# ECON 1123 Section 9

**Slides at github.com/cjleggett/1123-section**

# Outline

- Name Circle
- Problem Set Feedback
- Lecture Recap / Questions + Practice Problems
  - Weak Instruments
  - Intrinsic Heterogeneity
  - J Statistics

# Name Circle

# Name Circle

- Name
- Something you’re bad at

# Problem Set Feedback

# Problem Set 8 Feedback

- LATE vs. ATE: Go through the steps!
- Let’s practice

# Which is Bigger, LATE or ATE?

1. Explain why ATE is not equal to LATE
2. Use intuition to think of who the compliant people (grasshoppers) are
3. Use intuition to decide whether treatment effect is higher or lower for compliant people (grasshoppers) and form conclusion

Let’s think about this for last problem: instruments of **twoboys** and **twogirls**

# 1: Why are we not in special case?

- $\pi_{1i}$ does not vary
- $\beta_{1i}$ does not vary
- $cov(\pi_{1i}, \beta_{1i}) = 0$

- Why does gender affect fertility differently for different people?
- Why does number of children affect workforce participation differently for different people?
- Why might the above two be related?

# Step 2: Identify Compliant Subjects

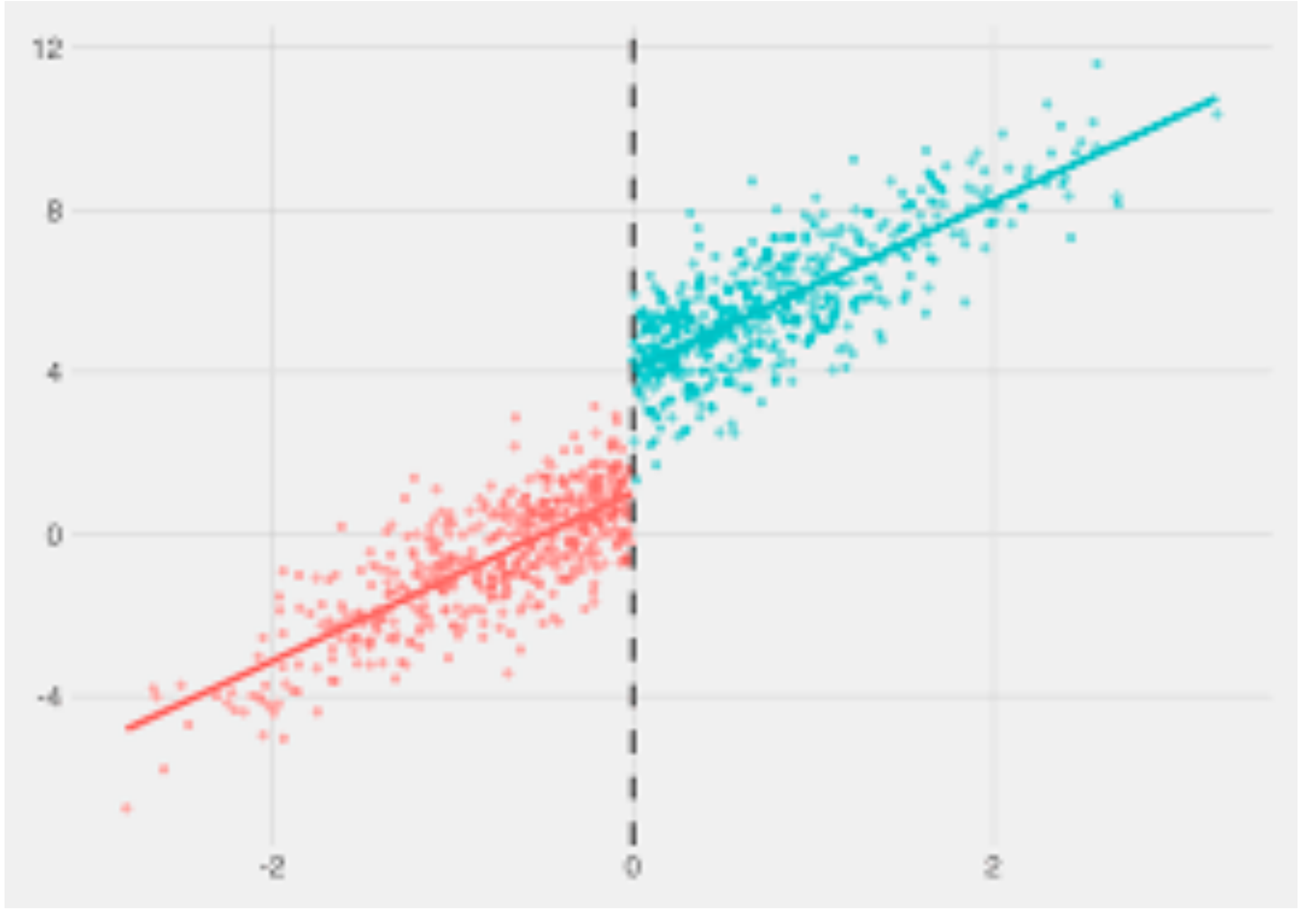
- Who are the grasshoppers?
- For whom does the instrument have the greatest effect on the treatment?
- What kinds of people will choose whether to have a third child based on genders of their first two?

# Step 3: Compare compliant to population

- Is the effect of the treatment on the outcome larger or smaller for grasshoppers?
- For people who care about the gender of their first children, do we think having a third child affects their workforce participation more or less than for people who don’t care about the gender?

# Lecture Recap

# Regression Discontinuity



# Running Example: Connor University

- Free to all students
- Located in Gilford, NH
- One of the best-known schools in the world
- Has a screening process for applicants: Must have at least 1200 SAT score

# Fuzzy vs. Sharp Regression Discontinuity

- Sharp: Treatment **always** applied on one side, **never** applied on the other (Everyone is compliant)
- Fuzzy: Probability of treatment changes over threshold

