School Size and Student Achievement in TIMSS 2003

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Motivation

- School size is an issue in the USA:
  - School and district consolidations
  - Optimal school size
  - Smaller schools seem to be beneficial for children from disadvantaged backgrounds
- Evidence for other countries is mostly lacking

Questions

- Is there a relationship between school size and student achievement?
  - Internationally and within different countries?
- Is school size more important for certain groups of students?

- Not considered here:
  - Why does school size have an effect?

TIMSS 2003 – 8th grade

- Mathematics and science
- 47 countries and 4 benchmarking participants 8th grade
- Background questionnaires answered by students, teachers, principals
- Stratified sampling design
  - First, schools were sampled
  - Then students within these schools

Participants in TIMSS 2003

- Armenia
- Australia
- Bahrain
- Belgium (Flemish)
- Botswana
- Bulgaria
- Chile
- Chinese Taipei
- Cyprus
- Egypt
- England
- Estonia
- Ghana
- Hong Kong, SAR
- Hungary
- Indonesia
- Iran, Islamic Republic
- Israel
- Italy
- Japan
- Jordan
- Korea, Rep. of
- Latvia
- Lebanon
- Lithuania
- Macedonia, Rep. of
- Malaysia
- Moldova, Rep. of
- Morocco
- Netherlands
- New Zealand
- Norway
- Palestinian Nat'l Auth.
- Philippines
- Romania
- Russian Federation
- Saudi Arabia
- Scotland
- Serbia
- Singapore
- Slovak Republic
- Slovenia
- South Africa
- Sweden
- Syrian Arab Republic
- Tunisia
- United States
- Basque Country, Spain
- Indiana State, US
- Ontario Province, Can.
- Quebec Province, Can.

Dataset

- 8th grade students
- 237,833 student observations in complete sample
  - Between 2200 and 8900 per country
- Student outcome: math test scores
- Only math teachers were linked to students (only one)
- Use of imputed values, where possible
  - School size was not imputed
- Stratified sampling design

➔ In regressions, use clustering linear robust method &

➔ Weighted least squares to account for sampling probabilities

Including school size in educational production funct's

- Easiest way:
  - Linearly as a continuous variable
  - Problem: increasing enrolment from 100 to 110 has probably a different effect than increasing enrolment from 1000 to 1010
  - Problem: not possible to discover a possible optimal size range
- Other possibilities:
  - Log linear (model decreasing returns to school size)
  - Size categories (flexible)
  - Piecewise linear (linear effects within different size categories)
  - Linear together with quadratic term

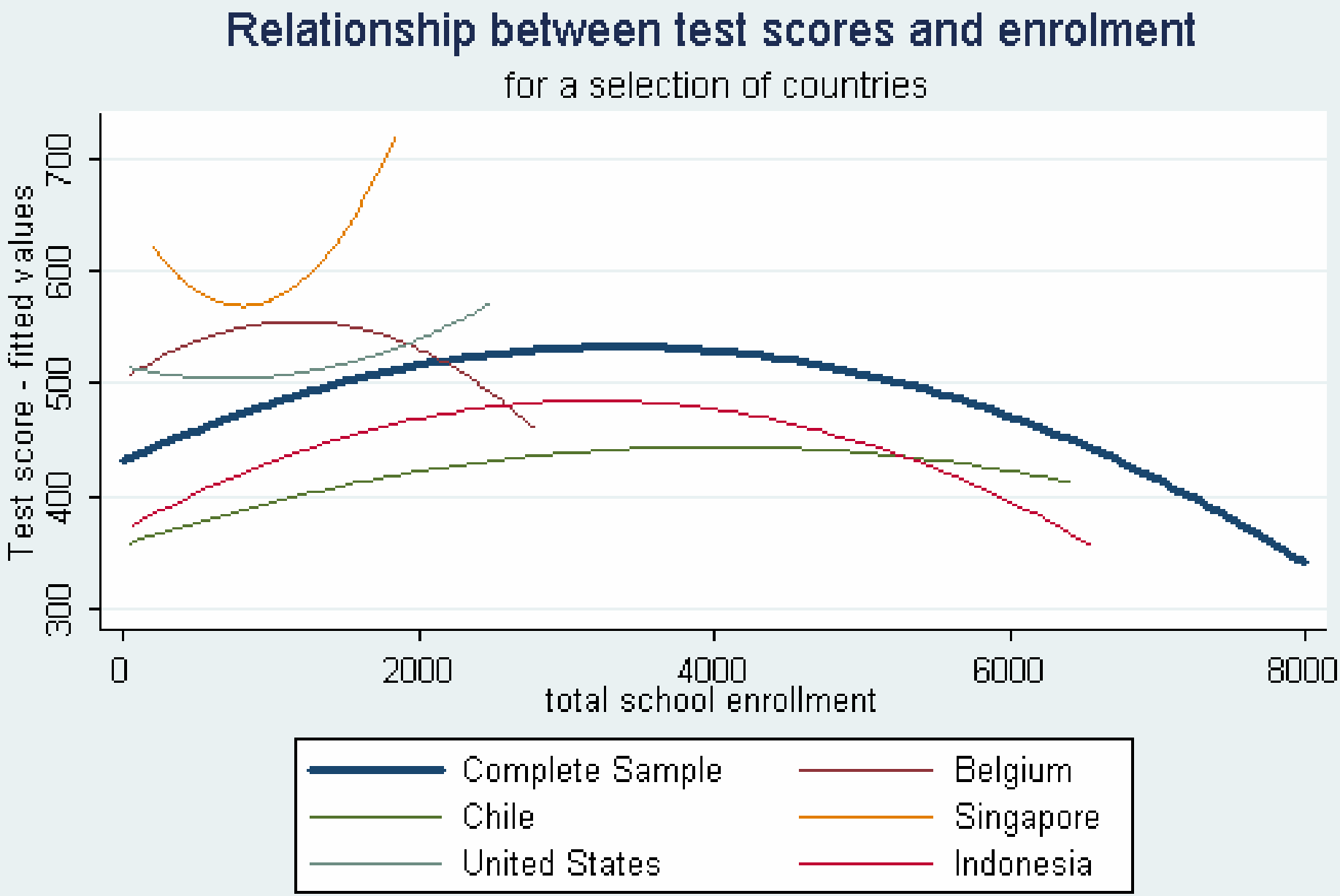
Estimating the coefficients on school size and squared

