# What Explains Vietnam's Exceptional Performance in Education Relative to Other Countries?

## Analysis of the 2012 and 2015 PISA Data

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## Vietnam: An Apparent International Education Success Story …

Vietnam's achievements have generated a great deal of international attention

→ Primary completion rate 97%, Lower secondary enrollment rate of 95%

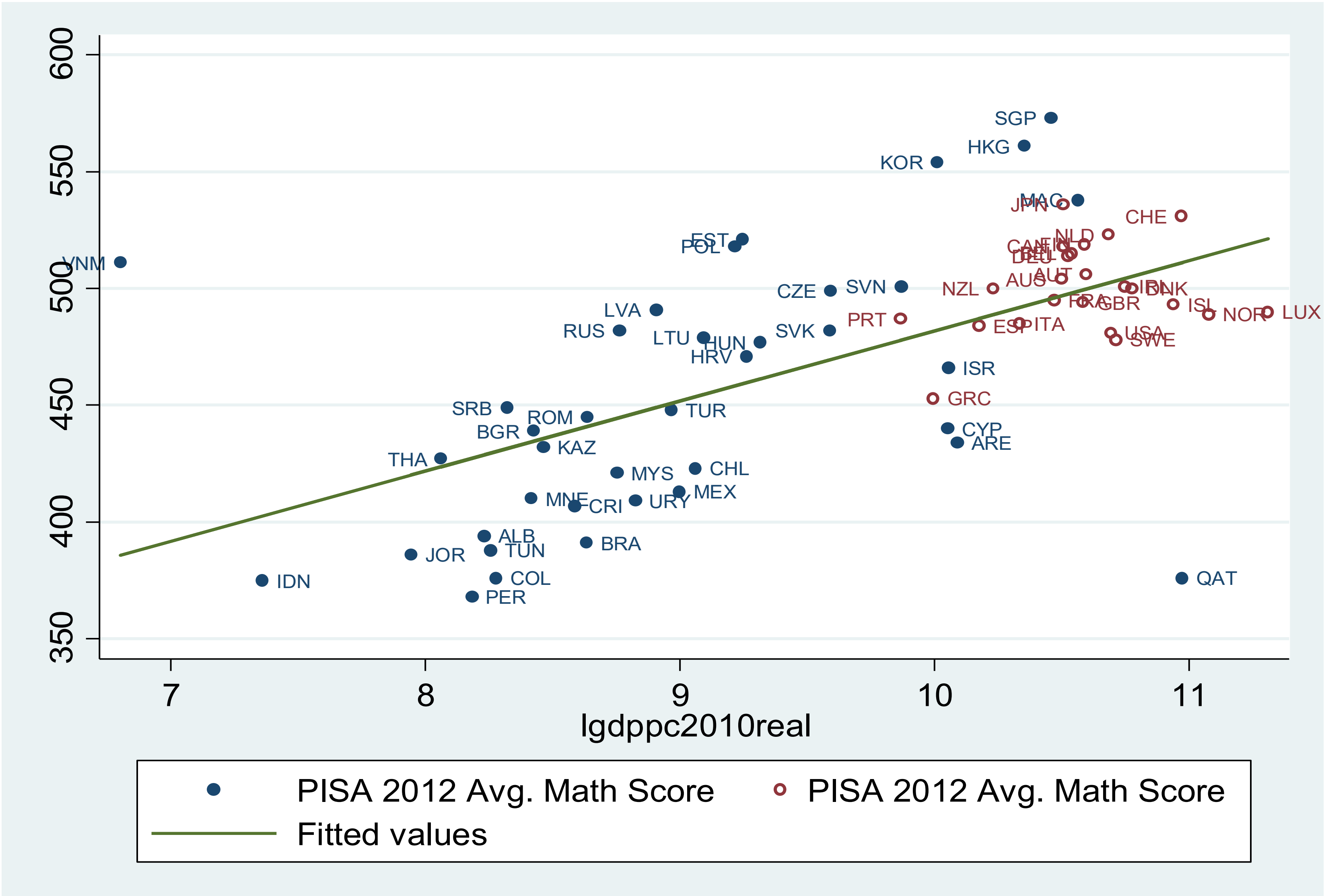
→ 2012 PISA (Programme for International Student Assessment)

- 16$^{th}$ in math (out of 63 participating countries)
- 18$^{th}$ in reading (out of 63 participating countries)
- Ahead of U.S. and U.K.!
- Vietnam's PISA scores much higher than predicted by its income level …

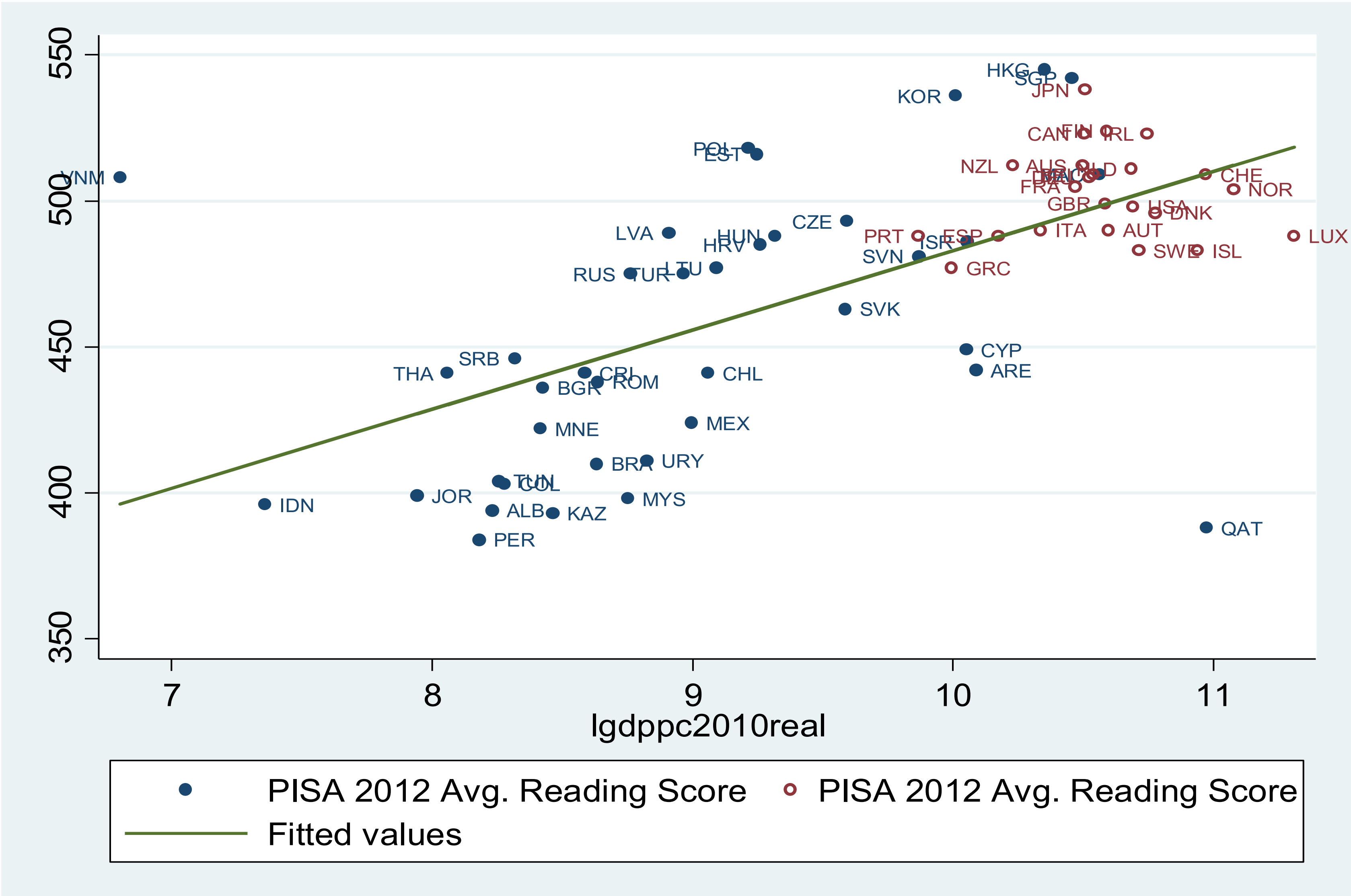
Note 1: The same pattern is found when PPP-adjusted GDP per capita is used.

Note 2: Vietnam's performance on 2015 was similar, though slightly lower.

