What Explains Vietnam's Exceptional Performance in Education Relative to Other Countries? Analysis of the 2012 PISA Data

Paul Glewwe, Jongwook Lee and Khoa Vu
Department of Applied Economics, University of Minnesota

Hai Anh Dang
The World Bank

June 9, 2017

Abstract

Vietnam's economic growth in the last 30 years has transformed it from one of the world's poorest countries to a middle income country. In more recent years, Vietnam's accomplishments in education have also generated substantial international attention. While its success at getting all children into school (primary completion rate of 97%, and lower secondary enrollment rate of 92%) is impressive, most striking is its performance on the 2012 PISA assessment: It ranked 16th in math and 18th in reading out of 63 countries and territories, ahead of both the US and the UK and much higher than any other developing country. This paper uses the 2012 PISA data to accomplish three tasks. First, it investigates whether the Vietnamese students who participated in the 2012 PISA are representative of 15-year-olds in Vietnam in 2012. Second, it uses regression methods to investigate what family or school characteristics in the PISA data can "explain" the high performance of Vietnamese students. Third, it applies an Oaxaca-Blinder decomposition to better understand the difference in average test scores between Vietnamese students and students in the other countries that participated in the 2012 PISA assessment. The following conclusions are drawn. First, it appears that the students in the PISA sample for Vietnam have higher socio-economic status than 15-year-old students in the 2012 Vietnam Household Living Standards Survey (VHLSS), and adjustments to the PISA sample to make it more "representative" yield somewhat lower test scores, although Vietnam remains a positive outlier conditional on its GDP per capita. Even more important is that Vietnam has the third lowest school enrollment rate of the 63 countries that participated in the 2012 PISA assessment, at only 55.7%; a comparison that focuses on the top 50% of the entire population of 15-year-olds greatly reduces Vietnam's rank among the 63 PISA countries, but it is still an outlier conditional on its low level of GDP. Second, household and school level variables in the PISA data do not explain Vietnam's high performance on the 2012 PISA relative to its income level. Third, the Blinder-Oaxaca decompositions indicate that the gap in average test scores between Vietnam and the other 62 countries primarily reflects greater "productivity" of Vietnamese students in grade 10, relative to the "productivity" of grade 10 students in other countries, while differences in students' and schools' observable characteristics between Vietnam and the other PISA countries do not explain Vietnam's higher performance.

We would like to thank Francesco Avvisati, Luis Felipe Saenz and Nic Spaull, as well as seminar participants at Columbia University (Teachers College) and the City University of New York, for helpful comments.

I. Introduction

Vietnam's achievements in terms of economic growth in the last 30 years have resulted in its transformation from one of the poorest countries in the world to a middle income country (World Bank, 2013). While these economic achievements have attracted much attention, in more recent years Vietnam's accomplishments in education have also generated a great deal of international attention.

Vietnam's high performance in the "quantity" of education is exemplified by its high primary completion rate of 97%, and its high lower secondary enrollment rate of 95%.[1] More striking still is the 2012 PISA assessment: Vietnam's performance ranked 16th in math and 18th in reading out of 63 countries and territories,[2] ahead of both the US and the UK and much higher than that of any other developing country (OECD, 2014a). 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), a nearby country that is most similar to Vietnam among all the 2012 PISA participating countries in terms of GDP per capita.[3]

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, which plot PISA scores in math and reading by the log of per capita GDP for all 63 countries. In both figures, Vietnam is in the upper left of the figure, higher than any other country above the line that shows the expected test score given per capita GDP.

---

[1] The lower secondary rate is from Dang and Glewwe (2017), while the primary completion rate was calculated by the authors using the 2014 VHLSS data.

[2] 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.

[3] 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).

This paper uses the PISA data to understand this unusually high performance. More specifically, it has three objectives. First, it examines whether the 15-year-old Vietnamese students who participated in the 2012 PISA are representative of 15-year-olds in Vietnam in the same year, focusing on the enrollment rate of this specific age cohort (which is very low in Vietnam relative to the other PISA countries) and on the representativeness of the PISA sample for Vietnam conditional on being enrolled in school. Second, it uses regression methods to investigate what family, teacher or school characteristics in the PISA data can "explain" the high performance of Vietnamese students. Third, it applies the Oaxaca-Blinder decomposition to better understand the difference in average test scores between Vietnamese students and students in the other countries that participated in the 2012 PISA assessment.

The following conclusions can be drawn. First, a major reason for Vietnam's impressive performance on the 2012 PISA assessment appears to be the low enrollment rate of 15-year-olds in Vietnam; of the 63 countries that participated in that assessment, Vietnam's "coverage index" was only 55.7%, the third lowest of the 63 countries. To adjust for this low enrolment rate, if one assumes that 15-year-olds not in school at the time of the PISA assessment would have scored in the bottom half of all 15-year-olds had they taken the PISA exams, and then compares the top 50% of 15-year-olds in all 63 PISA countries, Vietnam would have ranked much lower: 40^{th} in math and 41^{st} in reading out of 63 countries. Yet even so, Vietnam would still be an outlier relative to its GDP per capita. It is also the case that Vietnamese 15-year-olds who participated in the PISA assessment are better off than a sample of students born in 1996, and thus about 15 years old in 2012; those in the PISA sample are of higher socio-economic status than 15-year-old students in the 2012 Vietnam Household Living Standards Survey (VHLSS). A particularly important difference is that the students in the PISA data are more likely to be in grade 10 (and less likely to be in grade 9) than students born in 1996 in the VHLSS data. Setting aside the issue of lower enrollment of 15-year-olds, when mean values of child characteristics from the VHLSS data are used to predict test scores from regression coefficients estimated from the PISA data, Vietnam's PISA scores are much lower – Vietnam would have ranked 29^{th} out of 63 in both math and reading – although they are still much higher than what one would predict based on their income alone.

Second, accounting for household level and school level variables in the PISA data does not explain Vietnam's higher performance on the 2012 PISA relative to its income level. In particular, adding these variables to an initial regression of PISA test scores on GDP per capita or household wealth does not reduce, and thus does not account for, Vietnam's "outlier" status.

Third, Oaxaca-Blinder decompositions indicate that the gap in average test scores between Vietnam and the other 62 countries primarily reflects greater "productivity" of grade 10 students in Vietnam relative to the "productivity" of grade 10 students in other countries. This could reflect the fact that only Vietnamese students who pass an entrance exam are allowed to proceed from grade 9 to grade 10, which is the first grade of the upper secondary cycle in Vietnam. In contrast, differences in household and school characteristics explain very little of the gap between Vietnam and the other countries that participated in the PISA assessment.

II. Are the 15-year-olds in the PISA Data Representative of Vietnam's 15-year-olds?

Some observers, both Vietnamese and international, of Vietnam's high performance on the 2012 PISA have expressed surprise that Vietnam could perform so well. This raises the question of whether the 15-year-old Vietnamese students who participated in the 2012 PISA assessment are representative of Vietnamese 15-year-olds.

In each country, the students who participated in the PISA should be a random sample of all children born in 1996 (and thus were 15 years old at the start of 2012) who were enrolled in school in 2012 (OECD, 2014b).[4] One possible explanation for Vietnam's strong performance is that many 15-year-old children in Vietnam are not enrolled in school, and those that are in school are likely to be better students than those who are not. Indeed, of the 63 countries that participated in the 2012 PISA assessment Vietnam's "coverage index" indicates that only 55.7% of Vietnam's 15-year-olds were included in the PISA, primarily because of the low proportion of Vietnamese 15-year-olds who are enrolled in school (OECD, 2014a, Table A2.1). This is the third lowest coverage index among the 63 countries; only Albania (55.2%) and Costa Rica (49.6%) had a lower coverage rate.

It is very likely that the 44.3% of 15-year-olds who did not participate in the 2012 PISA assessment were relatively weak students before they left school, since most of those who did participate were in grade 10 (as discussed further below) and students are admitted to that grade only if they pass an entrance exam. Thus one possible explanation for Vietnam's strong performance in the 2012 PISA is that the 44% of 15-year-olds who did not participate in that assessment were the weakest students, while in other countries a much smaller proportion of 15-year-olds did not participate. One way to adjust each country's performance to account for this differential participation is to focus on the "top 50%" of 15-year-olds. This can be done by "adding back in" non-participating students but assuming that they would have scored in the

[4] Most PISA countries, including Vietnam, conducted the testing in April of 2012. Thus children born in 1996 would be in the age range of between 15 years and 3 (completed) months of age (if born in December of 1996) and 16 years and 2 (completed) months (if born in January of 1996). Technically, the target population was defined as "all students aged from 15 years and 3 completed months to 16 years and 2 completed months at the beginning of the assessment period" (OECD, 2014b, p.66). Our comparisons with the VHLSS data define the population of interest as those born in 1996, which is very close to the official PISA definition.

lowest 50% of the distribution of test scores among all 15-year-olds if they had participated in the assessment. The results of doing those are shown in Table 1.

The first two columns of Table 1 show the widely reported scores in the PISA reports, which include all test participants (and exclude nonparticipants).[5] After excluding the two entities that are not countries, Vietnam ranks 16 out of 63 in math and 18 out of 63 in reading. However, when 15-year-olds who are not students are included, and are assumed to be in the bottom 50% if they had taken the exam, then the performance of Vietnam's "top 50%" of 15-year-olds is not as impressive, ranking only 40 out of 63 in math and 41 out of 63 in reading. This is shown in the third and fourth columns of Table 1.

Yet even this much lower ranking is still impressive when one recalls that Vietnam is a relatively poor developing country. First, it still outperforms all other developing countries that participated in the PISA, although Chile and Turkey are not far behind (and the other hand, Chile and Turkey are much wealthier than Vietnam). Second, as seen in Figures 3 and 4, given that Vietnam is the poorest of all of the 63 countries it is still by far the largest positive outlier when these scores of the "top 50% of all 15-year-olds" are plotted against log of per capita GDP. Although Vietnam's "top 50%" scores in mathematics and reading are not much higher than their "unadjusted" scores, and the increase in test scores when focusing on the top 50% of all 15-year-olds was much higher for other countries, the increases were highest in the wealthier countries since those countries generally have the highest PISA participation rates. This increases the slope of the lines in Figures 3 and 4, relative to Figures 1 and 2, and since Vietnam is at the far left of all these figures the higher slope makes it more of an outlier.

[5] These are slightly different from the numbers in OECD (2014a) because sample weights were not used; they were not used for comparability with columns 3 and 4, which could not use sampling weights to exclude 15-year-olds who did not participate in the exam.