- Regression of test scores on school size, its squared and a constant

$$TS_{ij} = \alpha_0 + \alpha_1 * SchoolSize_j + \alpha_2 * SchoolSize_j^2 + \varepsilon_{ij}$$

- CLR estimation, using weighted least squares

- But:
  - Not controlling for control variables and outliers


Relationship between test scores and enrolment
for a selection of countries
Test score - fitted values
300
400
500
600
700
0
2000
4000
6000
8000
total school enrollment
Complete Sample
Belgium
Chile
Singapore
United States
Indonesia

The problem of causality

- Unobserved heterogeneity
  - Schools that differ in size might also differ in other respects (e.g. resources)
- Selection of students into schools
  - Schools of different sizes attract different student populations (e.g. suburbs or rural areas)
  - Better-off families might be better able to exert choice
- No randomized experiment

➔ Use of control variables at the student, teacher and school level

Control Variables

- Student level:
  - Age, gender, books at home dummies, parents' education dummies, student born in country, parents born in country, test language never or sometimes spoken at home
- Teacher level:
  - Teacher experience and its squared, teacher education dummies, class size
- School level (reported by headmaster):
  - More than 50% of students from disadvantaged backgrounds,
  - City size dummies
  - Instruction affected by a lot or some shortages in:

    Instructional material, budget for supplies, school buildings and grounds, teachers

Regression using controls

- Regression of test scores on school size, its squared and controls

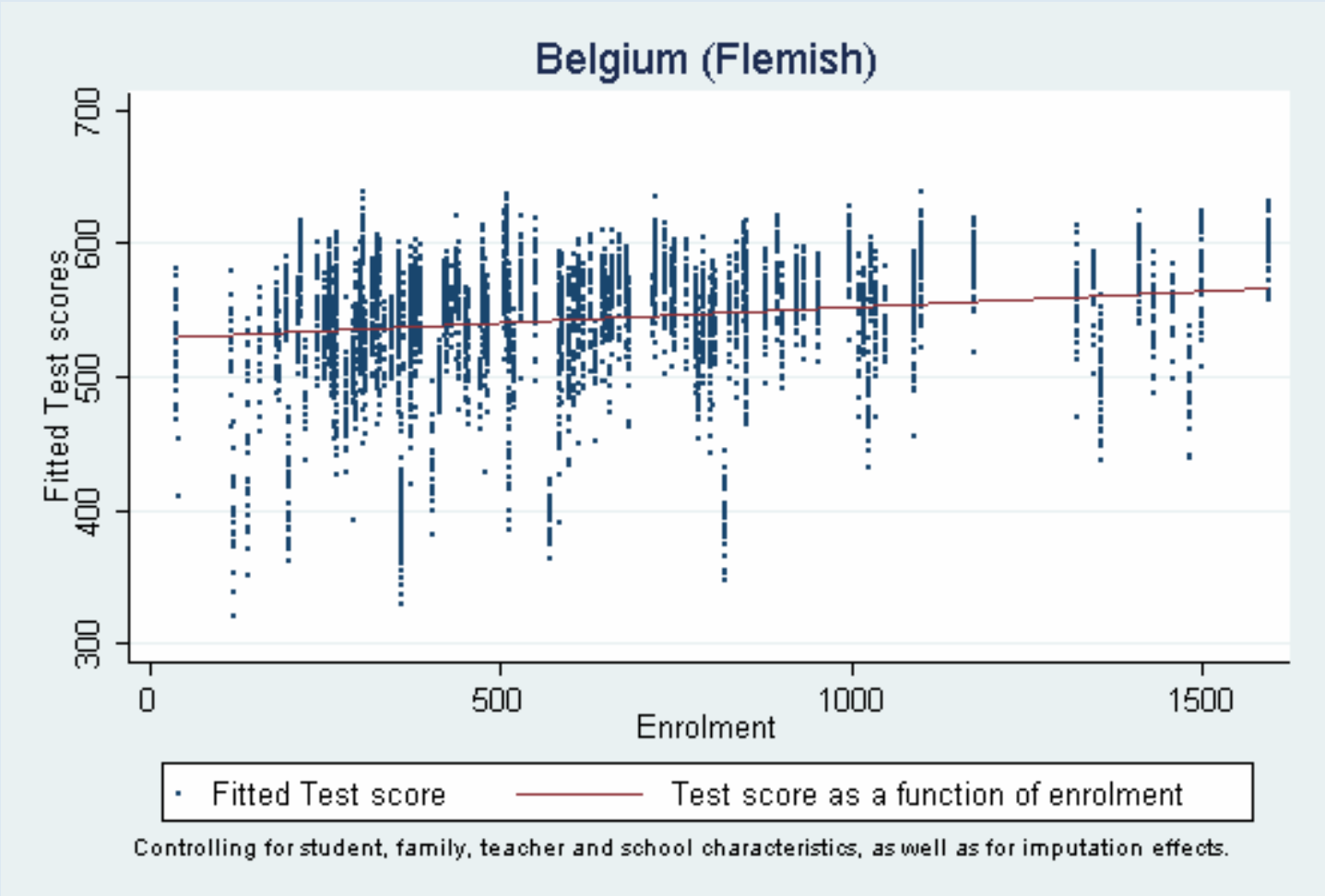
$$TS_{ij} = \alpha_0 + \alpha_1 * SchoolSize_j + \alpha_2 * SchoolSize_j^2$$
$$+ \alpha_3 * stud_{ij} + \alpha_4 * teach_{ij} + \alpha_5 * school_j + \varepsilon_{ij}$$

