

# K-12 Education

## Economics of Public and Social Issues

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## Plan for today

- ▶ K-12 Education Review
- ▶ Education Production Function

## K-12 Education

## K-12 Education: Background

- ▶ U.S. spends nearly \$1 trillion per year on K-12 education
  - ▶ Decentralized system with substantial variation across schools
    - ▶ Private schools and growing presence of charter schools

## K-12 Education: Overview

- ▶ Main question: how can we maximize the effectiveness of this system to produce the best outcomes for students?
  - ▶ Traditional approach to study this question: qualitative work in schools
  - ▶ More recent approach: analyzing big data to evaluate impacts

Reference 1: Chetty, Friedman, Hilger, Saez, Schanzenbach, Yagan. "How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project STAR" QJE 2011.

Reference 2: Reardon, Kalogrides, Fahle, Shores. "The Geography of Racial/Ethnic Test Score Gaps." Stanford CEPA Working Paper 2016

Reference 3: Fredriksson, Ockert, Oosterbeek. "Long-Term Effects of Class Size." QJE 2012

Reference 4: Chetty, Friedman, Rockoff. "Measuring the Impacts of Teachers I and II" AER 2014

## Using Test Score Data to Study K-12 Education

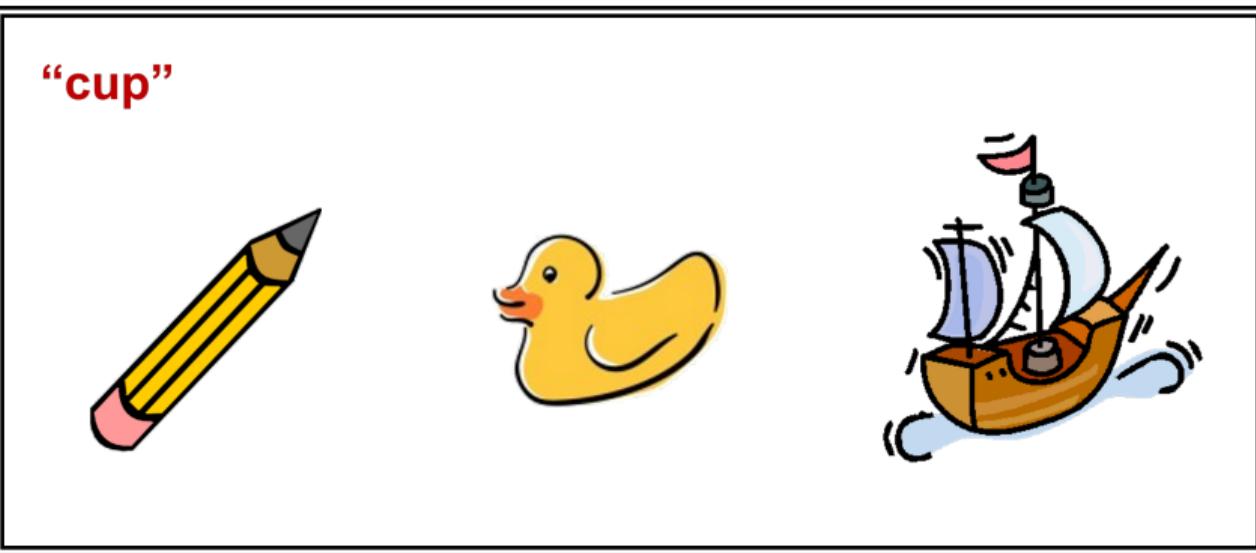
- ▶ Primary source of big data on education: standardized test scores obtained from school districts
  - ▶ Quantitative outcome recorded in existing administrative databases for virtually all students
  - ▶ Observed much more quickly than long-term outcomes like college attendance and earnings

## Using Test Score Data to Evaluate Primary Education

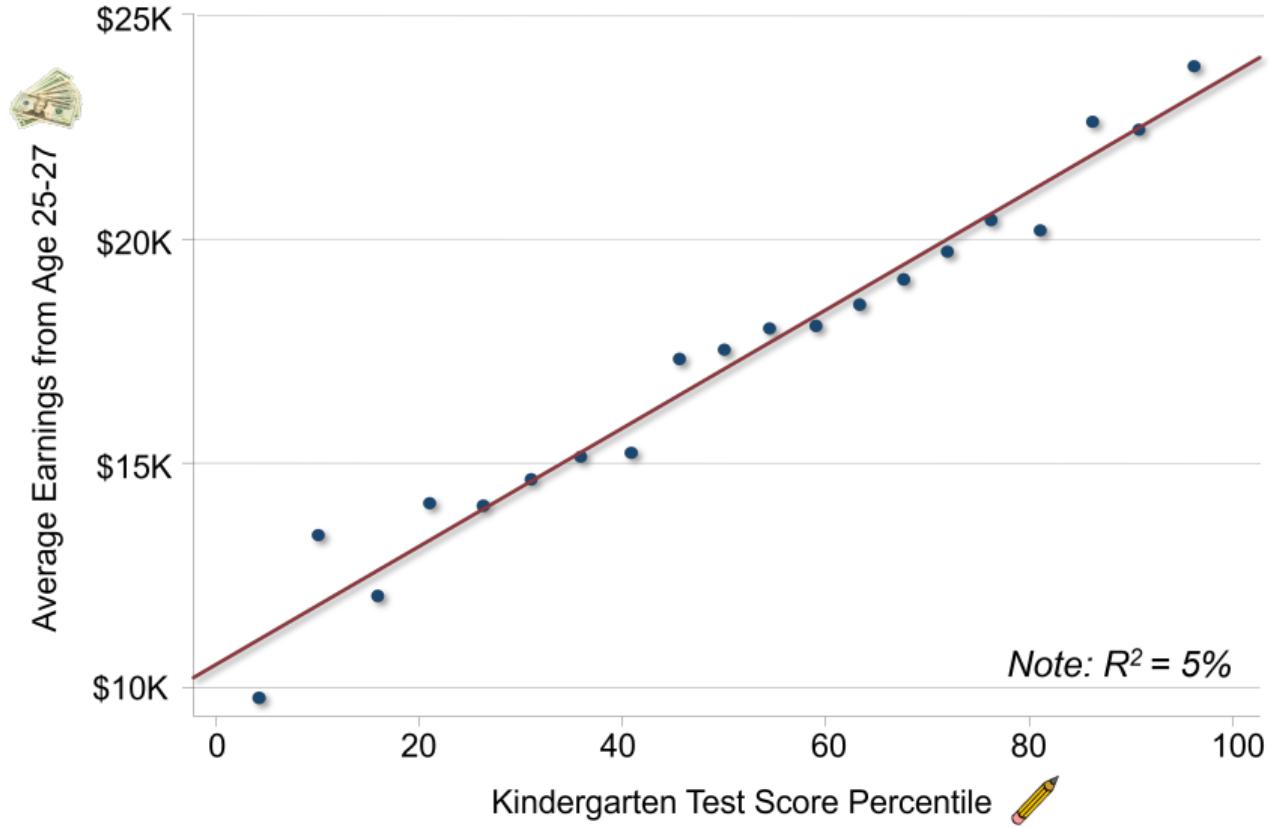
- ▶ Common concern: are test scores a good measure of learning?
  - ▶ Do improvements in test scores reflect better test-taking ability or acquisition of skills that have value later in life?
- ▶ Chetty et al. (2011) examine this issue using data on 12,000 children who were in Kindergarten in Tennessee in 1985
  - ▶ Link school district and test score data to tax records
  - ▶ Ask whether KG test score performance predicts later outcomes

# A Kindergarten Test

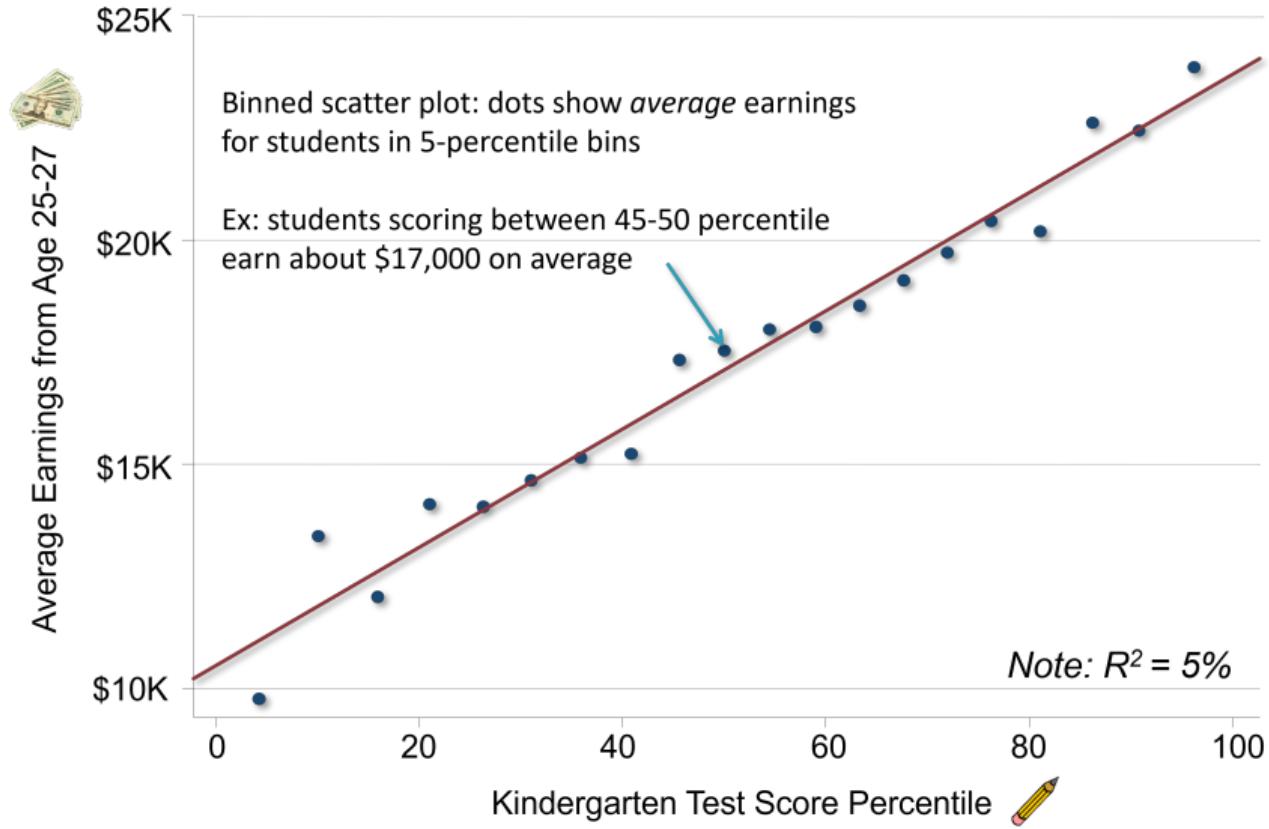
- ▶ I'll say a word to you. Listen for the ending sound.
- ▶ You circle the picture that starts with the same sound



