



THE WORLD BANK



Session V

Regression Discontinuity

(RD)

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Reminder: main objective of an evaluation.



- Estimate the effect of an intervention T on a results indicator Y

- For example:
 - What is the effect of an increase in the minimum wage on employment?
 - What is the effect of a school meals program on learning achievement?
 - What is the effect of a job training program on employment and on wages?

Regression discontinuity

- When to use this method?
 - The beneficiaries/non-beneficiaries can be ordered along a quantifiable dimension.
 - This dimension can be used to compute a well-defined index or parameter.
 - The index/parameter has a cut-off point for eligibility.
 - The index value is what drives the assignment of a potential beneficiary to the treatment. (or to non-treatment)

- Intuitive explanation of the method:
 - The potential beneficiaries (units) just above the cut-off point are very similar to the potential beneficiaries just below the cut-off point.
 - We compare outcomes for units just above and below the cutoff point.

Indexes are common in targeting of social programs

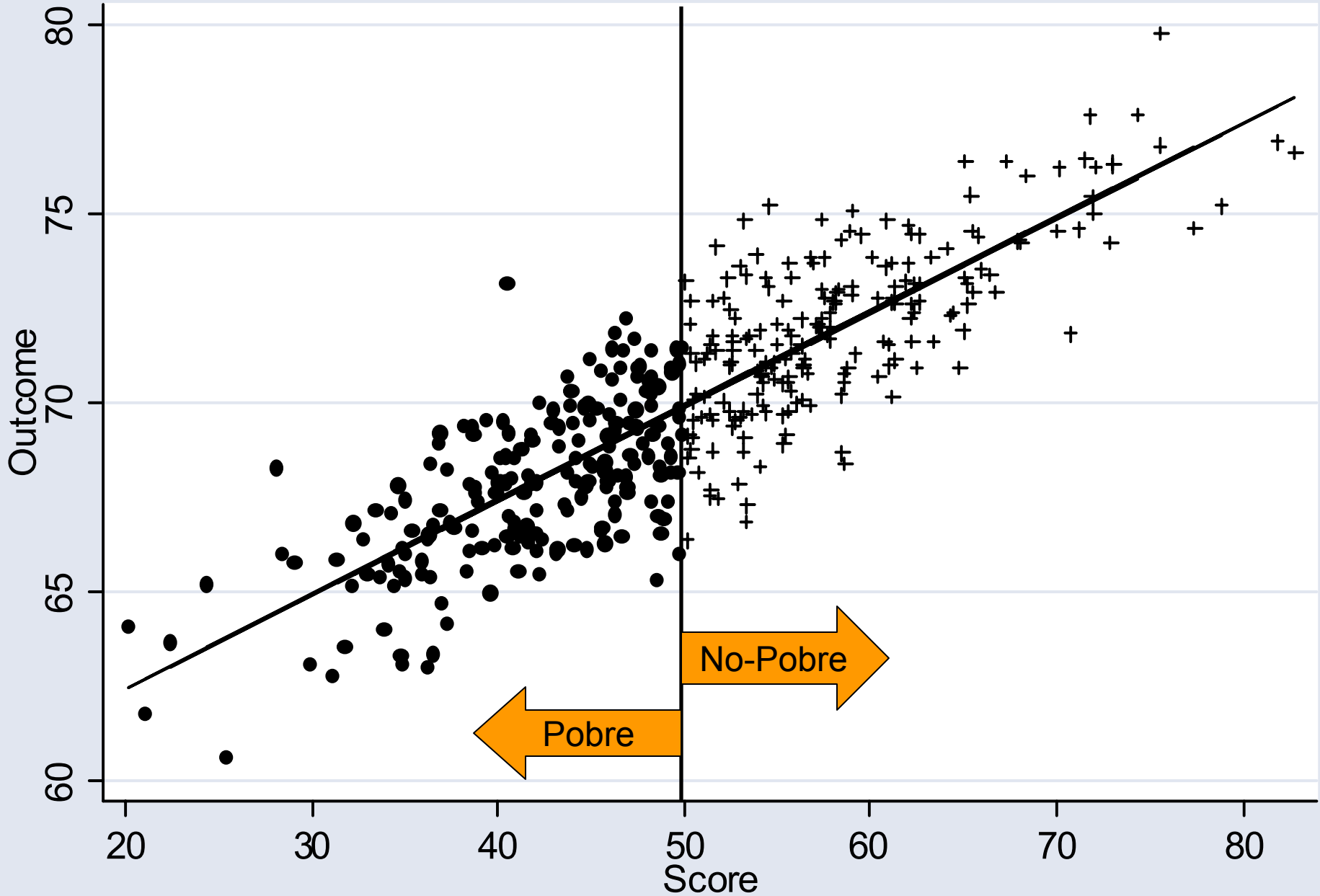


- Anti-poverty programs
 - ➔ targeted to households below a given poverty index
- Pension programs
 - ➔ targeted to population above a certain age
- Scholarships
 - ➔ targeted to students with high scores on standardized test
- CDD Programs
 - ➔ awarded to NGOs that achieve highest scores

