HANDOUT 19 – REGRESSION DISCONTINUITY

AGENDA

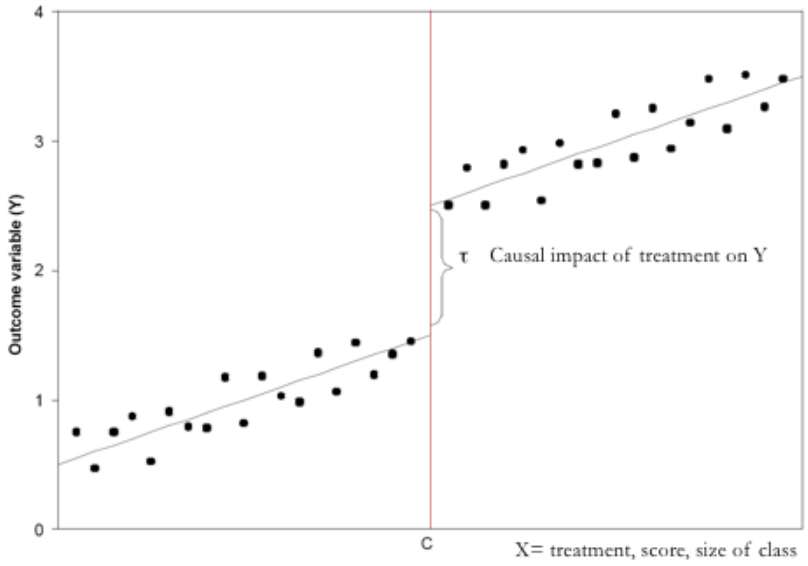
- Introduction to regression discontinuity
- Example: Does merit aid affect college enrollment?
- Takeaways
- Survey on topics to be reviewed

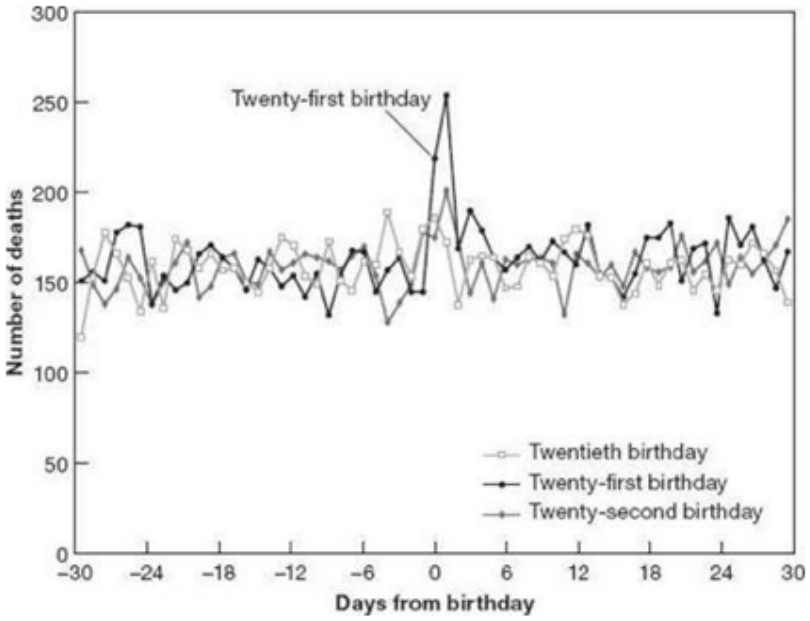
BIBLIOGRAPHY FOR TODAY´S CLASS

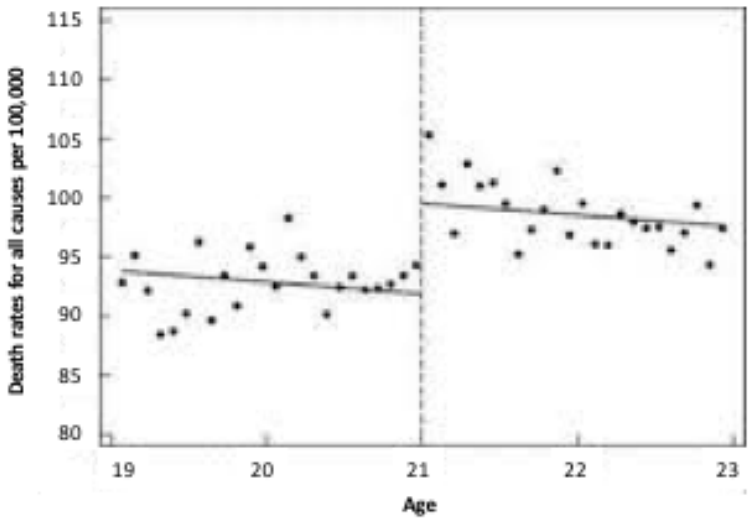
- Cohodes and Goodman (2014). Merit Aid, College Quality, and College Completion (Links to an external site.)Links to an external site.. Focus on the abstract and introduction (pp. 251-254) (*)
- Angrist and Pischke (2015), 4 (**)