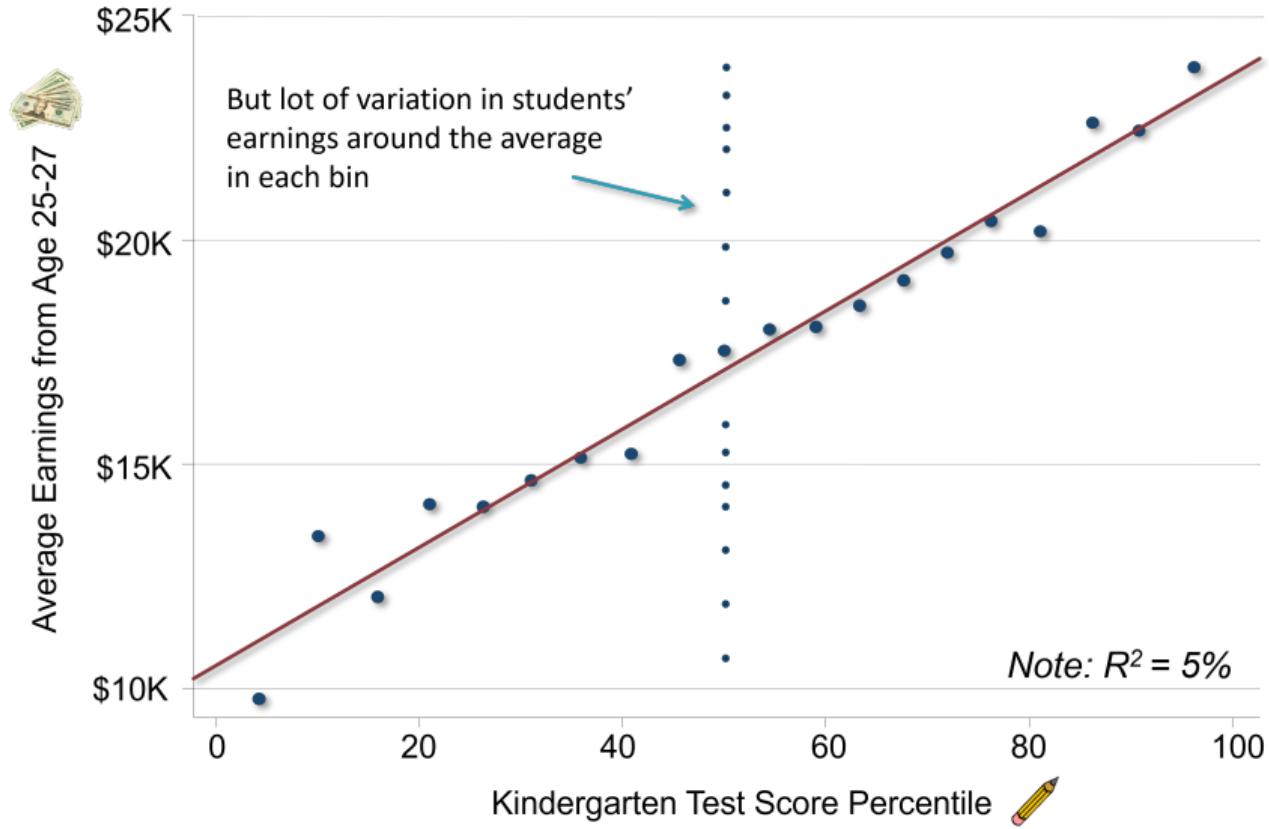
# Earnings vs. Kindergarten Test Score



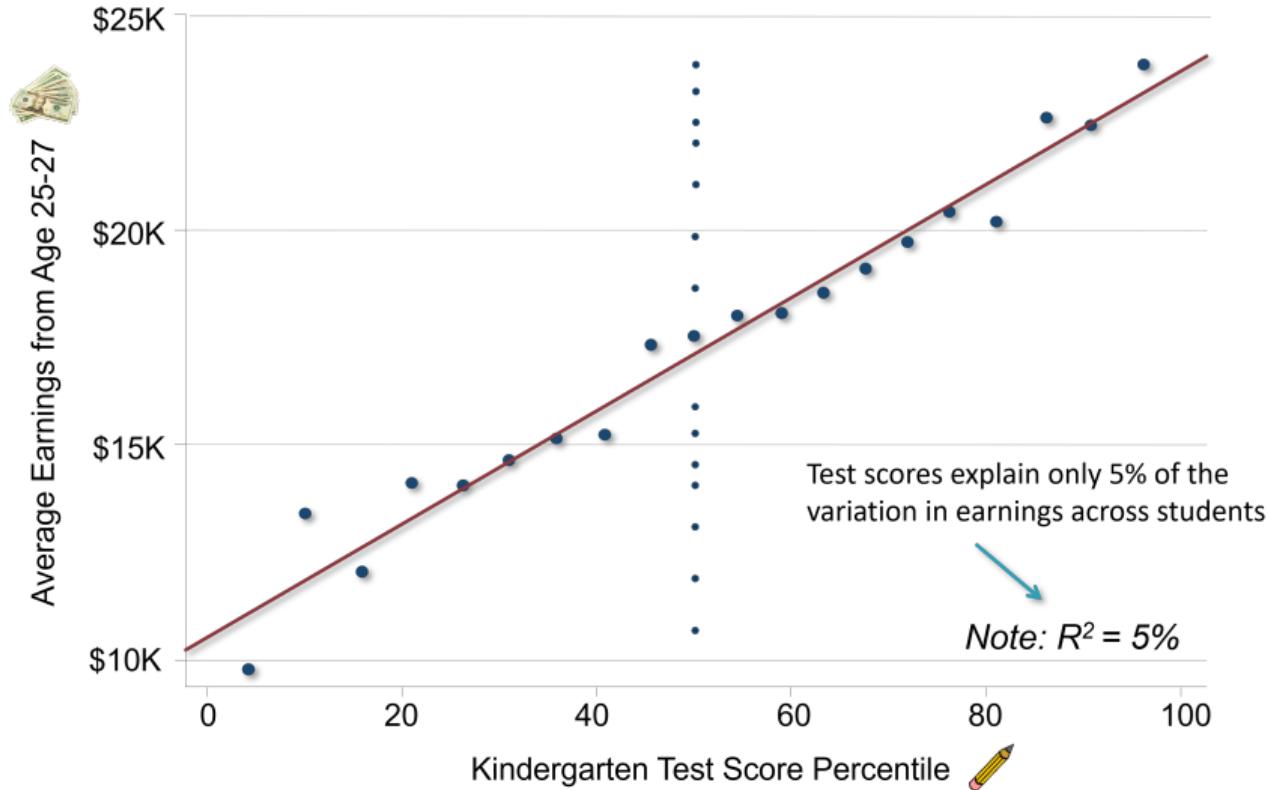
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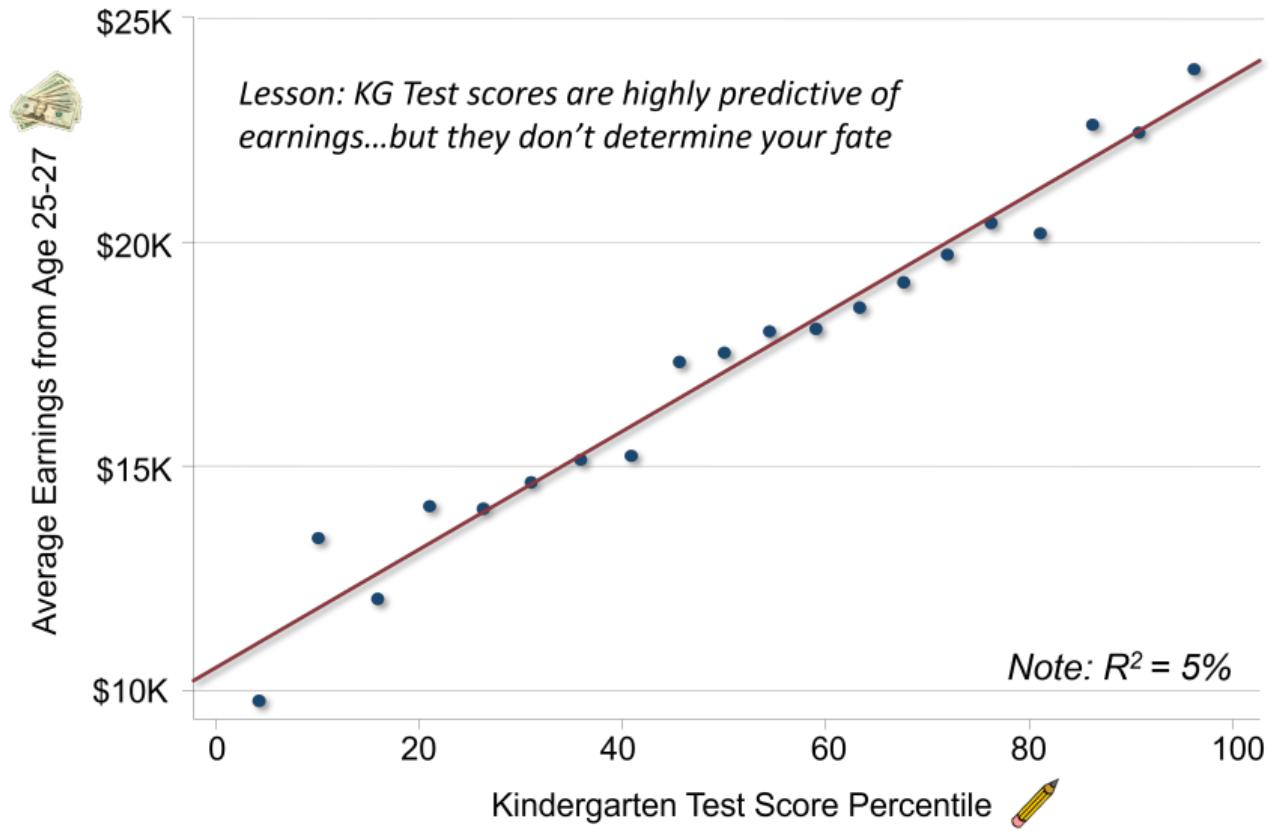
