DD and Regression Discontinuity

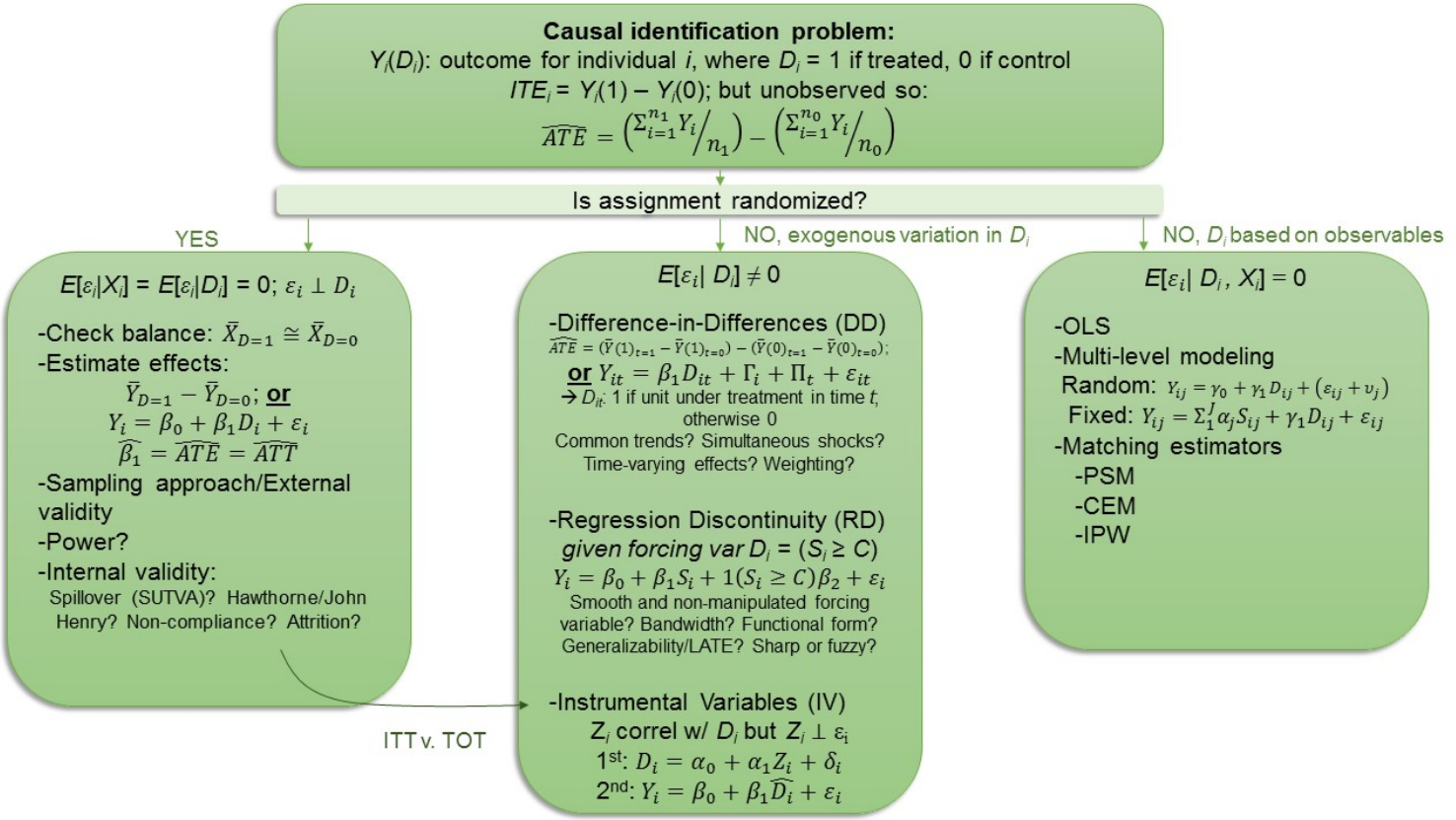
EDLD 650: Week 3

David D. Liebowitz

Agenda

1. Roadmap and Goals (9:00-9:10)
2. Analyzing Liebowitz, Porter & Bragg (9:10-10:10)
3. How DARE you! (10:10-10:45)
    - More questions?
    - Preview debrief
4. Break (10:45-11:00)
5. Regression discontinuity (11:00-11:40)
6. Wrap-up (11:40-11:50)
    - Research project proposal
    - Plus/Deltas & Clear/Murky

