Quantitative Economics for the Evaluation of the European Policy

Dipartimento di Economia e Management

Co-funded by the Erasmus+ Programme of the European Union

Project funded by
European Commission Erasmus + Programme –Jean Monnet Action
Project number 553280-EPP-1-2015-1-IT-EPPJMO-MODULE

Irene Brunetti Davide Fiaschi Angela Parenti[1]

12/10/2017

[1] ireneb@ec.unipi.it, davide.fiaschi@unipi.it, and aparenti@ec.unipi.it.

Becker,S. *et al.* (2010) **Going NUTS: The effect of EU structural funds on regional performance**

- The European Union (EU) provides grants to disadvantaged regions to allow them to achieve the EU average.
- **Objective 1**: to promote the development and structural adjustment of regions whose development is lagging behind.
- Objective 1 is *regionalised*.
- Only those with a per capita gross domestic product (GDP) lower than 75% of the Community average are eligible under Objective 1.

Going NUTS: The effect of EU structural funds on regional performance

- The rule imposed by EU gives rise to a regression-discontinuity design that exploits the discrete jump in the probability of EU transfer receipt at the 75% threshold.
- The analysis sheds light on the **effectiveness of the Objective 1 scheme** and **its net benefits**.

Why they chose Objective 1?

For three main reasons:

- Objective 1 funding has the explicit aim of fostering GDP-per-capita growth in disadvataged regions.
- Objective 1 expenditures form the largest part of the overall *Structural Funds Programme* budget.
- The Objective 1 scheme has been largely unchanged over all three programming periods of its existence.

The classification system of regional units in the EU

Eurostat distinguishes between:

- NUTS1: large regions with a population of $3 - 7$ million inhabitants;
- NUTS2: groups of counties and unitary authorities with a population of $0.8 - 3$ million inhabitants;
- NUTS3 regions: counties of $150 - 800$ thousand inhabitants.

Data sources

They link data from several sources:

- Data for **Outcome variable** at the NUTS2 and NUTS3 regional levels are taken from *Cambridge Econometrics' Regional* Database.
  - **Outcome variable**: the average annual growth of GDP per capita at purchasing power parity (PPP) during a programming period.
  - **Alternative outcome variable**: average annual employment growth.
- Data on **Objective 1 treatment and the amount of funds** are collected from *documents of the European Commission* concerning structural funds.
- As **control variables**: sectoral employment, population, and investment. (Cambridge Econometrics' Regional Database)
- **Sensitivity checks**: geographical size and location of regions (Geographic Information System of the European Commission (GISCO)). Other measure of countries' voting power in the EU Council: Shapley and Shubik (1954) index.

Descriptive statistics

- According to the 75%-*rule*: all NUTS2 regions in a country would be eligible for Objective 1 transfers if the maximum GDP per capita across all regions were smaller than 75% of the EU25 average.
- The NUTS2 average GDP per capita over the years 1994 – 1996 relative to the Community average was used for the EU15 countries while the average over the years 1997 – 1999 was applied for the accession countries of 2004
- Since a region's initial GDP per capita is the only official criterion for Objective 1 status $\Longrightarrow$ they compares treated and non-treated regions with respect to the difference in their GDPper capita.
- the average difference in per capita GDP between Objective 1 and non-Objective 1 regions in column 3 **increases as further countries join the EU over the course of the three programming periods**

Descriptive statistics

- The main problem is that the real per capita GDP determines not only the probability of Objective 1 *treatment* but also the growth of real per capita income (the *outcome*).
- They show that some regions got treated even though they were too rich to be formally eligible and others were not treated even though they were poor enough to be eligible $\Longrightarrow$ there is an exceptions from the 75%-rule. $\Longrightarrow$ **fuzzy regression-discontinuity design**.
- Fig. 2 illustrates graphically *how the probability of Objective 1 treatment relates to region-specific per capita GDP* at PPP prior to a programming period.