REGRESSION DISCONTINUITY

- Today we will discuss our final quasi-experimental technique, called regression discontinuity (RD; **regression discontinuity** design).
- RD can be used when treatment is based on a continuous variable called the **running variable** (or assignment variable, or forcing variable).
    - If the value of the assignment variable falls on one side of the cutoff, the person is assigned to the "treatment" group.
    - If the value of the assignment variable falls on the other side of the cutoff, the person is assigned to the "control" group.
- Assignment variable can be anything defined prior to treatment.
- Examples include:
    - Assigning social welfare benefits on the basis of income.
    - Opening new classrooms on classes where certain size is reached.
- In many settings the assignment variable is a measure of need or merit.
- Basic idea: check of a noticeable difference (discontinuity) in the outcome between nearly identical people who fall on either side of arbitrary threshold.
- Big advantage over diff-in-diff: no need for multiple time periods!


Outcome variable (Y)
τ Causal impact of treatment on Y
c
X= treatment, score, size of class


Twenty-first birthday
Number of deaths
Twentieth birthday
Twenty-first birthday
Twenty-second birthday
Days from birthday


Death rates for all causes per 100,000
Age

- Treatment is a deterministic function of the **running variable age** (sharp RD):

$$D_a = \begin{cases} 1 \; if \; a \geq 21 \\ 0 \; if \; a < 21 \end{cases}$$

- A simple RD analysis of the MLDA estimated causal effects using a regression:

$$\overline{M}_a = \beta_0 + \beta_1 D_a + \beta_2 age + \varepsilon$$

- To the left of the cut-off the regression line becomes:

- To the right of the cut-off the regression line becomes:

- The coefficient of interest in this case is:

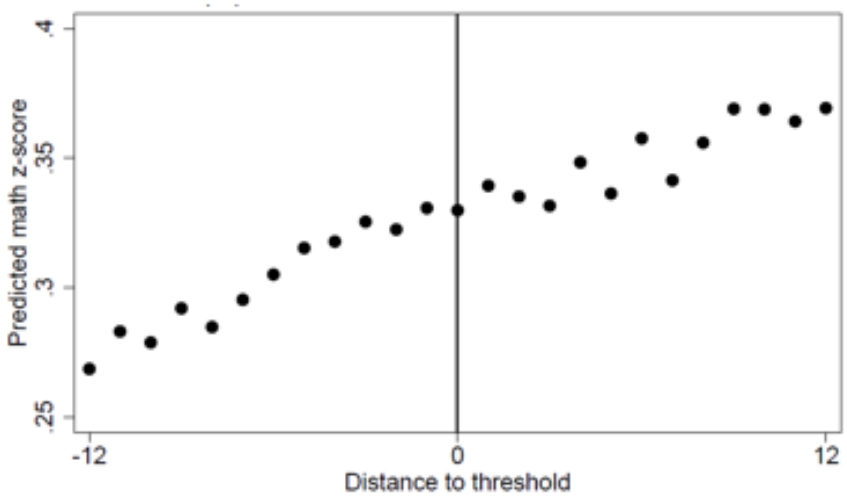
- How would that equation look if we were to control for a possible non-linear relationship between age and death?

EXAMPLE: MERIT AID AND COLLEGE CHOICE:

- Policy question:
  - How does financial aid based on academic merit affect college choice?
- The Adams Scholarship is a Massachusetts merit aid program that:
  - Waives tuition at in-state public colleges ("Adams colleges").
  - If a student's 10^{th} grade test score is at above the 75^{th} percentile.
- We have data on student's test scores and college choice.
- Why might simple comparisons of eligible and ineligible students' college choices be biased?

- To get rid of OVB: exploit the eligibility threshold.
- Students just above and just below the threshold should be nearly identical in all ways except for scholarship eligibility.
  - Whether student gets one question right feels like coin toss (i.e. random).

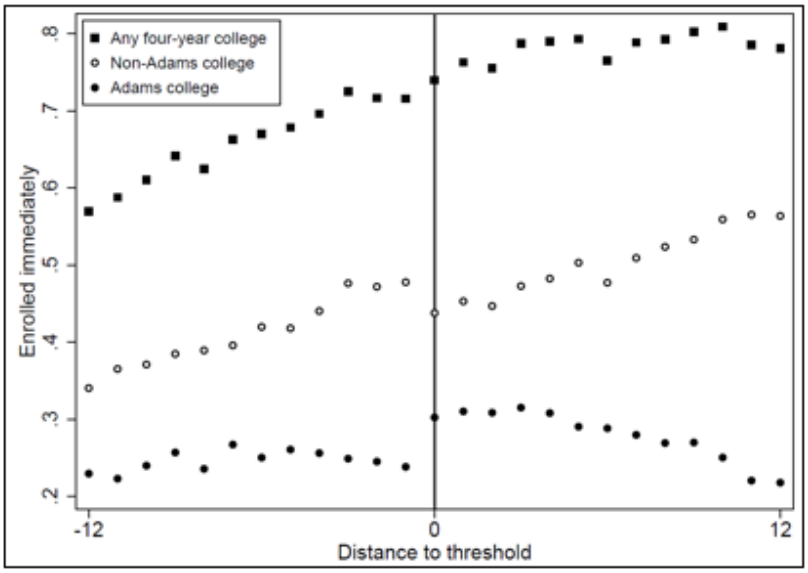
- RD is sometimes called "local randomization" (i.e. random near threshold).
- Students at the 75th percentile have nearly the same academic skills as those at the 74th percentile.
    - Should also be similar in terms of gender, race, family background, etc.
- As long as they can't control the side of threshold they fall on.
- Just like RCTs, we can check whether the threshold generated two nearly identical groups!
- Do treatment and control groups 8th grade math scores look balanced?



