})$	$(\boldsymbol{\beta}_{vn}-\bar{\boldsymbol{\beta}})'\bar{\mathbf{x}}_{vn} + (\bar{\boldsymbol{\beta}}-\boldsymbol{\beta}_{p})'\bar{\mathbf{x}}_{p}$
Wealth index (adjusted), age 12	0.715***	0.635	0.513***	0.638	0.614	-0.002	0.129
Mom years schooling	0.034***	6.332	0.039***	8.162	0.037	-0.067*	-0.030
Number of siblings, age 8	0.001	1.292	-0.005	1.571	-0.002	0.001	0.008
Height-for-age Z-score,	0.073**	-1.337	0.076***	-1.435	0.075	0.007	-0.011
Hours study at home, age 8	0.015	2.922	0.008	2.095	0.012	0.009	0.016
Hours study at home, age 12	0.066***	2.688	0.057**	1.896	0.062	0.049***	0.019
Hours study at home, age 15	0.102***	2.608	0.060**	2.126	0.081	0.039**	0.100*
Hours/day in school, age 8	0.009	4.945	-0.003	6.029	0.003	-0.003	0.065
Hours/day in school, age 12	0.001	5.491	0.058**	6.121	0.030	-0.019**	-0.333**
Hours/day in school, age 15	0.067***	5.139	0.063***	6.857	0.065	-0.112***	0.024
Parents hope child go to university	0.150**	0.809	-0.021	0.956	0.065	-0.009	0.150*
Prop. tchrs with general univ. degree	0.228	0.941	0.238	0.842	0.233	0.023	-0.009
Days teacher absent	-0.122	0.263	-0.094	0.464	-0.108	0.022	-0.010
Principal years of experience	0.021*	10.409	0.011	12.774	0.016	-0.038	0.112
School has electricity	0.000	1.000	-0.460	0.945	-0.230	-0.013	0.448
School has a library	-0.130	0.789	-0.050	0.446	-0.090	-0.031	-0.049
School has computers for students	0.157	0.312	-0.059	0.596	0.049	-0.014	0.098
Teacher latent math ability (IRT)	0.306**	1.934	0.242	0.414	0.274	0.417**	0.076
Constant	-0.389	1.000	0.100	1.000	0.185	0.000	-0.489
						0.260	0.314

Table 13: Oaxaca-Blinder Decomposition for Latent Math Skill, Age 15, Vietnam and Peru (diff = 0.688 – 0.033 ≈ 0.636)

Variable	$\boldsymbol{\beta}_{vn}$	$\bar{\mathbf{x}}_{vn}$	$\boldsymbol{\beta}_{p}$	$\bar{\mathbf{x}}_{p}$	$\bar{\boldsymbol{\beta}}$	$\bar{\boldsymbol{\beta}}'(\bar{\mathbf{x}}_{vn}-\bar{\mathbf{x}}_{p})$	$(\boldsymbol{\beta}_{vn}-\bar{\boldsymbol{\beta}})'\bar{\mathbf{x}}_{vn} + (\bar{\boldsymbol{\beta}}-\boldsymbol{\beta}_{p})'\bar{\mathbf{x}}_{p}$
Wealth index (adjusted), age 12	0.637***	0.635	0.462***	0.638	0.550	-0.002	0.111
Mom years schooling	0.033***	6.332	0.033***	8.162	0.033	-0.060*	-0.006
Number of siblings, age 8	-0.005	1.292	0.003	1.571	-0.001	0.000	-0.012
Height-for-age Z-score,	0.080***	-1.337	0.065***	-1.435	0.073	0.007	0.068
Hours study at home, age 8	0.019	2.922	0.005	2.095	0.012	0.010	0.037
Hours study at home, age 12	0.061***	2.688	0.047**	1.896	0.054	0.043***	0.032
Hours study at home, age 15	0.092***	2.608	0.066***	2.126	0.079	0.038**	0.061
Hours/day in school, age 8	0.005	4.945	0.003	6.029	0.004	-0.004	0.015
Hours/day in school, age 12	0.009	5.491	0.029	6.121	0.019	-0.012	-0.116
Hours/day in school, age 15	0.059***	5.139	0.060***	6.857	0.060	-0.103***	-0.008
Parents hope child go to university	0.107**	0.809	-0.051	0.956	0.028	-0.004	0.139**
Prop. tchrs with general univ. degree	0.200	0.941	0.269	0.842	0.235	0.023	-0.062
Days teacher absent	-0.141*	0.263	-0.086	0.464	-0.114	0.023	-0.020
Principal years of experience	0.015	10.409	0.009	12.774	0.012	-0.029	0.060
School has electricity	0.000	1.000	-0.458	0.945	-0.229	-0.013	0.445
School has a library	-0.156	0.789	-0.077	0.446	-0.117	-0.040	-0.049
School has computers for students	0.163	0.312	0.075	0.596	0.119	-0.034	0.040
Teacher latent math ability (IRT)	0.282**	1.934	0.219	0.414	0.251	0.381**	0.074
Constant	0.491	1.000	0.892**	1.000	0.973	0.000	-0.400
						0.226	0.410*