Descriptive statistics

- They display average treatment rates in equally sized bins of width of two percentage points to the left and the right of the threshold.
- Some regions that would be formally eligible do not obtain Objective 1 status $\Longrightarrow$ the probability of Objective 1 status is smaller than unity.
- They plot local polynomial functions of per capita GDP at PPP prior to each programming period (the **forcing variable**) against average annual growth of per capita GDP at PPP during that period (an **outcome**) based on local averages of the forcing variable.
- In Fig.3 authors use circles for those observations for which the 75% rule is correctly applied. Crosses indicate observations which did not receive Objective 1 funds despite being formally eligible or received Objective 1 funds despite not being formally eligible.

Descriptive statistics

- The majority of crosses are generally positioned below the local polynomial to the left of the threshold but above the local polynomial to the right of the threshold
- $\Longrightarrow$ the treatment effect is underestimated by the discontinuity at the threshold in Fig. 3.
- A consistent estimate of the discontinuity can, however, be obtained by instrumental variable estimation when using the (Objective 1) **treatment eligibility** rule as **an instrument**.

Regression Analysis

The regression-discontinuity design (RDD)

- Think of a NUTS2 region A with a GDP per capita of 74.99% and a NUTS2 region B with a GDP per capita of 75.01%, one formally eligible for Objective 1 transfers, one not.
- These two regions are certainly more comparable than regions far away from the threshold.
- The crucial question is whether the discontinuity at the threshold is visible from a polynomial function of reasonable order about the per capita income level.
- They show that the 75%-rule gives rise to a fuzzy RDD that requires instrumental variables estimation

Regression analysis

- They want to estimate the regression discontinuity parameter ρ on $Treat_{it}$ by using a regression of the following form:

$$Growth_{it} = \theta_t + \rho Treat_{it} + f(Force_{it}) + \lambda_i + \mu_{it}; \quad (1)$$

where θ_t is a time-specific constant,
λ_i is a region-specific effect that may be random or fixed, and
μ_{it} is a possibly heteroskedastic error term.

- With a fuzzy design, OLS estimation on Eq.(1) results in a biased estimate of the average treatment effect as captured by ρ.

- However, an unbiased estimate can be obtained by 2SLS, where $Treat_{it}$ in Eq.(1) may be instrumented by a first stage regression of the form:

$$Treat_{it} = \alpha_t + \beta Rule_{it} + f(Force_{it}) + \kappa_i + \epsilon_{it} \quad (2)$$

Main results

- There is no evidence of significant effects on average employment growth induced by Objective 1 treatment in any of the specifications
- However, there is robust evidence of a positive impact of Objective 1 treatment on GDP/capita growth.
- The treatment effect estimates are significantly different from zero at least at 15% statistical significance across the board.
- In terms of order of the polynomials, it seems preferable to use at least fourth-order polynomials rather than a 3rd-order polynomial function to model the continuous relationship.
- Overall, they show a positive effect of Objective 1 treatment on per capita GDP growth that is significantly different from zero

Sensitivity checks and extensions

They check the sensitivity of the results in a number of regards:

1. **Using NUTS3 rather than NUTS2 outcome and treatment**:
   - EU Commission assigns Objective 1 transfers to some of the NUTS3 regions rather than NUTS2 regions; **BUT** the assignment rule and the forcing variable refer to the NUTS2 level $\Longrightarrow$ Using that approach leads to a point estimate at the NUTS3 level in a regression.
   - However, there is no indication of an impact on employment growth.
   - The assignment of funds might be partly correlated with NUTS3 population size, population density, employment share in total population and etc.
   - Controlling for these variables at the NUTS3 level reduces the point estimate growth from 0.017 to 0.012 but does not affect the significance of the estimate.

Sensitivity checks and extensions

2 **Using only data within certain windows around the treatment threshold**

- They report estimates for per capita GDP growth and employment growth for sub-samples of the data within certain windows around the treatment threshold.
- This idea is described by Lee and Lemieux (2009) and serves to contrast the polynomial estimation approach with a kind of local linear regression approach where window width around the cutoff point is varied.
- This strategy reduces the number of observations dramatically.
- There is less chance that the polynomial function $f(Force_{it})$ is misspecified.

