Short Course in Regression Discontinuity Designs

Mixtape Sessions

October 3rd-October 5th, 2023

Virtual course

Last update: October 3, 2023

1 Basic Information

Instructors:	Rocío Titiunik Professor Department of Politics Princeton University titiunik@princeton.edu https://scholar.princeton.edu/titiunik
Schedule:	6:00pm–9:00pm EDT
Course website:	Regression Discontinuity Designs

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2 Overview

The goal of this workshop is to give an introduction to standard and recent methodological developments in the analysis and interpretation of regression discontinuity (RD) designs. The course focuses on methodology and empirical practice, as well as on conceptual issues, but not on the technical details of the statistical and econometric theory underlying the results. A brief description of the course, along with references to further readings, is given below.

It is assumed that participants have elementary working knowledge of statistics, econometrics and policy evaluation. It would be useful, but not required, if participants were familiar with basic results from the literature on program evaluation and treatment effects at the level of Wooldridge (2010). The course is nonetheless meant to be self-contained and hence most underlying statistics/econometrics concepts and results are introduced and explained in class.

3 Reading Materials

The main textbooks for the class are Cattaneo, Idrobo and Titiunik (2020) and Cattaneo, Idrobo and Titiunik (2022):

- Matias Cattaneo, Nicolás Idrobo, and Rocío Titiunik. 2020. *A Practical Introduction to Regression Discontinuity Designs: Foundations*, Cambridge Elements: Quantitative and Computational Methods for Social Science, Cambridge University Press. Download published version. Download pre-preprint version.

- Matias Cattaneo, Nicolás Idrobo, and Rocío Titiunik. 2021. *A Practical Introduction to Regression Discontinuity Designs: Extensions*, to appear in Cambridge Elements: Quantitative and Computational Methods for Social Science, Cambridge University Press. Download current version.

In addition to these practical guides, we have recently finished a comprehensive review of the RD methodological literature, Cattaneo and Titiunik (2022), which can be downloaded from here. There are also several prior review articles on RD methodology and empirical practice. In particular, Imbens and Lemieux (2008) and Lee and Lemieux (2010) are very helpful references, although they do not cover many of the most recent methodological results available in the literature.

We also provide specific background references under each specific topic below.

4 Computing and Software

To participate in the hands-on exercises, you are strongly encouraged to secure access to a computer with the most recent version of `Stata` or `R` plus `RStudio` installed.

All functions and packages are available in `Stata`, which is not free, and `R`, a free and open-source statistical software environment. We also have `Python` versions of some of the packages (we are still in the process of creating `Python` libraries for all the commands).

The workshop will employ several empirical illustrations, which will be analyzed using `Stata` and/or `R`. The following `Stata`/`R`/`Python` modules modules/commands will be used:

- `rdrobust`: RD inference employing local polynomial and partitioning methods.
  See Calonico, Cattaneo and Titiunik (2014, 2015) for introductions.
- `rddensity`: Manipulation testing for RD designs.
  See Cattaneo, Jansson and Ma (2018) for an introduction.
- `rdlocrand`: RD inference employing randomization inference methods.
  See Cattaneo, Titiunik and Vazquez-Bare (2016) for an introduction.
- `rdmulti`: Local polynomial methods for estimation and inference for RD designs with multiple cutoffs.
- `rdpower`: Power and sample size calculations using robust bias-corrected local polynomial inference methods.

Further details, including how to install the packages in both `R` and `Stata` may be found at:

`https://rdpackages.github.io`

Replication files in both `R` and `Stata` for all the empirical analyses in Cattaneo, Idrobo and Titiunik (2020) and Cattaneo, Idrobo and Titiunik (2022) may be found at:

`https://github.com/rdpackages-replication/CIT_2020_CUP`

Please make sure you have `Stata` or `R` and the above modules/commands installed and fully functional in your personal computer before the course begins. Datasets, do-files and `R` files will be provided in advance.

4.1 Software installation instructions

If you will be using R, I suggest also installing RStudio. To install these programs, follow the instructions below:

1. Download the most recent version of R and install it in your computer. R is free and available for Windows, Mac, and Linux operating systems. Download the version of R compatible with your operating system from CRAN. If you are running Windows or MacOS, you should choose one of the precompiled binary distributions (i.e., ready-to-run applications) that are linked at the top of the page, *not* the source codes.

2. Download and install R Studio. This is an integrated development environment (IDE) that includes a console, a syntax-highlighting editor, and other tools for plotting, history, debugging and workspace management for R use. RStudio is free and available for Windows, Mac, and Linux platforms.

If you are using Stata, you will have to obtain a license from here. Stata is licensed through StataCorp and is frequently offered at a significant discount through academic institutions to their employees and students. Seminar participants who are not yet ready to purchase Stata could take advantage of StataCorp's 30-day software return policy and obtain the latest version of Stata on a trial basis in the weeks immediately preceding this course. Use this link for 30-day trial copy: http://www.stata.com/customer-service/evaluate-stata/

4.2 Package installation instructions

You will need to install the following packages: rdrobust, rddensity, rdlocrand, rdpower and rdmulti.