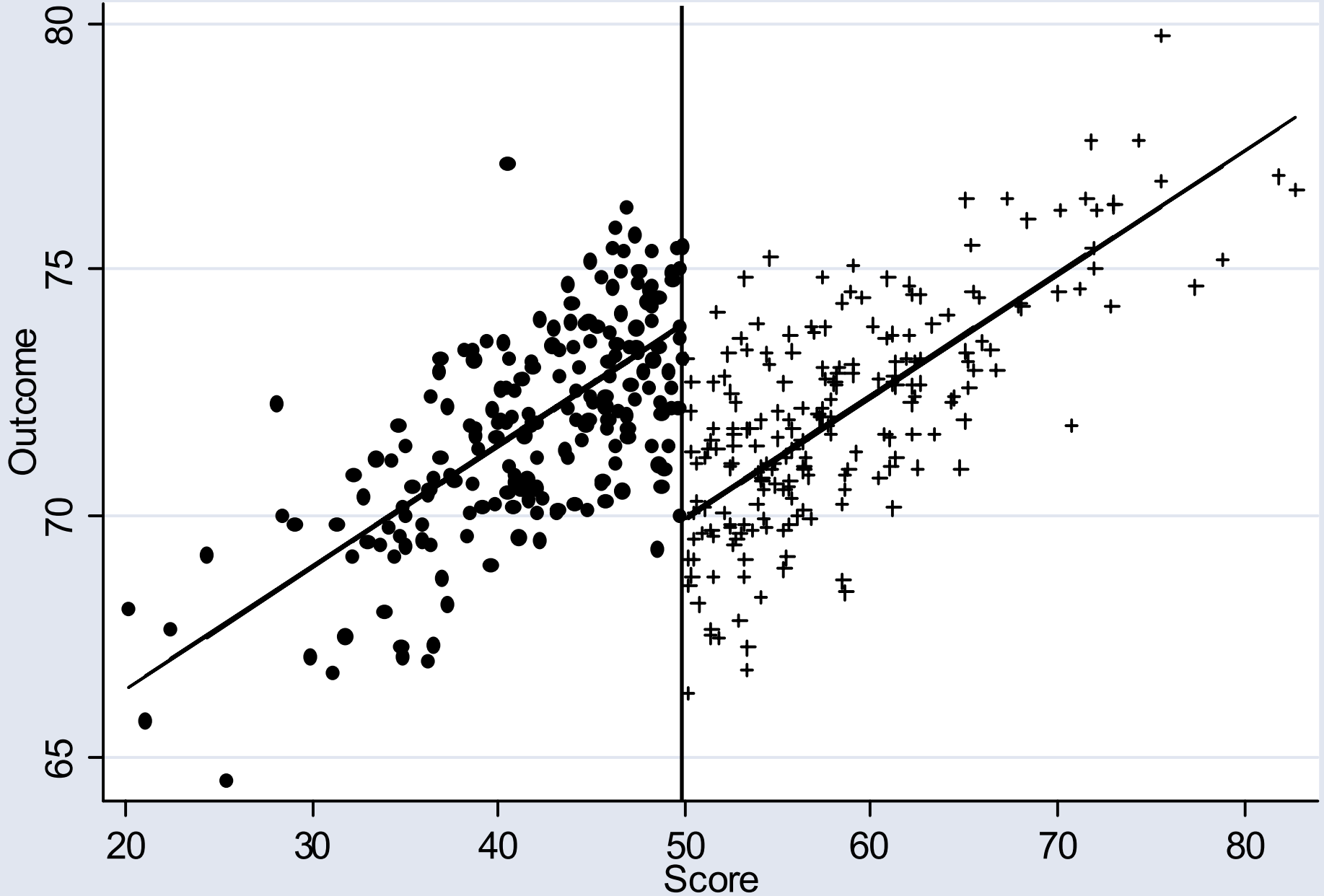
Example: effect of cash transfer on consumption

- **Goal:** Target transfer to poorest households
- **Method:**
 - Construct poverty index from 1 to 100 with pre-intervention characteristics
 - Households with a score ≤ 50 are poor
 - Households with a score > 50 are non-poor
- **Implementation:**
 - Cash transfer to poor households
- **Evaluation:**
 - Measure outcomes (i.e. consumption, school attendance rates) before and after transfer, comparing households just above and below the cut-off point.