# Exercises: Part 1

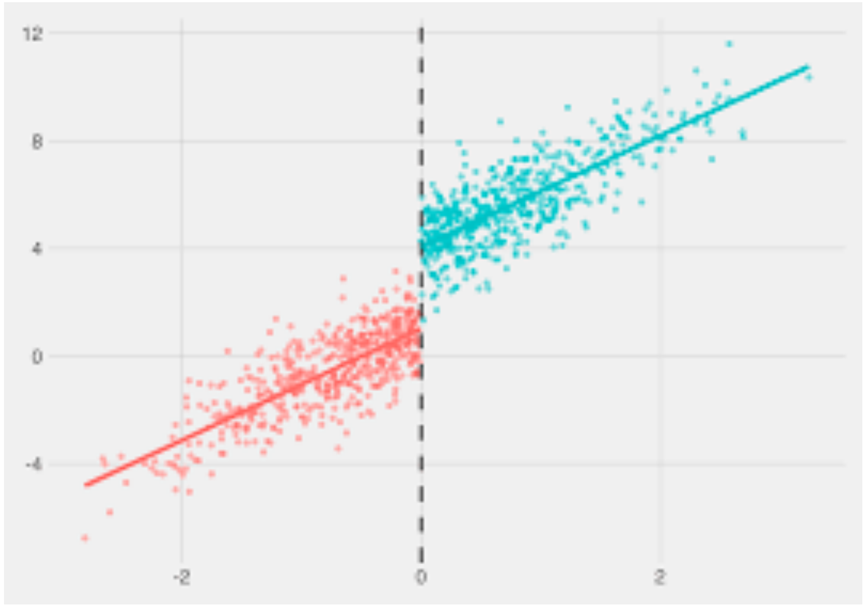
# Fuzzy RD as instrumental variables

- In the fuzzy case, we can think of this as a case of instrumental variables
- Instrument is crossing the threshold
- We can use similar analysis as in 2SLS
- But we have to control for slopes on either side of the regression:

$$Y_i = \beta_0 + \beta_1 Z_i + \beta_2 X_i + \beta_3 Z_i \times X_i + u_i$$

$$Y_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 W_i + \alpha_3 Z_i \times W_i + u_i$$

Y

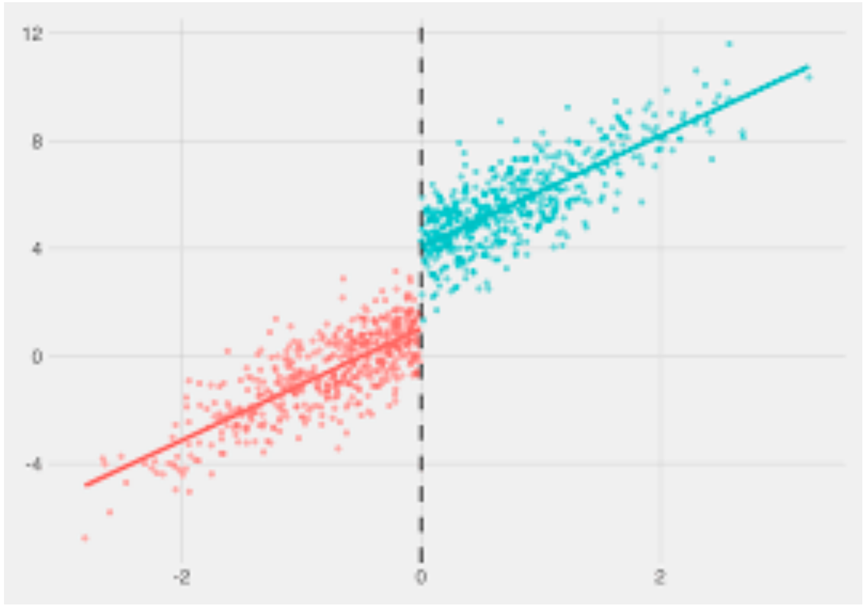



W

W = SAT Score
Y = Income
Z = ?

$$Y_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 W_i + \alpha_3 Z_i \times W_i + u_i$$

Y




W

W = SAT Score

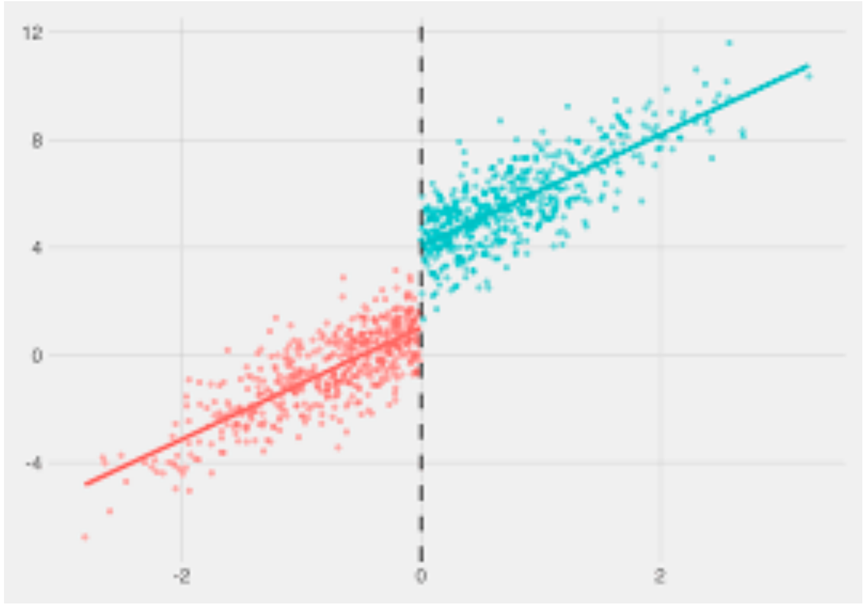
Y = Income

Z = SAT Score > 1200

$$Y_i = \alpha_0 + \alpha_1 Z_i + \boxed{\alpha_2 W_i} + \boxed{\alpha_3 Z_i \times W_i} + u_i$$

Control Terms

Y

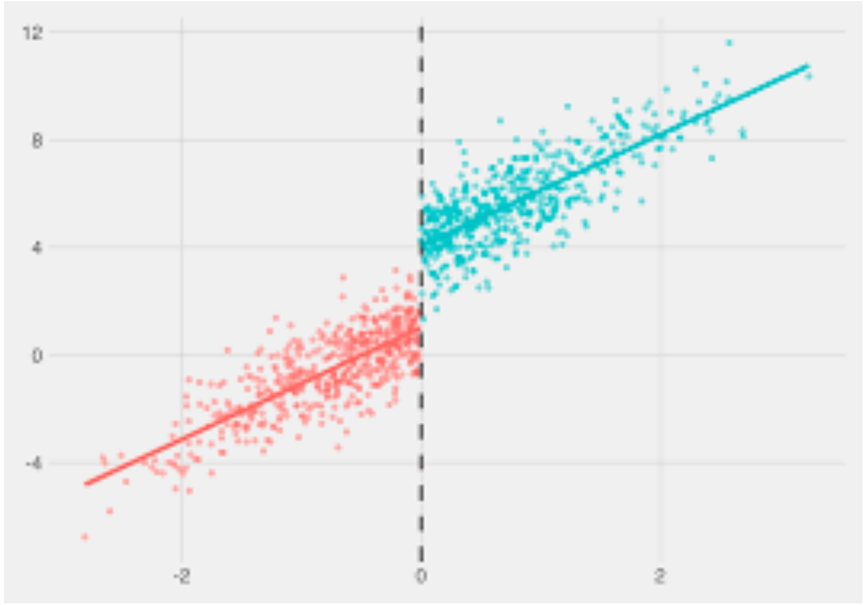



W

$$Y_i = \alpha_0 + \boxed{\alpha_1 Z_i} + \alpha_2 W_i + \alpha_3 Z_i \times W_i + u_i$$