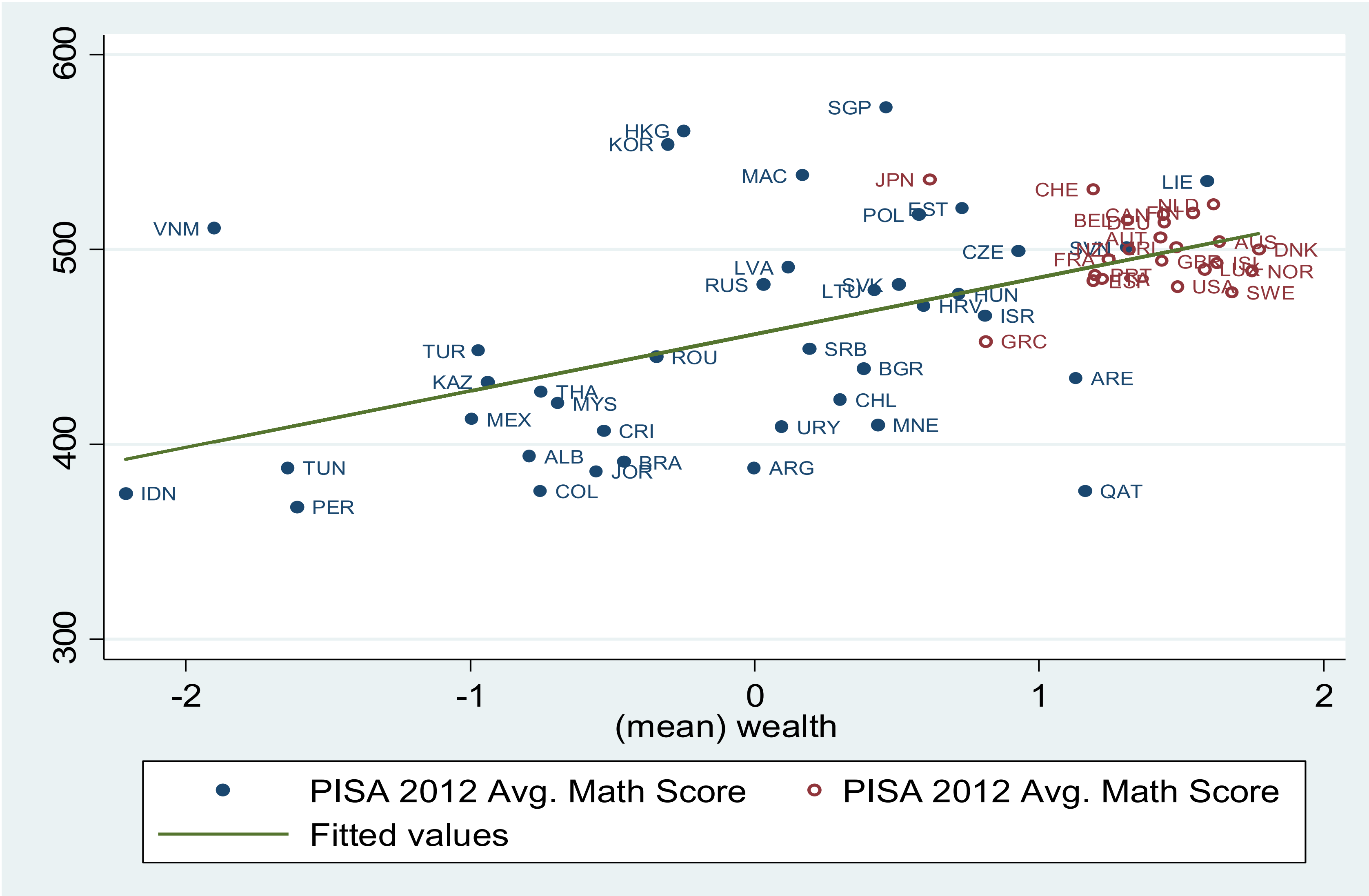
# Mean Age 15 Math Scores in 2012 (PISA), by 2010 Log Real GDP/capita



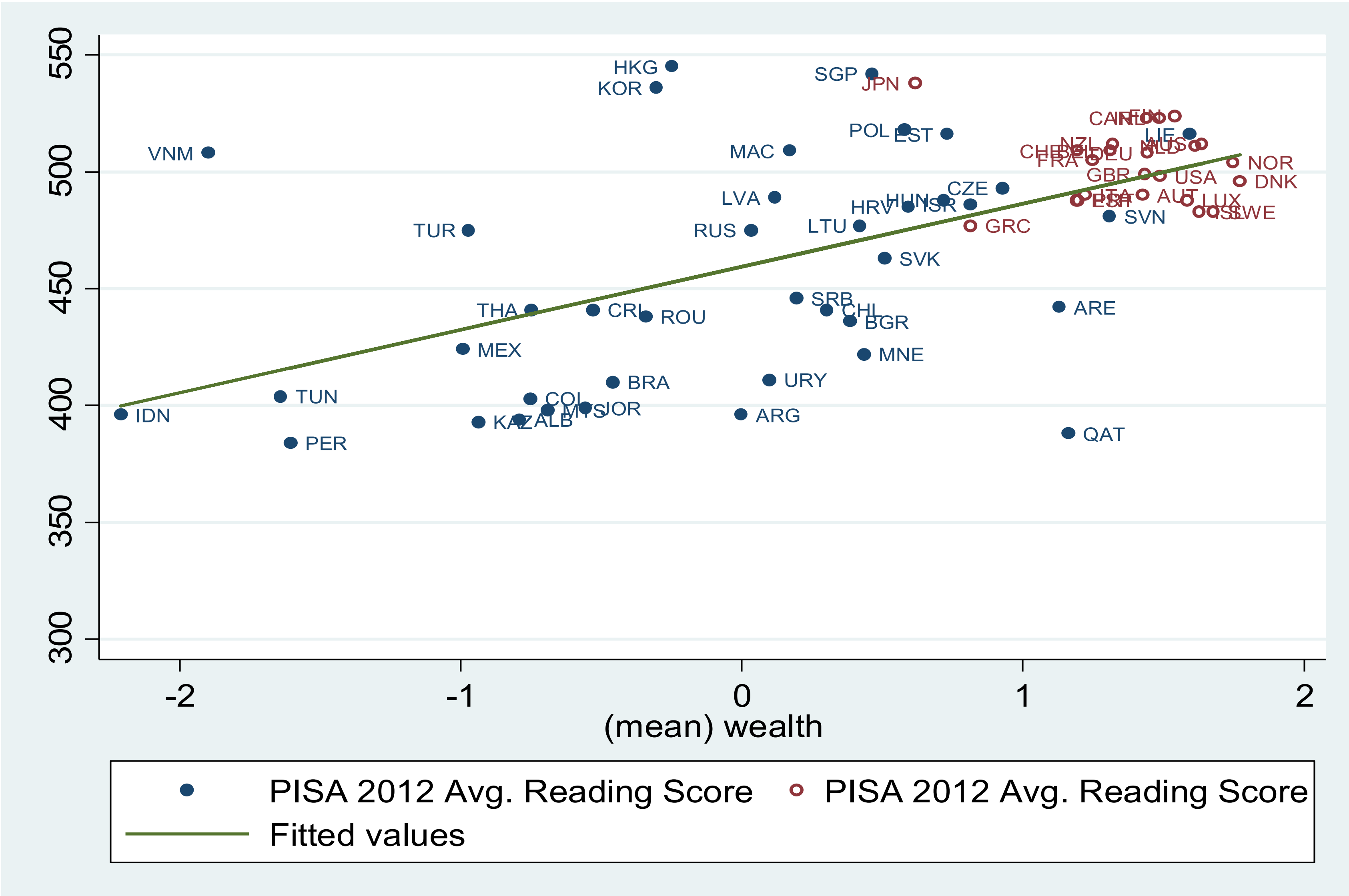
# Mean Age 15 Reading Scores in 2012 PISA, by 2010 Log Real GDP/capita