- CLR estimation, using weighted least squares

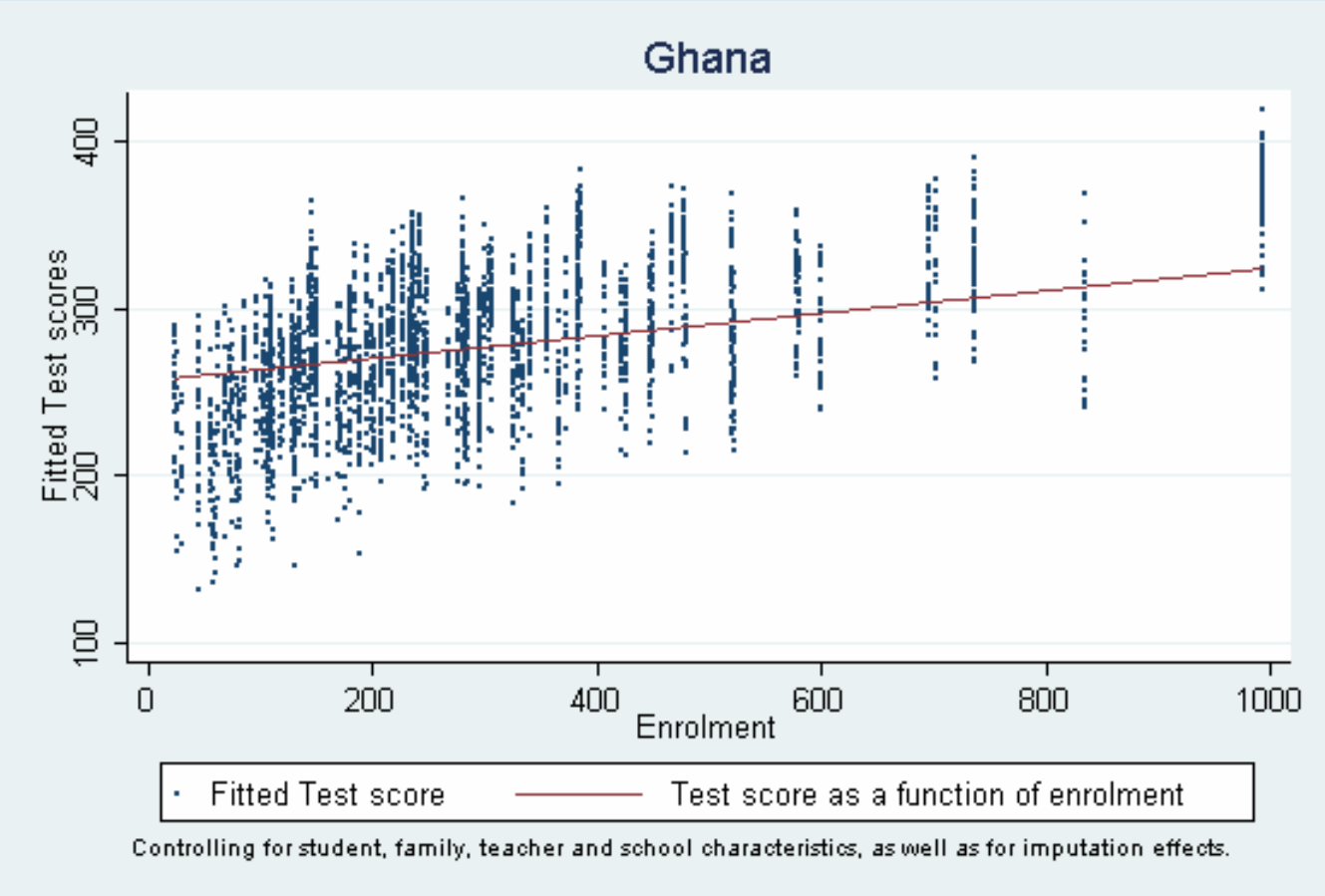
Results

- No significant relationship found in most countries
- Where a relationship exists, it is mostly “bigger is better”:
  - whether linear or with decreasing returns to size
  - Belgium, Chile, Ghana, Hong Kong, Lebanon
  - United States seems increasing
- Inversely U-Shaped relationship:
  - Indonesia, Serbia
- U-Shaped relationship:
  - Singapore