While correcting for Vietnam's lower participation rate makes its unconditional performance less impressive, it still outperforms all other developing countries, and conditional on its GDP it is still an extreme outlier and thus its education system is worthy of study. Yet another question remains that requires investigation before concluding that Vietnam is outperforming all other developing countries: Are the Vietnamese students who participated in the 2012 PISA assessment representative of children born in Vietnam in 1996 who were students in 2012?

This question can be addressed by using data from the 2012 Vietnam Household Living Standards Survey (VHLSS). Vietnam's General Statistical Office conducts the VHLSS every two years on a random sample of Vietnamese households. This data set can be used to compare the characteristics of the Vietnamese students who participated in the 2012 PISA with a general sample of children born in 1996 who were still students in 2012.

Table 2 uses data from the 2012 PISA assessment and the 2012 VHLSS to assess the representativeness of the Vietnamese students who participated in the 2012 PISA. There are several discrepancies between the two data sources. Assuming that the VHLSS data are accurate, the students who participated in the 2012 PISA are less likely to be from rural areas (50% vs. 74%) and thus more likely to be from urban areas (50% vs. 26%),[6] are slightly more likely to be in grade 10 (86% vs. 84%) and thus less likely to be in grade 9 (10% vs. 14%), have more educated mothers (8.3 vs. 6.8 years of schooling) and fathers (9.0 vs. 7.2 years of schooling), and are more likely to live in homes with air conditioners, cars, computers and televisions (which implies that their families are even wealthier).

[6] The urban/rural classification in the PISA sample refers to location of schools, not students. It is quite possible that some students residing in rural areas attend schools located in urban areas. Such students would be classified as urban in the PISA sample but as rural in the VHLSS sample, which could account for some of the discrepancy between the two samples regarding location in urban and rural areas.

The discrepancy regarding the likelihood of being in grades 9 and 10 is larger if one notes that the 2012 PISA assessment was administered in Vietnam in April of 2012, which is a time when 22% of the children born in 1996 are still in grade 9, as seen in the third column of Table 1. More specifically, of the children born in 1996 who were still in school and were interviewed between March and July in the 2012 VHLSS (and thus had not yet reached the next grade of schooling in September of 2012),[7] only 76% were in grade 10, while 22% were in grade 9; in contrast, of the students who took the PISA exam in April of 2012 86% were in grade 10 and only 10% were in grade 9. The distinction between grades 9 and 10 is particularly important in Vietnam, because almost all children complete grade 9, but only those who score relatively high on an entrance exam (about 60% of students in grade 9) are allowed to enroll in grade 10. Thus 86% of the students in the PISA sample consist of students who have passed the exam that selects relatively high performing students for admission to upper secondary school, but the VHLSS data indicate that only about 76% of children in Vietnam who were eligible to participate in the PISA exam at the time it was administered (in April of 2012) were in grade 10 and thus had passed that entrance exam.

The discrepancies in Table 2 between the PISA and the VHLSS raise the question of how Vietnamese students would have scored on the PISA exam if the PISA sample had had the same characteristics as the VHLSS sample. One way to assess is this is to use the student level PISA data for Vietnam to predict the performance of Vietnamese students on the PISA exam, and assume that the predictive power of the student level characteristics is valid for the mean values of those same characteristics as measured by the VHLSS data.

[7] Of the 236 15-year-olds in the 2012 VHLSS who were students and were interviewed in the first two (out of four) rounds of that survey, about half were interviewed in March or April, and about half were interviewed in June. Less than five were interviewed in May, and less than five were interviewed in July.

More specifically, consider an ordinary least squares (OLS) regression that uses the PISA data for Vietnam only to predict students' scores on the PISA exam based on the student level variables in Table 2. This regression can be depicted as:

$$\text{PISAscore}_i = \boldsymbol{\beta}'\mathbf{X}_i + u_i \qquad (1)$$

where $\mathbf{X}_i$ is a vector, for student *i*, of the student characteristics in Table 2.

These regressions are shown in Table 3, separately for the reading and mathematics scores. The predictive power of these regressions is high, with an R^2 of 0.341 for the reading score and 0.310 for the math score. Given that the test scores may have substantial random error, the explanatory power of these regressions for the "true" skills that these tests are designed to measure are likely to be much higher, perhaps as much as 0.500. Note also that most of these variables are highly statistically significant, and the signs are in the expected direction for almost all of them.

A convenient property of OLS regressions is that the mean values of the explanatory variables perfectly predict the mean value of the dependent variable. That is:

$$\overline{\text{PISAscore}} = \hat{\boldsymbol{\beta}}_{OLS}'\overline{\mathbf{X}}_{PISA} \qquad (2)$$

where the horizontal bars indicate mean values. This is shown in the first, fourth and fifth columns of Tables 4 (reading) and 5 (math). The first columns in those tables depict $\overline{\mathbf{X}}$ from the PISA data in Table 1, the fourth column shows the $\boldsymbol{\beta}$ coefficients from Table 2, and the fifth column shows the product of each variable by its respective coefficient. Summing the fifth column produces the actual PISA scores, which are 509.8 for reading and 512.7 for math.

These regression coefficients can also be used to predict what the PISA score would have been if $\bar{\mathbf{X}}$ had been the means in the VHLSS data instead of the means in the PISA data. The VHLSS means for all of 2012 from Table 2 (second column) are shown in the second columns of Tables 4 and 5, and the predicted PISA scores are shown in the sixth column of those two tables. They are somewhat smaller, namely 497.5 for reading and 497.9 for math. The last columns in Tables 5 and 6 show which variables are most responsible for the difference in the two predicted test scores. None of the variables has a particularly large contribution, although together mother's and father's education account for almost half of the difference (4.9 out of 12.3 points for reading and 6.3 out of 14.9 for math).

This exercise can be repeated using the means in the third column of Table 2, which are most relevant since the PISA exam was administered in Vietnam in April of 2012. The VHLSS means for the months of March through July of 2012 from Table 2 (third column) are shown in the second columns of Tables 6 and 7, and the predicted PISA scores are shown in the sixth column of those two tables. These declines in the scores are larger than those in Tables 5 and 6, namely a decline of about 20 points, to 489.5, for reading and of about 24 points, to 489.0, for math. Most interesting about Tables 6 and 7 is that about half of the difference between the average PISA score and the predicted average after adjusting for the potential non-representative sample is due to the larger percentage of students in grade 10 in the PISA schools, which is seen in the last column of both Table 6 and Table 7.

The overall message from Tables 6 and 7, however, is that the differences in the child, parent and household characteristics in the 2012 PISA sample and the 2012 VHLSS sample explain at most 20-24 points of Vietnam's performance on the PISA. While this adjustment implies a drop in the PISA test scores by 0.20-0.24 standard deviations, a quick glance at Figures 1 and 2, or even Figures 3 and 4, shows that Vietnam is still an outlier even after making these adjustments.

III. What Observed Variables in PISA Explain the Gaps Conditional on Income?

The evidence presented in the previous section indicates that 15-year-old students in Vietnam score unusually high on the PISA assessment given Vietnam's low level of GDP per capita, even after adjusting for the low enrollment rate of 15-year-olds in Vietnam and the possibility that the PISA sample was not representative of the 15-year-olds enrolled in school in April of 2012. Presumably there is some reason why Vietnamese students perform better than students in other countries after conditioning on (controlling for) per capita GDP. More specifically, Figures 1 and 2 (and Figures 3 and 4) are based on the following simple linear regression equation:

$$\text{Test Score} = \beta_0 + \beta_{gdp}\times\text{Log(GDP per capita)} + u \qquad (3)$$

where β_0 is a constant term (the "intercept") and β_{gdp} is the slope coefficient for the GDP per capita variable.

In Figures 1 and 2 (and Figures 3 and 4), the distance between any particular country and its performance on the test is given by u in equation (3). In particular, the value of u for Vietnam is very high. While the simple regressions that generated Figures 1 and 2 had one observation per country, analogous regressions that have one observation per student in each country that participate in the 2012 PISA assessment yield the same finding. Such regressions, which regress the student level data in the 2012 PISA data on a constant term and the log of per capita GDP, are shown in the first two columns of Table 8. As expected, the predictive power of GDP per capita is positive: on average, countries with a higher GDP have higher test scores. However, Vietnam's test scores in the 2012 PISA are much higher than those indicated by this regression equation. In particular, for the math regression Vietnam's average value of u (the "residual", which is shown in bold in the fifth row of Table 8) is 135.8, and for the reading regression it is 119.0. These are the highest values among all the countries included in the regression, as indicated by the "Residual Rank" row in Table 8, just as Vietnam is the largest positive outlier in the country-level regressions that generated Figures 1 and 2.

This raises the question: Why is the residual, u, so high for Vietnam? More specifically, would adding more variables to the regression equation result in a "better fit" in which the average residual (value of u) for Vietnam would not be so high? This question is addressed in the rest of this section, first by adding household and student level characteristics, and then adding by school characteristics, using data from the 2012 PISA data set, which not only administered reading and mathematics tests but also collected data from students, parents and schools.

The remaining columns in Table 8 explore the simple relationship between student test scores and national and household level income and wealth. One disadvantage of the regression in the first two columns is that the variable for the log of GDP per capita does not vary for different students within the same country, and ideally it would be useful to have a wealth or income variable that accounted for that variation, which should allow it to have more explanatory power in student-level regressions. Fortunately, it is possible to generate a wealth variable from the PISA data by using information on the students' households, as reported in the student questionnaire. More specifically, principle components was applied to the following household level variables in the PISA data: internet connection, dishwasher, DVD, number of cell phones, number of televisions, number of computers, and number of cars. The first estimated principle component is used as a wealth variable in the analysis of this section. The third and fourth columns of Table 8 show that when this variable is used instead of the log of GDP per capita, Vietnam is still the largest outlier in the math regression, although it is only the second largest outlier in the reading regression, after Hong Kong. The rest of the analysis of this section, and of the next section, will use this wealth variable instead of the log of GDP per capita because this wealth variable varies across students within all of the countries in the PISA data.

