

Université Paris-Saclay  
Master of Economics – 1st year  
Advanced Econometrics – Tutorial #8 \*

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## Context of the session and objectives

This session illustrates the analysis of regression discontinuity based on the paper by Jens Ludwig and Douglas L. Miller “*Does Head Start Improve Childrens Life Chances? Evidence from a Regression Discontinuity Design*”, Quarterly Journal of Economics (2007).

The U.S. “Head Start” program has been providing preschool, health and other social services to poor children age three to five and their families since 1965. At the time of the research article, 900,000 children benefit from the program each year. Evaluating whether the program improves childrens life chances is challenging because participation is likely correlated with outcomes.

Ludwig and Miller (2007) exploit the fact that in 1965, only the poorest 300 counties in the U.S. received federal support in applying for the program. This leads to participation and funding rates to be 50–100 percent higher in counties with poverty rates above the cutoff compared with those just below. This discontinuity in the implementation generated a “treatment” group of counties above the poverty rate cutoff and a “control” group made of counties below. This funding difference appears to have persisted through the late 1970s. This discontinuity is then used by the authors to identify impacts by comparing outcomes for people in treatment and control counties “near” the cutoff.

In this session we replicate the parametric (OLS) estimates they get on mortality reduction, one of the main results of their study.

## 1 Presentation of the estimation strategy and the data

### 1.1 The regression discontinuity design estimation strategy

1. We first come back on some the regression discontinuity design estimation strategy and the required assumptions to appropriately identify an effect of the policy.
  - (a) What is the principle of the regression discontinuity design estimation strategy?
  - (b) What assumption on the potential outcomes needs to be made to identify an effect at the cutoff?

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## 1.2 Analyzing the discontinuity setting with the data

We have county-level observations regarding several variables, and in particular federal spending data at the county-level. These measures of expenditures at the county level are only available for years 1968 and 1972. The Head Start program includes public spending in several dimensions. Around 40 percent of the program's budget is for early childhood schooling. Other services included nutritional program, social services, mental health services and health services. This bundle of services in the Head Start program may affect health (our focus in this tutorial) and schooling (the other focus of the research article) through a variety of channels. Concerning health, most of these services increased the chances children saw a doctor, and improve early detection and treatment of some conditions. We aggregate all spendings at the county level and divide them by the number of kids in the county at the time of the program and obtain the variables `hsspend_per_kid_68` and `hsspend_per_kid_72`.

Data on child mortality are also at the county level. `age5_9_sum2` measures the mortality of children in the age group five to nine on the 1973 and 1983 period, as all children five to nine at this time period would have been of Head Start age after the program was launched. `age5_9_injury_rate` measures the children mortality caused by injuries (around 55 percent of deaths to all children five to nine in 1973–1983). `age25plus_sum2` measures the mortality. For `rate_5964`, it gives the children mortality in the age group five to nine on the 1959 and 1964 period, **before the implementation of the program**.

2. We are here interested in assessing whether the regression discontinuity design can be an appropriate strategy given our data. To do so, we first implement some preliminary graphical and statistical analysis.
  - (a) First, generate an identifying variable, denoted `id`, which assigns for every county its rank in the distribution of the poverty rate in 1960 from the poorest to the richest. Second, generate a dummy variable, denominated `g`, which identifies counties benefiting from the provision of grant-writing assistance. Recall that those are the 300 counties with the highest level of poverty rate in 1960. Third, generate a variable, denominated `povrate`, which is the `povrate60` variable rescaled so that the value of `povrate` at the discontinuity corresponds to zero.
  - (b) Produce an histogram for the poverty rate variable before the implementation of “Head Start” program (in 1960). What can you conclude regarding this distribution and our estimation strategy?
  - (c) We chose to compare counties closed to the cutoff. We arbitrarily decide to only use counties with either a bandwidth in poverty rate of 8% below and above the cutoff, or a bandwidth in poverty rate of 16% below and above the cutoff. Generate the two variables, denominated respectively `bandwidth1` and `bandwidth2` which identify counties within these bandwidths.
  - (d) We now investigate the similarities or differences in covariates and in children mortality between the groups of counties benefiting from the program and those excluded **within** the second bandwidth and **before** the implementation of the pro-

gram in 1965. Do you observe significant differences in the counties characteristics between treated counties and non-treated counties? Given the presence or the absence of differences, what do you conclude on the identification of any effect using the RDD estimation strategy?

