THE ECONOMICS OF CLASS SIZE

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INTRODUCTION

- Class size reduction is a politically popular but relatively expensive education reform
- Understanding the causal relationship between class size and student achievement is critical for determining whether class-size reduction can be recommended as a policy to improve student outcome

WHY CLASS SIZE MIGHT MATTER

- Lazear (2001) puts forth a useful theory of education production
  - Reducing class size decreases the amount of time that the classroom is disrupted, increasing time devoted to productive tasks

A simple summary of the model is as follows:

A child is behaving in class at a given moment with probability p, and misbehaving with probability $(1-p)$

When there are n children in the classroom, p^n is the probability that the entire class is behaving and learning is taking place (assuming that p is independent across children)

Assuming a constant disruption rate, having fewer students in the class means that learning is taking place in a larger fraction of time

In the model, the impact of reducing class size depends not only on the size of the class, but also on the behavior of the students in it

The Lazear theory predicts that class-size effects should be larger for classes with more poorly behaved students

E.g. on average p may decrease with age, so the impact of class-size reduction might be smaller for high school students than elementary school students

The impact of class-size reduction –all else equal- is predicted to be larger for groups with lower propensities to behave

EMPIRICAL APPROACHES TO STUDYING THE IMPACT OF CLASS SIZE

- Economist typically model the relationship between student achievement and class size for student i in school j as

$$Y_{ij} = aS_{ij} + bF_{ij} + \varepsilon_{ij} \qquad (1)$$

Where Y represents a measure of student achievement

S contains information on school-level inputs that impact achievement, such as class size

F contains family inputs, such as parental education, and

ε is an error term

Both S and F measure inputs over the child's entire lifetime, and may contain inputs that are not observable to the econometrician

A negative coefficient on class size would suggest that student achievement declines as class size increases

Class size may be endogenous such that $E(\varepsilon|S, F) \neq 0$

E.g. if students are assigned to small classes in a compensatory manner – low baseline test scores or low levels of family inputs – but that information is not available to the researcher, the estimated impact of school resource will be biased

Biased will result if parents who are more motivated in their children's education are more likely to push for a smaller class or better teachers, and parental involvement is not measured in the dataset

Due to these confounding factors, researchers have relied on strategies that use exogenous variation in class size in order to identify the causal impact of class size on student achievement

- Students are randomly assigned to classes of different size
- The benefit of using a randomized experiment is that the treatment assignment is unrelated to any omitted characteristics
- Such a design allows researchers to isolate the impact of the policy they are trying to test, without confounding factors such as parental pressure or compensating assignments
- An experimental study offers more compelling evidence than a nonexperimental study which simple observes the relationship between Y and S in the real world

A well-designed experimental assignment, a straightforward comparison of means by class type will provide an unbiased estimate of the impact of class size on achievement

In the case of a class size experiment in which students are randomized within schools, the equation to be estimated might be as follows:

$$Y_{ics} = \beta_0 + \beta_1 SMALL_{cs} + X_{ics}\gamma + \alpha_s + \upsilon_{ics} \qquad (2)$$

Where $SMALL$ is an indicator variable for randomly assigned small-class treatment, and c indexes class c in school s. X is a vector of student-level characteristics. A school-level fixed effect, α, is included, so that identification of small-class effects are identified off of within-school comparisons. The error term contains class-level and individual level components, reflecting random differences in teacher student quality

When treatments are randomized, student-level covariates are not related to class assignment and their inclusion should not change the estimated effect on class size, but should just contribute to the overall explanatory power of the model

EXPERIMENTAL RESEARCH

PROJECT STEPS TO ACHIEVING RESILIENCE (PROJECT STAR)

- A large-scale randomized trial in the US state of Tennessee to test the impact of reducing class sizes in grade K-3
- In the experiment, students were randomly assigned within school to one of three treatment types: a small-size class (target of 13-17 students), a regular-size class (target of 22-25 students), or a regular-size class with a full-time teacher's aide
- Teachers were randomly assigned to class type
- 79 public schools across a variety of geographic locations (inner-city, suburban, and rural; predominantly low income and middle class) for a single cohort of students in kindergarten through third grade in years 1985-89

- 11600 students and 1330 teachers took part in the experiment
- Experiment made some students better off than they would have been, but of course did not otherwise increase class size beyond their normal range in the state at the time
- New entrants into the program were randomly assigned to class types – randomization allows them to compare new entrants in each grade to other new entrants in the same school across class types
- The school-level fixed effect in equation (2) is replaced with a fixed effect that combines school with a student's grade of entry to the experiment, as this is the pool within which random assignment was determined

In general, work on Project STAR has employed the following approach:

$$Y_{igs} = \beta_{0g} + \beta_{1g}SMALL_{is} + \beta_{2g}AIDE_{is} + \beta_{3g}X_{is} + \alpha_{sw} + \upsilon_{igs} \quad (3)$$

g indexed the grade of the outcome measure

Both the $SMALL$ and $AIDE$ variables are measured as initial assignment, and not actual class attendance

The fixed effect varies by the randomization pool – school interacted with entry wave w

The coefficient on the control for classes with a teacher aide is sometimes omitted, as there appears to be no difference in outcomes between regular and regular-aide classes

CHECKS FOR RANDOMIZATION

- A compelling check of randomization is to examine a pretest to ensure that there are no measurable differences in the dependent variable between class types before the program begins
- To compare student characteristics that are related to student achievement but cannot be manipulated in response to treatment such as student race, gender, and age – if there are no systematic differences in observable characteristics across class types, this provides support that the randomization was done properly