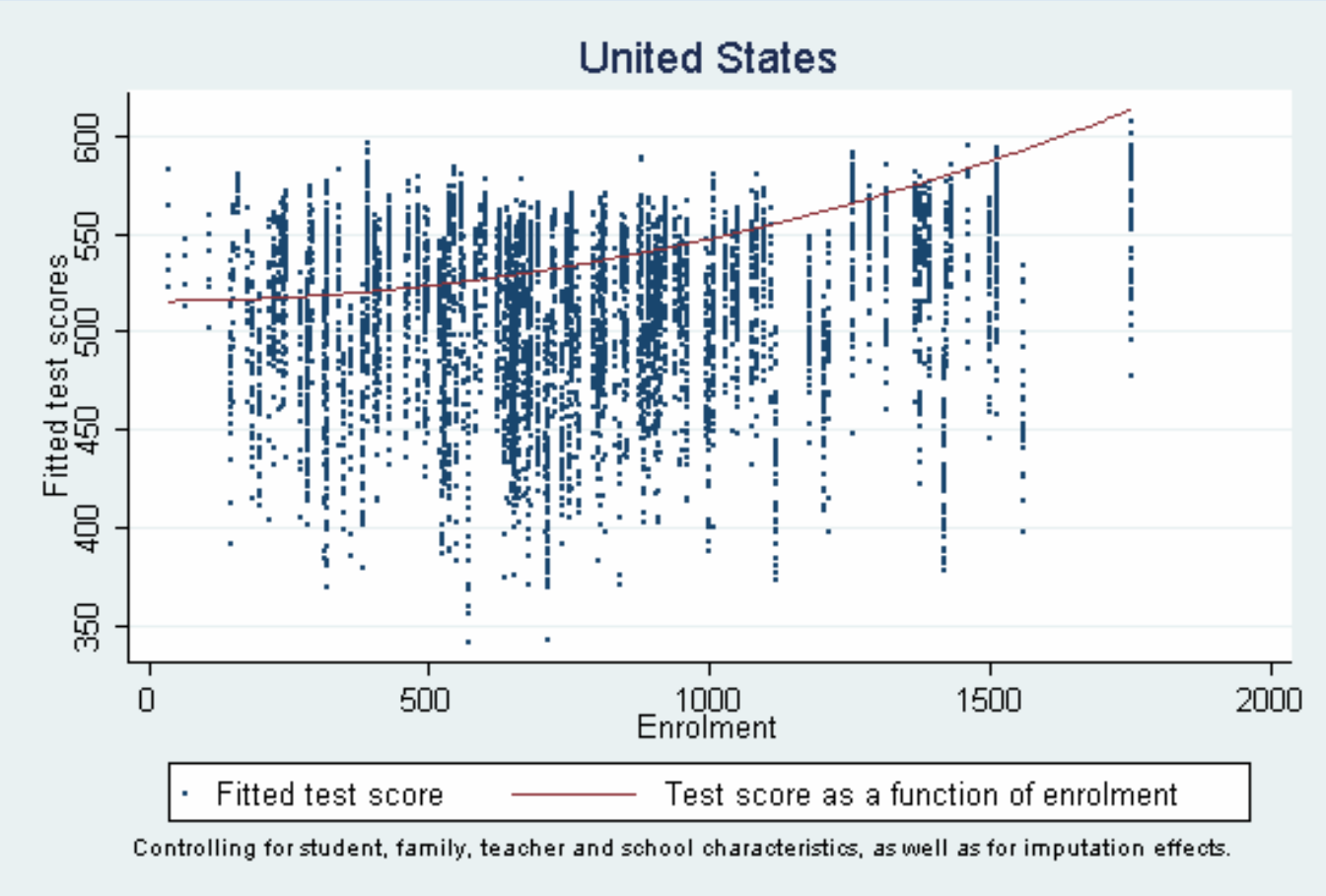
Belgium – positive linear relationship



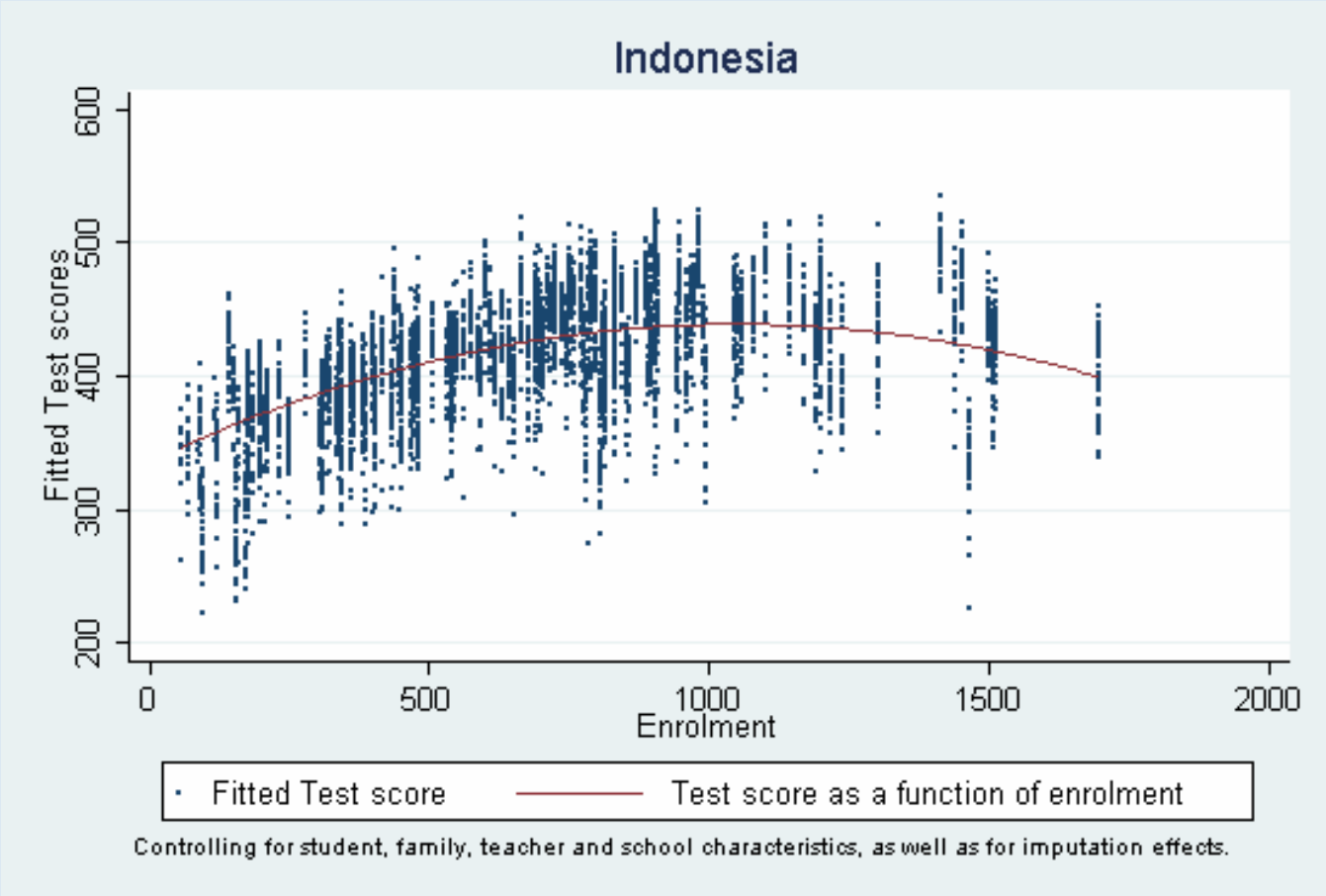
Ghana – linear positive (or decreasing returns)