Roadmap


Causal identification problem:
$Y_i(D_i)$: outcome for individual i, where D_i = 1 if treated, 0 if control
$ITE_i = Y_i(1) - Y_i(0)$; but unobserved so:
$\widehat{ATE} = \left(\Sigma_{i=1}^{n_1} Y_i / n_1\right) - \left(\Sigma_{i=1}^{n_0} Y_i / n_0\right)$
Is assignment randomized?
YES
NO, exogenous variation in D_i
NO, D_i based on observables
$E[\varepsilon_i|X_i] = E[\varepsilon_i|D_i] = 0$; $\varepsilon_i \perp D_i$
-Check balance: $\bar{X}_{D=1} \cong \bar{X}_{D=0}$
-Estimate effects:
$\bar{Y}_{D=1} - \bar{Y}_{D=0}$; or
$Y_i = \beta_0 + \beta_1 D_i + \varepsilon_i$
$\widehat{\beta_1} = \widehat{ATE} = \widehat{ATT}$
-Sampling approach/External validity
-Power?
-Internal validity:
Spillover (SUTVA)? Hawthorne/John Henry? Non-compliance? Attrition?
ITT v. TOT
$E[\varepsilon_i| D_i] \neq 0$
-Difference-in-Differences (DD)
$\widehat{ATE} = (\bar{Y}(1)_{t=1} - \bar{Y}(1)_{t=0}) - (\bar{Y}(0)_{t=1} - \bar{Y}(0)_{t=0})$;
or $Y_{it} = \beta_1 D_{it} + \Gamma_i + \Pi_t + \varepsilon_{it}$
→ D_{it}: 1 if unit under treatment in time t, otherwise 0
Common trends? Simultaneous shocks? Time-varying effects? Weighting?
-Regression Discontinuity (RD)
given forcing var D_i = ($S_i \geq C$)
$Y_i = \beta_0 + \beta_1 S_i + 1(S_i \geq C)\beta_2 + \varepsilon_i$
Smooth and non-manipulated forcing variable? Bandwidth? Functional form? Generalizability/LATE? Sharp or fuzzy?
-Instrumental Variables (IV)
Z_i correl w/ D_i but $Z_i \perp \varepsilon_i$
1st: $D_i = \alpha_0 + \alpha_1 Z_i + \delta_i$
2nd: $Y_i = \beta_0 + \beta_1 \widehat{D_i} + \varepsilon_i$
$E[\varepsilon_i| D_i, X_i] = 0$
-OLS
-Multi-level modeling
Random: $Y_{ij} = \gamma_0 + \gamma_1 D_{ij} + (\varepsilon_{ij} + \upsilon_j)$
Fixed: $Y_{ij} = \Sigma_1^J \alpha_j S_{ij} + \gamma_1 D_{ij} + \varepsilon_{ij}$
-Matching estimators
-PSM
-CEM
-IPW

Goals

1. Describe threats to validity in difference-in-differences (DD) identification strategy and approaches to address these threats.

2. Conduct applied difference-in-difference analysis and interpret these results.

3. Describe conceptual approach to regression discontinuity analysis

So random...

How DARE you?!?!