RD Term

Y




W

# Reduced-Form

$$Y_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 W_i + \alpha_3 Z_i \times W_i + u_i$$

RD Term  Control Terms

# First-Stage

$$X_i = \pi_0 + \pi_1 Z_i + \pi_2 W_i + \pi_3 Z_i \times W_i + u_i$$

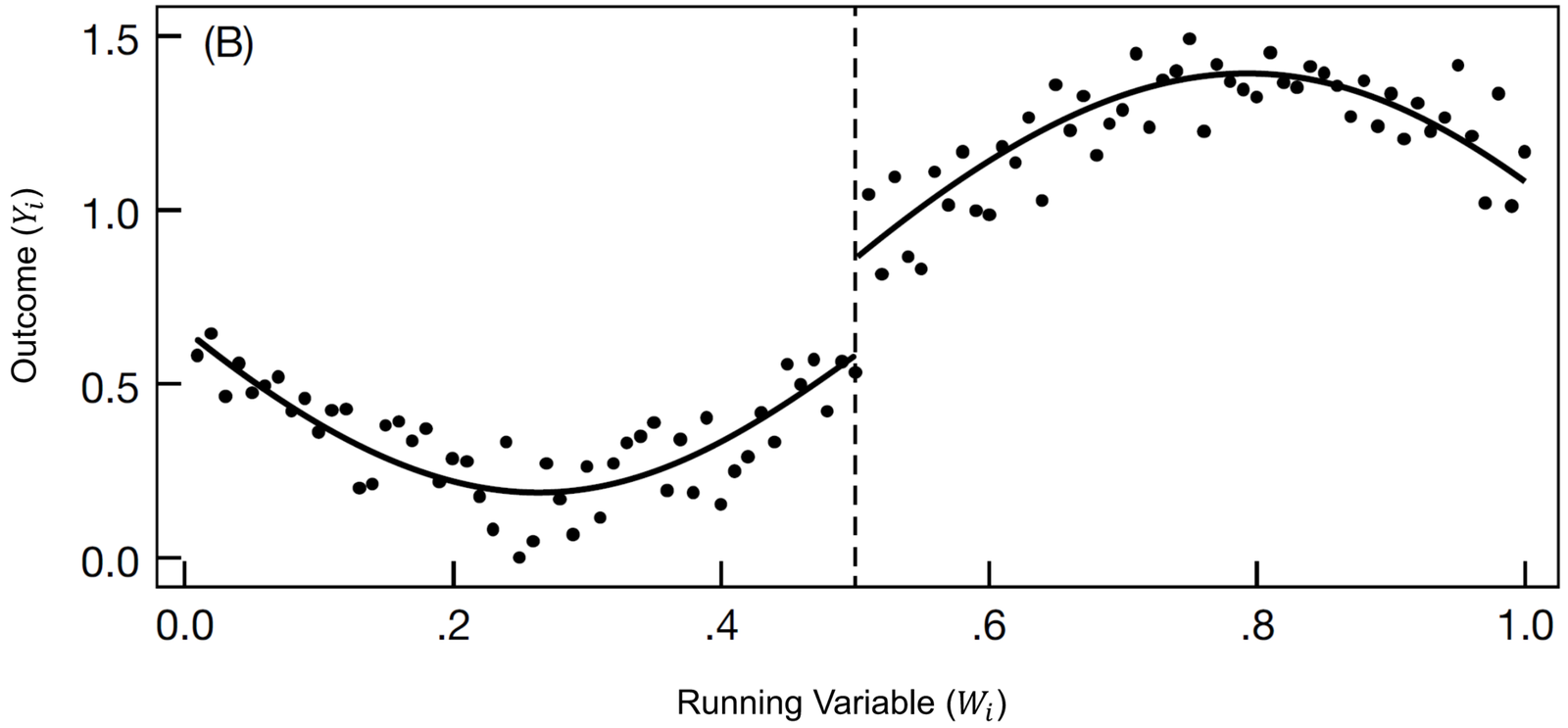
# 2SLS

$$Y_i = \beta_0 + \beta_1 \hat{X}_i + \beta_2 W_i + \beta_3 Z_i \times W_i + u_i$$

$$\beta_1 = \frac{\alpha_1}{\pi_1}$$

# Non-Linear Control Function

- Must include new term
- Must include interaction between new term and instrument



# Exercises: Part 2

# Validity

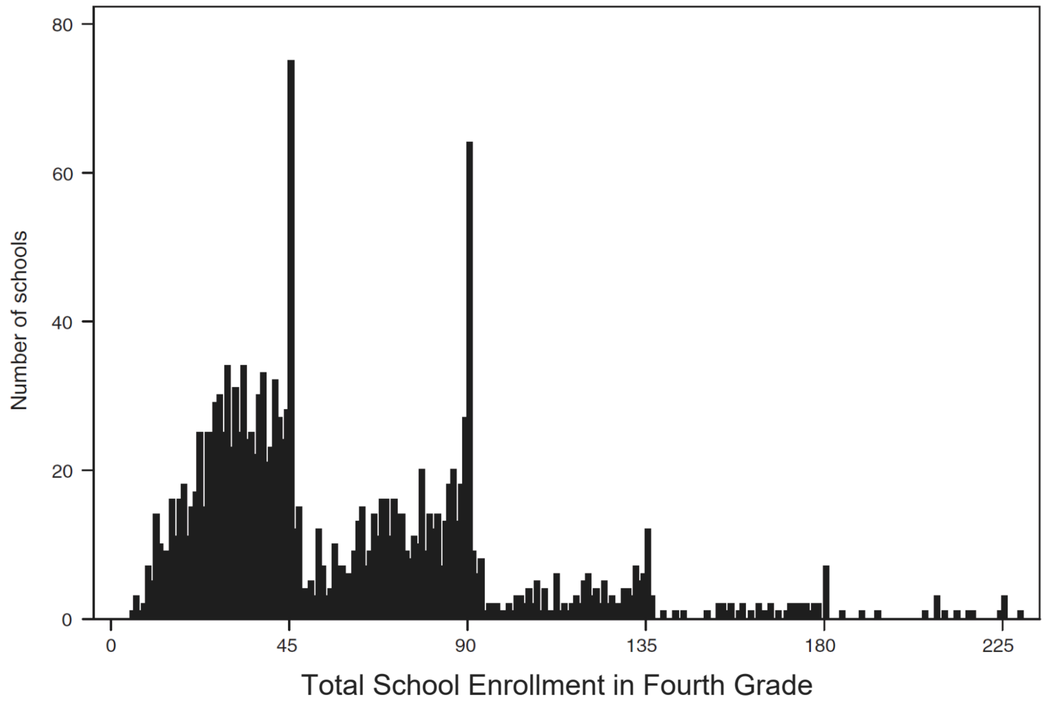
- Relevance: Does probability of treatment change at threshold?
- Exogeneity:
  - Distribution of other characteristics evolve smoothly over the threshold
  - Exceeding threshold only affects outcome through treatment.
    - When is this not the case?