Before proceeding to add other variables to equation (3), which is the focus of this section, the last four columns of Table 8 explore two aspects of the wealth variable that was generated by principal components analysis. First, the third and fourth columns in Table 8 use country averages of the wealth variable, for comparability with the first two columns in that table, which are based on the log of GDP per capita. In contrast, the fifth and sixth columns of Table 8 allow each student to have his or her own household-specific value of wealth, instead of the national average. This allows the wealth variable to explain not only the differences in test scores across countries but also within countries. This reduces the coefficients on the wealth variable somewhat, but it is still highly significant. More interesting is that Vietnam falls slightly in terms of its outlier status. For math it is now the fourth highest outlier, while for reading it is the second highest. The main reason for this is that a few other countries (in particular, Hong Kong, Singapore, South Korea and Taiwan) are quite wealthy in terms of GDP per capita but somewhat less wealthy in terms of the wealth index, so when the wealth index is used they move to the left of the figures, which makes them larger outliers.[8] Even so, Vietnam is still a large outlier, and it is much poorer than all these other outlier countries.

Second, the last two columns of Table 8 add country fixed effects, which again reduces the impact of wealth somewhat. The reported "residuals" in those two columns are simply the estimated country fixed effects. Again Vietnam is still an outlier, although slightly less of an outlier in that it has the fifth highest fixed effect for math and the third highest for reading.

The student-level regressions with country fixed effects in the last two columns of Table 8 are a useful starting point for a more systematic analysis to identify the characteristics of Vietnamese students, households, teachers and schools that explain Vietnam's outlier status in the 2012 PISA assessment. To begin, assume that the underlying skill (e.g. mathematics) measured by the PISA test score of student i in country c, denoted by S_{ic}, is a linear function of the characteristics of that student, the household in which the student lives, the teachers which he or she has had, and the school(s) which he or she has attended:

$$S_{ic} = \boldsymbol{\beta}'\mathbf{x}_{ic} + \varepsilon_{ic} \qquad (4)$$

where the $\mathbf{x}_{ic}$ variables are *all* the student, household, teacher and school characteristics that affect students' underlying skills, $\boldsymbol{\beta}$ is a vector of the causal impacts of those characteristics on that skill, and ε_{ic} is measurement error in the PISA test. The linearity assumption is not particularly restrictive since $\mathbf{x}_{ic}$ could include higher order terms and interaction terms.

An important distinction to make regarding the $\mathbf{x}_{ic}$ variables is that between those that are observed and those that are unobserved, which is made in the following equation:

[8] One example of a less informative wealth indicator is that only about 27% of families of students in Hong Kong own cars; this suggests less wealth but may be a less relevant wealth indicator for such a densely populated society.

$$S_{ic} = \boldsymbol{\beta}^{\mathbf{o}\prime}\mathbf{x}_{ic}{}^{o} + \boldsymbol{\beta}^{\mathbf{u}\prime}\mathbf{x}_{ic}{}^{u} + \varepsilon_{ic} \qquad (5)$$

$$= \boldsymbol{\beta}^{\mathbf{o}\prime}\mathbf{x}_{ic}{}^{o} + \boldsymbol{\beta}^{\mathbf{u}\prime}\bar{\mathbf{x}}_{c}{}^{u} + \boldsymbol{\beta}^{\mathbf{u}\prime}\mathbf{x}_{ic}{}^{u,d} + \varepsilon_{ic}$$

where the superscript o indicates observed and the superscript u indicates unobserved. The second line of equation (5) disaggregates $\mathbf{x}_{ic}{}^{u}$ into its country specific mean, $\bar{\mathbf{x}}_{c}{}^{u}$, and the within-country deviation from that mean for student i, $\mathbf{x}_{ic}{}^{u,d}$, where the superscript d indicates that deviation. This disaggregation implies that the within-country mean of $\mathbf{x}_{ic}{}^{u,d}$ equals zero for all countries.

In a regression with country fixed effects, the fixed effect for country c would be $\boldsymbol{\beta}^{\mathbf{u}\prime}\bar{\mathbf{x}}_{c}{}^{u}$, and the error term would be $\boldsymbol{\beta}^{\mathbf{u}\prime}\mathbf{x}_{ic}{}^{u,d} + \varepsilon_{ic}$. The last two regressions in Table 8 have only one observed variable, the wealth indicator. The goal of this section is to add additional variables to equation (5), which in effect moves those variables out of $\mathbf{x}_{ic}{}^{u}$ and into $\mathbf{x}_{ic}{}^{o}$ in that equation, to see whether Vietnam's outlier status can be explained by observed variables in the PISA data. This approach has been used, for example, by Fryer and Levitt (2004) to investigate the factors that explain the gap in test scores between black and white students in the U.S. More recently, Singh (2014) used it to explain differences in test scores of primary and secondary school age children across Ethiopia, India (Andhra Pradesh), Peru and Vietnam. If the key factors that explain Vietnamese students' success are available in the PISA data, then adding them to the regression will result in a very small and statistically insignificant country fixed effect for Vietnam by reducing the variables that contribute to the $\boldsymbol{\beta}^{\mathbf{u}\prime}\bar{\mathbf{x}}_{c}{}^{u}$ term in the second line of Equation (5), although it is still possible that other countries will have larger fixed effects if variables that explain their success (but do not explain Vietnam's success) are still not included among the observed variables. If all variables are included that explain the performance of *all* the countries in the PISA data set, then *all* country fixed effects will become insignificant and the error term will primarily consist of (within-country) variation in the measurement error, ε_{ic}.

Even if the PISA data lack some of the variables that are key to explaining Vietnam's success, and more generally to explaining student learning in all of the countries that participated in PISA in 2012, so that the country fixed effects are still statistically significant, it may be that those country fixed effects are greatly reduced and thus at least part of the reasons for Vietnam's success are explained by the PISA data. Even if Vietnam is still among the largest of the outliers, it may be a much smaller outlier – relative to the overall variation in the test scores in the PISA data – after adding the different variables available in the PISA data. In contrast, if the student, household, teacher and school variables that explain Vietnam's success are for the most part *not* in the PISA data, then Vietnam will continue to be a large, positive outlier and the reason(s) for its outlier status will be due to factors that are not measured, or at least are not measured very well, in the PISA data.

To begin, student and household level variables are added to the regression equation in Table 9. The first two columns of Table 9 show regression equations identical to those in the last two columns of Table 8, except that, the sample size is reduced so that the sample is identical to that in the third and fourth columns, which add four additional household variables. The estimates in the first two columns of Table 9 are very similar to those in the last two columns of Table 8. In particular, the rank of Vietnam's estimated country fixed effects is the same, and the countries with larger fixed effects are also the same.

The third and fourth columns of Table 9 add to the regressions in the first two columns four additional household characteristics that are "pre-determined" and may also explain students' test score performance: a dummy variable for girl students, an index of the number of siblings in the home (0 = none, 1 = brothers but no sisters, or sisters but no brothers, and 2 = sisters and brothers); mother's years of schooling, and father's years of schooling. Each of these household variables sometimes has missing values, which is why the sample size (401,489) is smaller than that in the last two columns of Table 8 (455,971). Missing values were particularly common for the sibling index. To avoid losing even more observations due to the sibling variable being missing, missing values were assigned the average value of the sibling variable and an additional variable was created that indicates that the sibling variable was missing.

The key question for Table 9 is whether adding these additional household level variables "explains" much of the very large country fixed effect for Vietnam when only household wealth is used as a regressor. Turning to the third and fourth columns in that table, including these additional variables in the regression reduces the explanatory power of the wealth index variable by about one third (although it is still highly significant) but it has very little impact on the country fixed effect for Vietnam. Indeed these fixed effects increase slightly, from 78.2 to 80.6 for the math test and from 68.3 to 70.7 for the reading test. Vietnam's outlier status is also largely unchanged in that its fixed effect in the math regression drops from fifth place to sixth place, but increases from third place to second place in the reading regression. Thus these four household level variables in the PISA data cannot explain Vietnam's strong performance in the 2012 PISA assessment. This is not surprising when the means of these variables are compared for Vietnam and these other countries. In particular, Table 11 shows that the average of Vietnam's sibling index is almost identical to that of the other PISA countries combined (1.048 vs. 1.086, respectively), and that Vietnamese parents have, on average, fewer years of schooling (8.3 for mothers and 8.8 for fathers) than do parents in the other PISA countries (11.0 for mothers and 11.1 for fathers), so these variables cannot explain why Vietnam outperforms other countries; indeed, its lower levels of parental education make its performance all the more remarkable.

The 2012 PISA data contain several variables that are directly related to students' education, such as the grade that they are in, years of preschool attendance, a variety of educational inputs, days of school attendance (in the past two weeks), books in the home not related to the child's schooling, and hours per week at tutoring classes. These variables are likely to be endogenous (parents may provide more educational inputs to children who are not doing well at school, or perhaps to children who are the most promising students), so adding them to the regression analysis is likely to produce biased estimates of the causal impacts of these variables. However, despite these concerns about bias these variables may provide informative explanatory power for the purpose of understanding why Vietnamese students perform unusually well. For example, Table 10 shows that, on average, Vietnamese students spend more hours per week in tutoring classes (1.3 for reading and 2.7 for math) than do students in the other PISA countries (0.9 for reading and 1.3 for math), so even if one cannot hope to obtain estimates of the causal impact of these classes on students' test scores, even biased estimates have the potential to make Vietnam less of an outlier.

The last two columns of Table 9 add these more education-focused child and household variables to the regression that had only parental education and the sibling index variable (this reduces the sample size, and so the fifth and sixth columns show the results with only household wealth but the same number of observations as in the last two columns). While adding these variables does reduce the explanatory power of the wealth variable, and reduces Vietnam's estimated country fixed effect (from 79.1 to 65.0 for math, and from 68.9 to 55.1 for math, it does not reduce Vietnam's outlier status: it remains the fifth highest outlier for the mathematics test and the third largest outlier for the reading test. Again, the reason for this is that, for some of the educational variables that were added to the regression, Vietnamese children have lower average values for these regressions than do the students in the other PISA countries. For example, as seen in Table 11 Vietnamese students have fewer educational inputs[9] and fewer books in the home.

The regressions in Table 9 fail to find child and household variables in the PISA data that explain Vietnam's exceptional performance (outlier status) in education. Perhaps that performance is due to better schools and teachers. To check this hypothesis, Table 10 shows regressions that add school and teacher characteristics. As before, the first two columns show, for comparison purposes, regressions that include only the wealth variable, but have the same number of observations as the regressions that include the school and teacher variables.