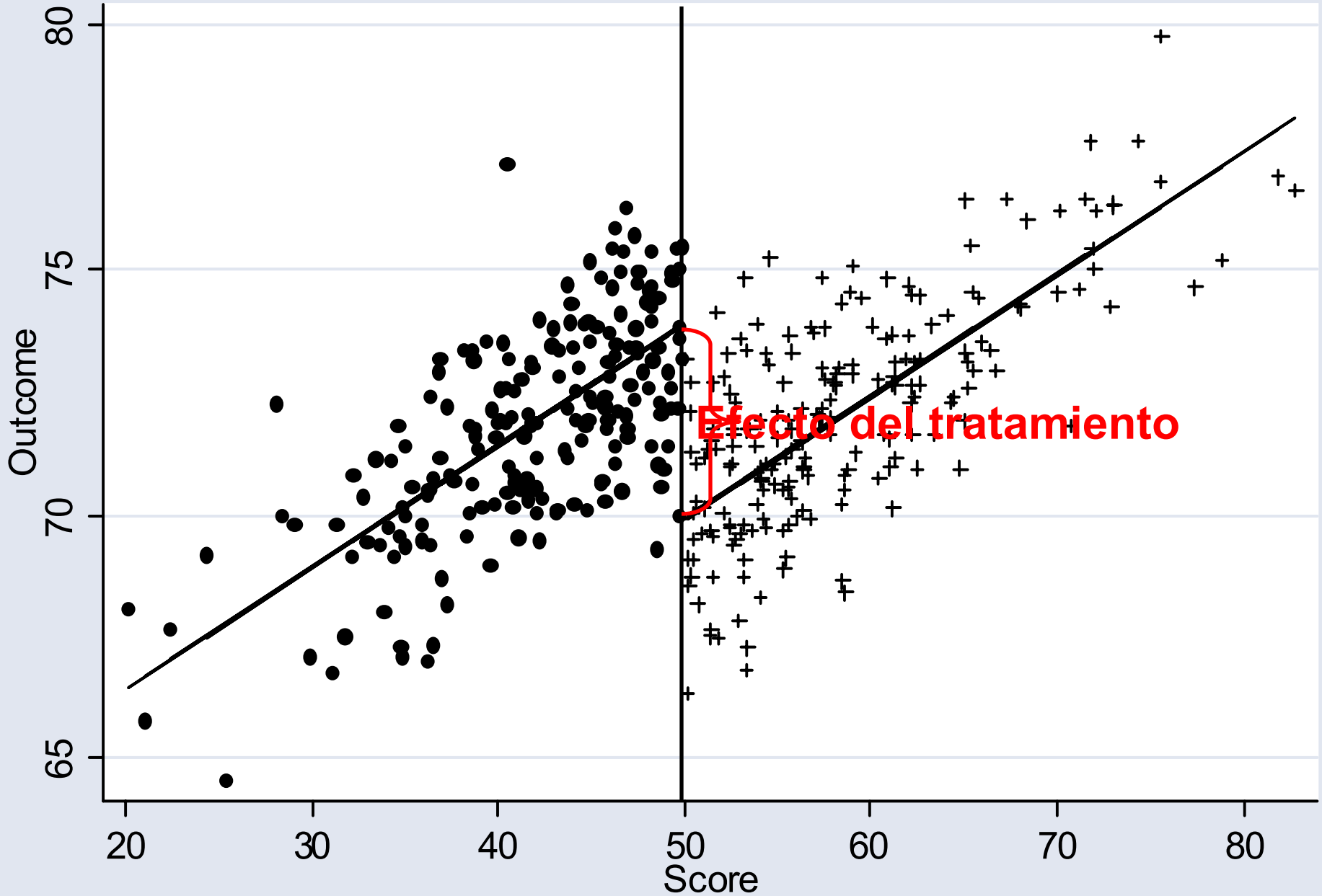
Regression Discontinuity Design - Baseline



Regression Discontinuity Design - Post Intervention



Regression Discontinuity Design - Post Intervention



Identification

$$y_i = \beta_0 + \beta_1 \text{Treatment}_i + \delta(\text{score}) + \varepsilon_i$$

Where:

- Treatment = 1 if score ≤ 50
- Treatment = 0 if score > 50
- $\delta(\text{score})$ is a function that is continuous around the cut-off point

Sharp and Fuzzy Discontinuity

□ Sharp discontinuity

- The discontinuity precisely determines treatment
- Equivalent to random assignment in a neighborhood
- E.g. Social security payment depend directly and immediately on a person's age

□ Fuzzy discontinuity

- Discontinuity is highly correlated with treatment .
- Use the assignment as an IV for program participation.
- E.g. Rules determine eligibility but there is a margin of administrative error.

Examples

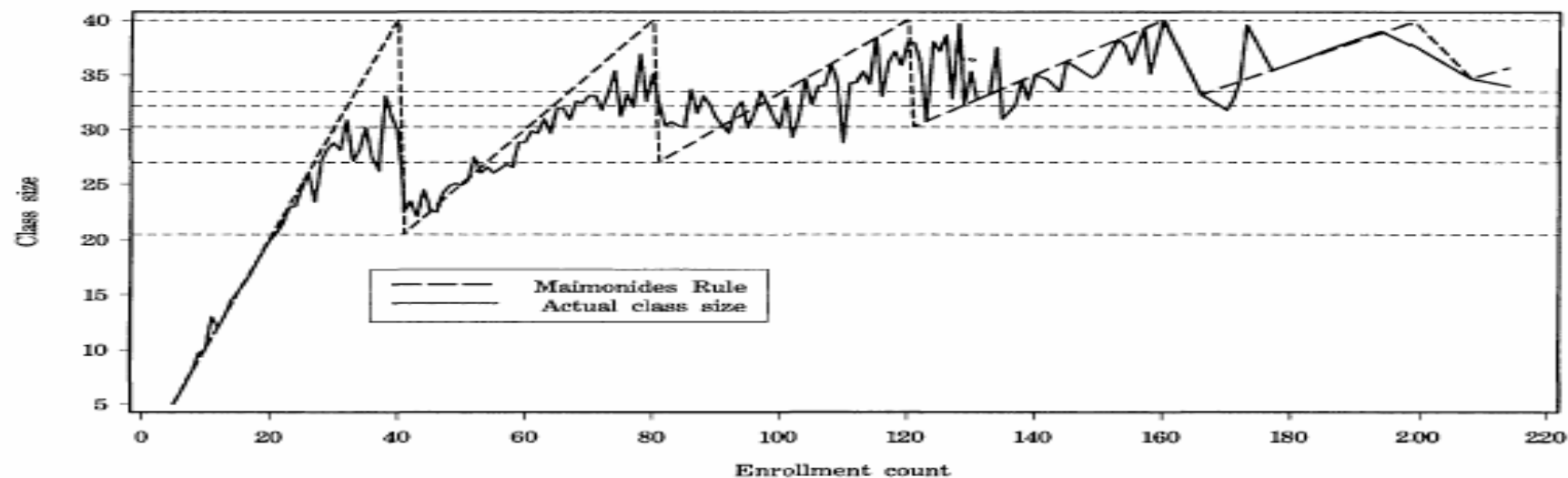
- ❑ Effect of class size on scholastic achievement
(Angrist and Lavy, 1999)
- ❑ Effect of transfers on labor supply
(Lemieux and Milligan, 2005)
- ❑ Effect of old age pensions on consumption -BONOSOL in Bolivia
(Martinez, 2005)
- ❑ The Effects of User Fee Reductions on School Enrollment
(Barrera, Linden y Urquiola, 2006)