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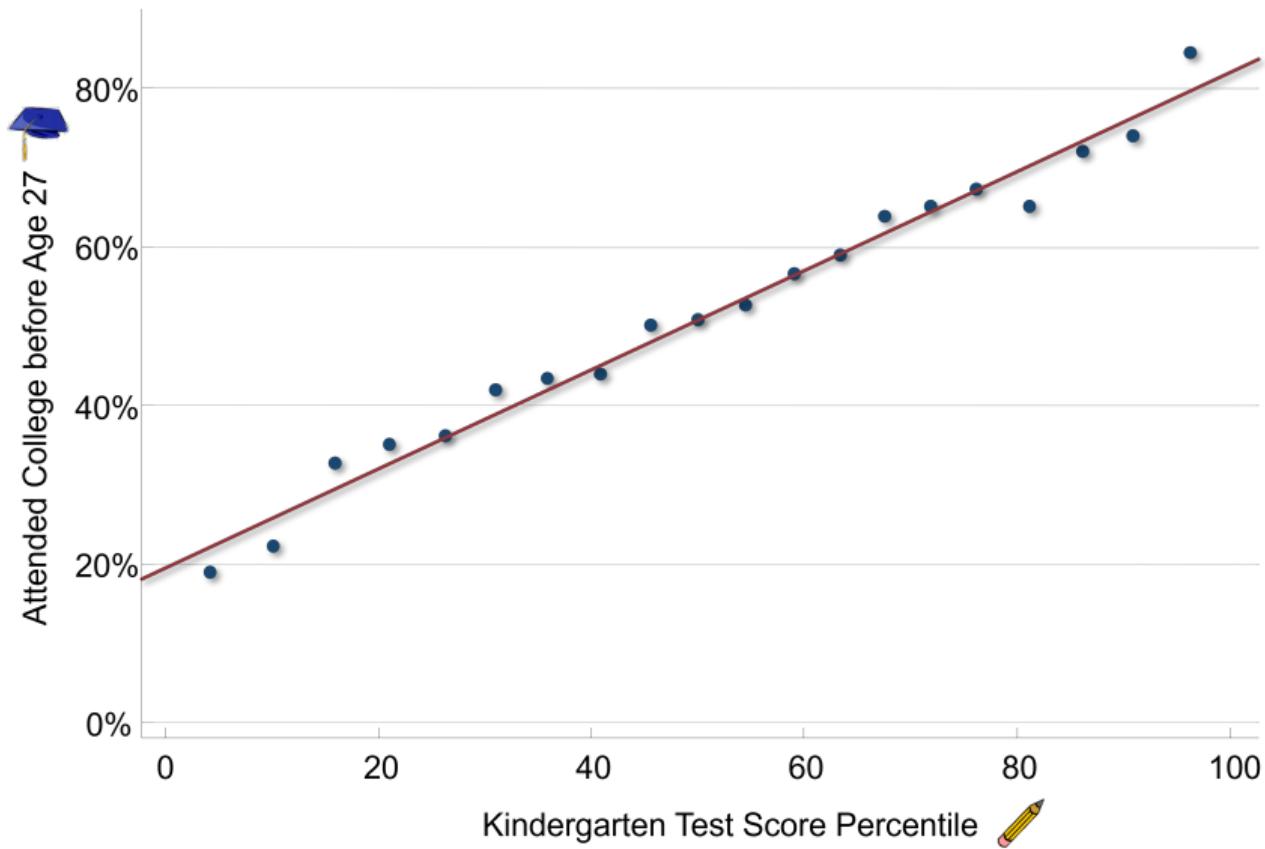
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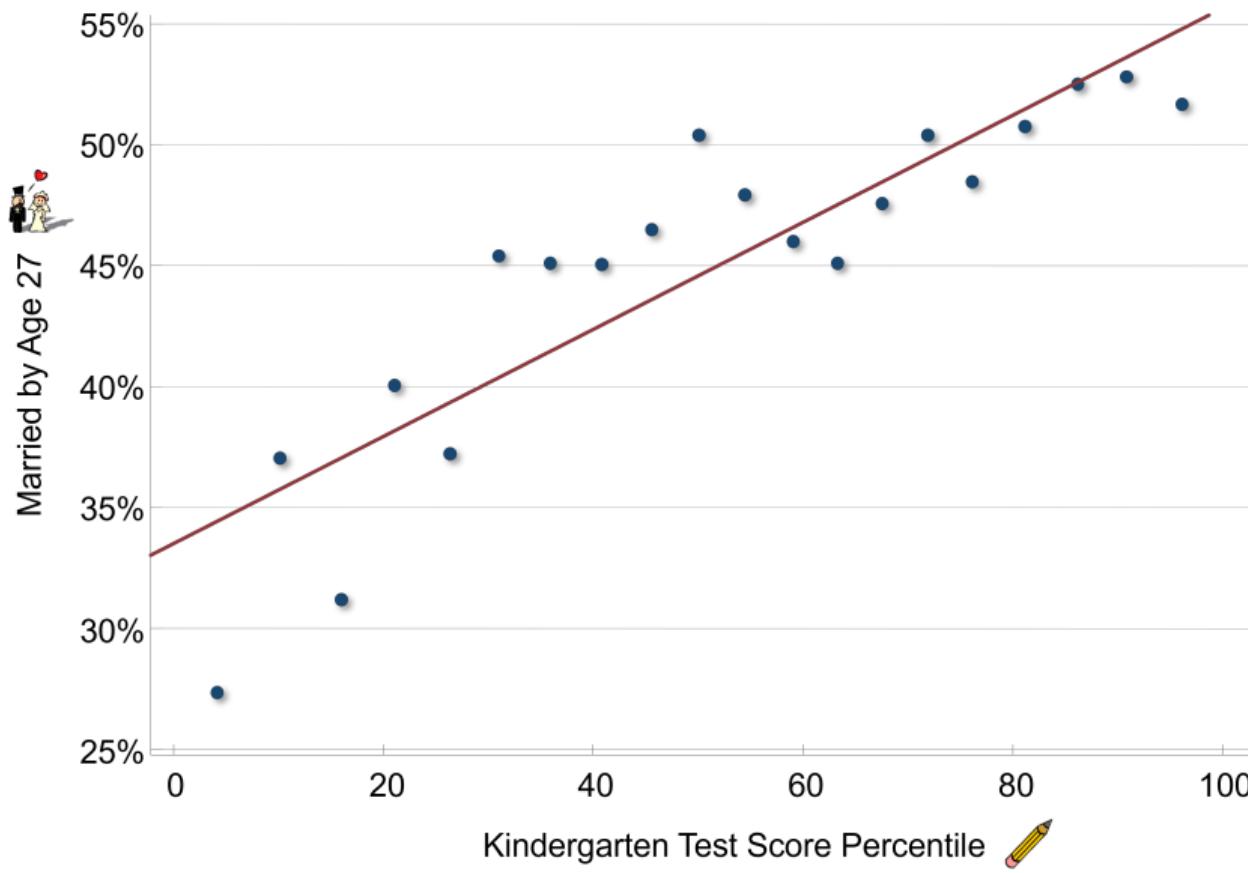
# Earnings vs. Kindergarten Test Score