TESTING WHETHER COVARIATES APPEAR RANDOMLY ASSIGNED

	(1)	(2)	(3)	(4)
Panel A: Student characteristics	Female =1 0.000 (0.012)	White =1 -0.002 (0.006)	Free lunch =1 -0.014 (0.011)	Age in 1985 (in year) -0.012 (0.011)
Panel B: Teacher characteristics	Female =1 -0.001 (0.006)	White =1 -0.001 (0.018)	Master's degree or higher=1 -0.051 (0.027)	Total experience (in years) -0.155 (0.470)

Each entry represents a separate regression. Only coefficients on initial assignment to small class are reported. Standard errors are in parentheses, clustered by randomization pool. Other covariates include randomization-pool fixed effects.

ACHIEVEMENT RESULTS

- The impact of initial assignment to a small class on student test scores in grades K-3
- Students benefit about 0.15 standard deviations from assignment to a small class (Word et al., 1990; Krueger, 1999; Krueger and Whitemore, 2001)
- When the results are disaggregated by race, it appears that black students benefited more from being assigned to a small class than the overall population, suggesting that reducing class size might be an effective strategy to reduce the black-white achievement gap

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- Whitemore (2002) find that this result is largely driven by a larger treatment effect for all students regardless of race in predominantly black school, suggesting that benefits from additional resources are higher in such schools
- Benefits are also larger for students from low socioeconomic status families, measured by whether they receive free or reduced price lunch

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SMALL-CLASS EFFECTS ON TEST SCORES DURING THE EXPERIMENT

	(1)	(2)	(3)	(4)
Panel A: Overall	Kindergarten	Grade 1	Grade 2	Grade 3
	0.187 (0.039)	0.189 (0.035)	0.141 (0.034)	0.152 (0.030)
Panel B: Black students only	Kindergarten	Grade 1	Grade 2	Grade 3
	0.214 (0.074)	0.249 (0.063)	0.207 (0.054)	0.242 (0.060)
Panel C: Free-lunch students only	Kindergarten	Grade 1	Grade 2	Grade 3
	0.188 (0.046)	0.195 (0.042)	0.174 (0.041)	0.174 (0.039)

Each entry represents a separate regression. Only coefficients on initial assignment to small class are reported. Standard errors are in parentheses, clustered by randomization pool. Other covariates include randomization-pool fixed effects and student demographic characteristics.

- In fourth grade, the class-size reduction experiment concluded and all students were returned to regular-sized classes
- At the same time, the assessment test was changed from the SAT to the Comprehensive Test of Basic Skills (CTBS) – both tests are multiple choice standardized tests that measure reading and math achievement, and are taken by students at the end of the school year
- All students in public schools statewide who had ever participated in Project STAR are included in the follow-up study, even if they had been retained a grade – it is estimated that 20% of students had been retained a grade by eight grade, but this did not very with initial class assignment

SMALL CLASS EFFECTS ON LONG TERM TEST SCORES

	Grade 4 (z-score) (1)	Grade 5 (z-score) (2)	Grade 6 (z-score) (3)	Grade 7 (z-score) (4)	Grade 8 (z-score) (5)	Took college entrance test (1=yes) (6)
Panel A: Overall	0.035 (0.025)	0.048 (0.024)	0.060 (0.025)	0.040 (0.025)	0.036 (0.025)	0.024 (0.010)
Panel B: Black students only	0.078 (0.048)	0.080 (0.043)	0.105 (0.045)	0.066 (0.042)	0.063 (0.046)	0.050 (0.018)
Panel C: Free-lunch students only	0.029 (0.036)	0.058 (0.031)	0.080 (0.034)	0.067 (0.031)	0.064 (0.034)	0.031 (0.014)

Each entry represents a separate regression. Only coefficients on initial assignment to small class are reported. Standard errors are in parentheses, clustered by randomization pool. Other covariates include randomization-pool fixed effects and student demographic characteristics.

ADDITIONAL CAVEATS

- Nonrandom movement across class-type assignment
- Sample attrition during treatment phase
- Hawthorne effect – people participating in the experiment might act differently than they normally do because they know they are being studied
- Whether the findings of this experiment may be generalized to other settings

QUASI-EXPERIMENTAL RESEARCH

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- Allow isolation of the causal impact of class-size reduction
- One of the strength of quasi-experimental approaches is that the participants are unaware that they are being studied, so Hawthorne effects are unlikely

ANGRIST AND LAVY (1999)

- Use a strict maximum class-size rule in Israel and a regression discontinuity (RD) approach
- In Israel, maximum class size is dictated by Maimonides' rule, which specifies that no more than 40 students shall be in one class
- Using the local variation around the enrolment sizes that are multiples of 40 students, Angrist and Lavy isolate the causal impact of class-size reduction
- They find strong improvement overall in both math and reading scores, of a magnitude that is consistent with Project STAR's experimental results
- They also find larger improvements among disadvantaged students

DISCUSSION

- A cost-benefit study of project STAR found that the overall benefits outweighed the costs (Krueger and Whitemore, 2001)
- The answer in other cases will depend on the school's situation
  - What is the current level of education inputs?
  - Are there many disadvantaged students?
  - Do we want to put extra weight on questions of equity?
  - Is there a ready supply of qualified individuals available to meet the increased demand for classroom teachers?
  - What is the next best use of the available funds?