- (e) Compare the per-kid total federal county-level spendings in 1968 and 1972. What does this suggest?

## 2 Further graphical analysis

We now implement some deeper graphical analysis to observe (i) the differences in federal spending introduced by the discontinuity, (ii) the differences in health status introduced by the discontinuity.

3. We want to check graphically that spending changed at the discontinuity. To do so, we want to reproduce their Figures II and III, which shows the differences in per-kid spendings between treated and non-treated counties. Instead of their nonparametric estimates of the regression function we can show flexible cubic fits. **We here compare counties with 16% poverty rate above and below the cutoff.**
  - (a) Generate five variables, first generate the squared and the cubic transformations of the variable `povrate`, and second generate the interaction of `povrate` with the fact of being a treated county (variable `g`), the interaction of the squared transformation and the cubic transformation of `povrate` with the fact of being a treated county (variable `g`).
  - (b) We now estimate the federal spending per-kid in 1968 as a function of poverty rate, the dummy variable identifying treated counties and their interaction term. Write the linear model. How do you interpret the respective coefficients? We explore three specifications: (i) a linear fit, (ii) a quadratic fit, (iii) and a cubic fit. Estimate these models and store the predicted values.
  - (c) Now group the counties into categories on each side of the cutoff. Five categories need to be constructed. We will then calculate the mean and standard error of the mean of federal spending for these five groups. To construct these categories, generate a variable denoted `bin` which is directly obtained from the following formula: 
$$\text{bin} = \left\lfloor \frac{\text{povrate}}{4} \right\rfloor \times 4 + 2 + 59.1984$$
, where  $\lfloor x \rfloor$  denotes the greatest integer less than or equal to  $x$ . Keep observations with the variable `bin` above 40 and below 80.
  - (d) Now generate two variables which give the mean value by categories of `hsspend_per_kid_68`, denominated `bin_mean` and the standard error of the mean by categories, denominated `stderror`. Compute the 95% confidence intervals for these categories, by generating two variables which gives lower and upper limit of the 95% confidence intervals of the `hsspend_per_kid_68` variable.
  - (e) Finally, generate a graphic to replicate figure II. To do so, concentrate on observations with poverty rate in 1960 above 40% and below 80%. Then, for each

categories plot the mean value. Then add the confidence intervals, and the three lines corresponding to the three parametric estimates (linear, square and cubic).

- (f) Transform your commands from question 3.(b) to question 3.(e) so that these series of commands are implemented through a program, which allows you to replicate the figure for any other variables than `hsspend_per_kid_68`.
  - (g) Replicate the figure for the spendings in 1972 (variable `hsspend_per_kid_72`), and also for the social spending in 1972 (variable `socspend_per_cap72`). From these three figures, what do you conclude regarding the effect of the discontinuity in the Head Start program on county-level federal spending?
4. We now want to assess how child mortality is affected at the discontinuity. To do so, we want to reproduce their Figure IV, which shows the differences in mortality outcomes between treated and non-treated counties. To do so, you can re-use your program constructed in question 3.(f) and apply it to variables `age5_9_sum2`, `age5_9_injury_rate`, `age25plus_sum2` and `rate_5964`. What can you conclude from these figures on the potential performance of the regression discontinuity design estimation strategy?

### 3 The implementation of the regression discontinuity estimation strategy

We now estimate the average treatment effect of Head Start program on children mortality.

5. Replicate the parametric results from Table III that correspond to the mortality outcomes in Figure IV we have just replicated (last two columns for bandwidths 8 and 16). Be careful to estimate several linear models for the four mortality outcomes (as in Table III), and by including in your linear model the interaction term between the dummy variables of treated counties and the 1960 poverty rate. What do you conclude on the effect of Head Start on children mortality?
6. To improve your estimation of the average treatment effect in question 5., now estimate impacts on the four mortality outcomes using the two different bandwidths and including polynomials in the 1960 poverty rate. How does it change the results?

## References