Angrist & Lavy: Using Maimonides' Rule

- Effect of class size on learning outcomes – i.e. test scores in 3rd and 4th grade

- Use Maimonides rule
 - When there are fewer than 40 pupils: one class
 - When there are more than 40 pupils: split the group into two classes

a. Fifth Grade



b. Fourth Grade

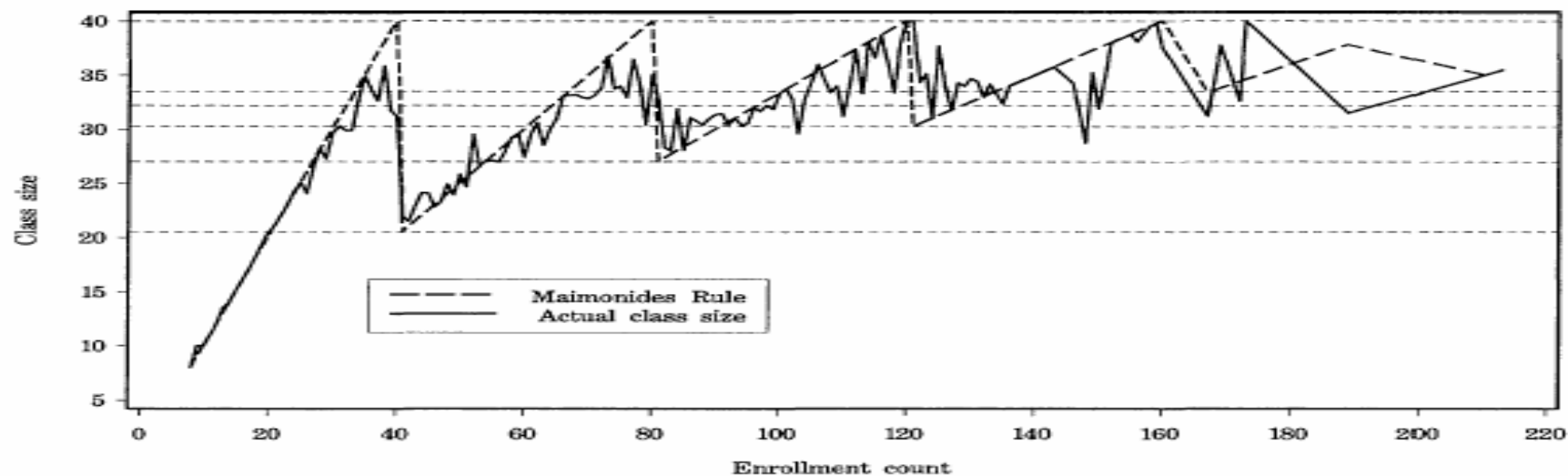


FIGURE I

Class Size in 1991 by Initial Enrollment Count, Actual Average Size and as Predicted by Maimonides' Rule