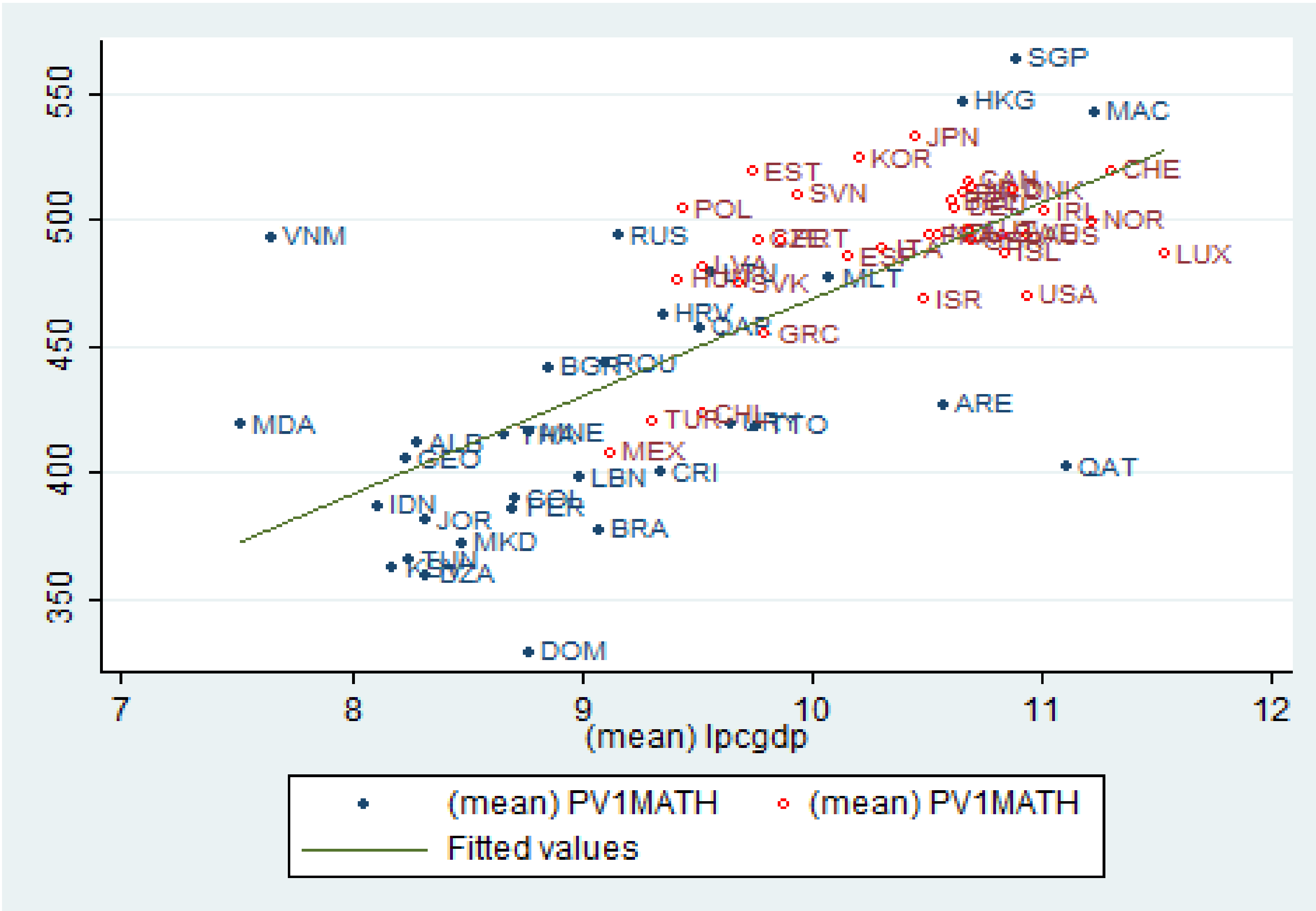
# Mean Age 15 Math Scores in 2012 (PISA), by 2012 PISA Wealth Index



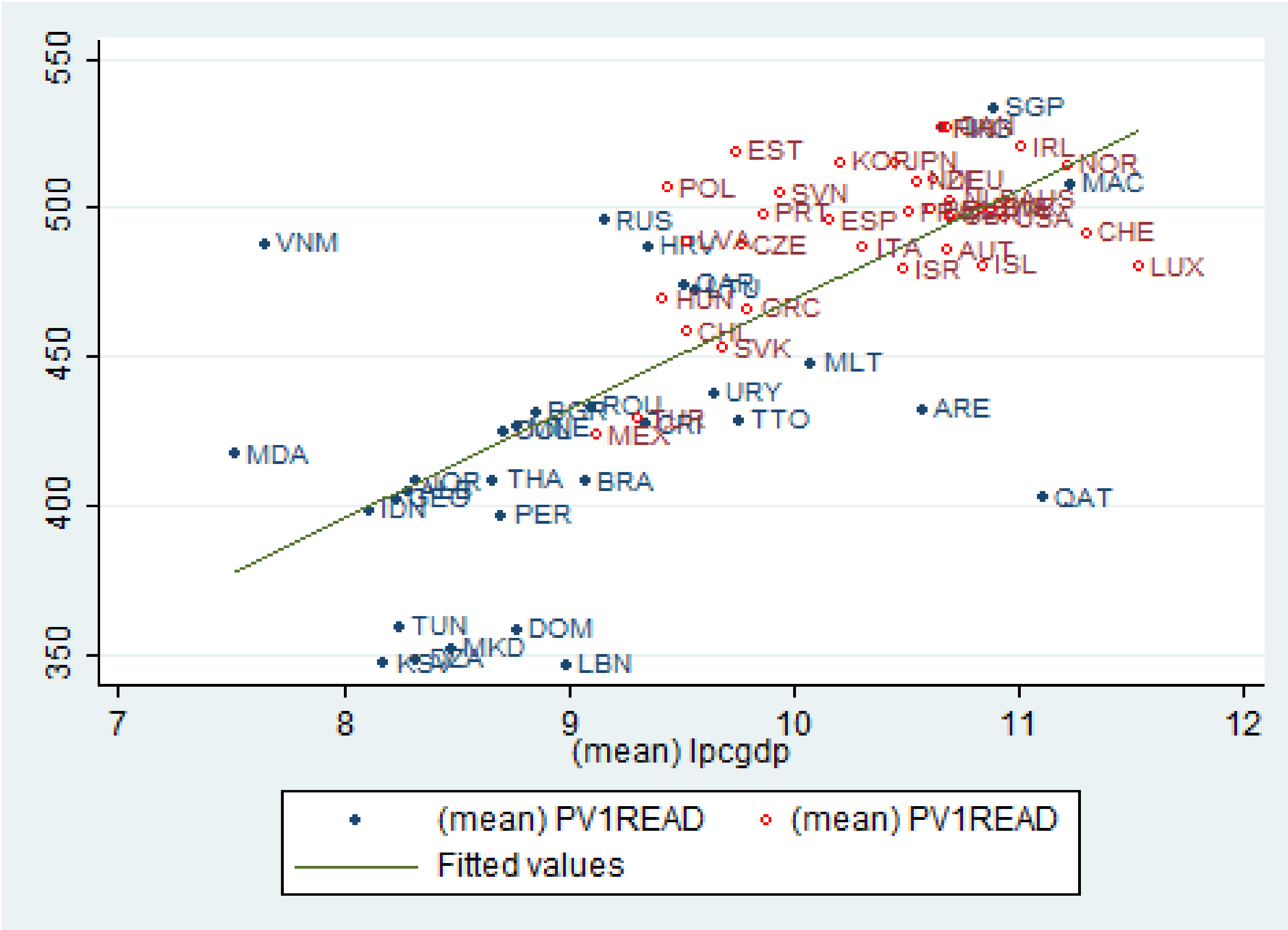
# Mean Age 15 Reading Scores in 2012 (PISA), by 2012 PISA Wealth Index



# Mean Age 15 Math Scores in 2015 PISA, by 2015 Log Real GDP/capita



## Mean Age 15 Reading Scores in 2015 PISA, by 2015 Log Real GDP/capita



**This apparent high performance raises important questions in education for both Vietnam and other developing countries.**

- How and why did Vietnam "get it right"?
- Did Vietnam *really* get it right?
    - How indicative are the PISA results of the true situation in Vietnam?

***Can Vietnam provide useful lessons for other developing countries?***

**This paper will examine:**

1. Whether the PISA sample is representative of Vietnam's 15 year olds, and if not what happens when it is adjusted to make it representative?
2. What observed variables in the PISA explain the gaps seen after conditioning only on income?
3. What can be learned from an Oaxaca-Blinder decomposition?

# 1. Are PISA 15-year olds Representative of Vietnam's 15-year-olds?

**Maybe not!** Of the 63 countries in the 2012 PISA Vietnam had the **third lowest enrollment rate** (coverage rate), at 55.7%. The average is 75-80%.