DARE 1 review process

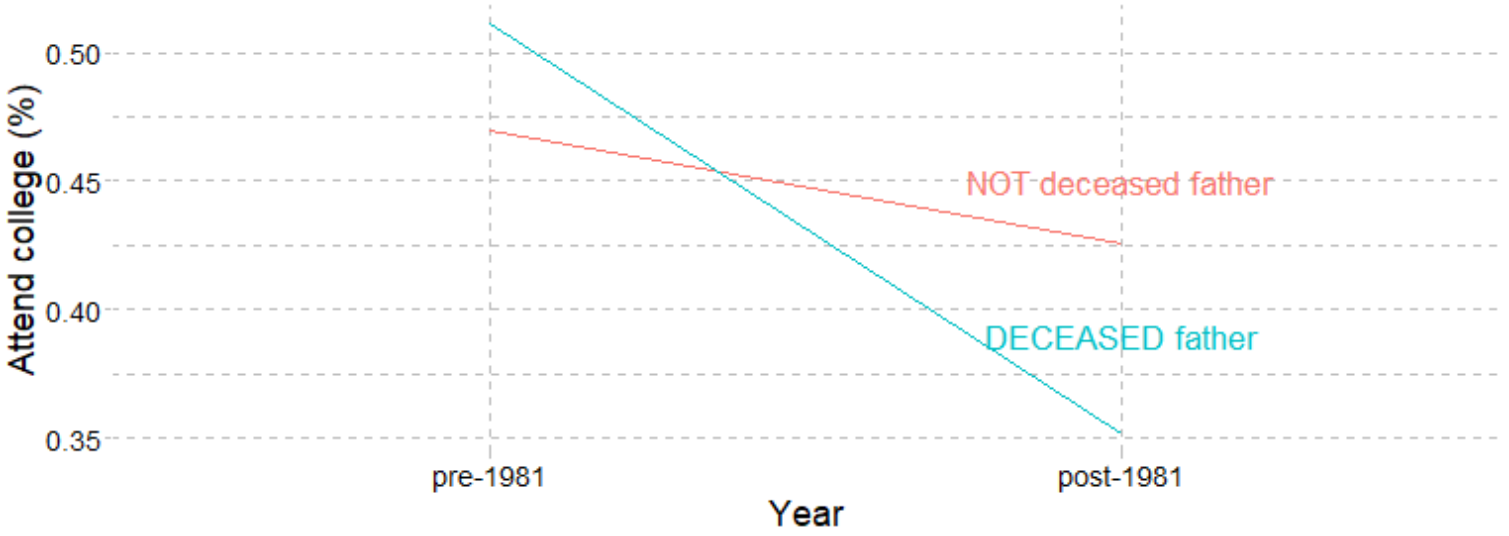
...we'll do this next class...

1. Form groups of 2-3 (not your DARE partner)
2. Independently review DARE #1 model response (10 min)
    - Take notes on where answers differ from model
    - Think about conceptual questions (modeling decisions, robustness checks, etc.)
    - Think about presentation and language (what to leave in, what to leave out? how to describe results?)
3. Discuss in group conceptual questions (15 min)
4. Independently review code posted on course website (5 min)
5. Join partner (for solo authors join another author)
6. Discuss coding choices and questions (10 min)
7. Whole-group debrief (10 min)
    - Lingering questions
    - Process

Break

Discontinuities everywhere!