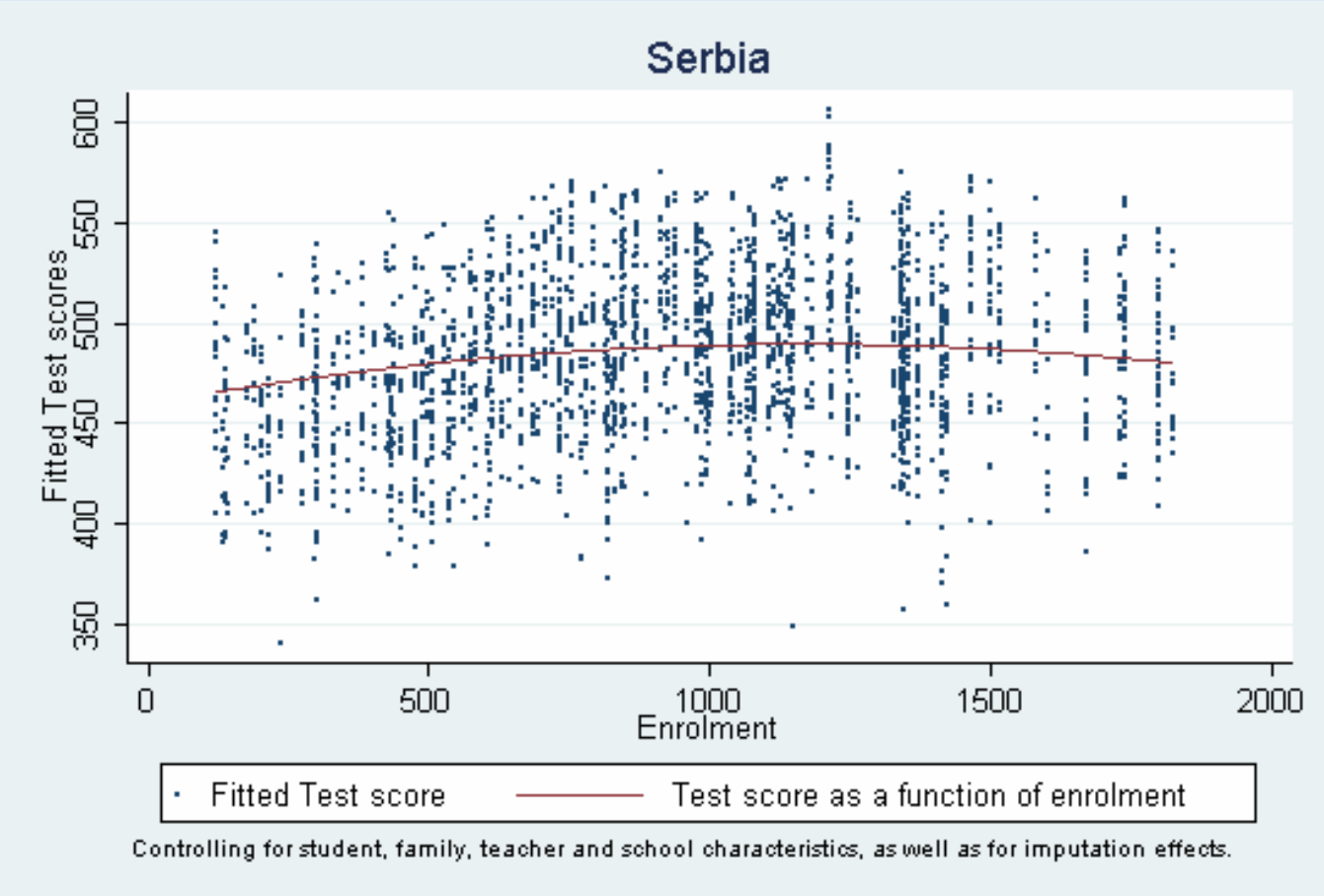
United States – positive quadratic relationship