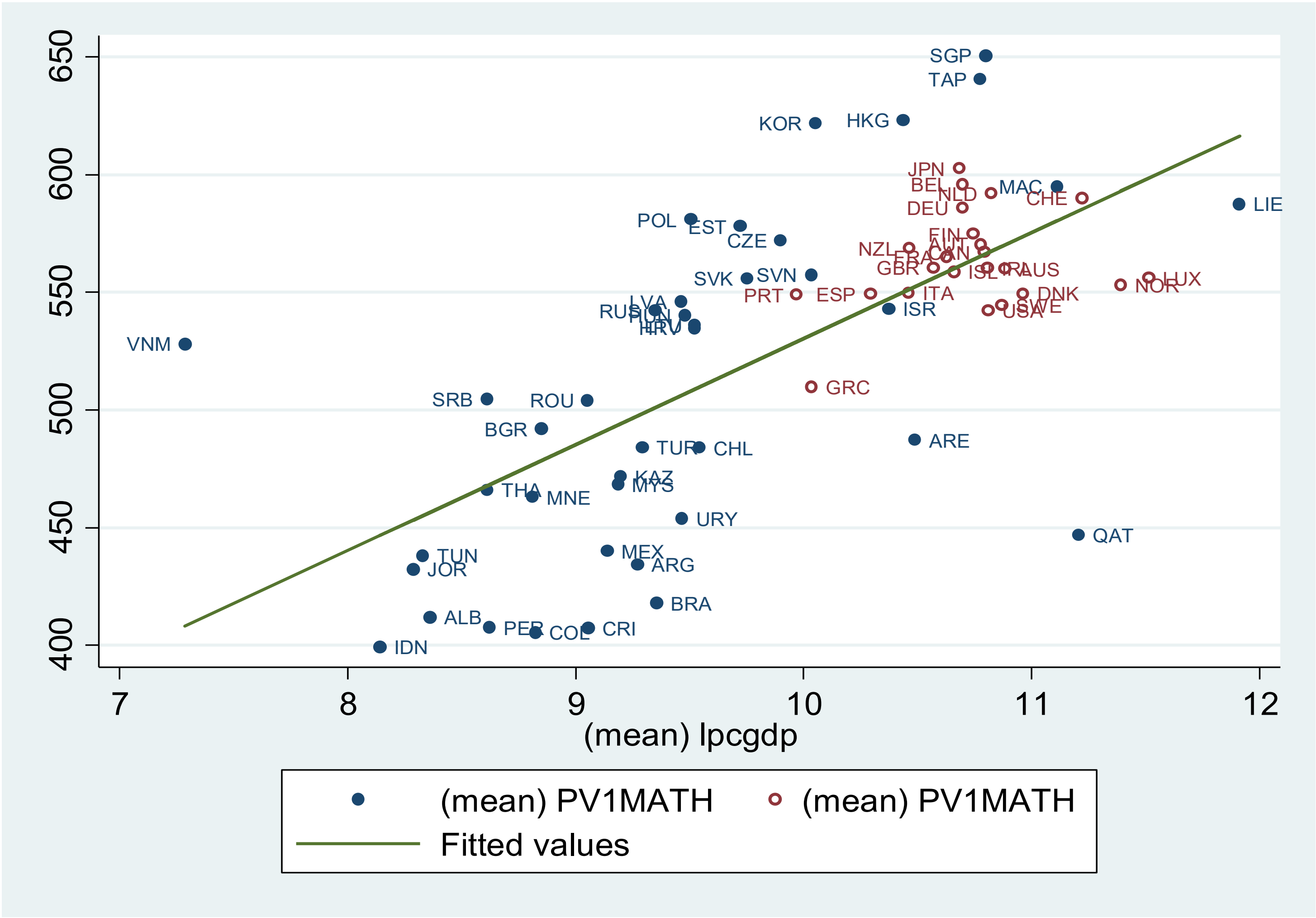
For a **"fair comparison"**, assume that those who are not in school would have scored below the 50$^{th}$ percentile of all 15-year-olds had they been in school. That is, **compare the "top 50%" of students**.

Vietnam's rank (out of 63 countries) drops sharply when this is done:

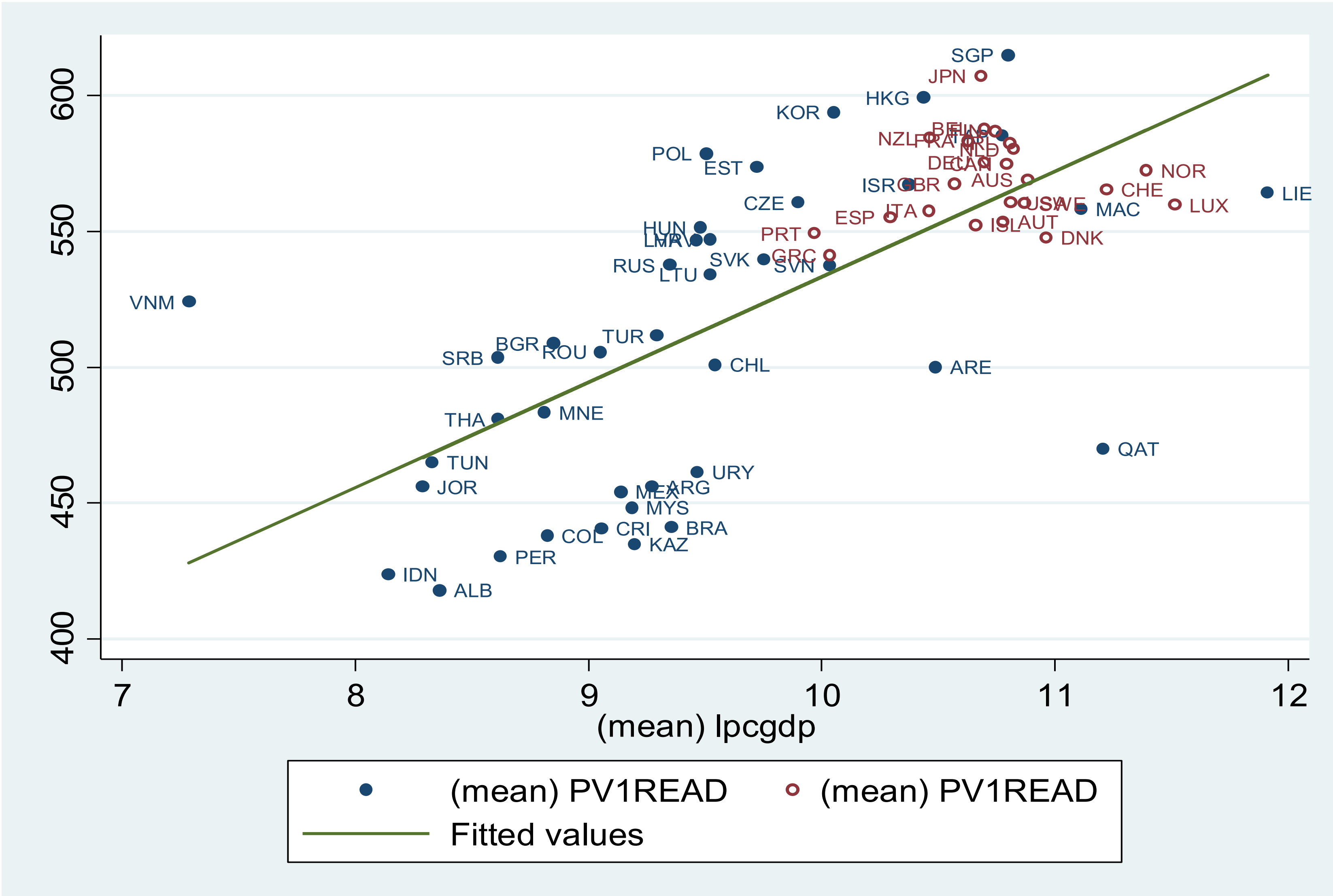
| | Math Rank | Reading Rank |
|---|---|---|
| Of 15-year-olds in school | 16 | 18 |
| Of top 50% of students | 40 | 41 |