The third and fourth columns show the regression results that add not only child and household variables (the results of which are not shown to reduce clutter) but also school and teacher variables. The school and teacher variables are: class size (student teacher ratio); the proportion of teachers who have the required qualifications; computers per student; a variable indicating whether student performance is used to assess the performance of teachers (a higher value indicates a "no" response); an indicator of teacher absenteeism; an index of whether parents put pressure on teachers; two variables indicating whether school principals and outside inspectors, respectively, observe teachers in the classroom; a variable indicating the extent to which teacher pay is determined by student performance; and an index that measures the extent of teacher mentoring. Most of these variables have the expected signs, but the key question for

[9] The educational inputs index is the first principal component of the following variables related to education in the home: availability of a desk, a quiet place to study, educational software, books of classical literature, books of poetry, educational books, technical books, and a dictionary.

this paper is whether adding these school characteristic variables "explains" more of the gap (measured in terms of the country fixed effect) in test scores between Vietnam's average test scores and the test score that was predicted using only the household wealth variable.

The results in Table 10 show that adding school and teacher variables reduces Vietnam's outlier status in the sense that the estimated Vietnam country fixed effects are reduced by nearly one fourth (from 76.7 to 58.1) for math and by one third (from 66.1 to 44.7) for reading, but little has changed in terms the relative value of Vietnam's estimated country fixed effect, that is Vietnam's outlier status. More specifically, while adding these variables to the math test does lead to a small reduction in the rank of Vietnam's estimated fixed effect, from five to eight, its rank for the reading test is unchanged at a value of four.

To summarize, the results in this section indicate that the observed child, household, school and teacher variables in 2012 PISA data provide little explanation of Vietnam's impressive performance on the 2012 PISA assessment relative to its income level. At most, adding child, household and school variables explains one fourth of Vietnam's exceptional performance in math and one third of its exceptional performance in reading. Thus most of the explanation for that performance must be found elsewhere.

IV. What Can Be Learned from Oaxaca-Blinder Decompositions?

The analysis in the previous section assumed that the impacts of each of the variables on test scores are the same for all 63 countries in the analysis. But perhaps Vietnam's exceptional performance is partly due to it being "more effective" in using various "inputs". For example, maybe each year of Vietnamese parents' years of schooling represent a higher level of cognitive skills than does the average year of parental schooling in the other PISA countries.

To examine this possibility, consider the standard Oaxaca-Blinder decomposition (Blinder, 1973; Oaxaca, 1973), applied to differences in test scores between Vietnam and all other countries. The scores on the tests, denoted by S, are assumed to be linear functions of the variables used in the regressions in the last two columns of Table 10, which can be denoted by the vector **x**. The impacts of these variables on test scores, denoted by the vector **β**, are allowed to be different in Vietnam than in the other countries that participated in the PISA assessment. This yields the following two regression equations:

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

$$S_{o} = \boldsymbol{\beta}_{o}'\mathbf{x}_{o} + u_{o} \quad \text{(Other countries)} \qquad (7)$$

where the error terms are denoted by u.

The constant term in each of these two regression equations can be normalized so that the mean of the error term equals 0. Then taking the mean of both sides of each regression equation gives the following expressions for the average test scores in Vietnam, denoted by $\overline{S}_{vn}$, and in the other 62 PISA countries, denoted by $\overline{S}_{o}$:

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

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

The Oaxaca-Blinder decomposition uses equations (8) and (9) to express the difference in the mean test scores between Vietnam and the 62 other countries in the PISA data as follows:

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

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

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

Thus the difference in the average test scores in Vietnam and the average test scores in the other 62 countries consists of two components. The first is the difference in the mean values of the $\mathbf{x}$ variables between Vietnam and the other countries, multiplied by the $\boldsymbol{\beta}$ coefficient for the other countries (denoted by $\boldsymbol{\beta}_o$). The second is the difference in the "effectiveness" of the $\mathbf{x}$ variables between Vietnam and the other countries, that is $\boldsymbol{\beta}_{vn} - \boldsymbol{\beta}_o$, multiplied by the mean value of the $\mathbf{x}$ variables for Vietnam (denoted by $\bar{\mathbf{x}}_{vn}$).

The second and fifth columns of Table 12 (and of Table 13) show the mean values of the $\mathbf{x}$ variables separately for Vietnam and for the other PISA countries. At the bottom of the table, in the third column, it also shows the mean math test score for Vietnam, 516.5, which is $\bar{S}_{vn}$, and the mean math test score for the other 62 countries, 462.8, which is $\bar{S}_o$. The gap between the two mean math scores is 53.7. Similarly, Table 13 shows that the gap between the two mean reading scores is 40.3. These gaps are smaller than the average residuals for Vietnam shown in Table 8 because those residuals effectively compared Vietnam to a hypothetical "typical" other country that had the same level of wealth as Vietnam, while the gaps in Tables 12 and 13 compare Vietnam, which has a very low mean wealth of -1.837, with the other 62 countries, that have a mean wealth of 0.132.

Returning to Table 12, the $\mathbf{x}$ variables for which the mean is higher in Vietnam than in the other 62 countries, and for which the corresponding $\boldsymbol{\beta}$ coefficients are positive, can explain part of the gap between the mean test scores in Vietnam and the other 62 countries. That is, the contribution of such variables to the $\boldsymbol{\beta}_o'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_o)$ component in equation (10) above is positive. The contribution is also positive when the mean for Vietnam is lower than for the other 62 countries and the corresponding **β** coefficient is negative. An example of the former is the variable on whether teachers are mentored. This is higher in Vietnam than in other countries, and one may expect that teachers who are mentored would be better teachers and thus would increase their students' test scores.

In contrast, if the mean is higher in Vietnam but the corresponding **β** coefficient is negative, or the mean is lower in Vietnam and the corresponding **β** coefficient is positive, this widens the gap and in that sense makes the gap even harder to explain. For example, the mean years of schooling of mothers and of fathers is lower in Vietnam than in the other 62 countries, and since one would expect that the corresponding **β** coefficients would be positive (more educated parents increase a child's test score), the parent education variables could not explain why Vietnamese students' scores are higher than those of students in the other countries, and in fact these variables "increase the burden" on other variables to explain that gap.

Table 12 provides the results of the Oaxaca-Blinder decomposition for the 2012 PISA mathematics test. As mentioned above, the overall gap to explain is 53.7 points. In fact, differences in the **x** variables, which are expressed as the $\boldsymbol{\beta}_o'(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_o)$ component of the decomposition, do little to explain the gap. Indeed, summing over all of the **x** variables shows that the values of the **x** variables lead one to expect an even bigger gap, with the overall contribution of -28.7 (see the bottom of the second to last column in Table 12). Instead, the main explanation is that the β coefficients for Vietnam reveal that Vietnam is "more efficient" in "converting" **x** variables into higher test scores; this is seen in the last column in Table 12.

The variable in the last column of Table 12 that plays the most important role is the percentage of students in grade 10, which accounts for nearly three fourths (71%) of this differential efficiency of the **β** coefficients. Quite simply, on average for other PISA countries, moving a student from grade 9 to grade 10 without changing any other characteristic increases his or her test score by 18.9 points, but in Vietnam this would increase a students' test score by 85.9 points. This almost certainly reflects the fact that movement from grade 9 to grade 10 in Vietnam is a selection process, that removes about 40% of grade 9 students, those with the weakest academic performance.

Table 13 yields similar results for the reading decomposition, though they are somewhat more difficult to interpret. The overall gap to be explained is 40.3 points. As with the math score, the differences in the **x** variables explain little, and in fact they widen the gap to be explained by 25.8 points. In contrast, the "greater efficiency" of the **x** variables explains more than the gap by accounting for 66.1 points in that gap. Two **x** variables stand out as making the biggest contribution to explaining this gap. First, as with the mathematical results, the differential efficiency of being in grade 10 can account for most of the gap (51.2 points). Again. this may not reflect differential efficiency as much as it reflects a screening process between grades 9 and 10 that removes the weakest students from the overall population of 15-year-old students. Second, and less intuitive, is that differential school attendance makes an even larger contribution, which was not seen with the mathematics exam. The contribution of this differential school attendance, 81.5 points, is so large that it requires some variable to have a large negative effect, and that variable is the constant term, which is much larger in the other countries than in Vietnam, a result also not seen with the mathematics test. These somewhat puzzling results for the reading decomposition require further scrutiny, and perhaps require a more general decomposition method than the one used here.

V. Conclusion

Vietnam's very high performance on the 2012 PISA assessment has raised the question of why Vietnam does so well, and whether other countries can improve their student learning outcomes by applying what works well in Vietnam. This paper has used the 2012 PISA data to do three types of analysis to understand better the reasons behind Vietnam's apparent success. The analysis done thus far has led to three general results, although more research is needed to confirm them, and to expand on them.

First, one important, albeit partial, explanation of Vietnam's very strong performance on the 2012 PISA is that the weakest students are excluded from grade 10, which results in 44% of 15-year-olds being excluded from the PISA sample since they are no longer in school. Adjusting for this differential enrollment rate by comparing the top 50% of students greatly reduces Vietnam's unconditional ranking in the PISA assessment, from 16 to 40 in math and from 18 to 41 in reading, yet Vietnam is still a large positive outlier after conditioning on its low income level. A related point is that the 15-year-old students who participated in the PISA assessment appear to be better off when compared to the 15-year-olds enrolled in school in 2012 in the 2012 Vietnam Household Living Standards Survey. While further analysis is needed, the results indicate that the sample of students born in 1996 (and thus about 15 years old in 2012) in the PISA sample are more urban and also of higher socio-economic status than 15-year-old students in the 2012 Vietnam Household Living Standards Survey (VHLSS). A particularly important difference is that the students in the PISA data are much more likely to be in grade 10 (and thus less likely to be in grade 9) than students born in 1996 in the VHLSS data. When mean values of child characteristics from the VHLSS data are used to predict test scores from regression coefficients estimated from the PISA data, Vietnam's PISA scores are 20-24 points lower, although they are still well above what one would predict based on their income alone.

Second, taking the PISA data at face value, this paper has used regression methods to investigate which family, teacher or school characteristics in the PISA data can "explain" the high performance of Vietnamese students. The general finding of this analysis is that accounting for household level and school level variables in the PISA data explains at most only one fourth or one third of Vietnam's high performance on the 2012 PISA relative to its income level. Moreover, adding these variables to an initial regression of PISA test scores on household wealth does not alter Vietnam's "outlier" status.