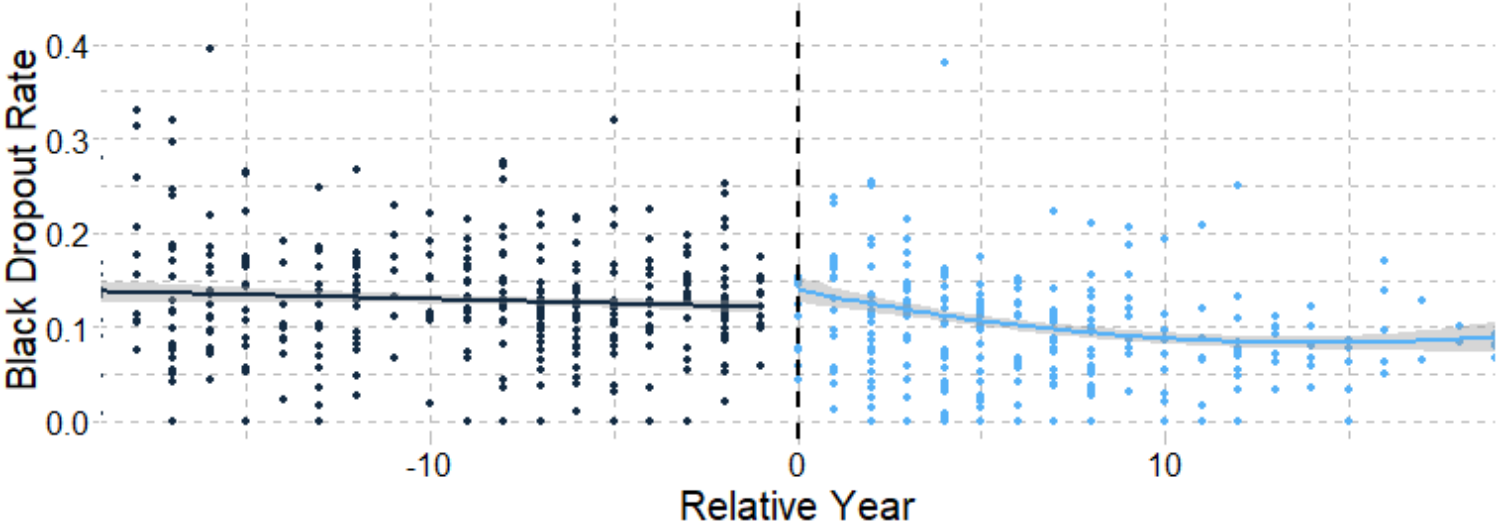
Recall the basic set up of DD



Time (literally the passage of years) can be considered a forcing variable--a measure, movement along which in one direction or another "forces" participants into treatment or control status.

DD's cousin: C-ITS

The Comparative-Interrupted Time Series approach:



In this way, DD may just be a specific application of a causal identification framework known as the **Regression Discontinuity (RD)** design.[1]

[1] In fact, many believe that repeated measures over time (a discrete ordered variable) are not divisible in same way as true continuous forcing variables are (e.g., test score, height, draft number). *This is crucial to determine the credibility of identification.*

C-ITS considered

Strengths

- Takes advantage of full range of data
- Compared to mean-effect-only DD, allows differentiation of discontinuous jump vs. post-trend
- Permits modeling of fully flexible functional form (can include quadratic, cubic, quartic relationships, interactions and more!)
- Data-responsive approach

Weaknesses

- Units on each side of discontinuity not *equal-in-expectation* w/o other assumptions
- Encourages over-fitting; risks generating unstable models
- Estimates are functional-form dependent

Note that a fully-saturated C-ITS model (i.e., a model that estimates a coefficient on an indicator for each time period) is identical to an event study.

Failing (passing) graduation test

Massachusetts, like somee other states (including Oregon until very recently) requires students to pass a test in order to graduate. **How does just passing (or failing affect students)?**[1]

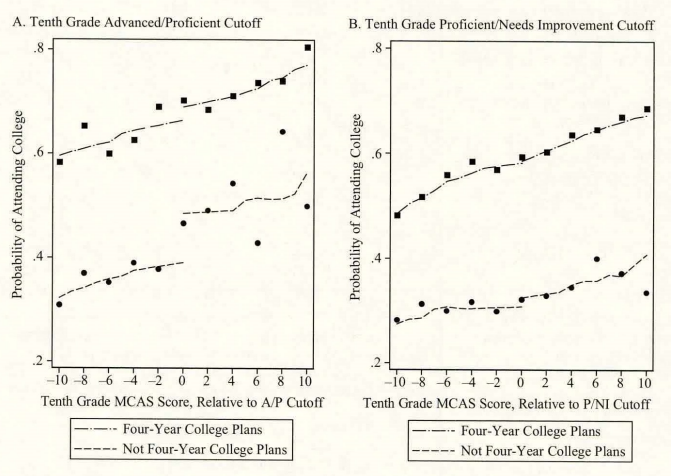


Figure 2
Fitted Local Linear-Regression Relationships between the Probability of Attending College and tenth Grade Mathematics Score Relative to the Advanced/Proficient Cutoff

[1] Papay, J.P., Murnane, R.J., & Willett, J.B. (2016). The impact of test-score labels on human capital investment decisions. *Journal of Human Resources, 51*(2), 357-388.