## But Vietnam's top 50% score is still a big outlier conditional on GDP/capita!

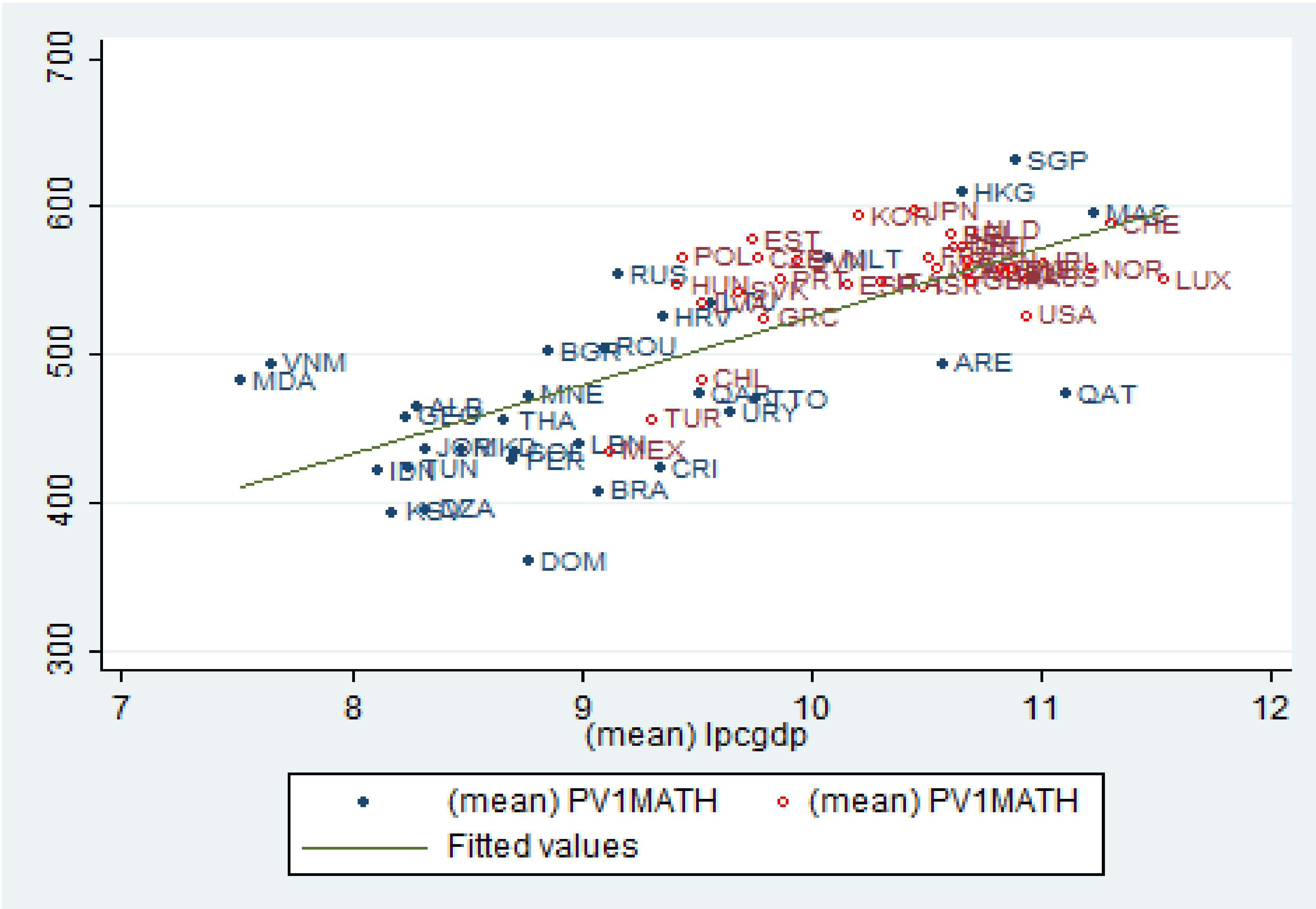
### Mean Age 15 Top 50% Math Scores in 2012 (PISA), by 2010 Log Real GDP/capita



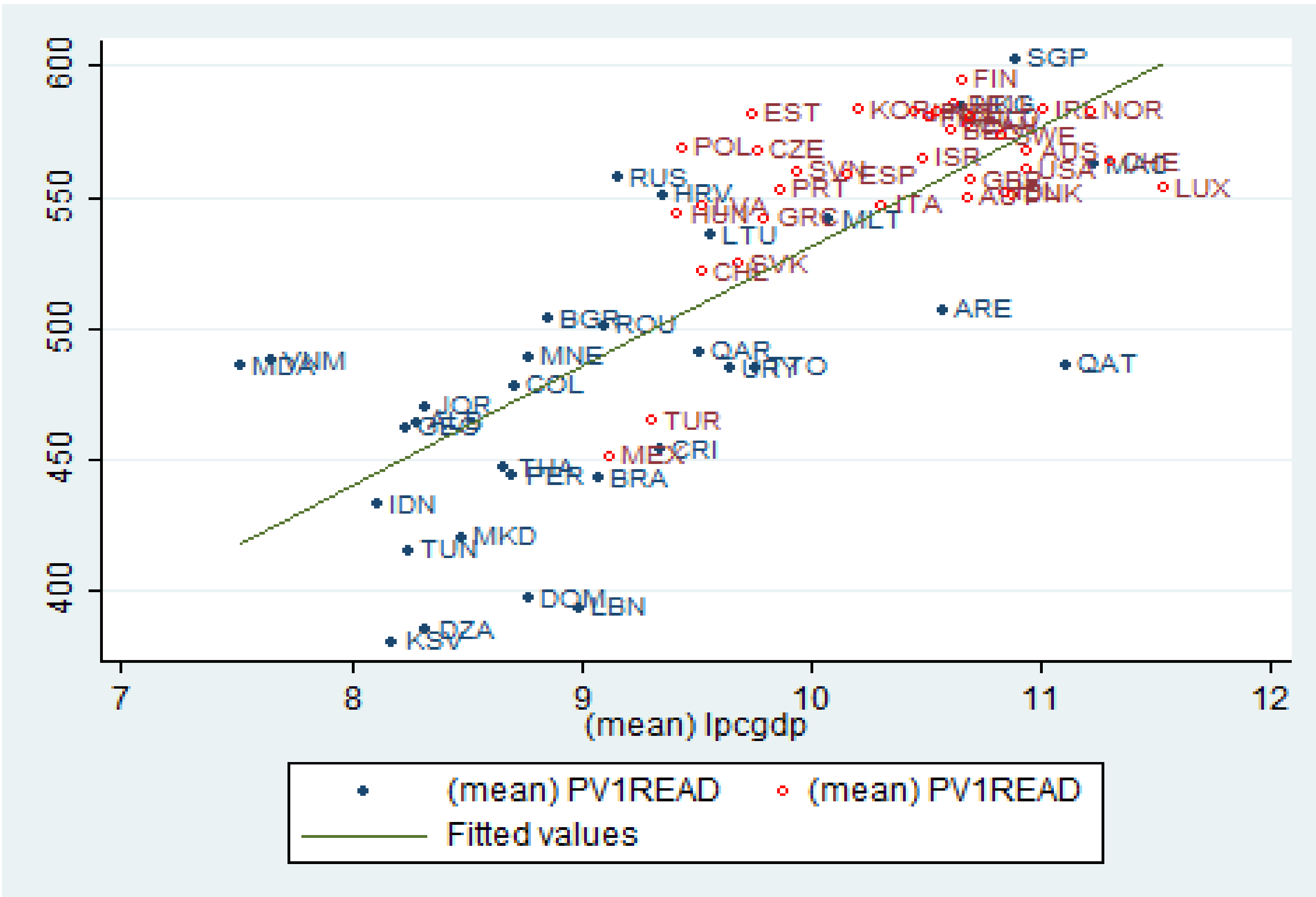
## Mean Age 15 Top 50% Reading Scores in 2012 PISA, by 2010 Log Real GDP/capita



**Mean Age 15 Top 50% Math Scores in 2015 PISA, by 2015 Log Real GDP/capita**



**Mean Age 15 Top 50% Reading Scores in 2015 PISA, by 2015 Log Real GDP/capita**



**Also, even conditional on being in school** it seems that the 15-year-old students in Vietnam in the 2012 PISA have a higher socio-economic status than 15-year-old students in the 2012 Vietnam Household Living Standards Survey:

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

| Variable | PISA | VHLSS (PISA-eligible only) | | |
|---|---|---|---|---|
| | | All | March-July | Sep-Nov |
| Rural (%) | 49.7 | 74.0 | 74.7 | 73.3 |
| Female (%) | 53.8 | 51.7 | 51.7 | 51.9 |
| Current grade: 10th grade (%) | 86.1 | 84.3 | 75.7 | 93.5 |
| Current grade: 9th grade (%) | 10.3 | 14.0 | 22.2 | 5.1 |
| Father's years of schooling | 8.95 | 7.18 | 7.19 | 7.16 |
| Mother's years of schooling | 8.34 | 6.80 | 6.93 | 6.66 |
| Owns an air-conditioner (%) | 16.0 | 7.1 | 7.1 | 7.2 |
| Owns a motorbike (%) | 93.1 | 91.0 | 90.7 | 91.1 |
| Owns a car (%) | 7.3 | 0.7 | 1.0 | 0.4 |
| Owns a computer (%) | 39.1 | 24.5 | 25.1 | 23.9 |
| Number of TVs owned | 1.39 | 1.00 | 1.00 | 0.99 |
| Sample (born 1996, enrolled 2012) | 4,771 | 455 | 236 | 219 |

## So what happens if we use VHLSS means to predict PISA scores?

First, regress PISA scores on all the variables in the previous table, which can be denoted by **X**, **only for observations from Vietnam:**

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

The table on the following slide shows the results of these regressions.

