Quantitative Economics for the Evaluation of the European Policy

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Example: Tennessee Project STAR.

The Effect of Class Size on Educational Achievement

- Krueger (1999) econometrically re-analyses a randomized experiment of the effect of class size on student achievement.
- The project is known as Tennessee Student/Teacher Achievement Ratio (STAR) and was run in the 1980s.
- $11,600$ students and their teachers were randomly assigned to one of three groups:
  - Small classes (13-17) students.
  - Regular classes (22-25) students.
  - Regular classes (22-25) students with a full time teachers aide.
- After the assignment, the design called for students to remain in the same class type for four years.
- Randomization occurred within schools.

STAR project

- Students entered kindergarten in the 1985 – 1986 school year participate in the experiment through third grade.
- Any student who entered a participating school in a relevant grade was added to the experiment.
- Those students who repeated a grade, skipped a grade were removed from the experiment.
- After the third grade the experiment ended, and all students were assigned to regular-size classes.

Limits of the experiment

- The STAR data set does not contain student's orginal class: only the class type that students actully were enrolled in each year are available.
- The baseline test score information on the students is not available.
- The randomization process would minimize the differences between the groups.

Checking for balance

Table I

Checking for balance

- Students assigned to small classes had fewer students in theur class than those in regular classes, on average.
- Small differences in the fraction of students on free lunch, racial mix, and the average age students in classes of different size (some of these differences are statistically significant, see rows 1 and 4).
- Computing the p-values for the joint F-tests of the differences among the three typ of classes.

P-values test fo within-school differences

Table II

P-values test fo within-school differences

- P-values are conditional on school effects.
- None of the **three background variables** displays a statistically significant association with cass-type assignment at the 10 percent level.
- Thus random assigment produces relatively similar groups in each class size, on average.
- Within school, there is no evidence that initial assignment to class types is correlated with students characteristics.

- There is a high rate of attrition from the project. It could accour for several reasons: including students moving to another school, students repeating a grade, and students being advanced a grade.
- It is impossiblr to prescribe the exact number of students in a class: families move in and out of a school district during the course; student become sick etc..
- If the movement between class types is associated with individual characteristics, a simple comparison of outcomes across class type will be bias!
- **Possible solution**: Include in the regression model an instrumental variable for actual class size.

Regression in Tennessee Project STAR

Krueger (1999) estimates by OLS the following econometric model:

$$Y_{ics} = \beta_0 + \beta_1 SMALL_{cs} + \beta_2 Reg/A_{cs} + \beta_3 X_{ics} + \alpha_s + \epsilon_{ics}, \qquad (1)$$

where:

- Y_{ics} is the percentile score of student i in class c at school s,
- $SMALL_{cs}$ is a dummy variable indicating whether student was assigned to a small class,
- Reg/A_{cs} is a dummy variable for the assignment to a regular class with aide,
- X_{ics} is the vector of observed student and teacher characteristics,
- α_s is the school FE because random assignment occurred within schools.

The error term

The error term is modeled in a components-of-variance framework. Specifically:

$$\epsilon_{ics} = \eta_{cs} + \epsilon'_{ics} \tag{2}$$

where η_{cs} is a class-specific random component that is common to all members of the same class, and ϵ'_{ics} is an idiosyncratic error term.

Results

Table V

Results I

- Columns 1 and 5 omit the school dummies.
- Students in small classes tend to perform better than those in regular and regular/aide classes.
- The gap is about 5% in kindergarten, 8.6 in the first grade, $5-6$ in the second and third grade.
- Column 2 and 6: including the school dummies leads to a slight increase in the effect of being assignd to a small class.
- Since class size is randomly assigned, including additional exogenous variables would not significantly modify the coefficient on the class size dummies. In fact, including covariates modest impact on these coefficients

Results II

- Studens charcteristics: white and asian students tend to score 8 percentile points higher than black students in kindergarten, and this gap is about 6 points in third grade.
- Free lunch has a negative effect on the score of students, while girls score $3-4$ points than boys in each grade level.
- The teacher characteristics have weak explanatory power. Their education does not have a systematic effect.

Problem 1: Attrition

- If attrition is random and affects the treatment and control groups in the same way the estimates would remain unbiased.
- Here the attrition is likely to be non-random: especially good students from large classes may have enrolled in private schools creating a selection bias problem.
- Krueger addresses this concern by imputing test scores (from their earlier test scores) for all children who leave the sample and then reestimates the model including students with imputed test scores.
- Using initialassignment (columns 5-8) there is only a slight decrease of the estimates of the effect, and are always statistically significant.

Problem 2: Students changed classes after random assignment

- Subjects moved between treatment and control groups.
- A common solution to this problem is to use initial assignment (here initial assignment to small or regular classes) as an instrument for actual assignment.
- Krueger reports reduced form results where he uses initial assignment and not current status as explanatory variable.
- In Kindergarten OLS and reduced form are the same because students remained in their initial class for at least one year.
- From grade 1 onwards OLS (column 1-4) and reduced form (columns 5-8) are different.

Two-Stage Least Squares (2SLS) Model

- Students assigned to small classes had varying numbers of students in their classes because of student mobility and enrollment differences across schools.
- Students in the regular-size classes had variable class sizes.
- More appropriate model: 2SLS

$$CS_{ics} = \pi_0 + \pi_1 S_{ios} + \pi_2 R_{ios} + \pi_3 X_{ics} + \delta_s + \tau_{ics} \quad (3)$$

$$Y_{ics} = \beta_0 + \beta_1 CS_{ics} + \beta_2 X_{ics} + \alpha_s + \epsilon_{ics}, \quad (4)$$

where:

- CS_{ics} is the actual number of students in the class,
- S_{ios} is a dummy variable indicating assignment to a small class the first year the student is observed in the experiment,
- R_{ios} is a dummy variable indicating assignment to a regular class the first year the student is observed in the experiment.

Results

Comparing OLS and 2SLS estimates weobserve that:

- 2SLS estimates tend to be a little larger in absolute value, especially in third grade.
- Dissagregating by the grade the student entered in the project: for each cohort of students, those attending smaller classes tend to score higher on the standardized test by the end of the first year they entered the experiment.
- See the paper for other interesting results according the effect of time spent in a small class