# Visualizations

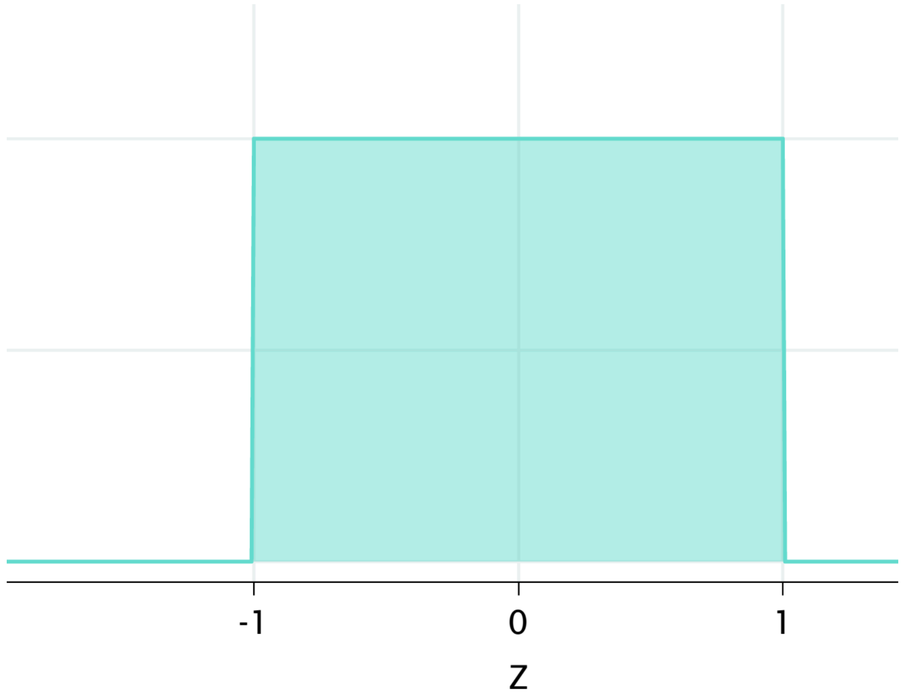
- Visuals are extremely important!
- First steps in any RD Problem:
  - Scatterplot of Running Variable on Treatment
  - Scatterplot of Running Variable on Outcome
  - Scatterplots of Running Variable on Other Variables
  - There should be jumps at the threshold for first two, not for the third

# Alternative to Parametric Models: Kernels

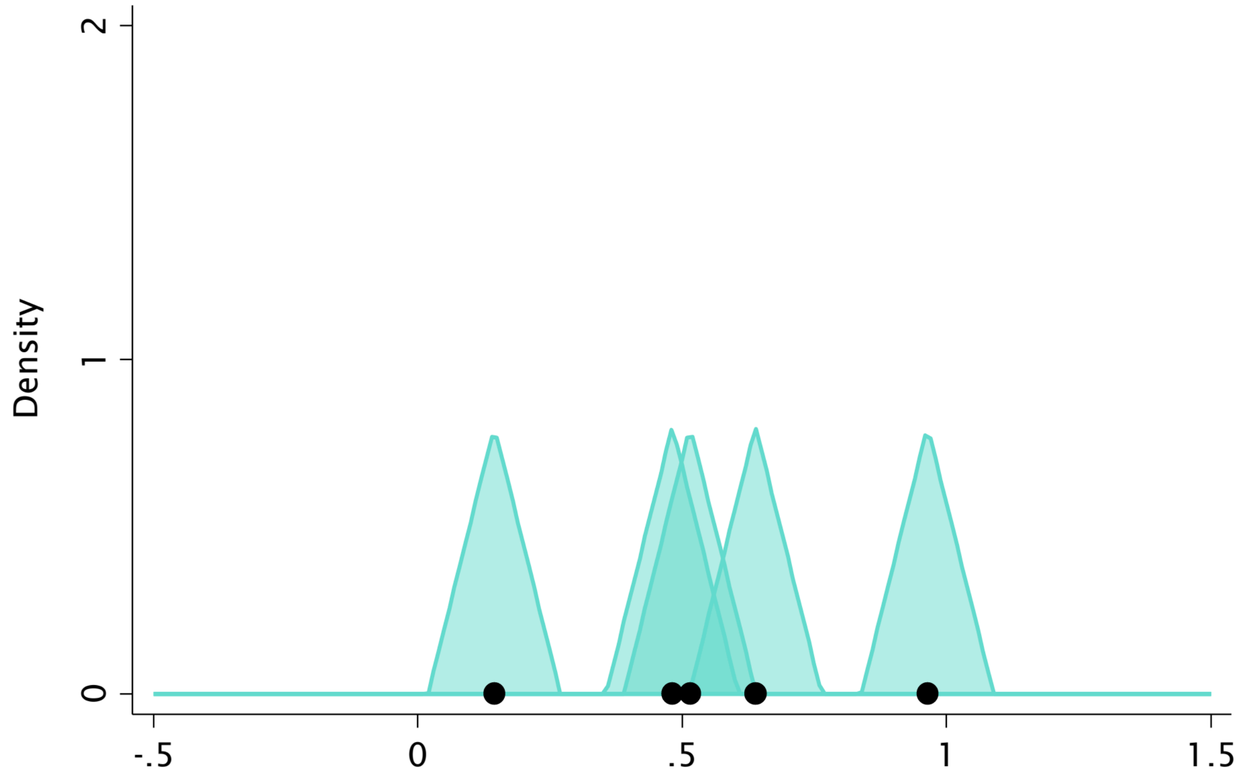
- We smooth this distribution out by applying different weights to data points near a value