# College Attendance Rates vs. KG Test Score



# Marriage by Age 27 vs. KG Test Score



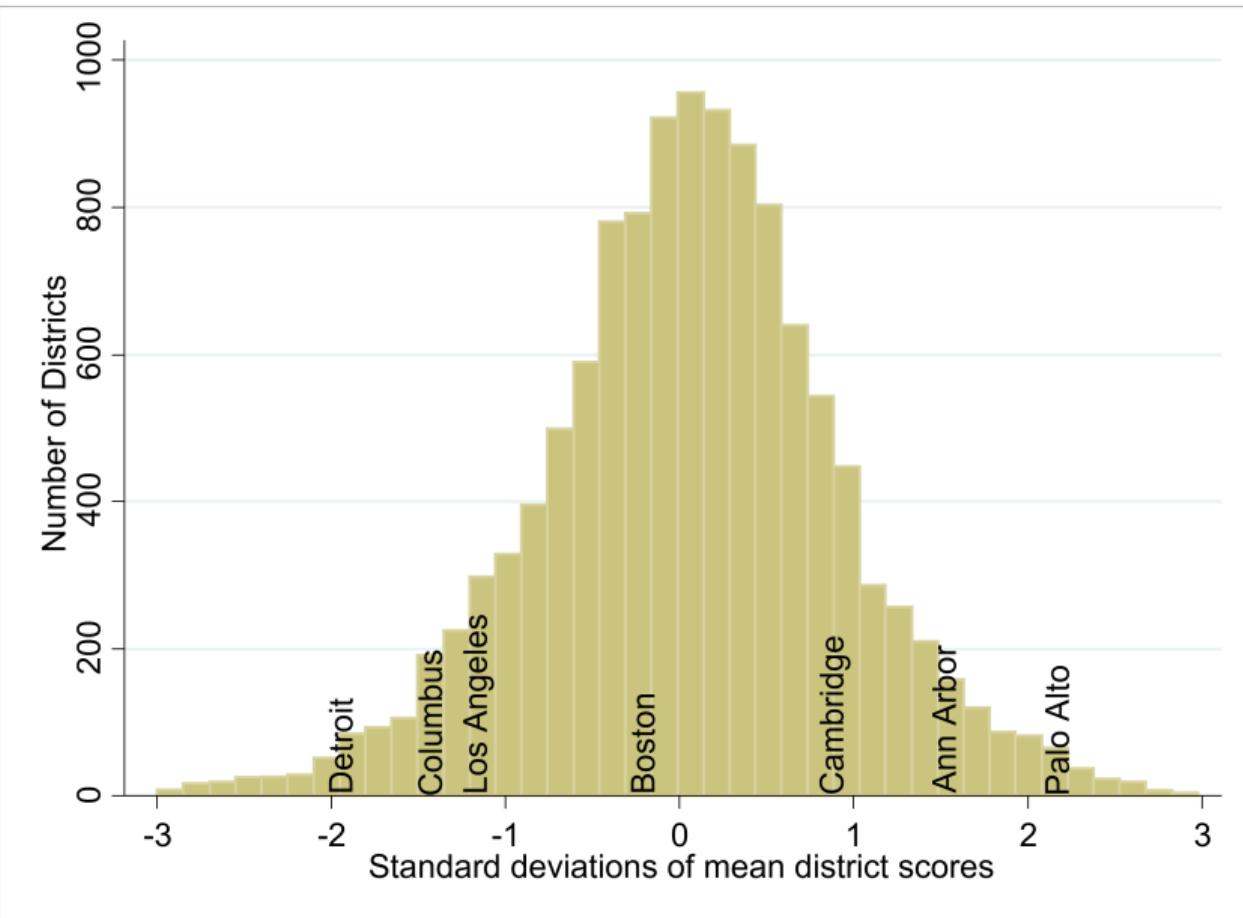
## Studying Differences in Test Score Outcomes

- ▶ Test scores can provide a powerful data source to compare performance across schools and subgroups (e.g., poor vs. rich)
- ▶ Problem: tests are not the same across school districts and grades
  - ▶ → makes comparisons very difficult
- ▶ Reardon et al. (2016) solve this problem and create a standardized measure of test score performance for all schools in America
  - ▶ Use 215 million test scores for students from 11,000 school districts across the U.S. from 2009-13 in grades 3-8

# Making Test Score Scales Comparable Across the U.S.

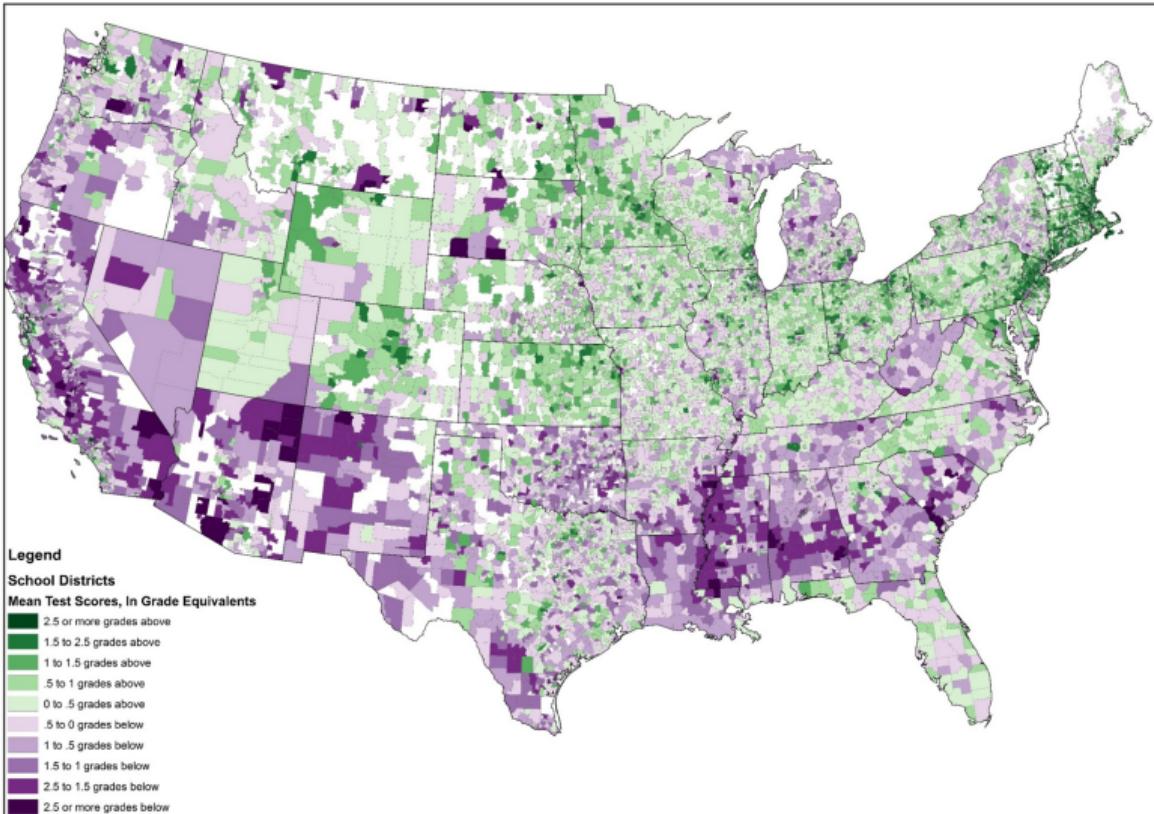
- ▶ Convert test scores to a single national scale in three steps:
  1. Rank each school district's average scores in the statewide distribution (for a given grade-year-subject)
  2. Use data from a national test administered to a sample of students by Dept. of Education to convert state-specific rankings to national scale
    - ▶ Ex: suppose CA students score 5 percentiles below national average
    - ▶ Then a CA school whose mean score is 10 percentiles below CA mean is 15 percentiles below national mean
  3. Convert mean test scores to “grade level” equivalents