Third, this paper has applied the Oaxaca-Blinder decomposition method to better understand the difference in average test scores between Vietnamese students and students in the other countries that participated in the 2012 PISA assessment. Unlike the analysis discussed in the previous paragraph, this approach is more flexible in that it allows the impacts (the $\boldsymbol{\beta}$'s) of the household and school variables (the $\mathbf{x}$ variables) to differ between Vietnam and all other countries that participated in the 2012. The Oaxaca-Blinder decompositions indicate that *all* of the gap in average test scores between Vietnam and the other 62 countries is due to the greater "productivity" of various household and school variables in Vietnam, relative to the "productivity" of those variables in other countries, especially the greater "productivity" that occurs when grade 9 students in Vietnam are enrolled in grade 10. This could reflect the fact that only Vietnamese students who pass an entrance exam are allowed to proceed from grade 9 to grade 10, which is the first grade of the upper secondary cycle in Vietnam. This is most clear for the mathematics results; the reading results show a similar pattern but also have other factors at work (in particular, more productivity from each day of school attendance). In contrast, differences in household and school characteristics explain very little of the gap between Vietnam and the other countries that participated in the PISA assessment; indeed, they add to the gap to be explained.

References

Blinder, Alan. 1973. "Wage Discrimination: Reduced Form and Structural Estimates". *Journal of Human Resources* 8(4):436-455.

Dang, Hai-Anh, and Paul Glewwe. 2017. "Well Begun, But Aiming Higher: A Review of Vietnam's Education Trends in the Past 20 Years and Emerging Challenges". Working Paper, University of Minnesota.

Fryer, Roland, and Steven Levitt. 2004. "Understanding the Black-White Test Score Gap in the First Two Years of School". *Review of Economics and Statistics* 86(2):447-464.

Oaxaca, Ronald. 1973. "Male-Female Differentials in Urban Labor Markets". *International Economic Review* 3(4):693-709.

OECD. 2014a. *PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science, Volume I (Revised Edition)*. Paris: Organization for Economic Cooperation and Development.

OECD. 2014b. *PISA 2012 Technical Report.* Paris: Organization for Economic Cooperation and Development.

Singh, Abhijeet. 2014. "Emergence and Evolution of Learning Gaps across Countries". Young Lives Working Paper 124. Department of International Development Oxford University.

World Bank. 2013. "Skilling up Vietnam: Preparing the workforce for a modern market economy". Vietnam Development Report 2014. World Bank, Washington, DC.

---. 2017. *World Development Indicators Online database*. World Bank, Washington, DC.

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

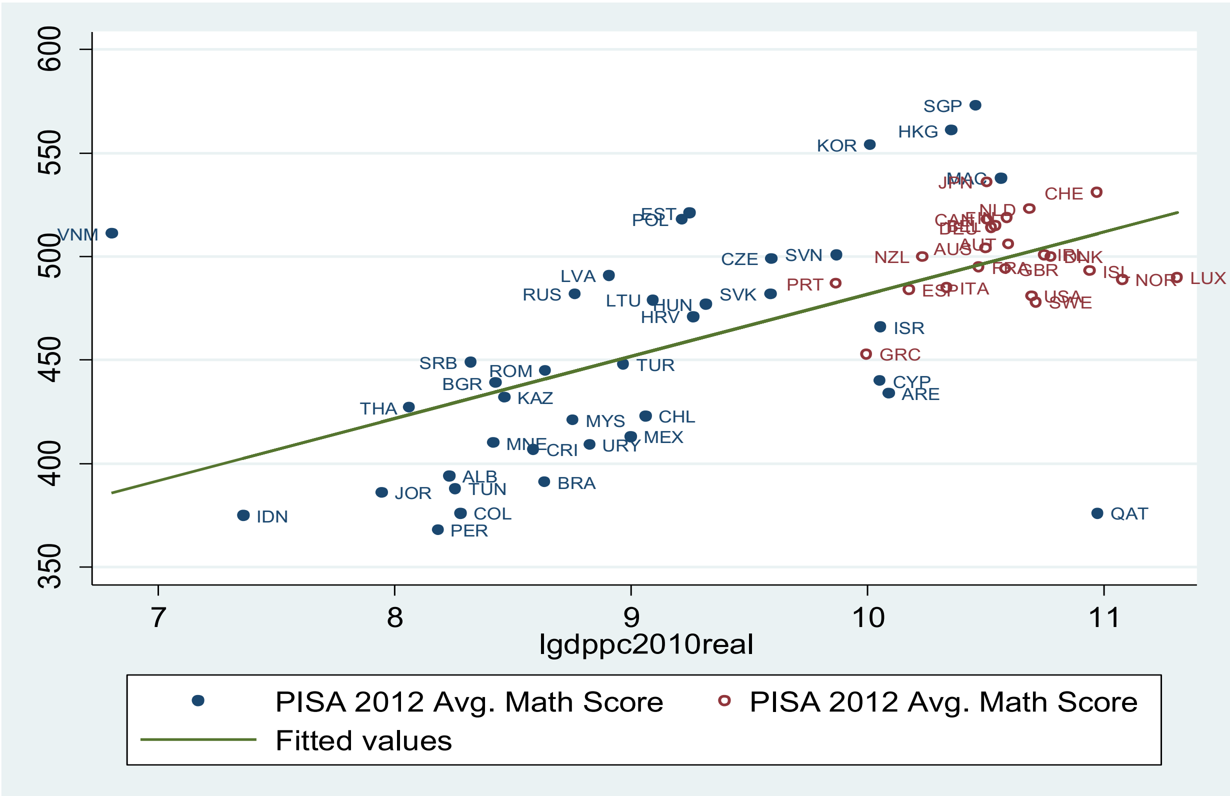

Figure 2. Mean Age 15 Reading Scores in 2012 PISA, by 2010 Log Real GDP/capita

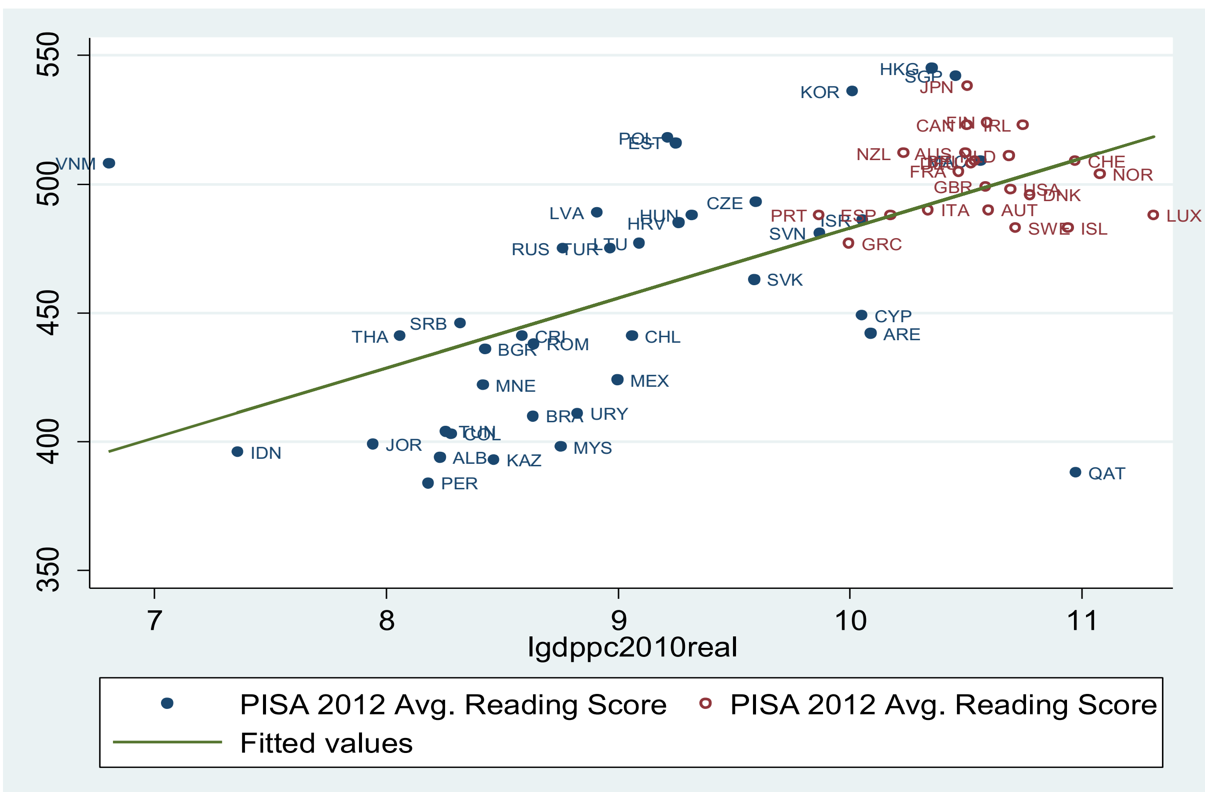

Figure 3. Mean Age 15 Top 50% Math Scores in 2012 (PISA), by 2010 Log Real GDP/capita

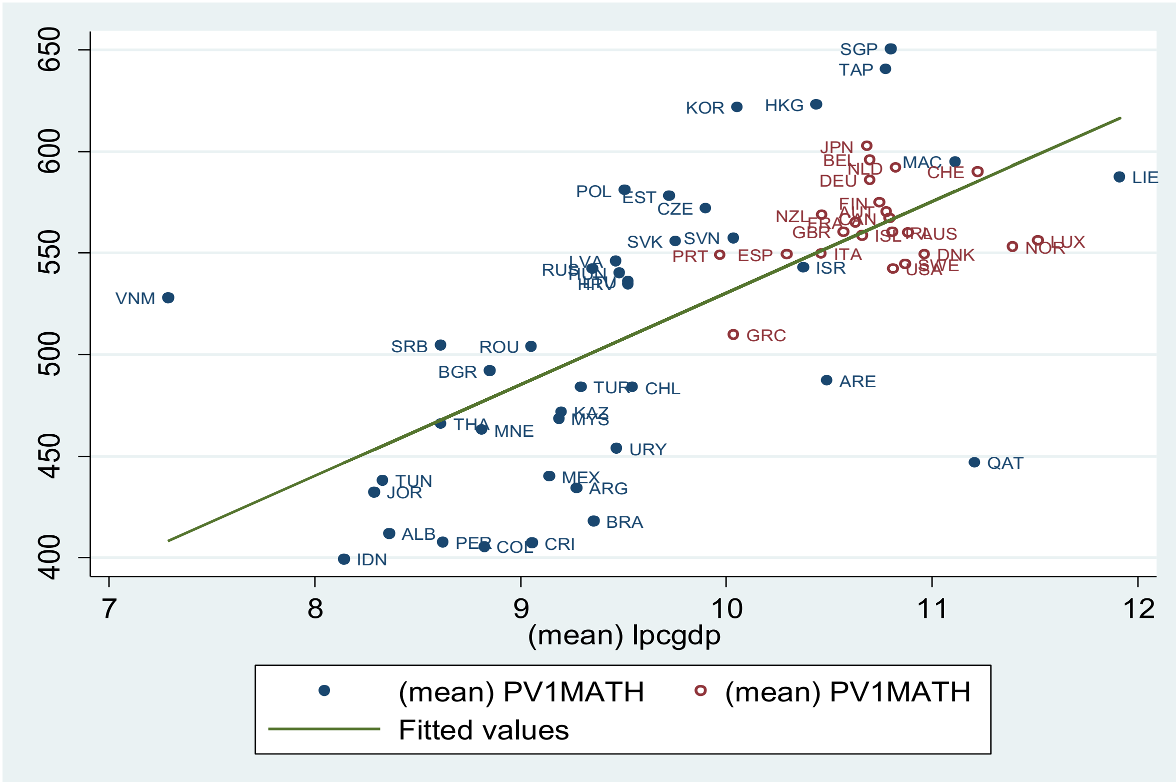

Figure 4. Mean Age 15 Top 50% Reading Scores in 2012 PISA, by 2010 Log Real GDP/capita