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 trying to measure are likely to be much higher, perhaps around 0.500.

## Table 3A: Predictors of 2012 PISA Scores in Vietnam (Observations = 4771)

| VARIABLES | READING | MATH |
|---|---|---|
| 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 schooling | 1.536*** | 2.231*** |
| | (0.315) | (0.374) |
| Mother years 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) |
| R-squared | 0.341 | 0.310 |

Second, note that OLS estimation implies that:

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

To obtain the predicted PISA score after adjusting $\bar{\mathbf{X}}$ to reflect the values in the 2012 VHLSS, assume that the predictive power of $\boldsymbol{\beta}_{\text{OLS}}$ does not depend on the distribution of the **X** variables, & replace $\bar{\mathbf{X}}_{\text{PISA}}$ with $\bar{\mathbf{X}}_{\text{VHLSS}}$:

$$\overline{\text{PISAscore}}_{\text{adjusted}} = \hat{\boldsymbol{\beta}}_{\text{OLS}}'\bar{\mathbf{X}}_{\text{VHLSS}} \qquad (3)$$

The PISA examine was given in Vietnam in April of 2012, so the means should be for the months of March – July, as shown in Table 1.

Tables 6A and 7A "adjust" average PISA using means from the VHLSS survey that are from the months of March – July (almost all of these interviews took place in either March, April or June).

**Bottom Line: This adjustment reduces Vietnam's PISA scores by only 20-24.**
(even lower for 2015 PISA, reduction is about 14 points, Tables 6B and 7B)

## Table 6A: Predicted PISA Reading Scores Based on VHLSS Data, Decomposed by Variable

| 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 |
| Girl | 0.538 | 0.517 | 0.021 | 24.61 | 13.2 | 12.7 | 0.5 |
| In 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 7A: Predicted PISA Math Scores Based on VHLSS Data, Decomposed by Variable

| 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 |
| Girl | 0.538 | 0.517 | 0.021 | -16.58 | -8.9 | -8.6 | -0.4 |
| In 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 |

## 2. What observed variables in the PISA data explain the gaps seen after conditioning only on income?

In theory, **something must explain why Vietnam is still an outlier**.

The **PISA data** collected a large amount of information on the students and their schools. **If these observed variables can explain** why Vietnam performs so well, then **Vietnam should no longer be an outlier** when they are added to the regression.

Assume that the underlying skill, $S_{ic}$, measured by the PISA score of student i in country c is a linear function of the characteristics of: (i) the student; (ii) his or her household; (iii) the teachers which he or she has had; and (iv) the school(s) which he or she has attended:

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

where **x** variables are **all** student, household, teacher and school characteristics, and $\varepsilon_{ic}$ is measurement error in the PISA test.

An **important distinction** to make regarding the $\mathbf{x}_{ic}$ **variables** is that between those that are **observed** and those that are **unobserved**:

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

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

(superscript o indicates observed & superscript u indicates unobserved).

The second line disaggregates $\mathbf{x}_{ic}^{u}$ into: (i) its country specific mean, $\bar{\mathbf{x}}_{c}^{u}$; and (ii) the within-country deviation from that mean for student i, $\mathbf{x}_{ic}^{u,d}$ (d superscript indicates "deviation").

For a regression with country fixed effects, the fixed effect for country c would be $\boldsymbol{\beta}^{u\prime}\bar{\mathbf{x}}_{c}^{u}$, and the error term would be $\boldsymbol{\beta}^{u\prime}\mathbf{x}_{ic}^{u,d} + \varepsilon_{ic}$.

**Now, let's look at some initial regressions.**

**Table 8A. 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 (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.

Regressions (1) and (2). Same as figures shown above except each student, rather than each country is an observation. Vietnam is still the largest outlier.

Regressions (3) and (4). Replace GDP per capita with average of wealth index (which does vary over student, but for now assign country average to each student). Vietnam is still the largest outlier in reading, but second largest in math.

Regressions (5) and (6). Allow wealth to vary across students. Vietnam is the second largest outlier in reading and fourth largest in math.

Regressions (7) and (8). Add country fixed effects. Vietnam is the third largest outlier in reading and fifth largest in math.

**Overall, for student level regressions with GDP per capita Vietnam is still the biggest outlier. Switching to student-level wealth and country fixed effects make it slightly less of an outlier, but it's still an outlier!**

The goal now is to **add additional variables to equation (5)**, which moves those variables out of $\mathbf{x}_{ic}{}^{u}$ and into $\mathbf{x}_{ic}{}^{o}$, to see whether Vietnam's outlier status can be explained by observed variables in the PISA data.

This approach has been used 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.

**If the key factors that explain Vietnamese students' success are in the PISA data**, adding them to the regression will lead to a small, 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).

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, $\varepsilon_{ic}$.

Even if the PISA data lack some variables that explain Vietnam's (and other countries') success, so that the country fixed effects are still statistically significant…

…it may still 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.

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, 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.

**So let's add some variables and see what happens!**

**Table 9A: 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*** |
| Girl | | | -8.705*** | 33.31*** | | | -15.39*** | 26.55*** |
| Sibling index | | | -1.905*** | -2.457*** | | | -1.930*** | -2.392*** |
| Sib. index missing | | | -19.59*** | -15.66*** | | | -17.54*** | -13.51*** |
| Mom years school | | | 2.978*** | 2.872*** | | | 1.800*** | 1.702*** |
| Dad years school | | | 3.310*** | 3.065*** | | | 2.046*** | 1.841*** |
| Grade 10 | | | | | | | 22.87*** | 23.87*** |
| Years of preschool | | | | | | | 10.74*** | 10.05*** |
| Educational input index | | | | | | | 7.432*** | 7.985*** |
| Attendance (past 2 weeks) | | | | | | | 7.710*** | 7.638*** |
| Books at home | | | | | | | 0.0689*** | 0.0595*** |
| Hours of study | | | | | | | 3.170*** | 3.017*** |
| Extra math classes (tutored) | | | | | | | 0.558*** | |
| Extra math var. missing | | | | | | | -2.929*** | |
| Extra read classes (tutored) | | | | | | | | -4.440*** |
| Extra read variable missing | | | | | | | | -3.052*** |
| **Vietnam residual (avg.)** | **78.2** | **68.3** | **80.6** | **70.7** | **79.1** | **68.9** | **65.0** | **55.1** |
| **Residual Rank** | **5** | **3** | **6** | **2** | **5** | **3** | **5** | **3** |
| **More highly ranked** | **HK<br>S. Korea<br>Singap.<br>Taiwan** | **HK<br>S. Korea** | **HK, Macao<br>Singap.<br>S. Korea<br>Taiwan** | **HK** | **HK<br>S. Korea<br>Singap.<br>Taiwan** | **HK<br>S. Korea** | **HK<br>Macao<br>Singap.<br>Taiwan** | **Finland<br>HK** |
| 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 |

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

| VARIABLES | MATH | READING | MATH | READING |
|---|---|---|---|---|
| Wealth | 15.32*** | 13.75*** | 5.436*** | 3.869*** |
| Class size | | | 0.0943*** | 0.271*** |
| Ratio qualified teachers | | | 13.28*** | 10.44*** |
| Qual. tchr. ratio missing | | | -1.370*** | -2.833*** |
| Square root of computers/pupil | | | -2.087*** | -0.710 |
| Stud. perf. used to assess teachers | | | 1.728*** | 2.049*** |
| Teacher absenteeism | | | -3.302*** | -2.961*** |
| Parents pressure teachers | | | 11.59*** | 11.33*** |
| Principal observes teachers | | | -2.741*** | 0.117 |
| Inspector observes teachers | | | -4.735*** | -6.698*** |
| Teacher pay linked to stud. perf. | | | -2.232*** | -2.501*** |
| Teacher mentoring index | | | 5.244*** | 5.906*** |
| **Vietnam residual (average)** | **76.7** | **66.2** | **58.1** | **44.7** |
| **Residual rank** | **5** | **4** | **8** | **4** |
| **More highly ranked** | **HK<br>S. Korea<br>Singap.<br>Taiwan** | **HK<br>S. Korea<br>Singap.** | **HK, Macao<br>Liecht.<br>S. Korea<br>Singap.<br>Switz.<br>Taiwan** | **Finland<br>HK<br>Liecht.** |
| Observations | 341,409 | 341,409 | 341,409 | 341,409 |
| R-squared | 0.354 | 0.286 | 0.460 | 0.405 |

**Bottom Line: 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.**

**Similar results are found for the 2015 PISA (Tables 9B and 10B)**

**Thus, most of the explanation for that performance must be found elsewhere.**

## 3. What can be learned from an Oaxaca-Blinder decomposition?

The analysis thus far assumes 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 Vietnamese parents' years of schooling represent a higher level of cognitive skills.