Failing a graduation test

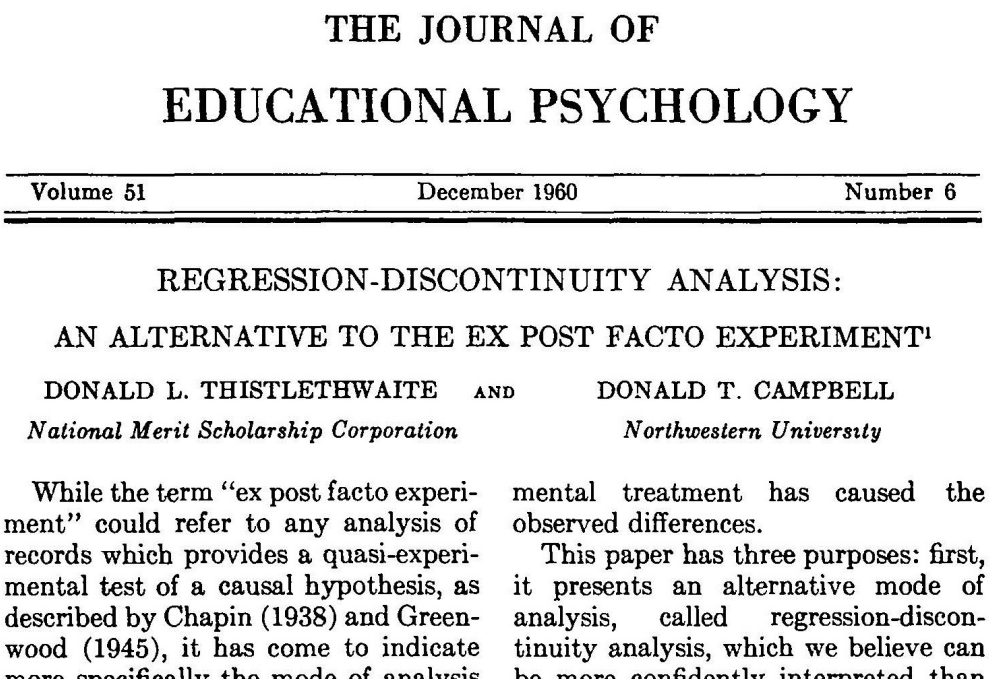
Failing a graduation test

Failing a graduation test

Failing a graduation test

A different effect?

Education FTW![1]



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REGRESSION-DISCONTINUITY ANALYSIS:

AN ALTERNATIVE TO THE EX POST FACTO EXPERIMENT[1]

DONALD L. THISTLETHWAITE AND DONALD T. CAMPBELL

National Merit Scholarship Corporation *Northwestern University*

While the term "ex post facto experiment" could refer to any analysis of records which provides a quasi-experimental test of a causal hypothesis, as described by Chapin (1938) and Greenwood (1945), it has come to indicate

mental treatment has caused the observed differences.

This paper has three purposes: first, it presents an alternative mode of analysis, called regression-discontinuity analysis, which we believe can

[1] Thistlethwaite, D. L., & Campbell, D. T. (1960). Regression-discontinuity analysis: An alternative to the ex post facto experiment. Journal of Educational Psychology, 51(6), 309–317