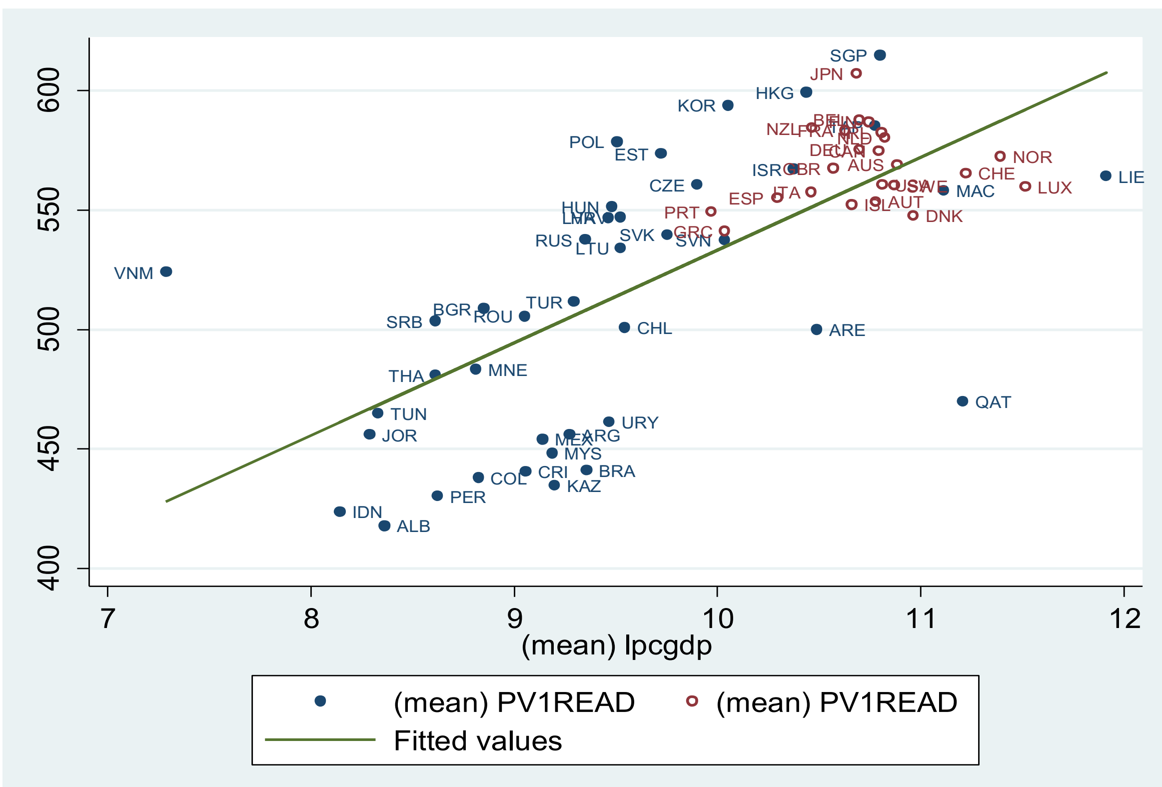

Table 1: PISA Assessment Country Rankings, Overall and Top 50% of Overall Population

	Math (all students)		Reading (all students)		Math (top 50% of pop.)		Reading (top50% of pop.)	
Rank	Country	Avg. score	Country	Avg. score	Country	Avg. score	Country	Avg. score
1	Singapore	573	Hong Kong	545	Singapore	651	Singapore	615
2	Hong Kong	561	Singapore	542	Taiwan	641	Japan	607
3	Taiwan	559	Japan	538	Hong Kong	623	Hong Kong	599
4	South Korea	554	South Korea	536	South Korea	622	South Korea	594
5	Macao	538	Finland	524	Japan	603	Belgium	588
6	Japan	536	Canada	523	Belgium	596	Finland	587
7	Liechtenstein	535	Taiwan	523	Macao	595	Taiwan	585
8	Switzerland	531	Ireland	523	Netherlands	592	New Zealand	584
9	Netherlands	523	Poland	518	Switzerland	590	France	583
10	Estonia	521	Liechtenstein	516	Liechtenstein	588	Ireland	582
11	Finland	519	Estonia	516	Germany	586	Netherlands	580
12	Poland	518	New Zealand	512	Poland	581	Poland	579
13	Canada	518	Australia	512	Estonia	578	Germany	575
14	Belgium	515	Netherlands	511	Finland	575	Canada	575
15	Germany	514	Macao	509	Czech Republic	572	Estonia	574
16	Vietnam	511	Belgium	509	Austria	570	Norway	572
17	Austria	506	Switzerland	509	New Zealand	569	Australia	569
18	Australia	504	Vietnam	508	Canada	567	United Kingdom	567
19	Ireland	501	Germany	508	France	565	Israel	567
20	Slovenia	501	France	505	United Kingdom	560	Switzerland	565
21	Denmark	500	Norway	504	Ireland	560	Liechtenstein	564
22	New Zealand	500	United Kingdom	499	Australia	560	Czech Republic	560
23	Czech Republic	499	United States	498	Iceland	559	United States	560
24	France	495	Denmark	496	Slovenia	557	Sweden	560
25	United Kingdom	494	Czech Republic	493	Luxembourg	556	Luxembourg	560
26	Iceland	493	Austria	490	Slovakia	556	Macao	558
27	Latvia	491	Italy	490	Norway	553	Italy	558
28	Luxembourg	490	Latvia	489	Italy	550	Spain	555
29	Norway	489	Spain	488	Denmark	549	Austria	553
30	Portugal	487	Luxembourg	488	Spain	549	Iceland	552
31	Italy	485	Portugal	488	Portugal	549	Hungary	551
32	Spain	484	Hungary	488	Latvia	546	Portugal	549
33	Russian Federation	482	Israel	486	Sweden	544	Denmark	548
34	Slovakia	482	Croatia	485	Israel	543	Croatia	547
35	United States	481	Iceland	483	United States	542	Latvia	547
36	Lithuania	479	Sweden	483	Russian Federation	542	Greece	541
37	Sweden	478	Slovenia	481	Hungary	540	Slovakia	540
38	Hungary	477	Greece	477	Lithuania	536	Russian Federation	538
39	Croatia	471	Lithuania	477	Croatia	535	Slovenia	537
40	Israel	466	Turkey	475	Vietnam	528	Lithuania	534
41	Greece	453	Russian Federation	475	Greece	510	Vietnam	524
42	Serbia	449	Slovakia	463	Serbia	505	Turkey	512
43	Turkey	448	Serbia	446	Romania	504	Bulgaria	509
44	Romania	445	United Arab Emirates	442	Bulgaria	492	Romania	506
45	Bulgaria	439	Chile	441	United Arab Emirates	487	Serbia	504
46	United Arab Emirates	434	Costa Rica	441	Turkey	484	Chile	501
47	Kazakhstan	432	Thailand	441	Chile	484	United Arab Emirates	500
48	Thailand	427	Romania	438	Kazakhstan	472	Montenegro	483
49	Chile	423	Bulgaria	436	Malaysia	468	Thailand	481
50	Malaysia	421	Mexico	424	Thailand	466	Qatar	470
51	Mexico	413	Montenegro	422	Montenegro	463	Tunisia	465
52	Montenegro	410	Uruguay	411	Uruguay	454	Uruguay	461
53	Uruguay	409	Brazil	410	Qatar	447	Jordan	456
54	Costa Rica	407	Tunisia	404	Mexico	440	Argentina	456
55	Albania	394	Colombia	403	Tunisia	438	Mexico	454
56	Brazil	391	Jordan	399	Argentina	434	Malaysia	448
57	Argentina	388	Malaysia	398	Jordan	432	Brazil	441
58	Tunisia	388	Indonesia	396	Brazil	418	Costa Rica	441
59	Jordan	386	Argentina	396	Albania	412	Colombia	438
60	Qatar	376	Albania	394	Peru	408	Kazakhstan	435
61	Colombia	376	Kazakhstan	393	Costa Rica	407	Peru	430
62	Indonesia	375	Qatar	388	Colombia	405	Indonesia	424
63	Peru	368	Peru	384	Indonesia	399	Albania	418

Table 2: Characteristics of Students in 2012 Who Were Born in 1996: PISA vs. VHLSS

Variable	PISA	VHLSS (PISA-eligible only)			Difference
		All	Mar.-July	Sep-Dec	(3) – (1)
	(1)	(2)	(3)	(4)	
Rural	49.7%	74.0%	74.7%	73.3%	24.9***
	(4.2)	(2.3)	(3.2)	(3.4)	(0.2)
Female	53.8%	51.7%	51.7%	51.9%	-2.1***
	(0.8)	(2.6)	(3.5)	(3.8)	(0.2)
Current grade: 10th grade or higher	86.1%	84.3%	75.7%	93.5%	-10.4***
	(2.6)	(1.8)	(3.0)	(1.7)	(0.2)
Current grade: 9th grade or lower	10.3%	14.0%	22.2%	5.1%	11.9***
	(2.2)	(1.7)	(2.8)	(1.5)	(0.2)
Current grade: unknown or other*	3.6%	1.7%	2.1%	1.4%	-1.5***
	(1.5)	(0.7)	(1.3)	(0.8)	(0.1)
Father's years of schooling	8.95	7.18	7.19	7.16	-1.76***
	(0.17)	(0.22)	(0.32)	(0.31)	(0.02)
Mother's years of schooling	8.34	6.80	6.93	6.66	-1.41***
	(0.19)	(0.19)	(0.26)	(0.27)	(0.02)
Owns an air-conditioner	16.0%	7.1%	7.1%	7.2%	-8.8***
	(2.1)	(1.4)	(2.1)	(1.9)	(0.1)
Owns a motorbike	93.1%	91.0%	90.7%	91.1%	-2.4***
	(0.5)	(1.4)	(2.0)	(1.9)	(0.1)
Owns a car	7.3%	0.7%	1.0%	0.4%	-6.3***
	(0.8)	(0.3)	(0.7)	(0.3)	(0.1)
Owns a computer	39.1%	24.5%	25.1%	23.9%	-14.1***
	(2.2)	(2.3)	(3.2)	(3.3)	(0.2)
Number of TVs owned	1.39	1.00	1.00	0.99	-0.38***
	(0.03)	(0.02)	(0.03)	(0.02)	(0.2)
Sample size (born in 1996 & enrolled in 2012)	4,771	455	236	219	
PISA coverage/eligibility rate	56%	75%	78%	72%	

Standard errors, clustered at school level in the PISA sample and at commune level in the VHLSS sample, are dhown in parentheses.
The difference column reports mean differences between the PISA sample and the VHLSS subsample interviewed from March to July, as well as their standard errors; t-tests are conducted to test whether the mean difference of each variable is significantly different from zero.
* In the PISA sample, this category consists of observations originally categorized as "Ungraded", with no further information; in the VHLSS sample, this category consists of observations originally categorized as "Attending vocational schools".