Concluding remarks

- This paper considers the estimation of causal effects of the European Union's (EU) Objective 1 transfers on economic growth.
- Objective 1 funds aim at facilitating convergence and cohesion within the EU and constitute the major part of the EU's Structural Funds Programme.
- The 75%-rule gives rise to a regression-discontinuity design that exploits the jump in the probability of Objective 1 recipience at the threshold.
- In the vast majority of cases the 75%-rule is strictly applied. Only 7% of their observations do not comply with the assignment mechanism.

Concluding remarks

- On average, Objective 1 status raises real GDPper capita growth by roughly 1.6% within the same programming period.
- They do not find significant employment effects during the period in which transfers are allocated
- There may be various reasons for a positive GDP growth effect and the absence of an employment growth effect:
  - objective 1 transfers mainly stimulate the volume and change the structure of investment;
  - job creation takes longer than the duration of a programming period of five to seven years.

Concluding remarks

They perform several robustness checks

- They estimate treatment effects at the level of NUTS3 rather than NUTS2 regions.
- They deal with possible spillovers of Objective 1 funds on neighboring regions by estimating separate regressions in which they exclude control regions adjacent to treated regions.
- They estimate the treatment effect within windows of the forcing variable of Objective 1 treatment.
- They provide estimates separately for three sub-periods.
- They estimate the dynamics behind the impact on average annual growth along the years from the start of a programming period.

Their results are qualitatively robust to these checks.

Concluding remarks

- They suggest that the treatment effect varies across programming periods.
- Objective 1 treatment status does not cause immediate effects but it takes, in the average programming period and region, at least four years to display growth effects on GDP per capita.

RDD in R

- Multiple packages for R (rddtools, rdrobust etc.)
- A lot of options (kernel density, bandwidth selection, local-polynomial order etc.)

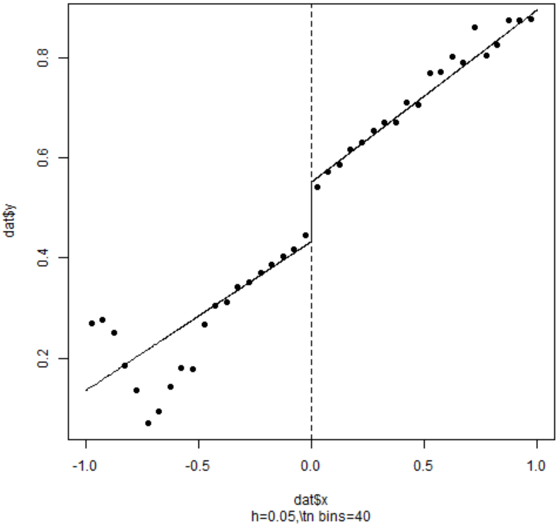
RDD in R (rddtools)

- Load rddtools package:
  library("rddtools")
- Use data from Lee (2008):
  data(house)
- Set outcome, forcing and cutoff variable:
  $house\_rdd < -rdd\_data(y = y, x = x, cutpoint = 0, data = house)$
- Estimate RDD:
  $reg\_para < -rdd\_reg\_lm(rdd\_object = house\_rdd)$
- Print results:
  $print(reg\_para)$