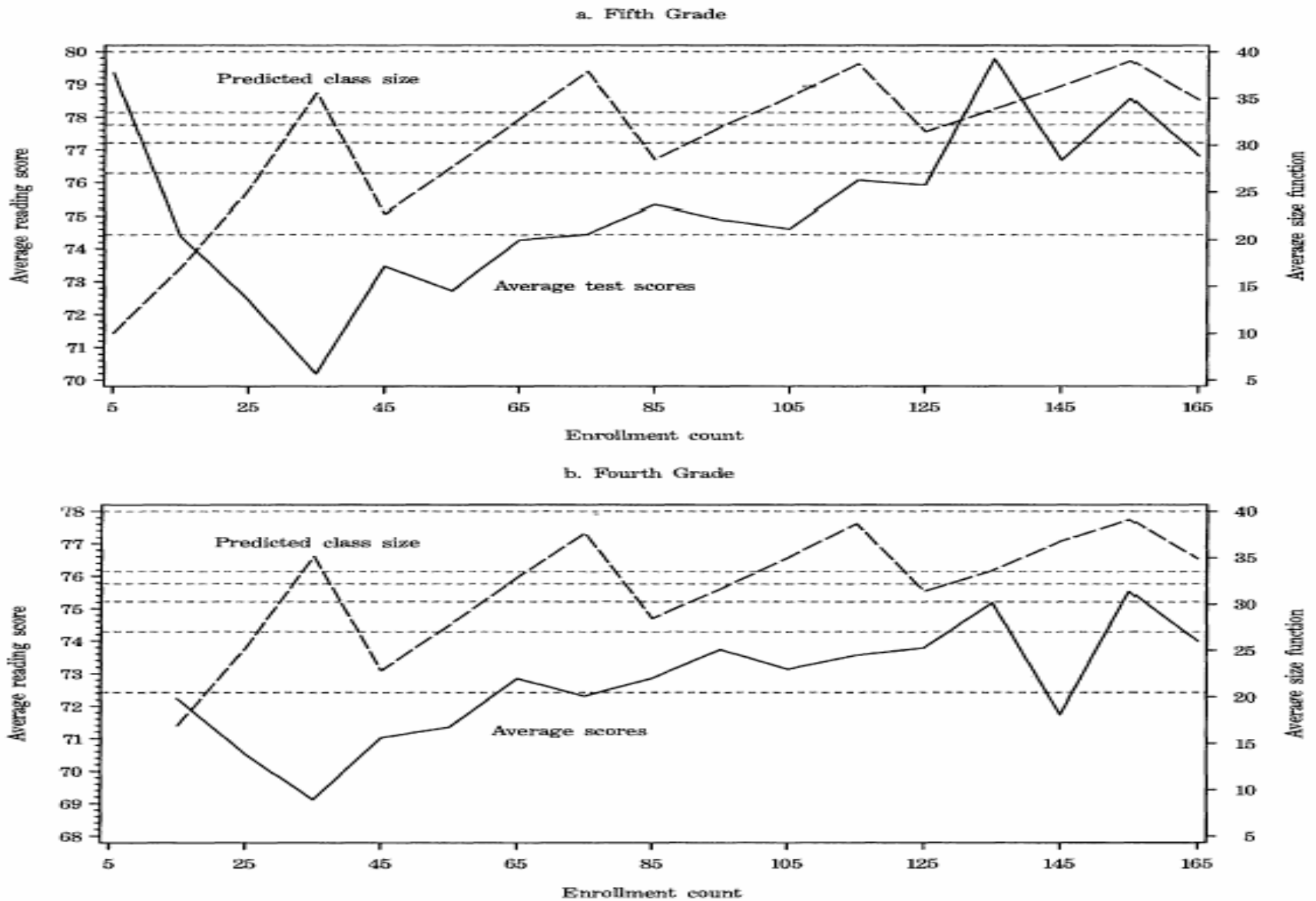


FIGURE II
Average Reading Scores by Enrollment Count, and the Corresponding Average Class Size Predicted by Maimonides' Rule

Angrist & Lavy: Using Maimonides' rule

- Maimonides' rule is not being used in all cases, e.g. there are classes of 42 pupils

- Fuzzy discontinuity \rightarrow instrumental variable instrumental
 - First use Maimonides' rule to predict the size of the class (T)
 - The explain the test results (y) with the predict class size (T hat)

Lemieux & Milligan: Incentive Effects of Social Assistance



- Social assistance to the unemployed:
 - Low social assistance payments to individuals under 30
 - Higher payments for individuals 30 and over

- What is the effect of increased social assistance on employment?