# Nationwide District Achievement Variation, 2009-2013

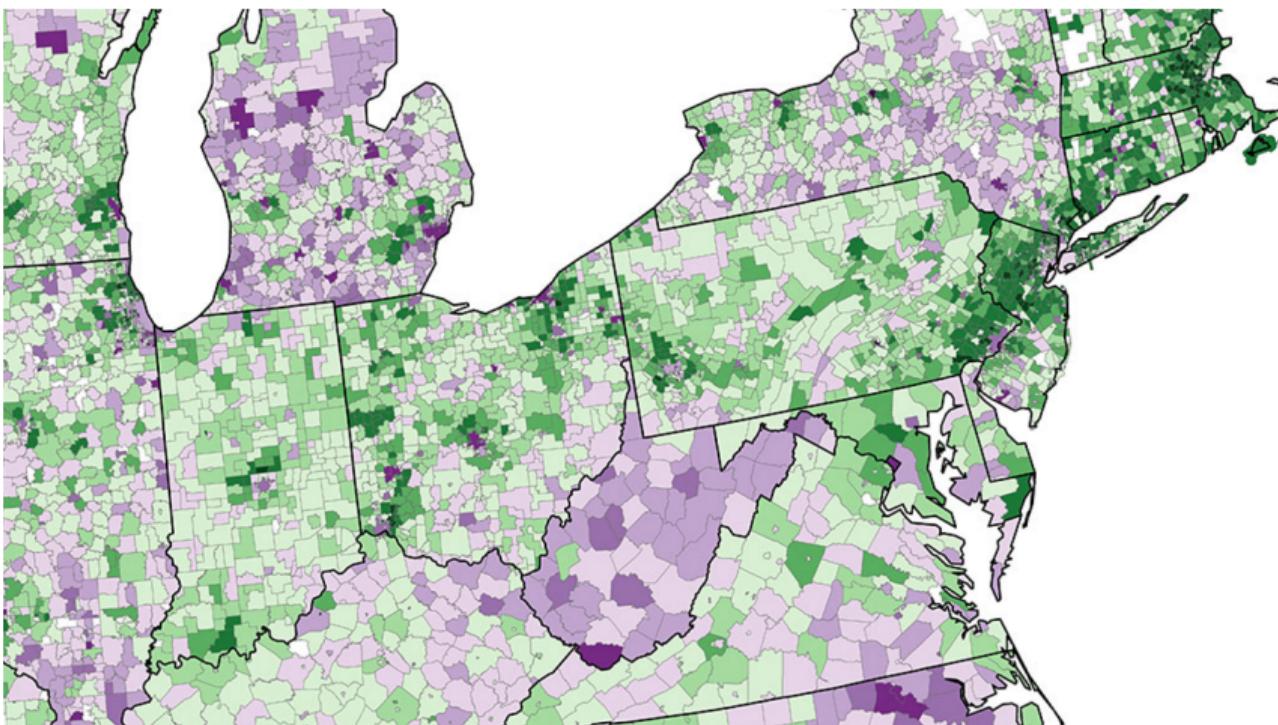


# Geography of District Achievement Variation, 2009-2013

Average Test Scores, by School District, Grades 3-8, 2009-2013



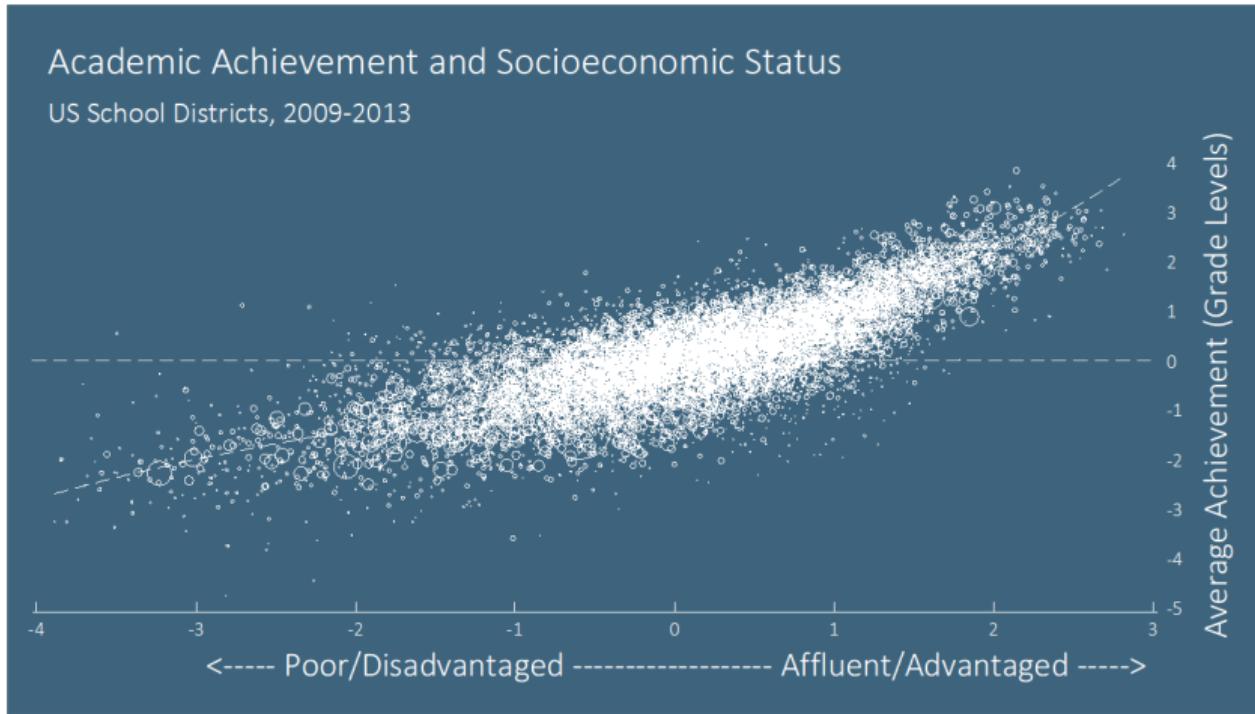
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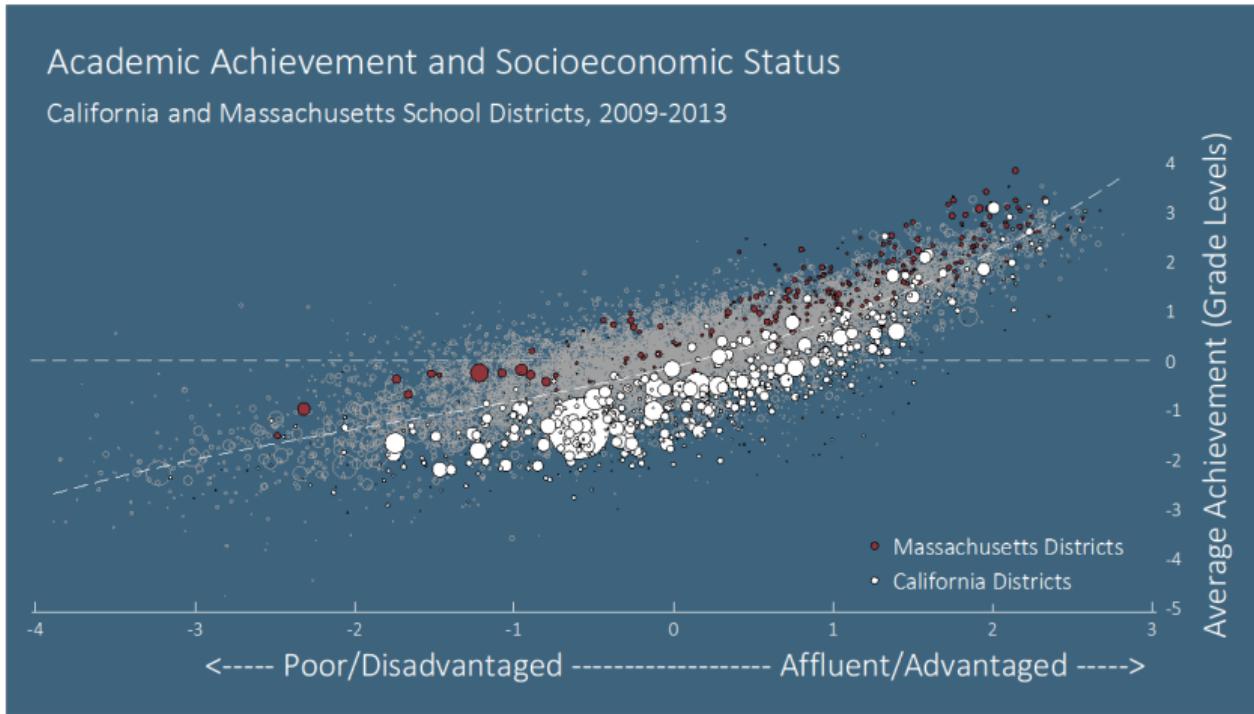
## Achievement Gaps in Test Scores by Socioeconomic Status

- ▶ Next, use these data to examine how test scores vary across socioeconomic groups
  - ▶ Define an index of socioeconomic status (SES) using Census data on income, fraction of college graduates, single parent rates, etc.