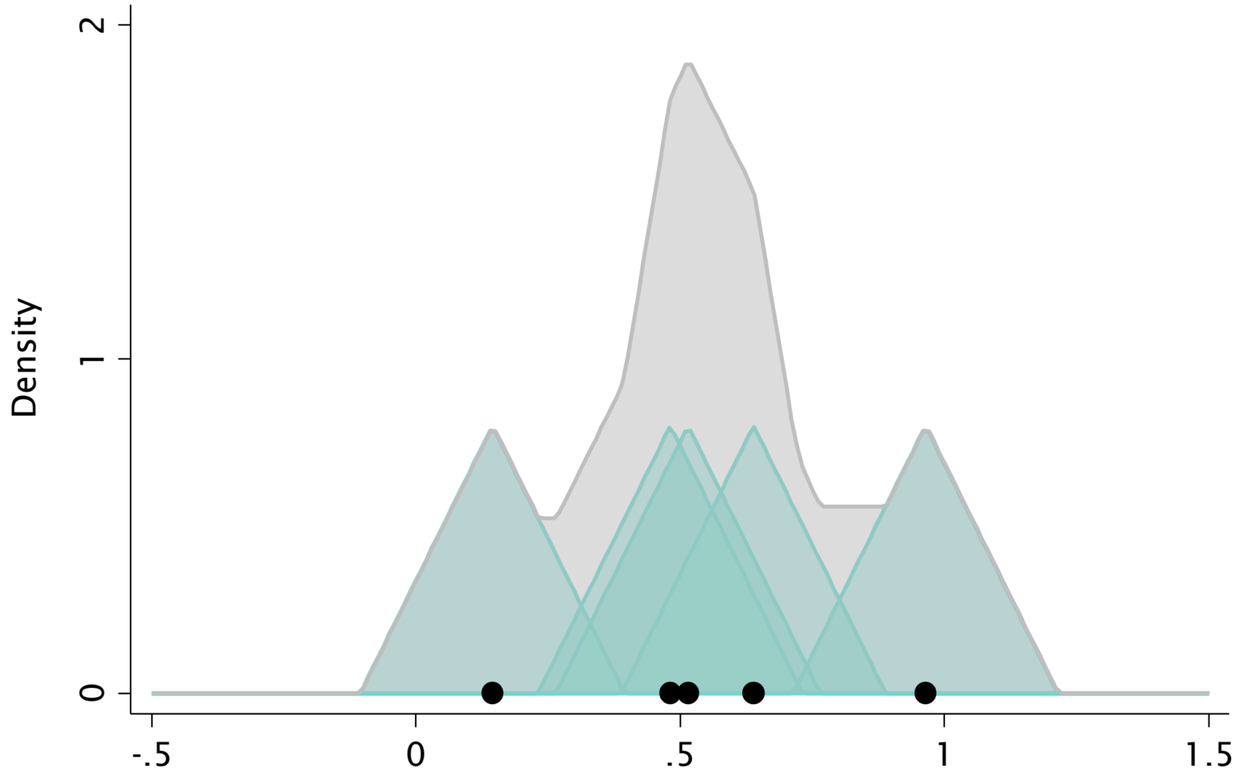
# Uniform Kernal (Same as in Histogram)