Figure 6: Social Assistance Income, Quebec 1986

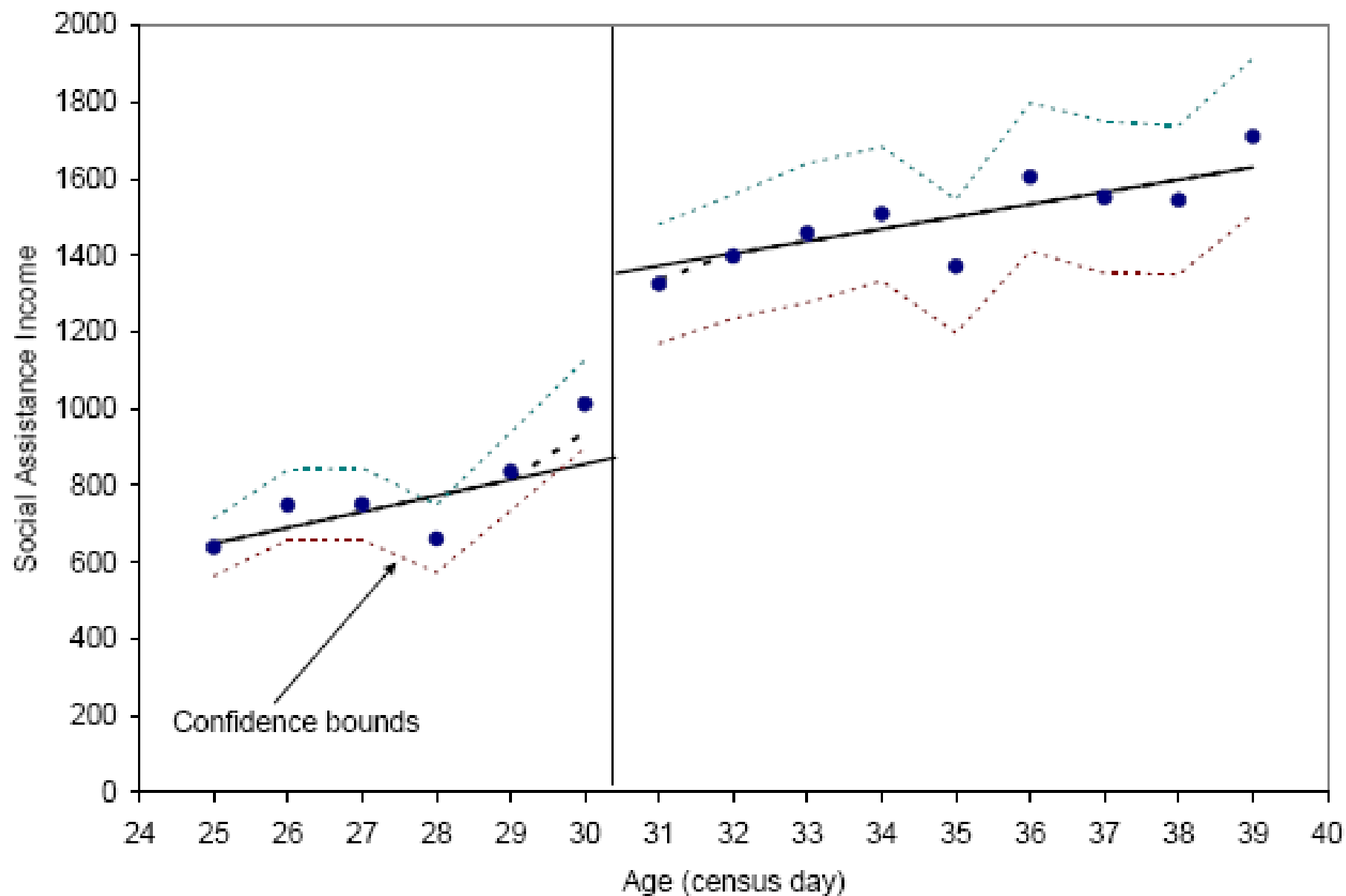
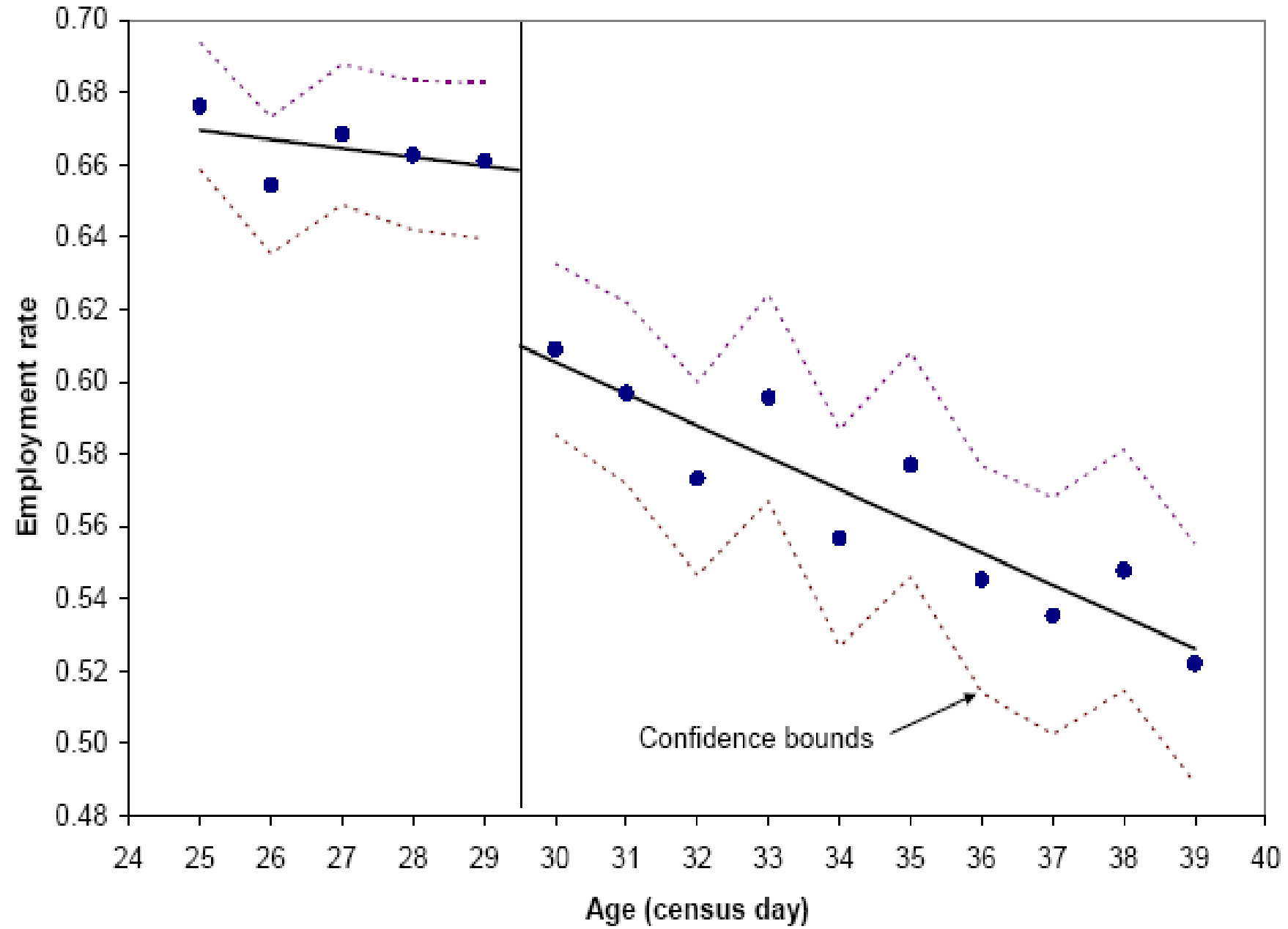