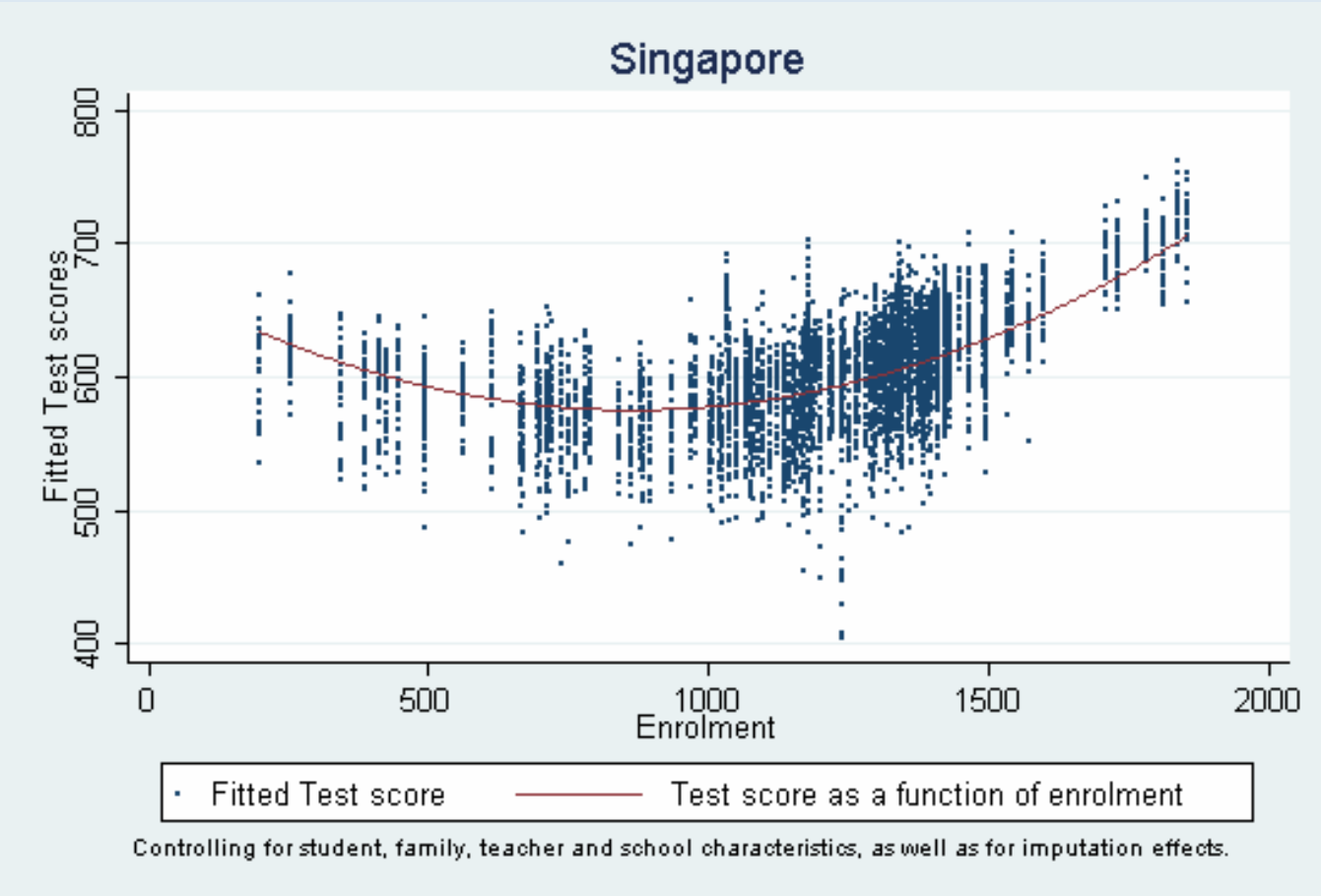
Indonesia – inversely u-shaped



Serbia – inversely u-shaped



Singapore – u-shaped



Conclusion

- Where an relationship between school size and student performance is found
  - It is mostly very weak
  - „bigger is better“
- Inversely u-shaped relationship:
  - Indonesia
- U-shaped relationship:
  - Singapore

Does the relationship differ between groups?

- Important aspect of equality of educational opportunity
- Along 2 dimensions:
  - Socio-cultural ➔ language of test spoken at home
  - Socio-economic ➔ parents' education
- Subpopulations:

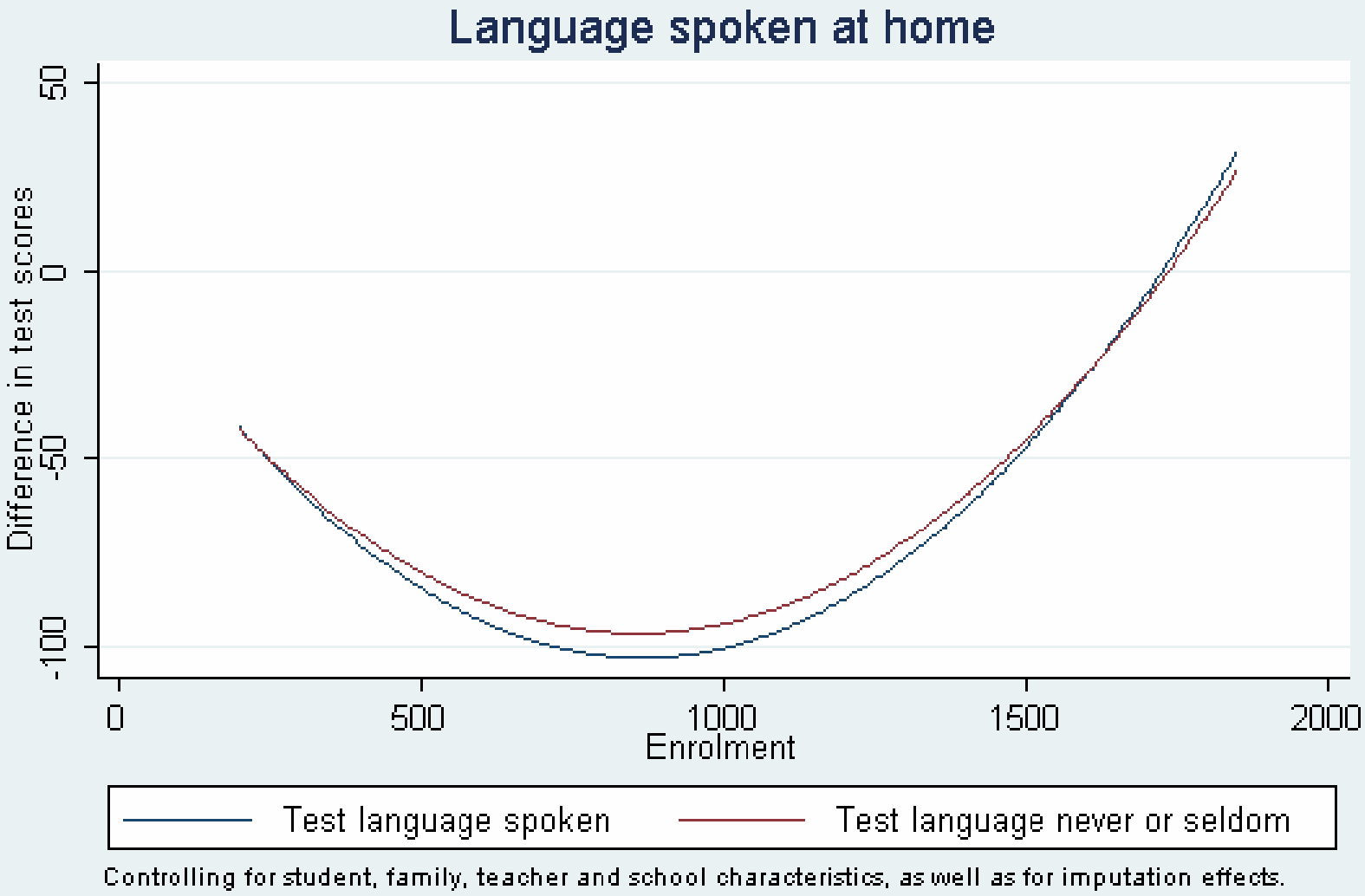
  Language:
    - Dummy, language of test never or sometimes spoken at home

  Parents' Education:
    - Dummy, education of parents below or equal to lower secondary