To examine this possibility consider the standard Oaxaca-Blinder decomposition, applied to differences in test scores between Vietnam and all other countries:

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

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

The constant term in each regression can be normalized so that the mean of the error term equals 0. Then taking the mean of both sides of each regression gives the following:

$$\overline{S}_{vn} = \boldsymbol{\beta}_{vn}'\overline{\mathbf{x}}_{vn}$$

$$\overline{S}_{o} = \boldsymbol{\beta}_{o}'\overline{\mathbf{x}}_{o}$$

The standard Oaxaca-Blinder decomposition uses the above two equations to express the difference in the mean test scores between Vietnam and the 62 other countries in the PISA data can be described as follows:

$$\overline{S}_{vn} - \overline{S}_{o} = \boldsymbol{\beta}_{vn}'\overline{\mathbf{x}}_{vn} - \boldsymbol{\beta}_{o}'\overline{\mathbf{x}}_{o}$$

$$= \boldsymbol{\beta}_{vn}'\overline{\mathbf{x}}_{vn} - \boldsymbol{\beta}_{o}'\overline{\mathbf{x}}_{o} + \boldsymbol{\beta}_{o}'\overline{\mathbf{x}}_{vn} - \boldsymbol{\beta}_{o}'\overline{\mathbf{x}}_{vn}$$

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

The analysis thus far has assumed that $\boldsymbol{\beta}_{VN} = \boldsymbol{\beta}_{O}$, but now we allow for differences in the effect of the variables in Vietnam and in other countries.

**However**, this decomposition has the following shortcoming:

> The differences in $(\bar{\mathbf{x}}_{vn} - \bar{\mathbf{x}}_{o})$ are "weighted" by the coefficients of the other 62 countries, while the differences in $(\boldsymbol{\beta}_{vn} - \boldsymbol{\beta}_{o})$ are weighted by the means of the **x** variables for Vietnam. It would be better if both sets of "weights" were based on all 63 countries.

To "fix" this problem, we use the following decomposition:

$$\bar{S}_{vn} - \bar{S}_{o} = \boldsymbol{\beta}_{vn}'\bar{\mathbf{x}}_{vn} - \boldsymbol{\beta}_{o}'\bar{\mathbf{x}}_{o}$$

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

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

where $\bar{\boldsymbol{\beta}} = (\boldsymbol{\beta}_{vn} - \boldsymbol{\beta}_{o})/2$. (Note: this is true for *any* definition of $\bar{\boldsymbol{\beta}}$)

Intuitively, the first term weights the differences in the **x** variables by the simple average of the two $\boldsymbol{\beta}$ coefficients, and the second term accounts for differences in $\boldsymbol{\beta}_{vn}$ and $\boldsymbol{\beta}_{o}$ 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 $\boldsymbol{\beta}_{o}$ and $\bar{\boldsymbol{\beta}}$, weighted by $\bar{\mathbf{x}}_{o}$.

**Table 11A: Means of Regression Variables, for Vietnam and for Other Countries, 2012**

| 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 |
| 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 math classes (tutoring), hours/week | 2.741 | 1.325 |
| Class size | 44.81 | 32.61 |
| Proportion of teachers who are qualified | 0.7999 | 0.8337 |
| Proportion qualified teacher missing | 0.06890 | 0.1879 |
| Square root of computers/pupil | 0.4173 | 0.6235 |
| Stud. 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 perform. | 2.487 | 1.703 |
| Teachers are mentored | 0.8450 | 0.6837 |
| Sample size | 4,421 | 336,988 |

**Table 12A: Math Decomposition for 2012 (diff = 516.54– 462.80 = 53.74)**

| Variable | $\beta_{vn}$ | $\bar{x}_{vn}$ | $\beta_{vn}'\bar{x}_{vn}$ | $\beta_o$ | $\bar{x}_o$ | $\beta_o'\bar{x}_o$ | $\bar{\beta}$ | $\bar{\beta}'(\bar{x}_{vn}-\bar{x}_o)$ | $(\beta_{vn}-\bar{\beta})'\bar{x}_{vn} + (\bar{\beta}-\beta_o)'\bar{x}_0$ |
|---|---|---|---|---|---|---|---|---|---|
| Wealth | 6.764*** | 4.143 | -28.02 | 9.633*** | 6.101 | 58.77 | 8.198 | -16.05 | -14.69 |
| Grade 10 | 85.85*** | 0.874 | 75.01 | 18.93*** | 0.584 | 11.05 | 52.39 | 15.19 | 48.76 |
| Sibling index | 3.152* | 1.048 | 3.30 | -1.697*** | 1.086 | -1.84 | 0.728 | -0.03 | 5.17 |
| Sibling index missing | -0.576 | 0.149 | -0.09 | -17.87*** | 0.238 | -4.25 | -9.225 | 0.82 | 3.35 |
| Mom years schooling | 0.962*** | 8.313 | 8.00 | 1.786*** | 10.975 | 19.60 | 1.374 | -3.66 | -7.95 |
| Dad years schooling | 1.511*** | 8.883 | 13.42 | 2.390*** | 11.086 | 26.50 | 1.950 | -4.30 | -8.78 |
| Years in preschool | 6.533*** | 1.600 | 10.45 | 13.07*** | 1.487 | 19.43 | 9.799 | 1.10 | -10.08 |
| Education inputs index | 4.397*** | 4.680 | 20.58 | 7.337*** | 5.154 | 37.81 | 5.867 | -2.78 | -14.46 |
| Books in home | 0.0089 | 57.59 | 0.51 | 0.0882*** | 114.07 | 10.07 | 0.049 | -2.74 | -6.81 |
| Days attend past 2 wks | 10.43*** | 9.849 | 102.72 | 8.094*** | 9.622 | 77.88 | 9.261 | 2.10 | 23.74 |
| Hours study per week | 2.920*** | 5.756 | 16.81 | 2.425*** | 5.362 | 13.00 | 2.672 | 1.05 | 2.75 |
| Extra math class, hrs/wk | 3.904*** | 2.741 | 10.70 | -0.633*** | 1.325 | -0.84 | 1.636 | 2.32 | 9.22 |
| Extra math class missing | 8.890*** | 0.336 | 2.98 | -3.188*** | 0.358 | -1.14 | 2.851 | -0.06 | 4.19 |
| Class size | 0.0643 | 44.81 | 2.88 | 0.148*** | 32.61 | 4.82 | 0.106 | 1.29 | -3.24 |
| Proport. qualified tchrs | 18.18*** | 0.800 | 14.55 | 46.08*** | 0.834 | 38.42 | 32.13 | -1.09 | -22.79 |
| Square root comp/pupil | -0.0392 | 0.417 | -0.02 | 4.925*** | 0.623 | 3.07 | 2.443 | -0.50 | -2.58 |
| Stud perf. to assess tchrs | 25.08** | 0.992 | 24.89 | -4.267*** | 0.708 | -3.02 | 10.40 | 2.96 | 24.95 |
| Teacher absenteeism | -0.759 | 0.692 | -0.53 | -6.600*** | 0.778 | -5.13 | -3.679 | 0.32 | 4.29 |
| Parents pressure tchrs | 15.71*** | 1.311 | 20.60 | 6.686*** | 0.957 | 6.40 | 11.20 | 3.97 | 10.24 |
| Principal observes tchrs | 14.12** | 0.965 | 13.63 | -3.816*** | 0.802 | -3.06 | 5.154 | 0.84 | 15.85 |
| Inspector observes tchrs | -16.73*** | 0.847 | -14.17 | -10.15*** | 0.406 | -4.12 | -13.44 | -5.93 | -4.13 |
| Tchr pay link stud. perf. | 2.209 | 1.487 | 3.28 | -2.279*** | 0.703 | -1.60 | -0.035 | -0.03 | -4.92 |
| Teachers are mentored | 6.766** | 0.845 | 5.72 | 7.722*** | 0.684 | 5.28 | 7.244 | 1.17 | -0.73 |
| Constant | 154.46*** | 1.000 | 154.46 | 160.07*** | 1.000 | 160.07 | 157.26 | 0.00 | -5.61 |
| | | | 516.54 | | | 462.80 | | -1.62 | 55.36 |

## Comments on Math Decomposition:

1. Almost all the Vietnam coefficients have the expected signs, but some of the "other" coefficients do not have the expected signs.