Figure 3: Employment Rate in Census Week, Quebec 1986



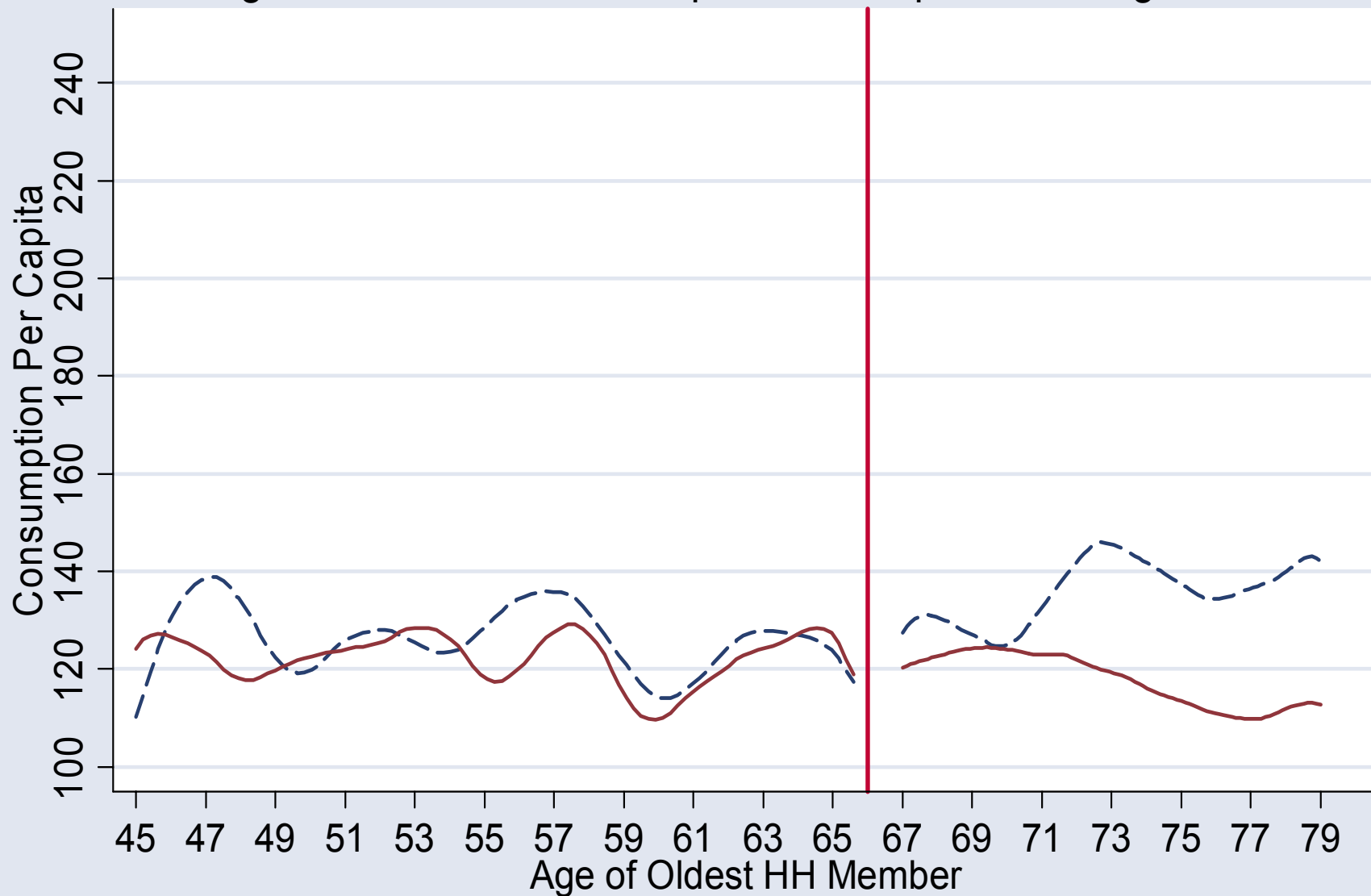
Martínez: BONOSOL

- Old age pension to all Bolivians
 - Pension transfer to large group of poor households
 - pensions paid as of 2001
 - Known eligibility criteria: 65+ years