The benefits of being recognized

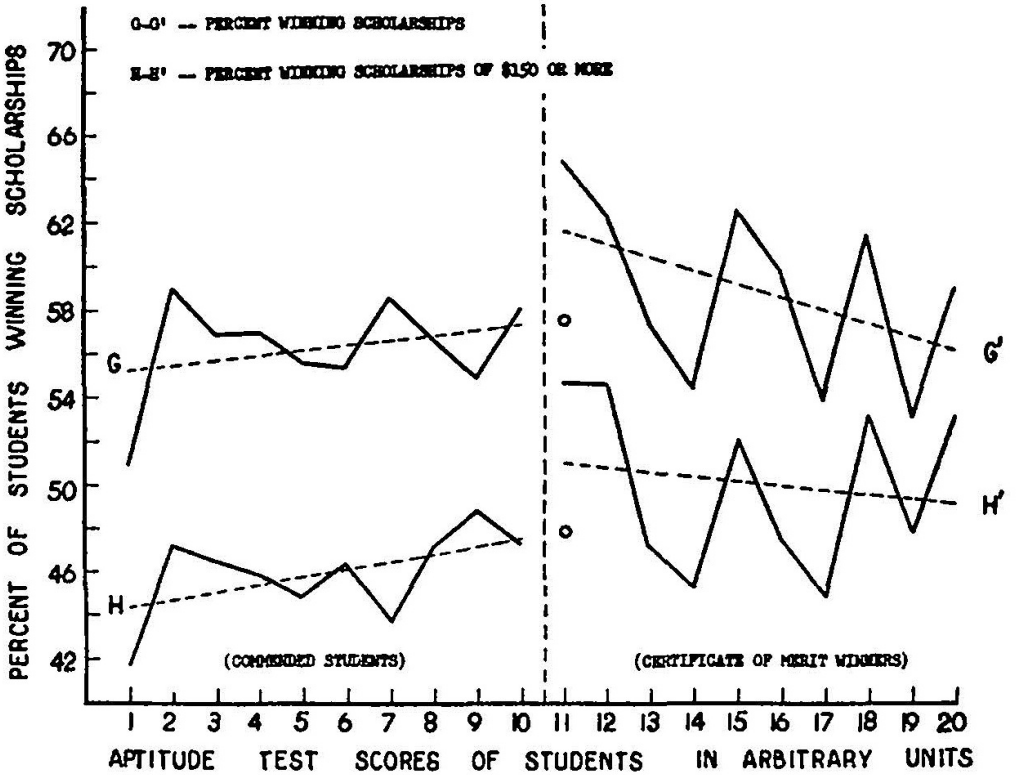

FIG. 2. Regression of success in winning scholarships on exposure determiner.

The basic set up in regression

Given a continuous forcing variable S_i such that individuals receive a treatment (D_i) when $S_i \geq$ a cutoff (C):

$$Y_i = \beta_0 + \beta_1 S_i + 1(S_i \geq C)\beta_2 + \varepsilon_i$$

Can you explain what is happening in this regression?

What about applied in a specific context?

$$p(COLL_i = 1) = \beta_0 + \beta_1 TESTSCORE_i + 1(TESTSCORE_i \geq 60)\beta_2 + \varepsilon_i$$

> This equation estimates a linear probability model, in which whether individuals attend college or not (expressed as a dichomotous indicator taking on the values of 0 or 1), is regressed on a linear measure of individual *i*'s test score $(TESTSCORE_i)$ and a indicator variable that takes the value of 1 if individual *i* scored 60 or higher on the test. β_2 is the causal parameter of interests and represents the discontinuous jump in the probability (p.p.) of attending college (adjusting for test score) of scoring just above the pass score.

Wrap-up

Goals

1. Describe threats to validity in difference-in-differences (DD) identification strategy and approaches to address these threats.

2. Conduct applied difference-in-difference analysis and interpret these results.

3. Describe conceptual approach to regression discontinuity analysis

To-Dos

Week 4: Regression Discontinuity

Readings:

- Murnane & Willet, Ch. 9
- Angrist & Lavy (1999)
- Dee & Penner (2017)
- *Further*: MHE: Ch. 6, 'Metrics: Ch. 4, Mixtape: Ch. 6

Research Project Proposal due 11:59pm, 1/28

- Talk to me!

DARE #2 due 11:59pm, 2/5

Feedback

Plus/Deltas

Front side of index card

Clear/Murky

On back