2. Differences in household and school characteristics do not explain the gap; in fact they slightly increase the gap.

3. **Differential effectiveness ($\beta_{vn}$ - $\beta_o$) explains the entire gap**.

4. The most important effect is that being in grade 10 has a much larger impact in Vietnam than it does in other countries. This may reflect that only students who pass an entrance exam can go on to grade 10.

5. Three other "large" contributing effects are:

    a) Greater "efficiency" in days attended in last 2 weeks
    b) Greater "efficiency" in using student perform. to assess teachers
    c) "Less" efficiency in proportion of teacher who are qualified (??)

**Table 13A: Reading Decomposition for 2012 (diff = 512.82– 472.52 = 40.30)**

| Variable | $\beta_{vn}$ | $\bar{x}_{vn}$ | $\beta_{vn}'\bar{x}_{vn}$ | $\beta_o$ | $\bar{x}_o$ | $\beta_o'\bar{x}_o$ | $\bar{\beta}$ | $\bar{\beta}'(\bar{x}_{vn}-\bar{x}_o)$ | $(\beta_{vn}-\bar{\beta})'\bar{x}_{vn} + (\bar{\beta}-\beta_o)'\bar{x}_0$ |
|---|---|---|---|---|---|---|---|---|---|
| Wealth | 4.748*** | 4.143 | 19.67 | 9.305*** | 6.101 | 56.77 | 7.026 | -13.75 | -23.34 |
| Grade 10 | 79.18*** | 0.874 | 69.18 | 20.58*** | 0.584 | 12.01 | 49.88 | 14.46 | 42.70 |
| Sibling index | 4.045** | 1.048 | 4.24 | -1.736*** | 1.086 | -1.89 | 1.154 | -0.04 | 6.17 |
| Sibling index missing | -0.428 | 0.149 | -0.06 | -12.01*** | 0.238 | -2.86 | -6.217 | 0.55 | 2.24 |
| Mom years schooling | 0.721** | 8.313 | 5.99 | 1.083*** | 10.975 | 11.88 | 0.902 | -2.40 | -3.49 |
| Dad years schooling | 0.694** | 8.883 | 6.17 | 1.877*** | 11.086 | 20.81 | 1.286 | -2.83 | -11.81 |
| Years in preschool | 4.884** | 1.600 | 7.81 | 10.98*** | 1.487 | 16.34 | 7.933 | 0.89 | -9.41 |
| Education inputs index | 5.657*** | 4.680 | 26.47 | 8.061*** | 5.154 | 41.55 | 6.859 | -3.25 | -11.82 |
| Books in home | 0.00231 | 57.59 | 0.13 | 0.0741*** | 114.07 | 8.45 | 0.038 | -2.16 | -6.16 |
| Days attend past 2 wks | 16.08*** | 9.849 | 158.34 | 7.806*** | 9.622 | 75.11 | 11.94 | 2.71 | 80.52 |
| Hours study per week | 2.335*** | 5.756 | 13.44 | 2.786*** | 5.362 | 14.94 | 2.651 | 1.01 | -2.51 |
| Extra math class, hrs/wk | -1.547*** | 2.741 | -1.99 | -4.887*** | 1.325 | -4.61 | -3.217 | -1.11 | 3.73 |
| Extra math class missing | 0.712 | 0.336 | 0.24 | -3.434*** | 0.358 | -1.23 | -1.361 | 0.03 | 1.44 |
| Class size | 0.258 | 44.81 | 11.58 | 0.358*** | 32.61 | 11.67 | 0.308 | 3.76 | 3.85 |
| Proport. qualified tchrs | 16.22*** | 0.800 | 12.98 | 35.92*** | 0.834 | 29.95 | 26.07 | -0.88 | -16.09 |
| Square root comp/pupil | -4.467 | 0.417 | -1.86 | 7.049*** | 0.623 | 4.40 | 1.291 | -0.27 | -5.99 |
| Stud perf. to assess tchrs | 1.901 | 0.992 | 1.89 | -4.253** | 0.708 | -3.01 | -1.176 | -0.33 | 5.23 |
| Teacher absenteeism | -1.489 | 0.692 | -1.03 | -5.874*** | 0.778 | -4.57 | -3.681 | 0.32 | 3.22 |
| Parents pressure tchrs | 9.980** | 1.311 | 13.08 | 8.313*** | 0.957 | 7.96 | 9.146 | 3.24 | 1.89 |
| Principal observes tchrs | 34.74*** | 0.965 | 33.53 | -1.893 | 0.802 | -1.52 | 16.42 | 2.68 | 32.37 |
| Inspector observes tchrs | -18.02** | 0.847 | -15.26 | -11.80*** | 0.406 | -4.79 | -14.91 | -6.57 | 3.90 |
| Tchr pay link stud. perf. | 3.676 | 1.487 | 5.47 | -4.785*** | 0.703 | -3.36 | -0.555 | -0.43 | 9.27 |
| Teachers are mentored | 9.211 | 0.845 | 7.78 | 7.342*** | 0.684 | 5.02 | 8.276 | 1.34 | 1.43 |
| Constant | 136.21*** | 1.000 | 136.21 | 186.68*** | 1.000 | 186.61 | 161.45 | 0.00 | -50.47 |
| | | | 512.82 | | | 472.52 | | -1.02 | 41.32 |

## Comments on Reading Decomposition:

1. Four of the Vietnam coefficients do not have the expected signs, and five of the "other" coefficients do not have the expected signs.

2. Differences in household and school characteristics do not explain the gap; in fact they slightly increase the gap.

3. **Differential effectiveness ($\beta_{vn}$ - $\beta_o$) explains the entire gap**.

4. The factor with the largest impact on the differential effectiveness component is the higher productivity of daily attendance, which is difficult to interpret.

5. Three other factors that "explain" differential effectiveness are:

   a) Greater "productivity" of being in grade 10, which may reflect a selection effect
   b) Greater "productivity" from school principals observing teachers
   c) A smaller constant term, which is difficult to interpret

## Two Final Possible Explanations

### 1. Intrinsic Motivation of Students

- **Gneezy et al. (2017)**, administered mathematics tests based on questions from previous PISA mathematics tests to students in China and the U.S.

- Chinese students did much better than U.S. students under standard conditions.

- However, **randomly selected students who were offered money for higher scores on the exam** (these offers were revealed immediately before the exam, so there was not time to prepare in response to the offer) either s**cored much better (U.S. students)** or **scored the same (Chinese students)**.

- The effects on the U.S. students were large, equivalent to an increase of 22-24 points on the PISA mathematics test.

- The lack of an effect for Chinese students suggests that they are motivated to do well on tests with no direct benefits. Vietnam's culture and education system are quite similar to those of China, so it may be that Vietnamese students' intrinsic motivation can increase their PISA test scores by 22-24.

## 2. Teachers and School Principals Were More Motivated

- When Vietnamese students took a draft version of the PISA exam in 2011 as part of preparations for implementing the 2012 PISA exam, their performance was lower than expected, and Vietnam's Ministry of Education took a series of steps to increase their performance.

- This does not violate the conditions for participating in the PISA assessment; schools can have students practice, using old exams, to become "accustomed" to the PISA exam format.

- The schools that participate in the PISA exam in any given country are selected several months before the exam is given, and the students who participate within those schools are selected 3-4 weeks before the exams.

- In addition to practicing on old PISA exams, the selected Vietnamese students were told that a strong performance would increase Vietnam's honor in the world, and they were given special t-shirts indicating that they would be participating in the PISA assessment.

- Studies in the U.S. and other developed countries have shown that preparation sessions for academic tests can greatly increase students' test scores. For example, Bangert-Drowns, Kulik and Kulik (1983) summarize a large number of studies, and programs that involved coaching sessions of more than nine hours in total duration led to an average increase in test scores of 0.39 standard deviations (of the distribution of test scores, which for the PISA test is equivalent to 39 points).

A rough estimate of the **combined impact of intrinsic motivation and preparation for the PISA exam** would be an impact of 62 points (23 from being more motivated and 39 from preparation for the exam). This would **explain about half of Vietnam's exceptional performance** in terms of the positive residuals discussed below (see Table 8A and 8B, columns 1 and 2), **assuming that few other countries had similarly motivated and well-prepared students**.

**Next step**: Conduct similar analyses using data from the 4 Young Lives countries, which have much richer data for examining why Vietnam does relatively well (although maybe not as well as PISA results indicate).

**Thank you!**

**Questions?**

**Comments?**