- Have pre- (1999) and post- (2002) data on consumption

- Goal: Estimate effect of BONOSOL on consumption

Figure 1.2b: Rural Consumption Per Capita - Fan regression

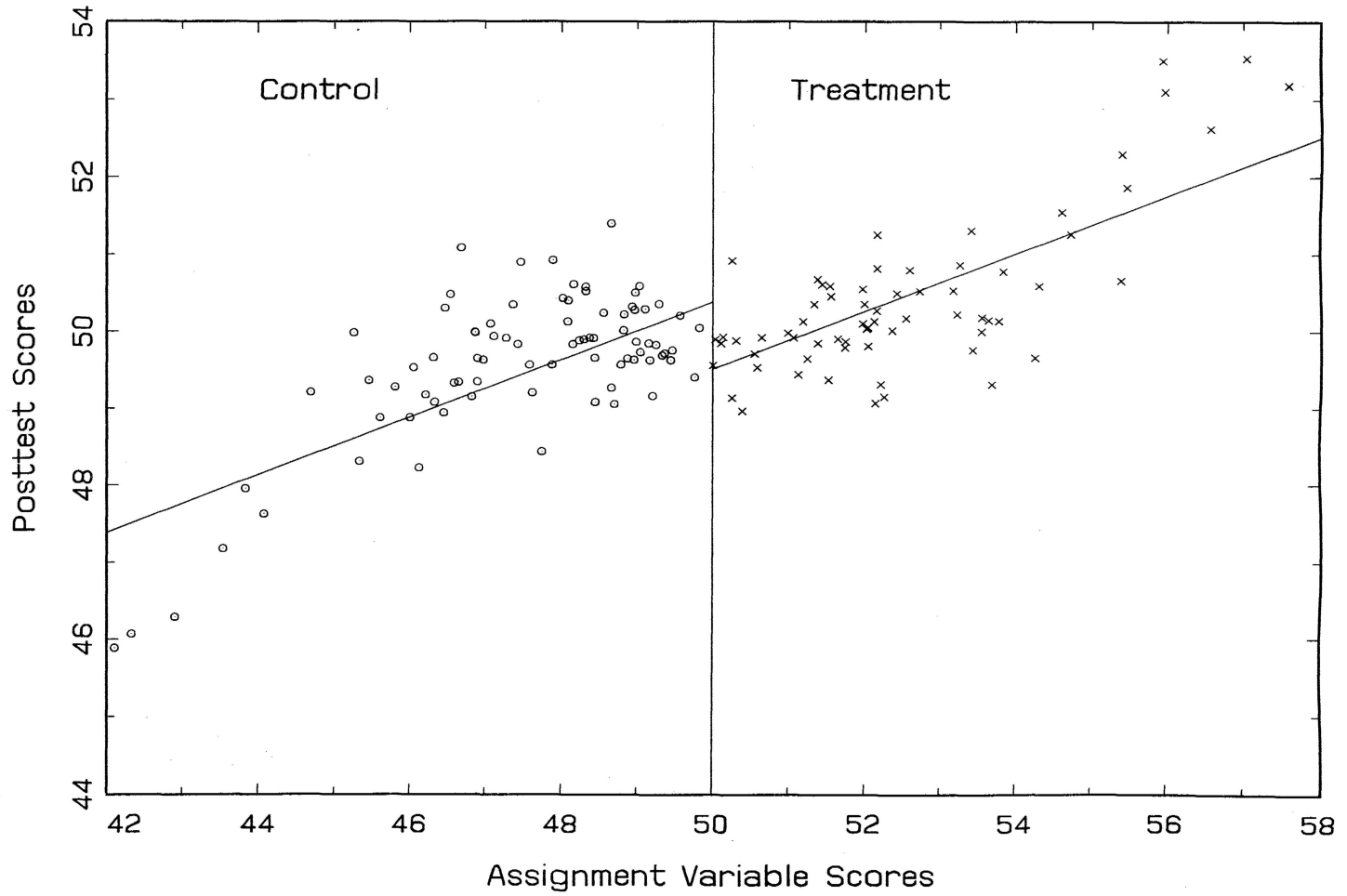


--- Treatment Year — Non-Treatment Year

Potential Disadvantages of RD

- Local average treatment effects
 - We estimate the effect of the program around the cut-off point
 - This is not always generalizable .
- Power:
 - The effect is estimated at the discontinuity, so we generally have fewer observations than in a randomized experiment with the same sample size
- Specification can be sensitive to functional form: make sure the relationship between the assignment variable and the outcome variable is correctly modeled, including:
 - Nonlinear Relationships
 - Interactions

False Regression Discontinuity Effect Due to Nonlinearity



7.5 7-9

Advantages of RD for Evaluation

- RD yields an unbiased estimate of treatment effect at the discontinuity

- Can take advantage of a known rule for assigning the benefit
 - This is common in the design of social interventions
 - No need to “exclude” a group of eligible households/individuals from treatment

References

- Angrist, J. and V. Lavy “Using Maimonodes Rule to Estimate the Effect of Class Size on Scholastic Achievement” *Quarterly Journal of Economics*, 114, 533-575
- Lemieux, T. and K. Milligan “Inentive Effects of Social Assistance: A Regression Discontinuity Approach”. NBER working paper 10541.
- Hahn, J., P. Todd, W. Van der Klaauw. “Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design”. *Econometrica*, Vol 69, 201-209.
- Barrera, Linden y Urquiola (2006), “The Effects of User Fee Reductions on Enrollment: Evidence from a quasi-experiment”