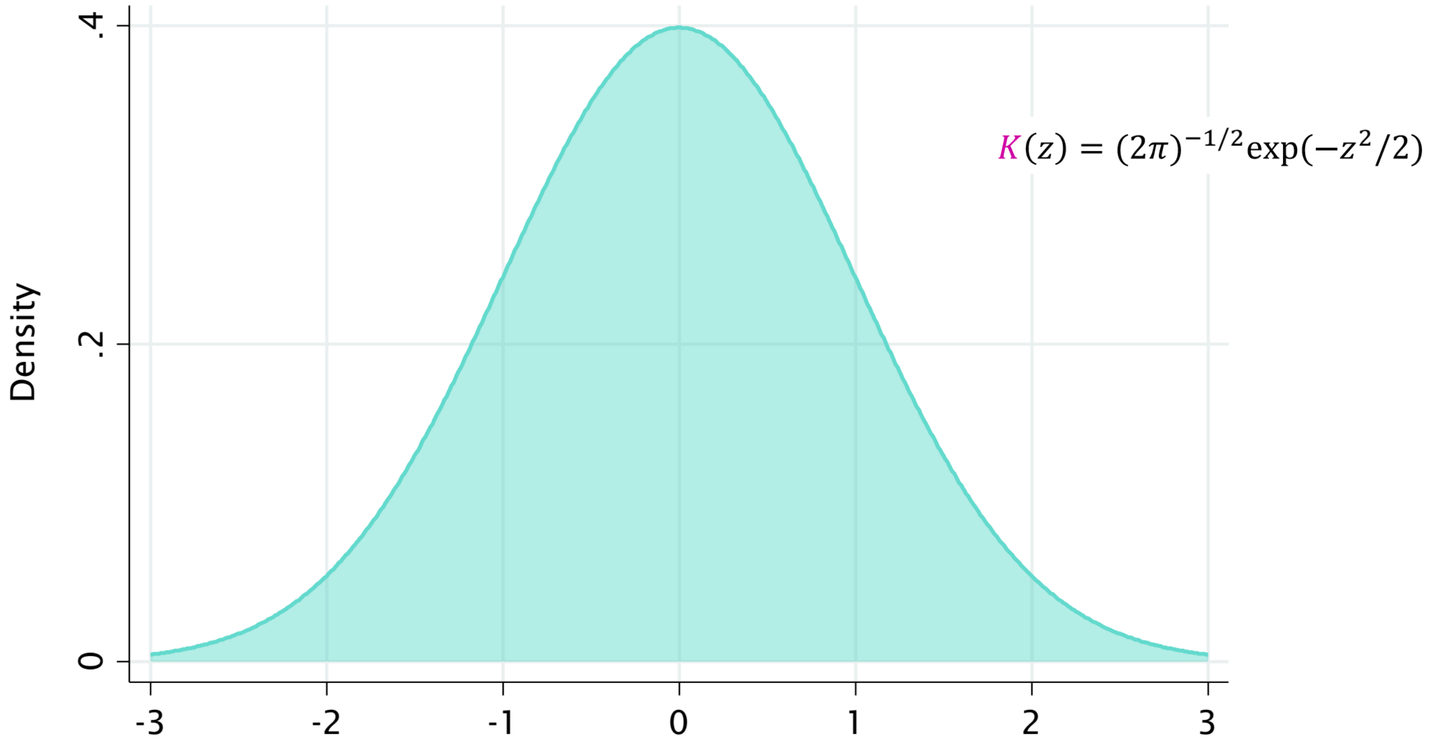
# Triangular



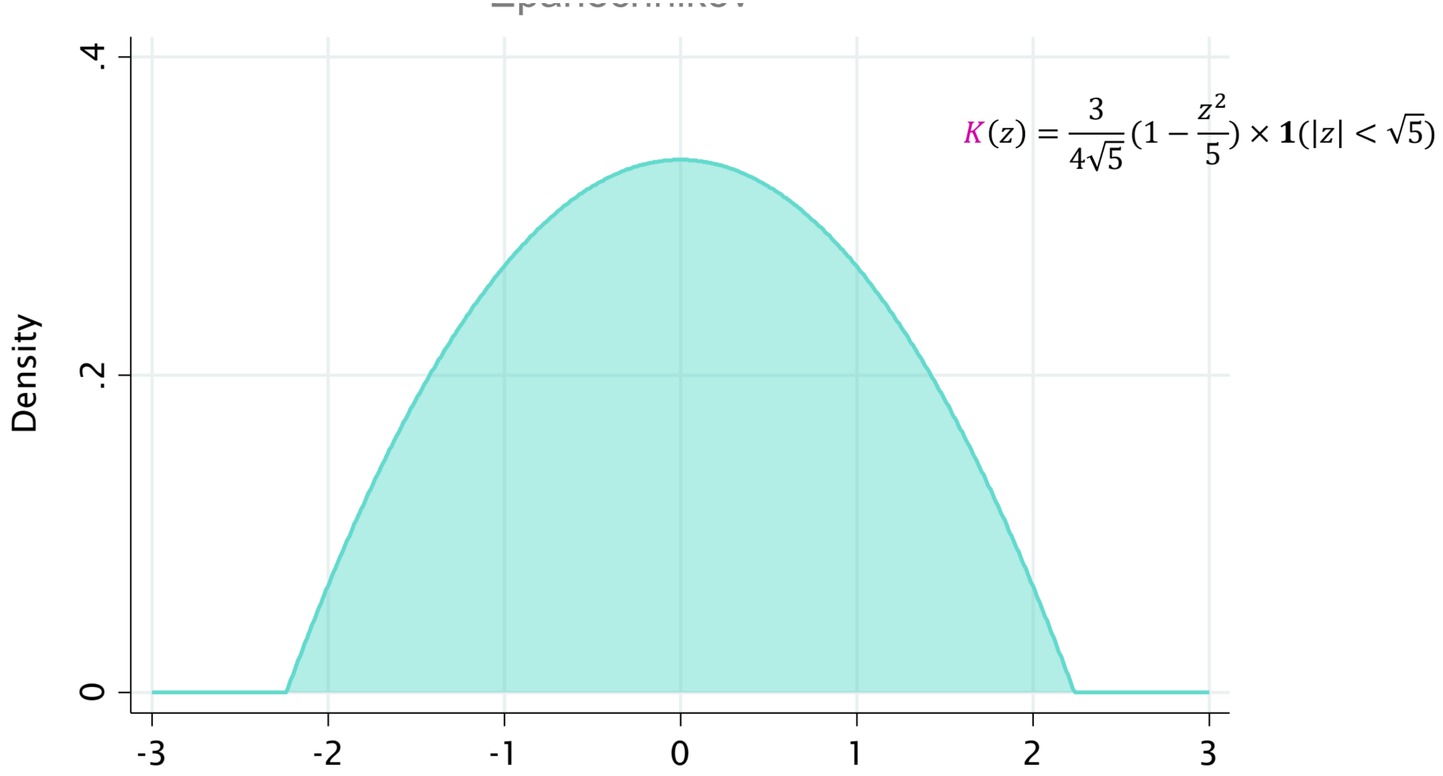
# Triangular



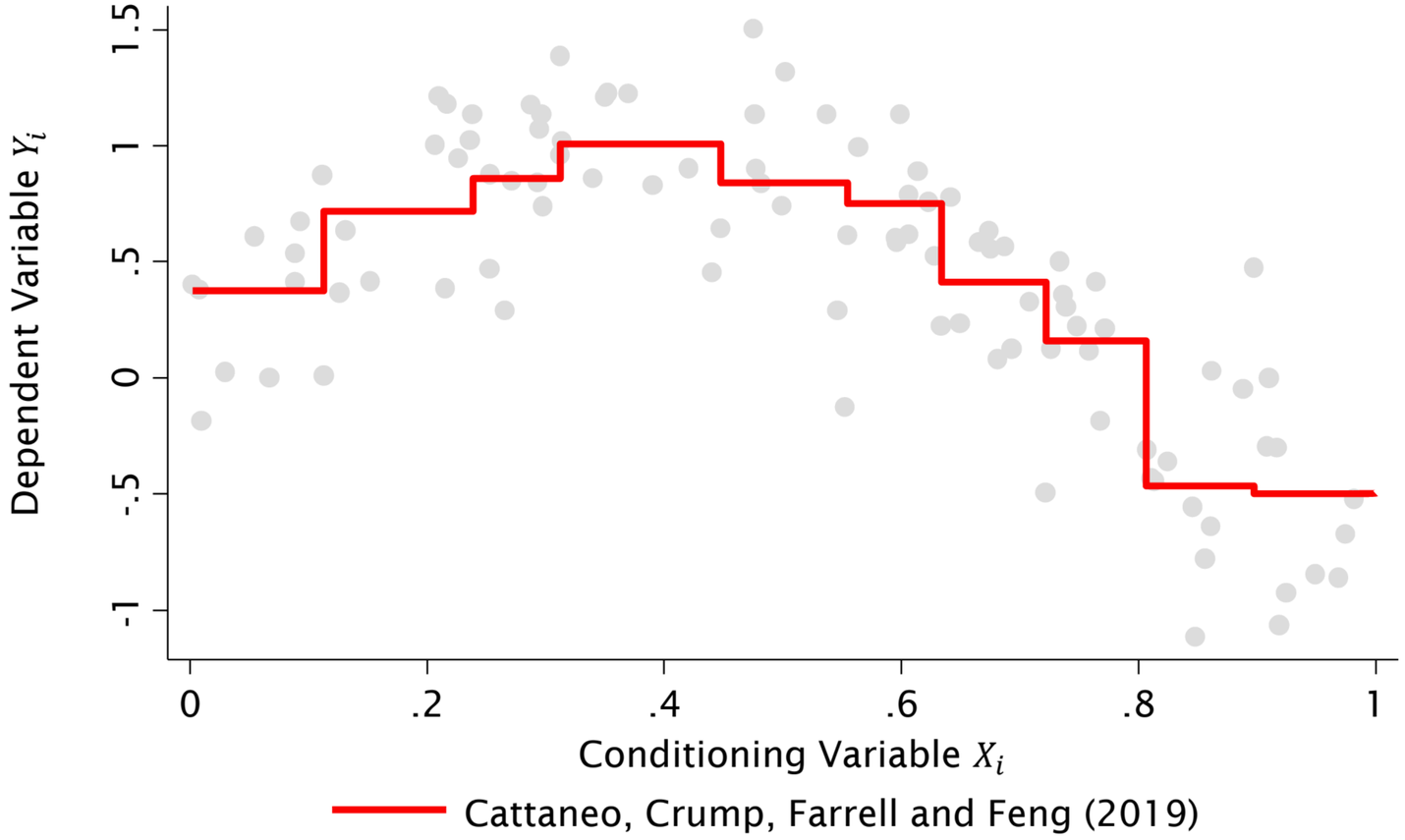
# Gaussian



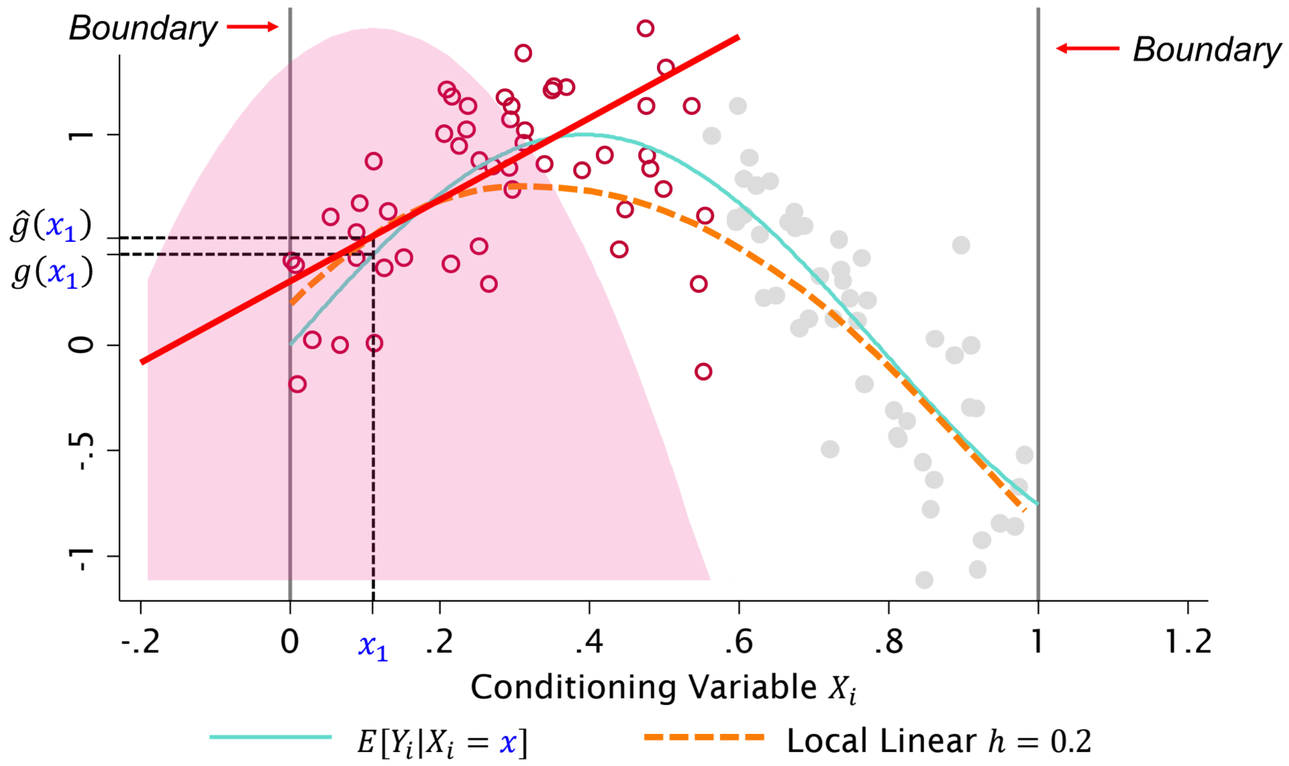
# Epinechnikov

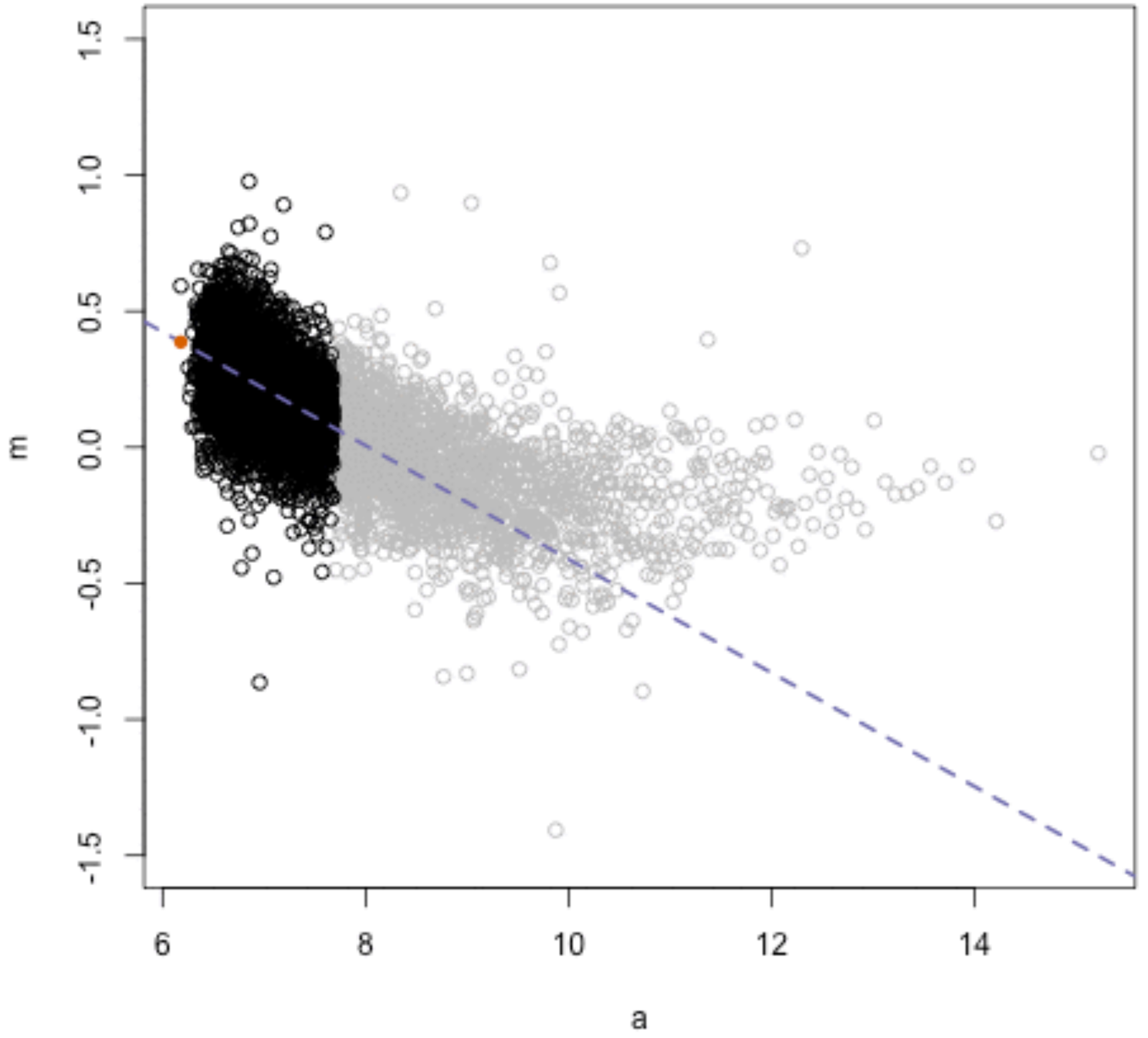


# Regression with histogram of means



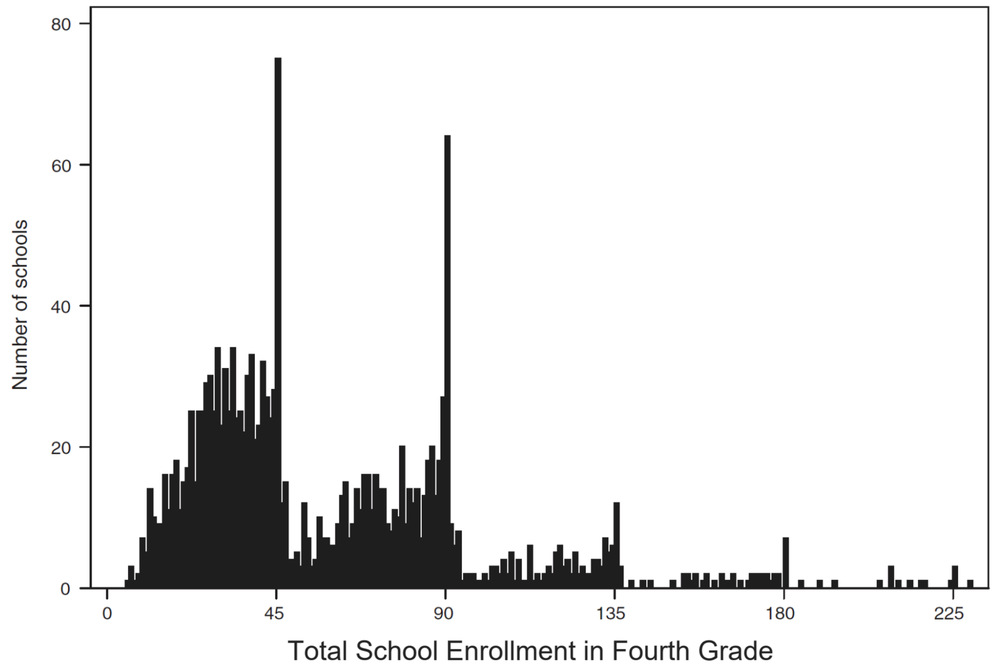
# Local Linear Regression




m
a
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
6
8
10
12
14

# Manipulation of the Running Variable

- If a treatment changes at a threshold, people will try to be on the “better” side.
- This can invalidate RD design
- We check for this by plotting a histogram and running a McCrary Test



# McCrary Test

- Null Hypothesis: The data evolves smoothly across the threshold
- Alternative Hypothesis: There is evidence of manipulation of the variable, so there are artificially more observations on one side of the threshold
- Critical Value: 1.96