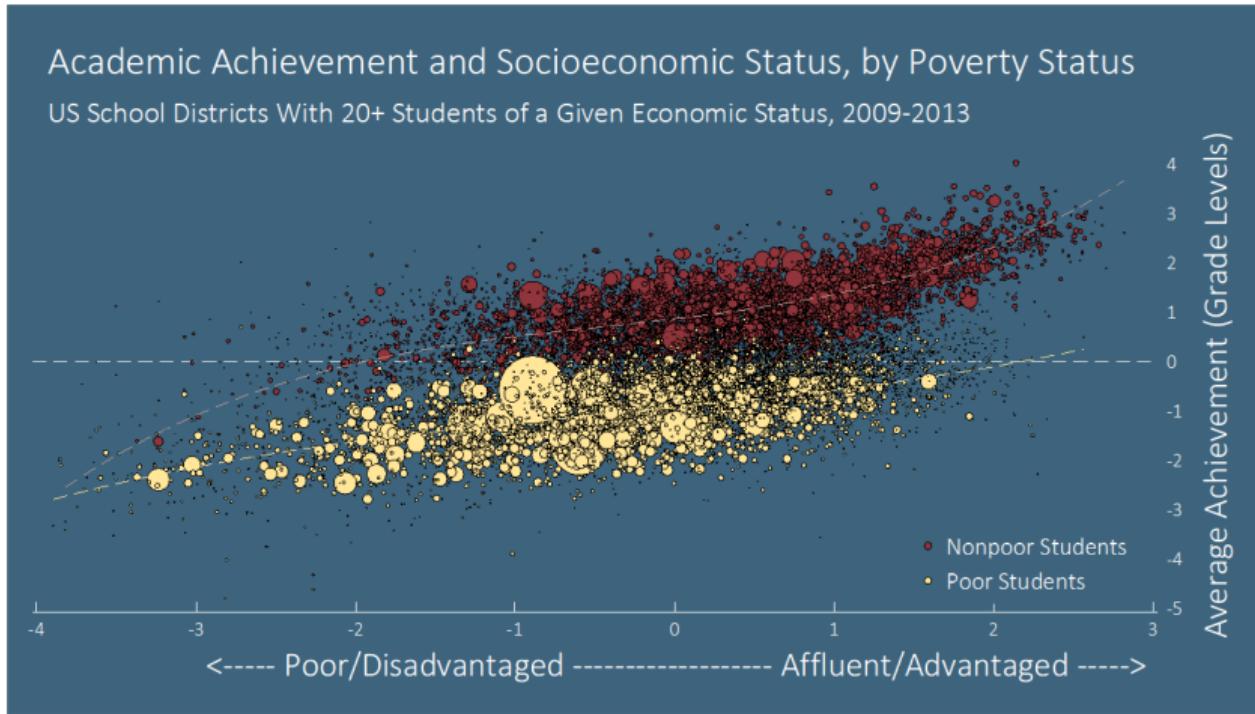
# Academic Achievement and SES



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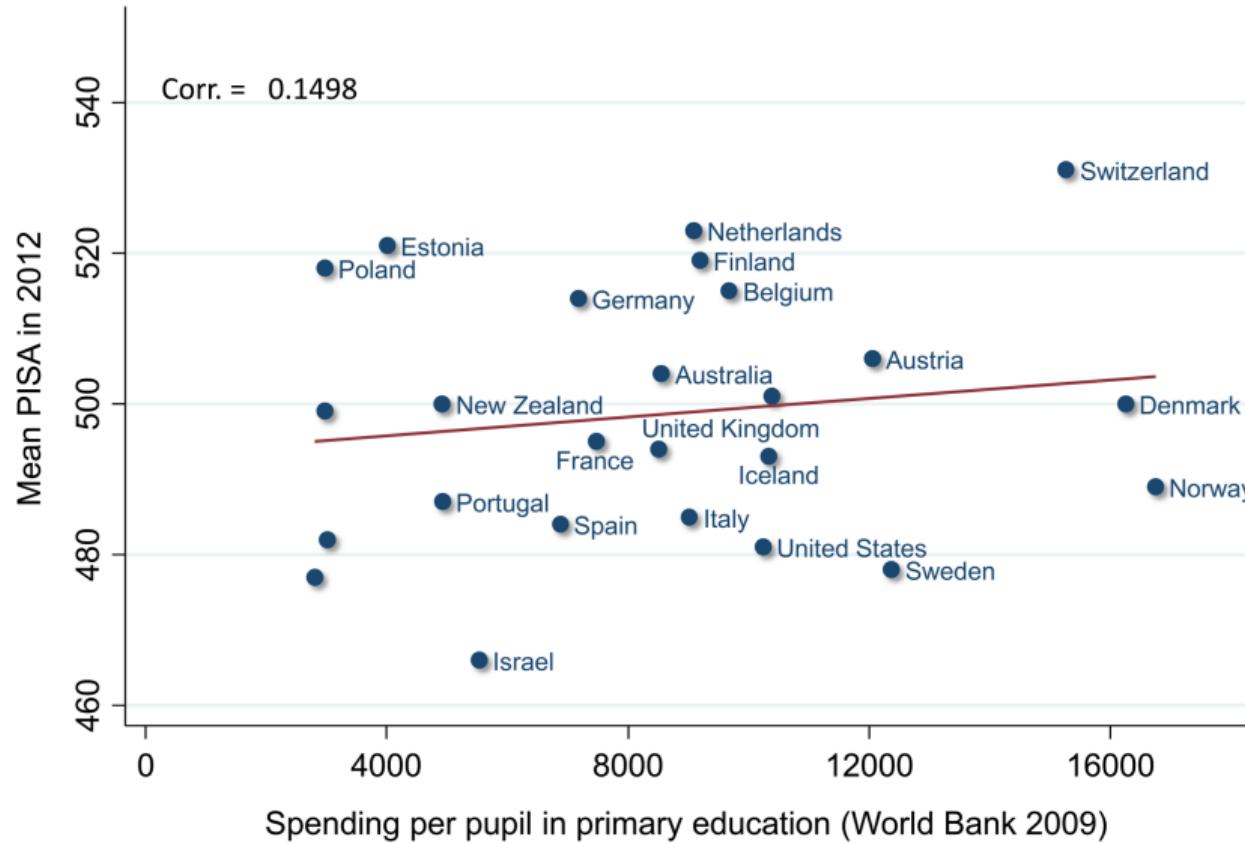
# Academic Achievement and SES



## How Can We Improve Poorly Performing Schools?

- ▶ There are many school districts in America where students are two grade levels behind national average, controlling for SES
- ▶ How can we improve performance in these schools?
  - ▶ Simply spending more money on schools is not necessarily the solution...

# Test Scores vs. Expenditures on Primary Education Across Countries



## Two Policy Paradigms to Improve Schools

- ▶ Two distinct policy paradigms to improve schools
  1. Government-based solutions: improve public schools by reducing class size, increasing teacher quality, etc.
  2. Market-based solutions: charter schools or vouchers for private schools
- ▶ Contentious policy debate between these two approaches
- ▶ We will consider each approach in turn

## Government-Based Solutions: Improving Schools

## Improving Schools: The Education Production Function

- ▶ Improving public schools requires understanding the education production function
- ▶ How should we change schools to produce better outcomes?
  - ▶ Better Teachers?
  - ▶ Smaller Classes?
  - ▶ Better Technology?

## Effects of Class Size: Tennessee STAR Experiment

- ▶ Student/Teacher Achievement Ratio (STAR) experiment
  - ▶ Conducted from 1985 to 1989 in Tennessee
  - ▶ About 12,000 children in grades K-3 at 79 schools
- ▶ Students and teachers randomized into classrooms within schools
  - ▶ Class size differs: small (~15 students) or large (~22 students)
  - ▶ Classes also differ in teachers and peers

## Effects of Class Size: Tennessee STAR Experiment

- ▶ Evaluate impacts of STAR experiment by comparing mean outcomes of students in small vs. large classes.
- ▶ Report impacts using regressions of outcomes on an indicator (0-1 variable) for being in a small class [Krueger 1999, Chetty et al. 2011]

## STAR Experiment: Impacts of Class Size

Dep Var: <b>Outcome</b>	Test Score	College Attendance	Earnings
	(1)	(2)	(3)
Small Class	4.81 (1.05)	2.02% (1.10%)	-\$4 (\$327)
Observations	9,939	10,992	10,992
Mean of Dep. Var.	48.67	26.4%	\$15,912

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*Estimated impact of being in a small KG class:  
4.81 percentile gain in end-of-KG test score*

## STAR Experiment: Impacts of Class Size

Dep Var:	Test Score	College Attendance	Earnings
	(1)	(2)	(3)
Small Class	4.81 (1.05)	2.02% (1.10%)	-\$4 (\$327)
Observations	<b>Standard Error</b>	9,939	10,992
Mean of Dep. Var.	48.67	26.4%	\$15,912

Standard  
Error

95% confidence interval = estimate +/- 1.96 times standard error  
→ 95% CI for test score impact = 2.71 to 6.91 percentiles

If we repeat experiment 100 times, 95 of the 100 estimates will lie between 2.71 and 6.91 percentiles

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<b>Mean Value of Outcome</b>			

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95% confidence interval: (-\$645, \$637)

→ Earnings impact could be as large as **\$637** (a 4% increase)

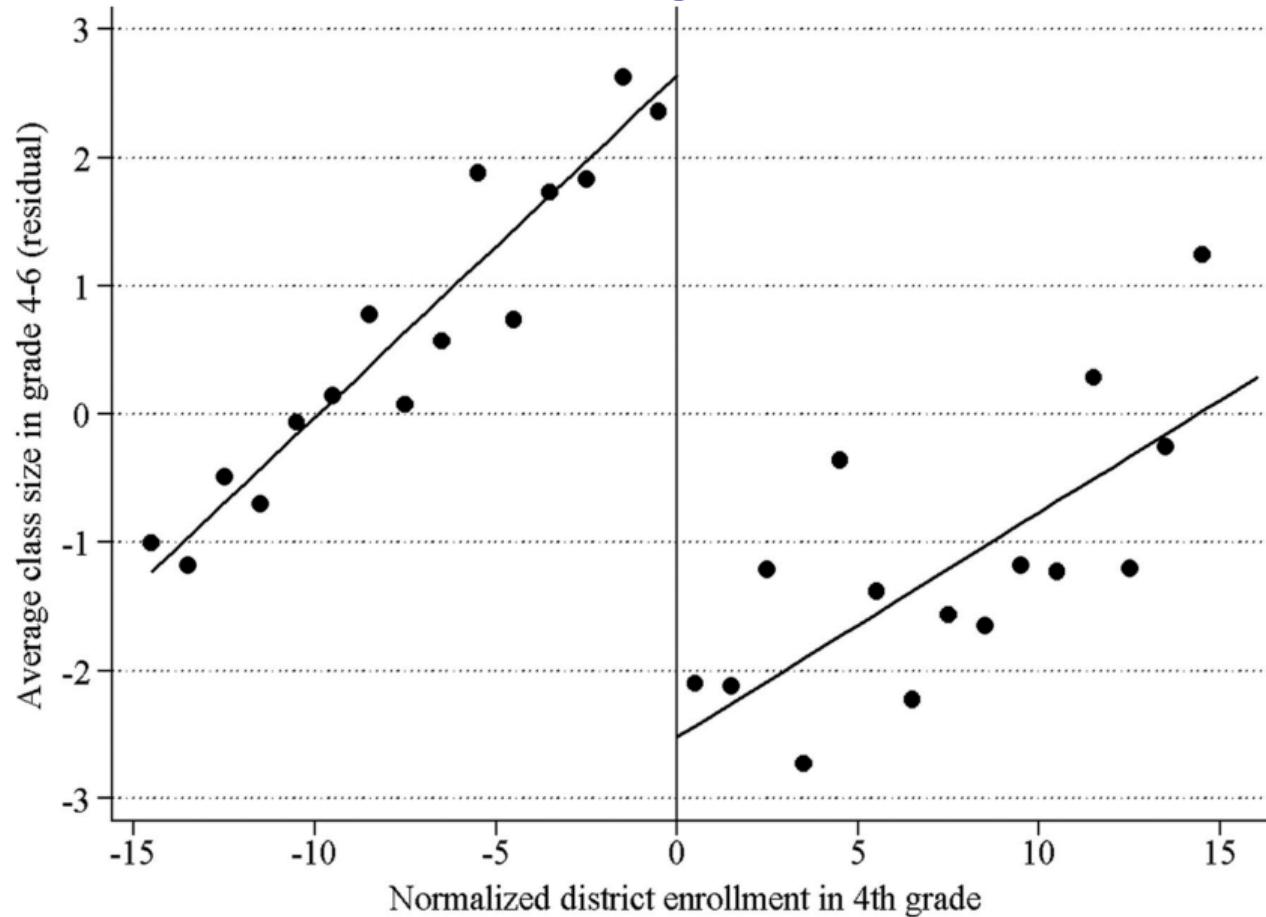
## Effects of Class Size: Quasi-Experimental Evidence

- ▶ Limitation of STAR experiment: sample is too small to estimate impacts of class size on earnings precisely
- ▶ Fredriksson et al. (2013) use administrative data from Sweden to obtain more precise estimates
  - ▶ No experiment here; instead use a quasi-experimental method: regression discontinuity.