Table 3: Predictors of 2012 PISA Scores in Vietnam

VARIABLES	PV1READ	PV1MATH
Rural	-11.56***	-18.04***
	(1.842)	(2.193)
Female	24.61***	-16.58***
	(1.737)	(2.068)
Grade 10	95.14***	105.8***
	(2.587)	(3.079)
Father years of schooling	1.536***	2.231***
	(0.315)	(0.374)
Mother years of schooling	1.661***	1.879***
	(0.309)	(0.368)
Owns an air conditioner	-0.626	5.456
	(2.910)	(3.464)
Owns a car	-3.442	-6.723*
	(3.089)	(3.677)
Owns a computer	10.86***	17.35***
	(2.039)	(2.427)
Number of TVs Owned	2.977*	0.526
	(1.609)	(1.915)
Constant	385.2***	396.7***
	(3.676)	(4.375)
Observations	4771	4771
R-squared	0.341	0.310

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Predicted PISA Reading Scores Based on VHLSS Data, Decomposed by Variable (all rounds of VHLSS data)

Variable	Variable Means		Difference in Means	Reading Coeff.	Reading Coefficient Multiplied by:		
	PISA	VHLSS			PISA Mean	VHLSS Mean	Difference in Means
Rural	0.497	0.740	-0.243	-11.56	-5.7	-8.6	2.8
Female	0.538	0.517	0.021	24.61	13.2	12.7	0.5
Grade 10	0.861	0.843	0.018	95.14	81.9	80.2	1.7
Dad yrs. sch.	8.81	7.18	1.63	1.536	13.5	11.0	2.5
Mom yrs. sch.	8.23	6.80	1.43	1.661	13.7	11.3	2.4
Air condit.	0.160	0.071	0.089	-0.626	-0.1	-0.0	-0.1
Car	0.094	0.007	0.087	-3.442	-0.3	-0.0	-0.3
Computer	0.391	0.245	0.146	10.86	4.2	2.7	1.6
TVs	1.39	1.00	0.39	2.977	4.1	3.0	1.1
Constant	1.000	1.000	0.000	385.2	385.2	385.2	0.0
Column sum	--	--	--	--	509.8	497.5	12.3

Table 5: Predicted PISA Math Scores Based on VHLSS Data, Decomposed by Variable (all rounds of VHLSS data)

Variable	Variable Means		Difference in Means	Math Coeff.	Math Coefficient Multiplied by:		
	PISA	VHLSS			PISA Mean	VHLSS Mean	Difference in Means
Rural	0.497	0.740	-0.243	-18.04	-9.0	-13.3	4.4
Female	0.538	0.517	0.021	-16.58	-8.9	-8.6	-0.4
Grade 10	0.861	0.843	0.018	105.8	91.0	89.2	1.9
Dad yrs. sch.	8.81	7.18	1.63	2.231	19.7	16.0	3.6
Mom yrs. sch.	8.23	6.80	1,43	1.879	15.5	12.8	2.7
Air condit.	0.160	0.071	0.089	5.456	0.9	0.4	0.5
Car	0.094	0.007	0.087	-6.723	-0.6	-0.0	-0.6
Computer	0.391	0.245	0.146	17.35	6.8	4.3	2.5
TVs	1.39	1.00	0.39	0.526	0.7	0.5	0.2
Constant	1.000	1.000	0.000	396.7	396.7	396.7	0.0
Column sum	--	--	--	--	512.7	497.9	14.9

Table 6: Predicted PISA Reading Scores Based on VHLSS Data, Decomposed by Variable (March – July only)

Variable	Variable Means		Difference in Means	Reading Coeff.	Reading Coefficient Multiplied by:		
	PISA	VHLSS			PISA Mean	VHLSS Mean	Difference in Means
Rural	0.497	0.747	-0.250	-11.56	-5.7	-8.6	2.9
Female	0.538	0.517	0.021	24.61	13.2	12.7	0.5
Grade 10	0.861	0.757	0.104	95.14	81.9	72.0	9.9
Dad Yrs. Sch.	8.81	7.19	1.62	1.536	13.5	11.0	2.5
Mom yrs. sch.	8.23	6.93	1.30	1.661	13.7	11.5	2.2
Air condit.	0.160	0.071	0.089	-0.626	-0.1	-0.0	-0.1
Car	0.094	0.010	0.084	-3.442	-0.3	-0.0	-0.3
Computer	0.391	0.251	0.140	10.86	4.2	2.7	1.5
TVs	1.39	1.00	0.39	2.977	4.1	3.0	1.1
Constant	1.000	1.000	0.000	385.2	385.2	385.2	0.0
Column sum	--	--	--	--	509.8	489.5	20.3

Table 7: Predicted PISA Math Scores Based on VHLSS Data, Decomposed by Variable (March – July only)

Variable	Variable Means		Difference in Means	Math Coeff.	Math Coefficient Multiplied by:		
	PISA	VHLSS			PISA Mean	VHLSS Mean	Difference in Means
Rural	0.497	0.747	-0.250	-18.04	-9.0	-13.5	4.5
Female	0.538	0.517	0.021	-16.58	-8.9	-8.6	-0.4
Grade 10	0.861	0.757	0.104	105.8	91.0	80.1	11.0
Dad Yrs. Sch.	8.81	7.19	1.62	2.231	19.7	16.0	3.6
Mom yrs. sch.	8.23	6.93	1.306	1.879	15.5	13.0	2.4
Air condit.	0.160	0.071	0.089	5.456	0.9	0.4	0.5
Car	0.094	0.010	0.084	-6.723	-0.6	-0.1	-0.6
Computer	0.391	0.251	0.140	17.35	6.8	4.4	2.4
TVs	1.39	1.00	0.39	0.526	0.7	0.5	0.2
Constant	1.000	1.000	0.000	396.7	396.7	396.7	0.0
Column sum	--	--	--	--	512.7	489.0	23.7

Table 8. Regressions of Test Scores on Log(GDP)/capita or Wealth/capita: Student Level Data

VARIABLES	(1) MATH	(2) READ	(3) MATH	(4) READ	(5) MATH	(6) READ	(7) MATH	(8) READ
Log of per capita GDP	34.14***	31.53***						
	(0.136)	(0.135)						
Wealth (national average)			28.84***	26.63***				
			(0.110)	(0.110)				
Wealth (student specific)					22.35***	20.82***	16.26***	15.16***
					(0.0772)	(0.0763)	(0.961)	(0.986)
Constant	126.1***	159.5***	454.9***	463.2***	458.3***	467.0***	--	--
	(1.319)	(1.310)	(0.140)	(0.139)	(0.139)	(0.138)		
Vietnam residual (average)	**135.8**	**119.0**	**111.6**	**96.7**	**98.2**	**83.6**	**82.8**	**73.4**
Residual Rank	**1**	**1**	**2**	**1**	**4**	**2**	**5**	**3**
More highly ranked	**none**	**none**	**HK**	**none**	**HK S. Korea Singap.**	**HK**	**HK S. Korea Singap. Taiwan**	**HK S. Korea**
Country fixed effects	No	No	No	No	No	No	Yes	Yes
Observations	473,236	473,236	473,236	473,236	455,971	455,971	455,971	455,971
R-squared	0.117	0.103	0.126	0.111	0.155	0.140	0.350	0.280

Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

For fixed effects regression, residual = fixed effect – constant in regression without fixed effects.

Table 9: Regressions of Test Scores on Wealth/capita and Student and Household Variables

VARIABLES	MATH	READ	MATH	READ	MATH	READ	MATH	READ
Wealth index	15.92***	14.66***	9.998***	9.548***	15.77***	14.49***	5.694***	5.080***
	(0.103)	(0.104)	(0.110)	(0.110)	(0.104)	(0.106)	(0.108)	(0.109)
Girl			-8.705***	33.31***			-15.39***	26.55***
			(0.254)	(0.255)			(0.243)	(0.244)
Sibling index			-1.905***	-2.457***			-1.930***	-2.392***
			(0.204)	(0.205)			(0.194)	(0.195)
Sibling index missing			-19.59***	-15.66***			-17.54***	-13.51***
			(0.303)	(0.305)			(0.289)	(0.290)
Mom years school			2.978***	2.872***			1.800***	1.702***
			(0.050)	(0.050)			(0.0479)	(0.0481)
Dad years school			3.310***	3.065***			2.046***	1.841***
			(0.049)	(0.049)			(0.0468)	(0.0470)
Grade10							22.87***	23.87***
							(0.290)	(0.291)
Years of preschool							10.74***	10.05***
							(0.204)	(0.205)
Educational input index							7.432***	7.985***
							(0.0970)	(0.0973)
Attendance (past 2 weeks)							7.710***	7.638***
							(0.130)	(0.130)
Books at home							0.0689***	0.0595***
							(0.00735)	(0.00738)
Hours of study							3.170***	3.017***
							(0.0293)	(0.0294)
Extra math classes (tutored)							-0.558***	
							(0.0722)	
Extra math variable missing							-2.929***	
							(0.252)	
Extra read. classes (tutored)								-4.440***
								(0.0841)
Extra read. variable missing								-3.052***
								(0.253)
Vietnam fixed effect	**78.2**	**68.3**	**80.6**	**70.7**	**79.1**	**68.9**	**65.0**	**55.1**
Fixed effect rank	**5**	**3**	**6**	**2**	**5**	**3**	**5**	**3**
More highly ranked:	**HK**	**HK**	**HK**	**HK**	**HK**	**HK**	**HK**	**Finland**
	S. Korea	**S. Korea**	**Macao**		**S. Korea**	**S. Korea**	**Macao**	**HK**
	Singap.		**Singap.**		**Singap.**		**Singap.**	
	Taiwan		**S. Korea**		**Taiwan**		**Taiwan**	
			Taiwan					
Observations	401,489	401,489	401,489	401,489	393,730	393,730	393,730	393,730
R-squared	0.366	0.295	0.399	0.350	0.360	0.291	0.464	0.421