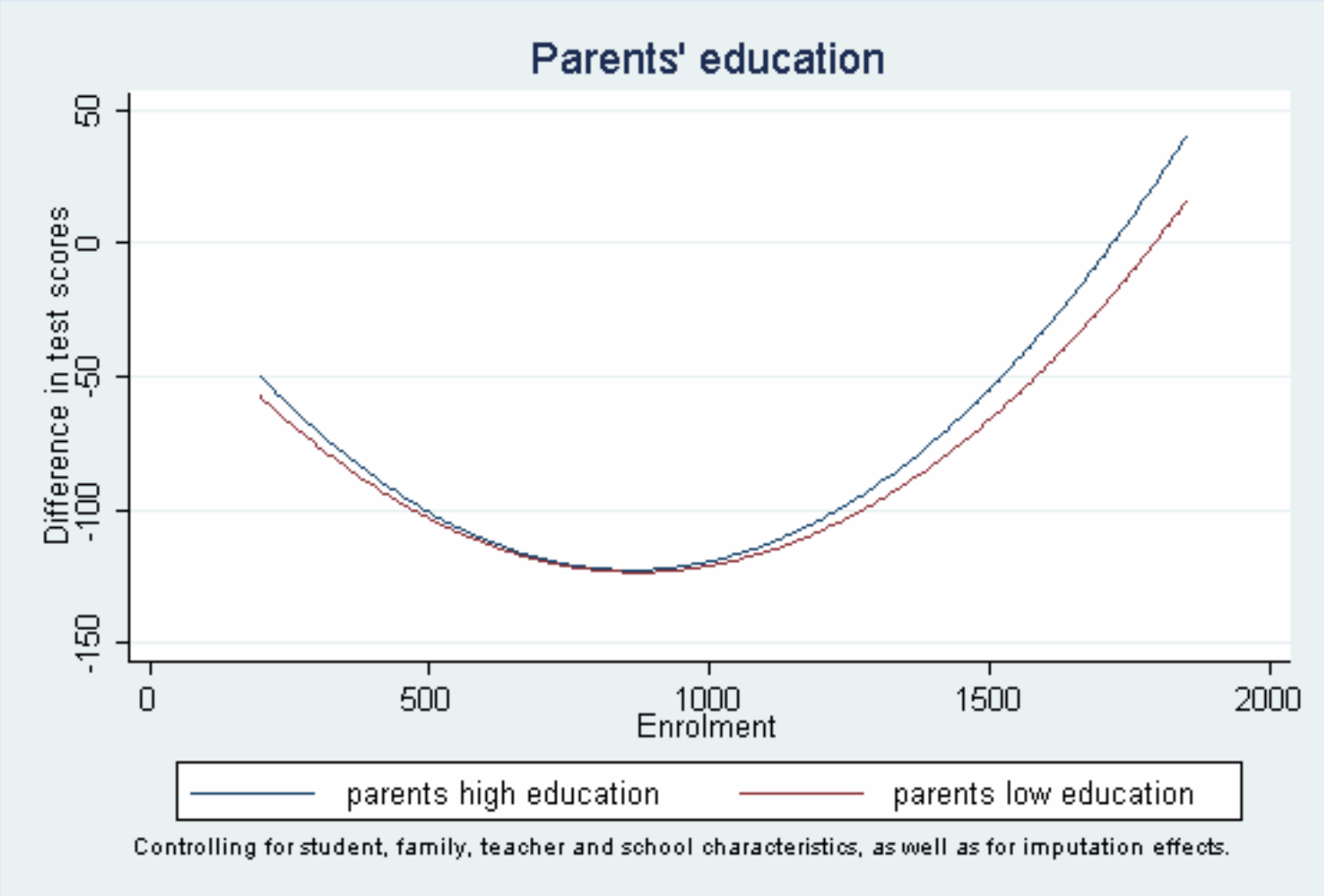
Results

- Quadratic relationship for subpopulations only significant in Singapore
  - No difference between groups

Singapore


Language spoken at home
Difference in test scores
50
0
-50
-100
0
500
1000
1500
2000
Enrolment
Test language spoken
Test language never or seldom
Controlling for student, family, teacher and school characteristics, as well as for imputation effects.