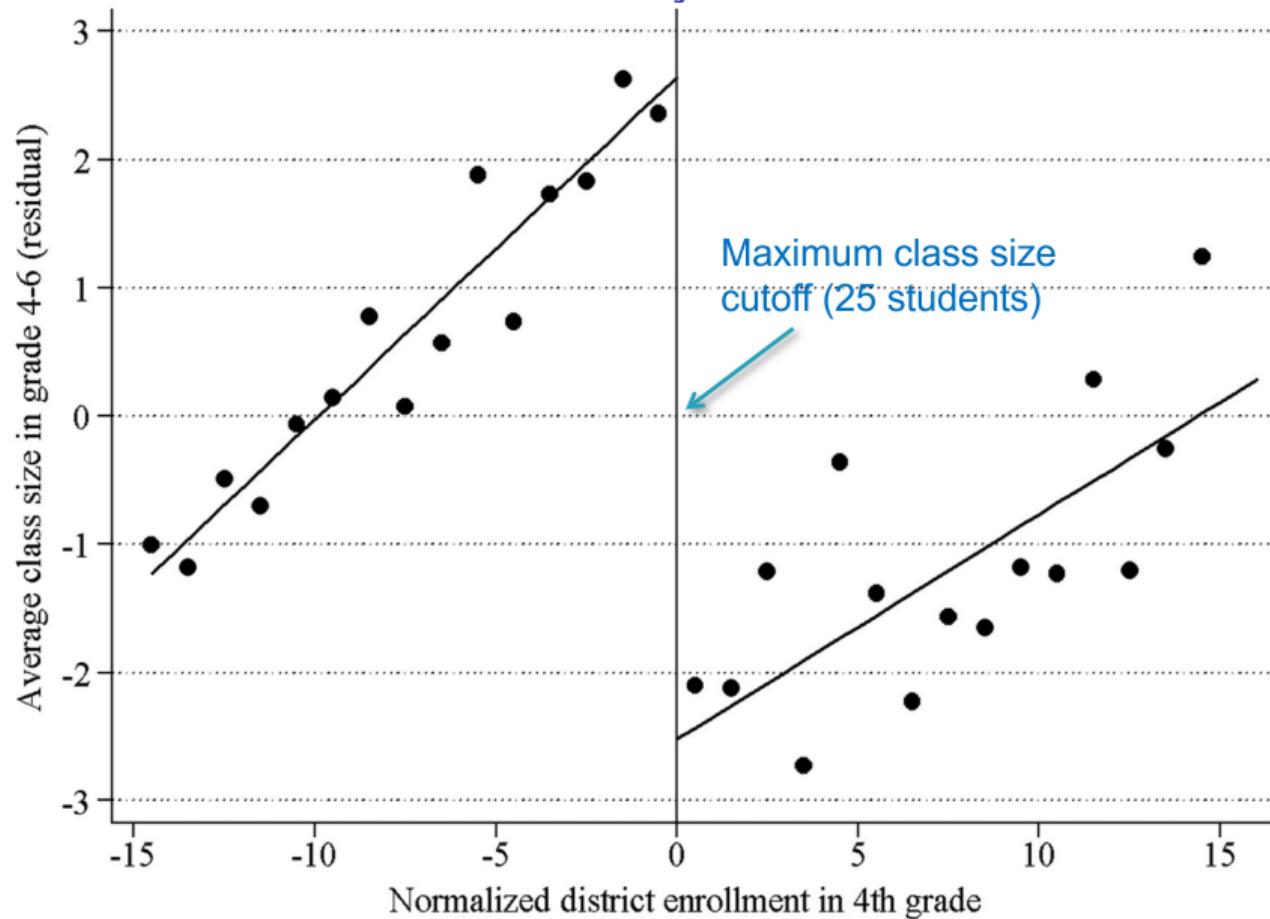
## Regression Discontinuity Using Class Size Cutoffs

- ▶ Sweden imposes a maximum class size of 25 students
  - ▶ School that has 26 students in a given grade will therefore have two classes of 13 students each
  - ▶ School that has 25 students may have one class of 25 students
- ▶ Schools that have 26 students in a grade are likely to be comparable to those that have 25 students
  - ▶ → Can identify causal effects of class size by comparing outcomes in schools with 26 vs. 25 students in a given grade

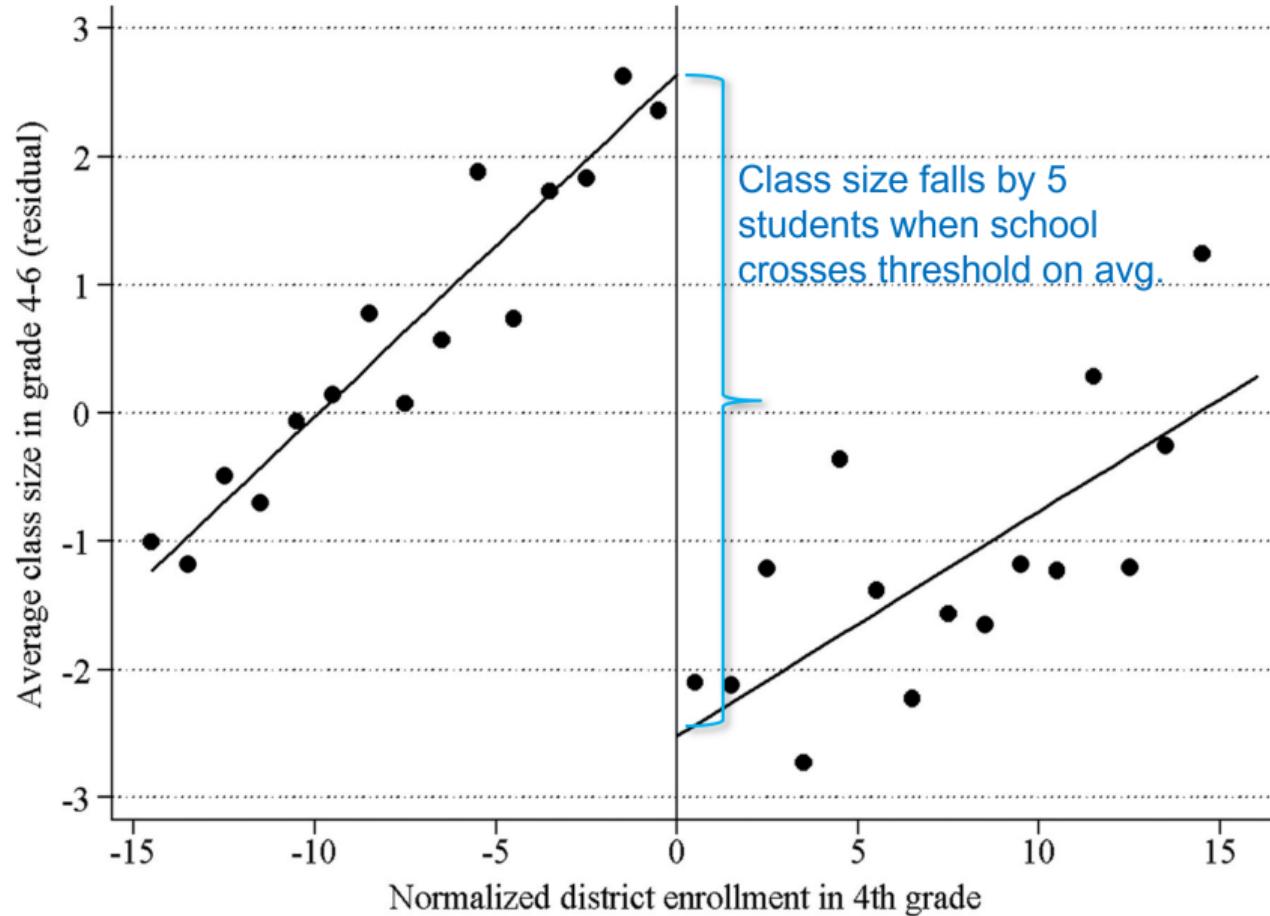
## Discontinuities in Class Size Created by Maximum Class Size Rule