Standard errors in parentheses. All regressions use country fixed effects.
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Regressions Test Scores on Wealth/capita and Student, Household and School Variables

VARIABLES	MATH	READING	MATH	READING
Wealth	15.32***	13.75***	5.436***	3.869***
	(0.111)	(0.112)	(0.116)	(0.117)
Class size			0.0943***	0.271***
			(0.0150)	(0.0151)
Ratio qualified teachers			13.28***	10.44***
			(0.616)	(0.621)
Qual. tchr. ratio missing			-1.370***	-2.833***
			(0.495)	(0.499)
Square root of computers/pupil			-2.087***	-0.710
			(0.518)	(0.522)
Stud. perf. used to assess tchrs			1.728***	2.049***
			(0.334)	(0.337)
Teacher absenteeism			-3.302***	-2.961***
			(0.182)	(0.183)
Parents pressure teachers			11.59***	11.33***
			(0.193)	(0.195)
Principal observes teachers			-2.741***	0.117
			(0.434)	(0.437)
Inspector observes teachers			-4.735***	-6.698***
			(0.303)	(0.305)
Tchr pay linked to stud perf			-2.232***	-2.501***
			(0.167)	(0.168)
Teacher mentoring index			5.244***	5.906***
			(0.306)	(0.308)
Vietnam residual (average)	**76.7**	**66.1**	**58.1**	**44.7**
Residual rank	**5**	**4**	**8**	**4**
More highly ranked	**HK**	**HK**	**HK**	**Finland**
	S. Korea	**S. Korea**	**Liecht.**	**HK**
	Singap.	**Singap.**	**Macao**	**Liecht.**
	Taiwan		**S. Korea**	
			Singap.	
			Switz.	
			Tawain	
Observations	341,409	341,409	341,409	341,409
R-squared	0.354	0.286	0.460	0.405

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Note: Student and household variables not shown. All regressions use country fixed effects.

Table 11: Means of Regression Variables, for Vietnam and for Other Countries

Variable (x)	Vietnam	Other PISA Countries
Math test score	516.5	462.8
Reading test score	512.8	472.5
Wealth	-1.857	0.1007
Grade 10	0.874	0.584
Sibling index	1.048	1.086
Sibling index missing	0.1494	0.2379
Mom years schooling	8.313	10.98
Dad years schooling	8.883	11.09
Years preschool enrollment	1.600	1.487
Education inputs index (desk, books)	-0.3201	0.1538
Books in home	57.59	114.1
Days attended in past 2 weeks	9.849	9.622
Hours of study per week	5.756	5.362
Extra reading classes (tutoring), hours/week	1.290	0.944
Extra reading classes variable missing	0.3366	0.3583
Extra math classes (tutoring), hours/week	2.741	1.325
Extra math classes variable missing	0.3357	0.3579
Class size	44.81	32.61
Proportion of teachers who are qualified	0.7999	0.8337
Proportion qualified teacher missing	0.0689	0.1879
Square root of computers/pupil	0.4173	0.6235
Student performance used to assess teachers	0.992	0.708
Teacher absenteeism	1.692	1.778
Parents pressure teachers	2.311	1.957
Principal observes teachers	0.9653	0.8018
Outside Inspector observes teachers	0.8471	0.4061
Teacher pay linked to student performance	2.487	1.703
Teachers are mentored	0.8450	0.6837
Sample size	4,421	336,988

Table 12: Math Decomposition (diff = 516.54– 462.80 = 53.74)

Variable	β_{vn}	X_{vn}	$\beta_{vn}'X_{vn}$	β_o	X_o	$\beta_o'X_o$	$\beta_o'(X_{vn}-X_o)$	$(\beta_{vn}-\beta_o)'X_{vn}$
Wealth	6.764***	-1.857	-12.56	9.633***	0.101	0.97	-18.85	5.335
Grade 10	85.85***	0.874	75.01	18.93***	0.584	11.05	5.49	58.47
Sibling index	3.152*	1.048	3.30	-1.697***	1.086	-1.84	0.07	5.08
Sibling index missing	-0.576	0.149	-0.09	-17.87***	0.238	-4.25	1.58	2.58
Mom years schooling	0.962***	8.313	8.00	1.786***	10.975	19.60	-4.75	-6.85
Dad years schooling	1.511***	8.883	13.42	2.390***	11.086	26.50	-5.27	-7.81
Years in preschool	6.533***	1.600	10.45	13.07***	1.487	19.43	1.47	-10.45
Education inputs index	4.397***	-0.320	-1.41	7.337***	0.154	1.13	-3.48	0.94
Books in home	0.00887	57.59	0.51	0.0882***	114.07	10.07	-4.98	-4.57
Days attend past 2 wks	10.43***	9.849	102.72	8.094***	9.622	77.88	1.84	23.00
Hours study per week	2.920***	5.756	16.81	2.425***	5.362	13.00	0.96	2.85
Extra math class, hrs/wk	3.904***	2.741	10.70	-0.633***	1.325	-0.84	-0.90	12.44
Extra math class missing	8.890***	0.336	2.98	-3.188***	0.358	-1.14	0.07	4.05
Class size	0.0643	44.81	2.88	0.148***	32.61	4.82	1.80	-3.75
Proport. qualified tchrs	18.18***	0.800	14.55	46.08***	0.834	38.42	-1.56	-22.32
Prop. qual. tchr. missing	-17.15***	0.069	-1.18	-23.14***	0.188	-4.35	2.75	0.41
Square root comp/pupil	-0.0392	0.417	-0.02	4.925***	0.623	3.07	-1.02	-2.07
Stud perf. to assess tchrs	25.08**	0.992	24.89	-4.267***	0.708	-3.02	-1.21	29.56
Teacher absenteeism	-0.759	1.692	-1.28	-6.600***	1.778	-11.74	0.57	9.88
Parents pressure tchrs	15.71***	2.311	36.32	6.686***	1.957	13.08	2.37	20.87
Principal observes tchrs	14.12**	0.965	13.63	-3.816***	0.802	-3.06	-0.62	17.32
Inspector observes tchrs	-16.73***	0.847	-14.17	-10.15***	0.406	-4.12	-4.48	-5.58
Tchr pay link stud. perf.	2.209	2.487	5.49	-2.279***	1.703	-3.88	-1.79	11.16
Teachers are mentored	6.766**	0.845	5.72	7.722***	0.684	5.28	1.25	-0.81
Constant	199.86***	1.000	199.86	256.74***	1.000	256.74	0.00	-56.88
			516.54			462.80	-28.69	82.42

Table 13: Reading Decomposition (diff = 512.82– 472.52 = 40.30)

Variable	β_{vn}	X_{vn}	$\beta_{vn}'X_{vn}$	β_o	X_o	$\beta_o'X_o$	$\beta_o'(X_{vn}-X_o)$	$(\beta_{vn}-\beta_o)'X_{vn}$
Wealth	4.748***	-1.857	-8.82	9.305***	0.101	0.94	-18.21	8.46
Grade 10	79.18***	0.874	69.18	20.58***	0.584	12.01	5.97	51.20
Sibling index	4.045***	1.048	4.24	-1.736***	1.086	-1.89	0.07	6.06
Sibling index missing	-0.428	0.149	-0.06	-12.01***	0.238	-2.86	1.06	1.73
Mom years schooling	0.721**	8.313	5.99	1.083***	10.975	11.88	-2.88	-3.01
Dad years schooling	0.694**	8.883	6.17	1.877***	11.086	20.81	-4.14	-10.51
Years in preschool	4.884***	1.600	7.81	10.98***	1.487	16.34	1.23	-9.76
Education inputs index	5.657***	-0.320	-1.81	8.061***	0.154	1.24	-3.82	0.77
Books in home	0.00231	57.59	0.13	0.0741***	114.07	8.45	-4.19	-4.13
Days attend past 2 wks	16.08***	9.849	158.34	7.806***	9.622	75.11	1.77	81.46
Hours study per week	2.335***	5.756	13.44	2.786***	5.362	14.94	1.10	-2.59
Extra reading class hr/wk	-1.547***	2.741	-1.99	-4.887***	1.325	-4.61	-1.69	4.31
Extra reading class miss.	0.712	0.336	0.24	-3.434***	0.358	-1.23	0.07	1.40
Class size	0.258***	44.81	11.58	0.358***	32.61	11.67	4.37	-4.45
Proport. qualified tchrs	16.22***	0.800	12.98	35.92***	0.834	29.95	-1.21	-15.76
Prop. qual. tchr. missing	-17.21***	0.069	-1.19	-16.85***	0.188	-3.17	2.01	-0.03
Square root comp/pupil	-4.467	0.417	-1.86	7.049***	0.623	4.40	-1.45	-4.81
Stud perf. to assess tchrs	1.901	0.992	1.89	-4.253***	0.708	-3.01	-1.21	6.11
Teacher absenteeism	-1.489	1.692	-2.52	-5.874***	1.778	-10.45	0.51	7.42
Parents pressure tchrs	9.980***	2.311	23.06	8.313***	1.957	16.27	2.94	3.85
Principal observes tchrs	34.74***	0.965	33.53	-1.893***	0.802	-1.52	-0.31	35.36
Inspector observes tchrs	-18.02***	0.847	-15.26	-11.80***	0.406	-4.79	-5.20	-5.27
Tchr pay link stud. perf.	3.676***	2.487	9.14	-4.785***	1.703	-8.15	-3.75	21.04
Teachers are mentored	9.211***	0.845	7.78	7.342***	0.684	5.02	1.18	1.58
Constant	180.82***	1.000	180.82	285.16***	1.000	285.16	0.00	-104.34
			512.82			472.52	-25.78	66.08