In R, make sure you have an internet connection and then launch R Studio. Copy the following line of text and paste them in to R's command prompt (located in the window named "Console"):

```
install.packages("rdrobust")

install.packages("rddensity")

install.packages("rdlocrand")

install.packages("rdpower")

install.packages("rdmulti")
```

In Stata, make sure you have an internet connection and then type:

```
net install rdrobust, from(https://raw.githubusercontent.com/rdpackages/rdrobust/master/stata) replace

net install rddensity, from(https://raw.githubusercontent.com/rdpackages/rddensity/master/stata) replace

net install rdlocrand, from(https://raw.githubusercontent.com/rdpackages/rdlocrand/master/stata) replace

net install rdpower, from(https://raw.githubusercontent.com/rdpackages/rdpower/master/stata) replace

net install rdmulti, from(https://raw.githubusercontent.com/rdpackages/rdmulti/master/stata) replace
```

5 Outline, Schedule & Background References

This section gives an overview of the topics covered. The schedule is only tentative; the exact pace of the course will adapt to students' needs and is thus subject to change. We also provide optional readings (whenever possible only review papers are cited for brevity).

Day 1 (Tuesday, October 3, 2023)

Introduction to Sharp RD design and graphical illustration. Continuity based framework: estimands, identification assumptions, and point estimation.

- Sharp RD design: introduction and graphical illustration with RD plots.
- Continuity based RD analysis: estimands and identification.
- Estimation of RD effects with local polynomials.
- Optimal bandwidth selection.

Assigned Reading: Cattaneo, Idrobo and Titiunik (2020), Chapters 1, 2, 3, and Sections 4.1 and 4.2 in Chapter 4.

Day 2 (Wednesday, October 4, 2023)

Continuity based framework, continued: robust inference based on local polynomials. Introduction to local randomization framework: estimands, window selection, estimation and inference.

- Continuity based RD analysis, continued:
  - Robust confidence intervals based on local polynomials
- Local Randomization RD analysis
  - Inferences based on Fisherian methods
  - Window selection based on covariates
  - Inferences based on large-sample methods

Assigned Readings: Cattaneo, Idrobo and Titiunik (2020), Chapter 4. Cattaneo, Idrobo and Titiunik (2022), Chapter 2.

Day 3 (Thursday, October 5, 2023): RD local randomization analysis, RD falsification methods, and extensions to canonical RD design

Falsification of RD assumptions: density and covariate balance tests. The RD design under imperfect compliance.

Assigned Readings: Cattaneo, Idrobo and Titiunik (2020), Chapter 5; Cattaneo, Idrobo and Titiunik (2022), Chapter 3.

References

Calonico, Sebastian, Matias D. Cattaneo and Rocio Titiunik. 2014. "Robust Data-Driven Inference in the Regression-Discontinuity Design." *Stata Journal* 14(4):909–946.

Calonico, Sebastian, Matias D. Cattaneo and Rocio Titiunik. 2015. "`rdrobust`: An R Package for Robust Nonparametric Inference in Regression-Discontinuity Designs." *R Journal* 7(1):38–51.

Cattaneo, Matias D., Michael Jansson and Xinwei Ma. 2018. "Manipulation Testing based on Density Discontinuity." *Stata Journal* 18(1):234–261.

Cattaneo, Matias D., Nicolás Idrobo and Rocío Titiunik. 2020. *A Practical Introduction to Regression Discontinuity Designs: Foundations*. Cambridge Elements: Quantitative and Computational Methods for Social Science, Cambridge University Press.

Cattaneo, Matias D., Nicolás Idrobo and Rocío Titiunik. 2022. *A Practical Introduction to Regression Discontinuity Designs: Extensions*. In preparation for Cambridge Elements: Quantitative and Computational Methods for Social Science, Cambridge University Press.

Cattaneo, Matias D. and Rocío Titiunik. 2022. *Annual Review of Economics* 14:821–851.

Cattaneo, Matias D., Rocio Titiunik and Gonzalo Vazquez-Bare. 2016. "Inference in Regression Discontinuity Designs under Local Randomization." *Stata Journal* 16(2):331–367.

Imbens, Guido and Thomas Lemieux. 2008. "Regression Discontinuity Designs: A Guide to Practice." *Journal of Econometrics* 142(2):615–635.

Lee, David S. and Thomas Lemieux. 2010. "Regression Discontinuity Designs in Economics." *Journal of Economic Literature* 48(2):281–355.

Wooldridge, J.M. 2010. *Econometric Analysis of Cross-Section and Panel Data*. Cambridge, MA: MIT Press.