# McCrary Test: Process

1. Build a histogram of the data, splitting it into $b_n$ bins
2. Build separate local linear regressions: one on the left of the cutoff and one on the right.
    A. Center of histogram bins is regressor
    B. log(height of bins) is output
    C. Smoothing requires bandwidth $h_n$
3. Use difference in predicted values to search for discontinuity, comparing test statistic to 1.96

# Alternatives to McCrary Test

- Have to make choices about number of bins and bandwidth
- We can get around this with a state of the art method:

1. Build empirical CDF of data
2. Fit local quadratic regression to the CDF
3. Take the derivative to find the PDF
4. Now compare before/after the cutoff

# Exercises: Part 3

# What do we do when we reject?

- Choose Analysis Sample Carefully
- Re-define running variable
- Discard observations near cutoff

# Choose Analysis Sample Carefully

- Can you make cuts to your data such that the remaining data is not manipulated?
- Can’t just remove data points on one side!
- Example: Do only some people know about cutoffs? Can only some people choose whether to manipulate which side they’re on?

# Re-define running variable

- Choose an instrument for the current running variable
- Should be something that cannot be manipulated

# Discard Observations Near Cutoff

- Donut Method
- Helps because people often round values
- Need to be careful! RDD only valid at the cutoff

# Sensitivity Analysis

- We often have to make choices as researchers
- We hope these choices don’t mess with our results
- One way of checking this is trying a few different choices and checking if there’s a large difference in results
- For RD: often we’ll choose a bandwidth around the cutoff point.

# Exercises: Part 4 Example 1

# LATE vs. ATE at the Threshold

- For Fuzzy RD, there are compliers and non-compliers
- We can do the same thing as before and predict if LATE > ATE
- Let’s do this for our college example!

# Exercises: Part 4 Example 2