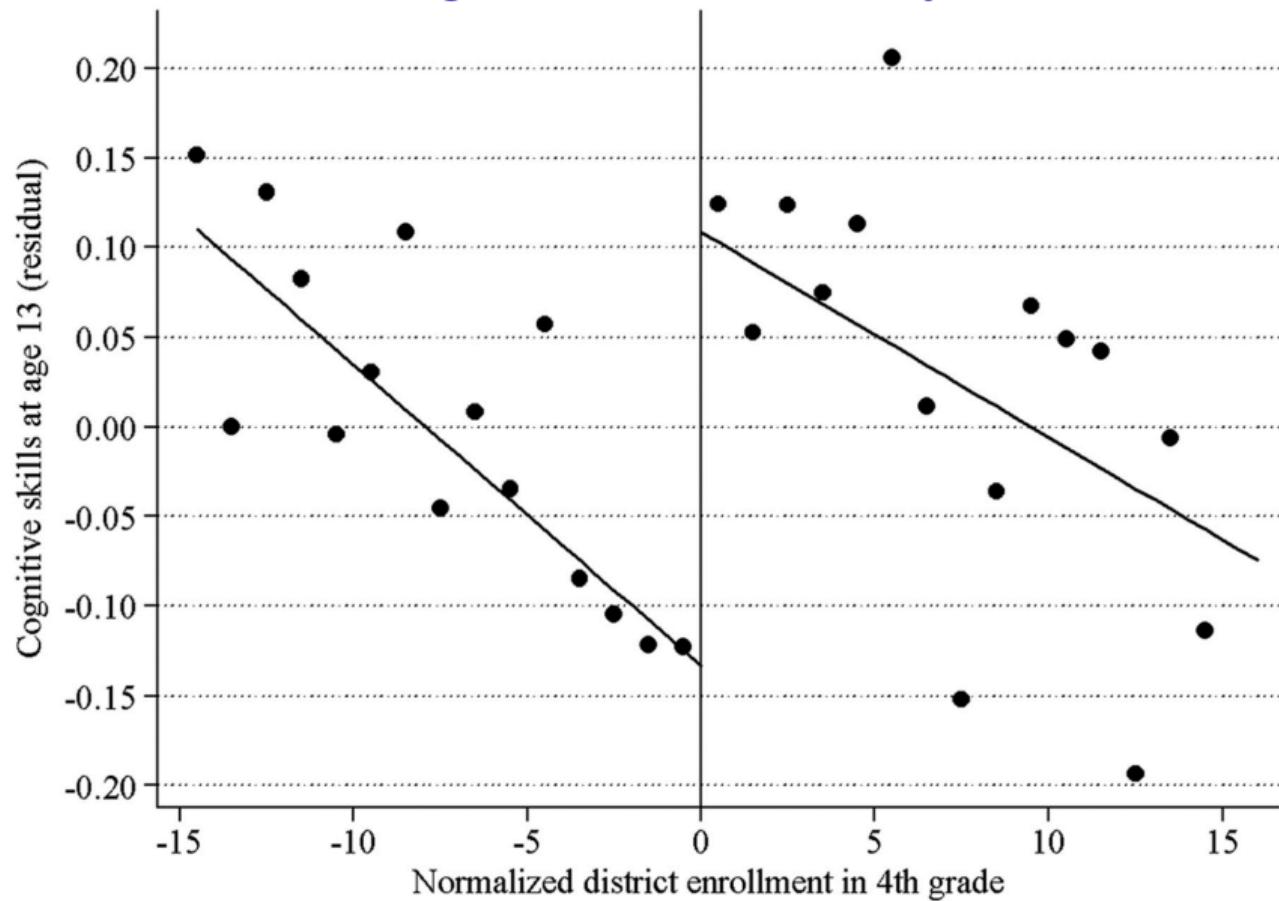
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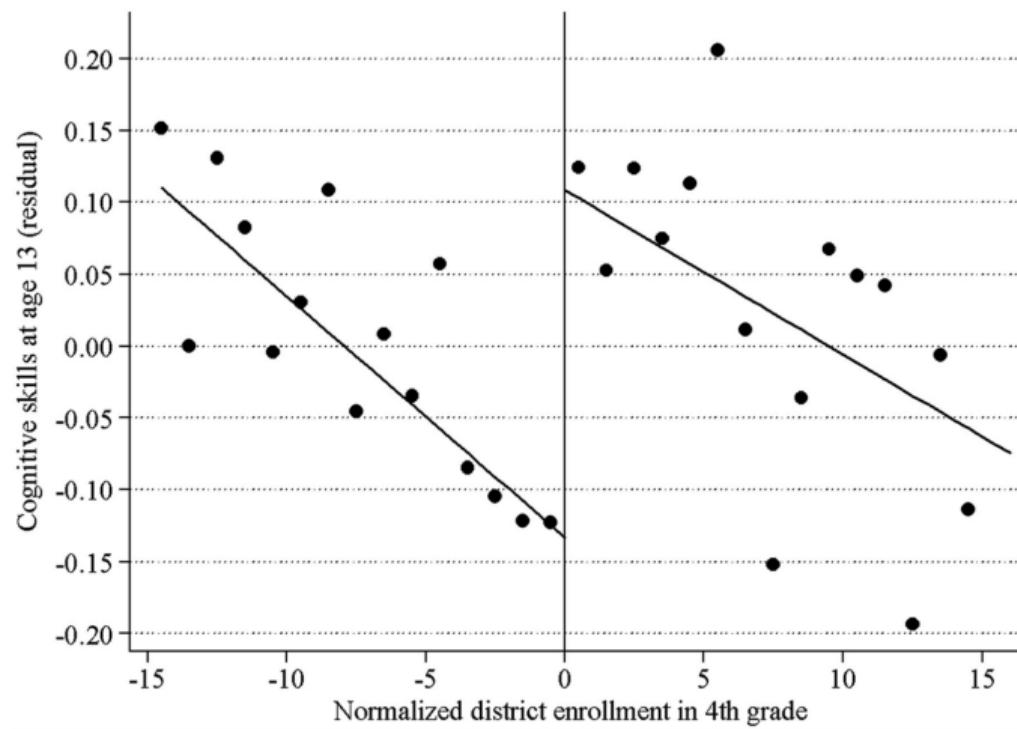
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## Test Score Achievement: Regression Discontinuity Estimates

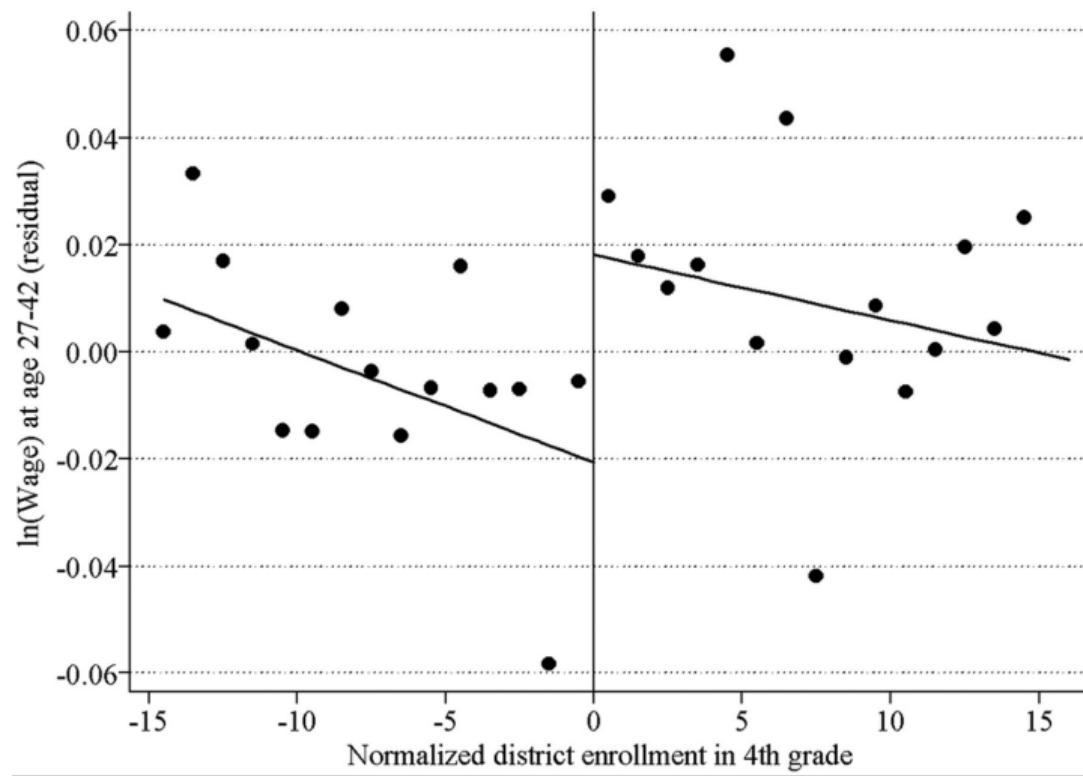


# Test Score Achievement: Regression Discontinuity Estimates



*Test scores jump by 0.2 standard deviations (8 percentiles) at cutoff  
→ Reducing class size by 5 students causes 8 percentile increase in scores*

## Earnings Impacts: Regression Discontinuity Estimates



*Earnings jump by 0.04 log points (4 percent) at cutoff  
→ Reducing class size by 5 students causes 4% increase in earnings*

## Lessons on Class Size

- ▶ Reducing class sizes in primary school by hiring more teachers can have large returns
  - ▶ Present value of lifetime earnings of a child growing up in a family at 25th percentile is about \$500,000 on average
  - ▶ 4% earnings gain from smaller class = \$20,000
  - ▶ Dividing a class of 30 students into two would increase total earnings of students by more than \$600,000
  - ▶ Costs (hiring another teacher and an additional room) likely to be well below \$600,000