RDD in R (rddtools)

```
# RDD regression: parametric ###
#  Polynomial order:  1
#  Slopes:  separate
#  Number of obs: 6558 (left: 2740, right: 3818)
#
#  Coefficient:
#    Estimate Std. Error t value  Pr(>|t|)
# D 0.1182314  0.0056799  20.816 < 2.2e-16 ***
# ---
# Signif.cod:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

RDD in R (rddtools): *plot*(*reg_para*)



RDD in R (rddtools)

- Restrict sample to bandwidth area:

  $bw\_ik <- rdd\_bw\_ik(house\_rdd)$

  $reg\_para\_ik <- rdd\_reg\_lm(rdd\_object = house\_rdd, bw = bw\_ik)$

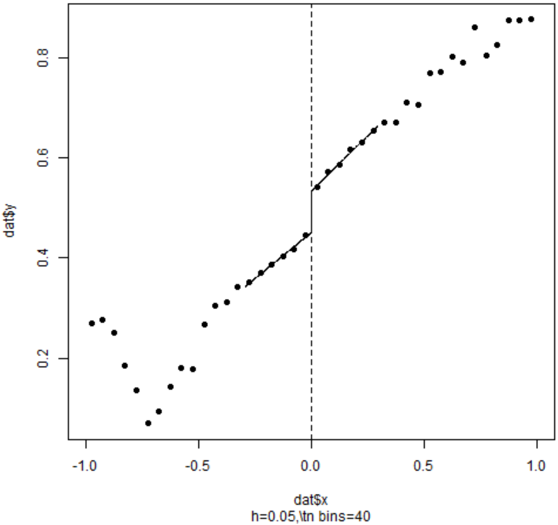
  reg_para_ik

Restrict sample to bandwidth area

```
## ### RDD regression: parametric ###

##  Polynomial order:  1
##  Slopes:  separate
##  Bandwidth:  0.2938561
##  Number of obs: 3200 (left: 1594, right: 1606)
##
##  Coefficient:
##    Estimate Std. Error t value  Pr(>|t|)
## D 0.0823378  0.0080236  10.262 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

RDD in R (rddtools): *plot*(*reg_para_ik*)



RDD in R (rdrobust)

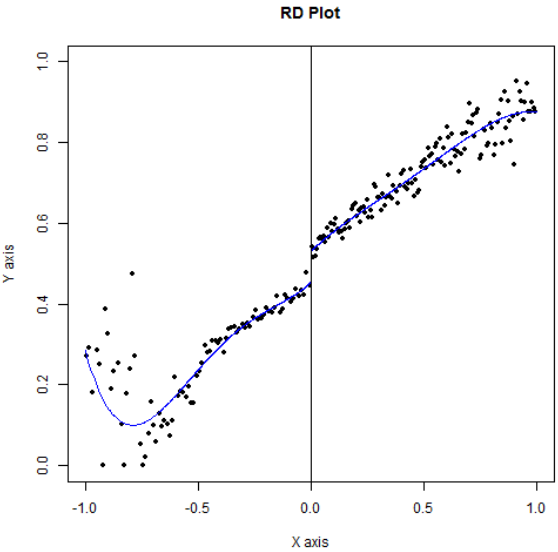
This package provides tools for data-driven graphical and analytical statistical inference in RDdesigns: rdrobust() to construct local-polynomial point estimators and robust confidence intervals for average treatment effects at the cutoff in Sharp and Fuzzy settings.

- Load rdrobust package:
  $library("rdrobust")$
- Estimate effect:
  $rdrobust(house\$y, house\$x)$

RDD in R (rdrobust)

```
## Call:
## rdrobust(y = house$y, x = house$x)
##
## Summary:
##
## Number of Obs 6558
## NN Matches    3
## BW Type       CCT
## Kernel Type   Triangular
##
##                         Left   Right
## Number of Obs           828    859
## Order Loc Poly (p) 1         1
## Order Bias (q)          2      2
## BW Loc Poly (h)         0.1429 0.1429
## BW Bias (b)             0.2542 0.2542
## rho (h/b)               0.5620 0.5620
## Estimates:
##                 Coef   Std. Err. z      P>|z|  CI Lower CI Upper
## Conventional 0.0650 0.0108    6.0322 0.0000 0.0439   0.0861
## Robust                                   0.0000 0.0366   0.0847
```

RDD in R (rdrobust): *rdplot*(*house$y*, *house$x*)



Conclusion

- Three components: Outcome, forcing variable, cutoff
- Validity depends upon the quality of the design and data
- Do graphs. Do a lot of graphs.
- Further reading: Skovron and Titiunik (2015): A Practical Guide to Regression Discontinuity Designs in Political Science