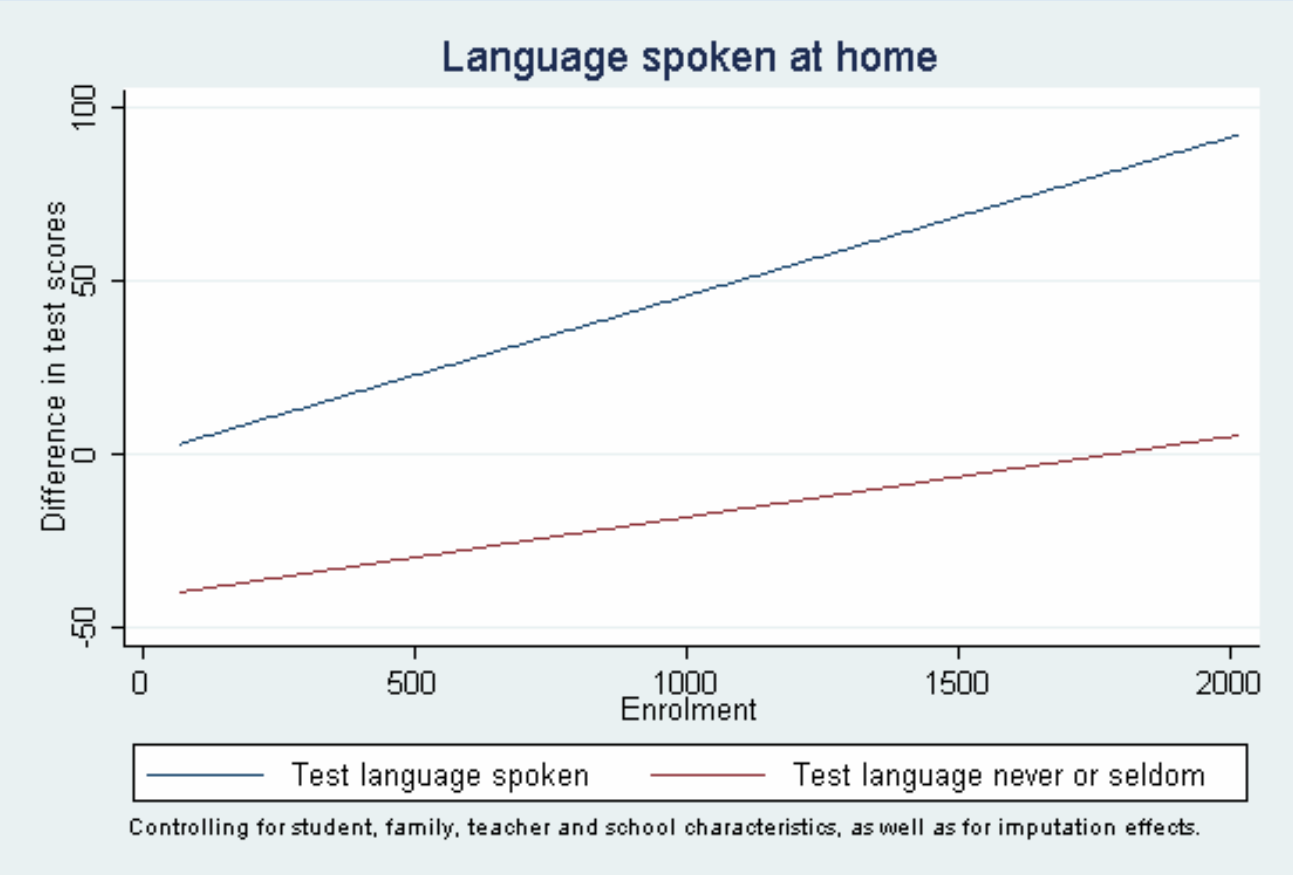
Singapore


Parents' education
Difference in test scores
50
0
-50
-100
-150
0
500
1000
1500
2000
Enrolment
parents high education
parents low education
Controlling for student, family, teacher and school characteristics, as well as for imputation effects.

Difference along socio-cultural dimension (language)

- No relationship in most countries
- Where a linear relationship could be significantly estimated:
- Relationship is positive for both subpopulations
- But the difference in the slopes is not significant
  - Belgium, Chile, Ghana, Hong Kong
- Exception: South Africa
  - Significant difference
  - Children from adv. backgrounds in South Africa profit more from increased size
  - Gap increases

South Africa

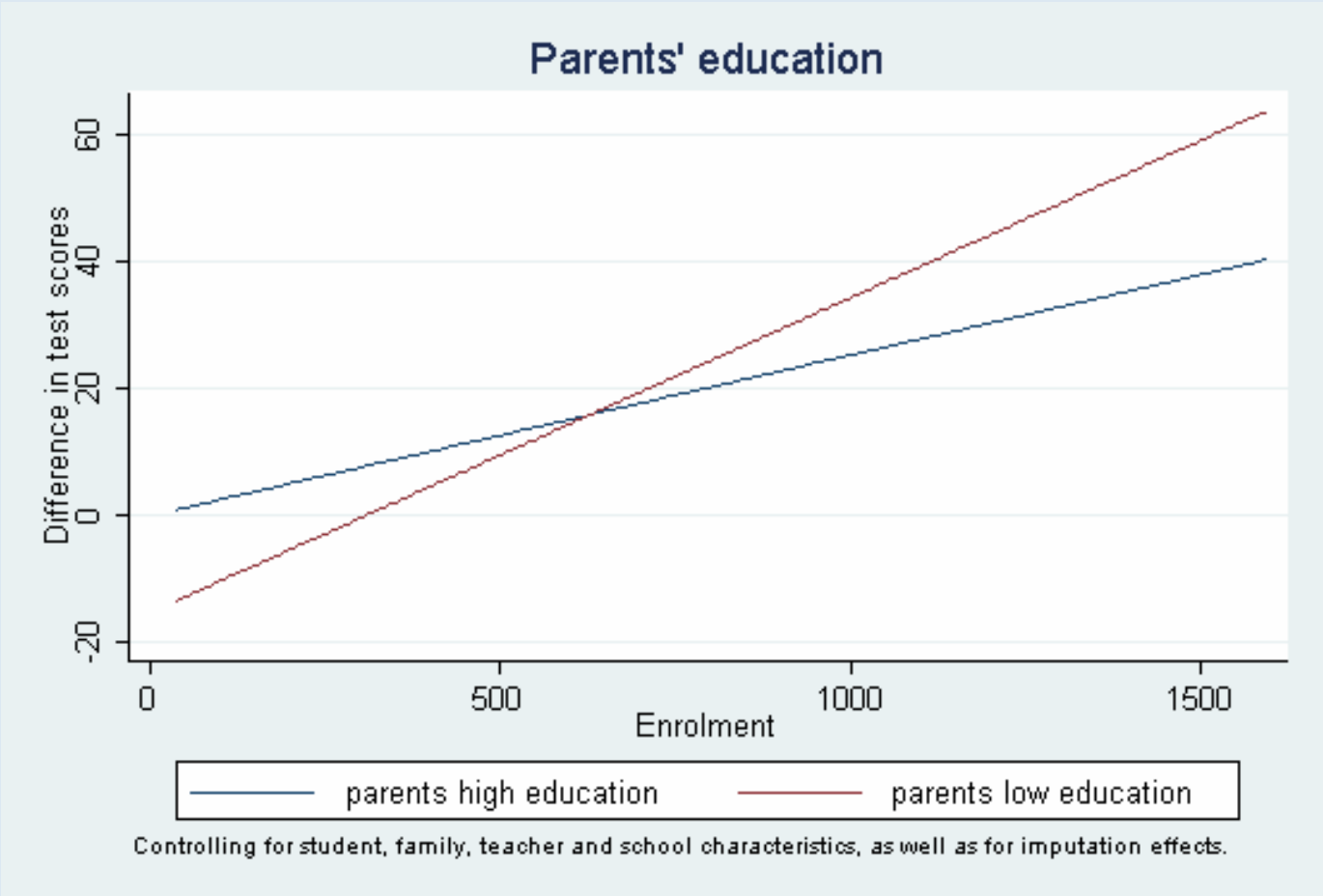


Difference along socio-economic dimension (education)

- Where a linear relationship could be significantly estimated
- Relationship is positive for both subpopulations
- The difference in the slopes is mostly not significant
  - Chile, Ghana, South Africa

- Exception: Belgium, Hong Kong
  - significant difference
  - children from disadv. backgrounds profit more from larger schools
  - Gap becomes smaller

Belgium


Parents' education
Difference in test scores
-20
0
20
40
60
0
500
1000
1500
Enrolment
parents high education
parents low education
Controlling for student, family, teacher and school characteristics, as well as for imputation effects.

Conclusion

- Internationally,
- Very little significant evidence on relationship between school size and student performance
- Where evidence exists it is mostly “bigger is better”
- Exceptions: Indonesia, Singapore

- Very little significant evidence on differences between groups of student
- Exceptions: South Africa (gap widens), Belgium, Hong Kong
- Slopes are not contraire to each other

Thank you for you attention

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Student Achievement in TIMSS 2003