- Graph would look similarly "smooth" if Y=income, race, gender, etc.
- Why is it important that individuals not be able to control the assignment variable? (assignment variable is not susceptible to being manipulated).

- If eligibility were based on having high school GPA of 3.5 or higher, would regression discontinuity yield internally valid estimates?

- Once we are satisfied that students across threshold look similar, we can examine mean outcomes by graphing them by distance to the threshold.



- Students just above threshold are _____ likely to enroll in in-state public colleges than students just below threshold.
- Students just above threshold are _____ likely to enroll in other four-year colleges than students just below threshold.
- Students just above threshold are _____ likely to enroll in any four-year college than students just below threshold.
- Regression version of eyeball test is OLS of the form:

$$College = \beta_0 + \beta_1 Above + \beta_2 Distance + \beta_3 Above * Distance + \varepsilon$$

College = 1 if student enrolls in a particular type of college.

Above = 1 if a student's test score qualified for the scholarship.

Distance measures student's distance from the threshold (test score points).

- β_1 is difference in outcome between those just above and below threshold.
- Because that regression draws two lines, one on either side of the threshold:
    - To the left:

    - To the right:

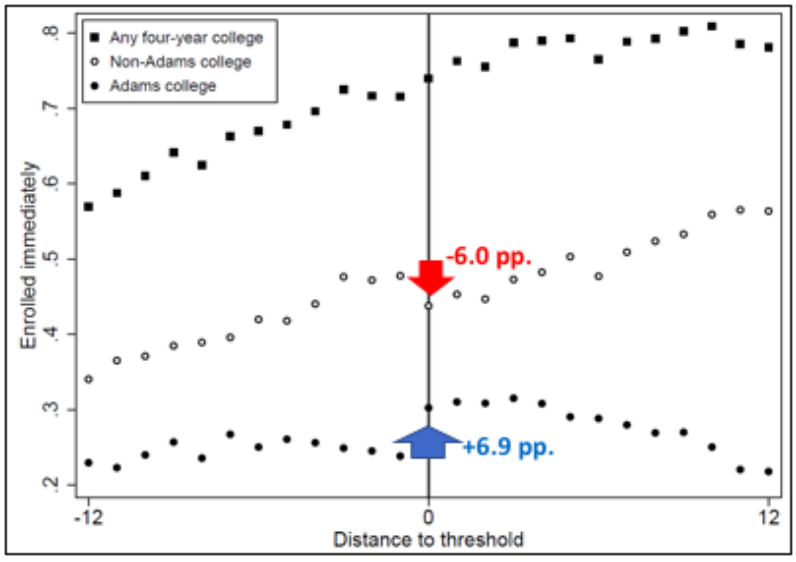
- Here are the regression results:

	Adams college, four-year (1)	Non-Adams college, four-year (2)	Any four-year college (3)
Enrolled immediately	0.069***	-0.060***	0.009
	(0.010)	(0.010)	(0.008)
$\bar{Y}$	0.238	0.478	0.716

- Do these match our eyeball test?

- Does this scholarship seem like a good use of public funds?

- Once we are satisfied that students across threshold look similar, we can examine mean outcomes by graphing them by distance to the threshold.



- Instrumental variables and regression discontinuity have a common property:
    - The estimates produced have a marginal interpretation, i.e. they are driven by a subset of the sample studies (LATE).
    - The estimate of β_1 has a marginal interpretation because it is generated by students near the eligibility threshold.
- Important to ask whether causal impacts would be different for individuals far from the threshold.
- Would merit aid affect lower scoring students differently?

TAKEAWAYS:

- Regression discontinuity is a powerful tool for causal inference.
    - It allows comparison of two groups who are nearly identical except for the fact they fall on different sides of an arbitrary threshold.
    - It's as close to an RCT as a non-RCT can get.
- Many public policies involve eligibility thresholds!
- If you are convinced that those on both sides of the policy threshold are similar but for the policy treatment itself, RD can provide causal estimates.
    - RD estimates are LATEs driven by those near the threshold.
- Today's example was. **Sharp RD,** where the threshold determines 100% of treatment status (i.e. below = no treatment, above = treatment).
- There are also cases of **fuzzy RD,** where the threshold changes the probability of treatment, but not from 0 to 100% (can be addressed by IV!).

VOCABULARY:

- Regression discontinuity: is a quasi-experimental pretest-posttest design that elicits the causal effects of interventions by assigning a cutoff or threshold above or below which an intervention is assigned.
- Running variable: observed assignment variable or forcing variable.
- Covariate balance test: balance test check for differences in covariates' means, but cannot account for differences in higher moments.