Problem Set 6

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2023-04-23

Comparing Estimators

Code is supplemented by READ_ME: https://github.com/reifjulian/driving

a)

```
# Load mortality data, convert deaths to death rates per 100,000
my_data <- read_dta("https://julianreif.com/driving/data/mortality/derived/all.dta")
my_data <- my_data %>% mutate(cod_any = 100000*cod_any/(pop/12))

# Create indicator for first month of driving eligibility
my_data <- my_data %>% mutate(firstmonth = agemo_mda==0)

# Estimate RD using rdrobust add-on package
Y <- my_data$cod_any
X <- my_data$agemo_mda
C <- as.integer(my_data$firstmonth)
summary(rdrobust(Y, X, covs = C))
```

```
## Covariate-adjusted Sharp RD estimates using local polynomial regression.
##
## Number of Obs.                   96
## BW type                       mserd
## Kernel                   Triangular
## VCE method                       NN
##
## Number of Obs.                   48           48
## Eff. Number of Obs.              10           11
## Order est. (p)                    1            1
## Order bias  (q)                   2            2
## BW est. (h)                  10.534       10.534
## BW bias (b)                  16.256       16.256
## rho (h/b)                     0.648        0.648
## Unique Obs.                      48           48
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     5.844     1.569     3.725     0.000     [2.769 , 8.919]
```

```
##         Robust          -          -     3.018     0.003     [1.990 , 9.364]
## =============================================================================
```

b) Uniform Kernel

```
summary(rdrobust(Y, X, covs = C, kernel = "uniform"))
```

```
## Covariate-adjusted Sharp RD estimates using local polynomial regression.
##
## Number of Obs.                   96
## BW type                       mserd
## Kernel                      Uniform
## VCE method                       NN
##
## Number of Obs.                   48            48
## Eff. Number of Obs.              11            12
## Order est. (p)                    1             1
## Order bias  (q)                   2             2
## BW est. (h)                  11.023        11.023
## BW bias (b)                  20.201        20.201
## rho (h/b)                     0.546         0.546
## Unique Obs.                      48            48
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     6.400     1.091     5.865     0.000     [4.261 , 8.539]
##         Robust         -         -     4.730     0.000     [3.591 , 8.672]
## =============================================================================
```

The deaths at the minimum legal driving age increased with the uniform distribution when compared to the triangular.

c) Quadratic Function

```
summary(rdrobust(Y, X, covs = C, p = 3))
```

```
## Covariate-adjusted Sharp RD estimates using local polynomial regression.
##
## Number of Obs.                   96
## BW type                       mserd
## Kernel                   Triangular
## VCE method                       NN
##
## Number of Obs.                   48            48
## Eff. Number of Obs.              24            25
## Order est. (p)                    3             3
## Order bias  (q)                   4             4
## BW est. (h)                  24.424        24.424
```

```
## BW bias (b)                     28.069       28.069
## rho (h/b)                        0.870        0.870
## Unique Obs.                         48           48
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     5.234     2.215     2.363     0.018     [0.893 , 9.576]
##         Robust         -         -     2.092     0.036     [0.338 , 10.394]
## =============================================================================
```

Increasing the order of the local quadratic function from 2 to 3 decreases the effect at the cutoff.

d) Bandwidth

```r
summary(rdrobust(Y, X, covs = C, h = 40))
```

```
## Covariate-adjusted Sharp RD estimates using local polynomial regression.
##
## Number of Obs.                     96
## BW type                        Manual
## Kernel                     Triangular
## VCE method                         NN
##
## Number of Obs.                     48           48
## Eff. Number of Obs.                39           40
## Order est. (p)                      1            1
## Order bias  (q)                     2            2
## BW est. (h)                    40.000       40.000
## BW bias (b)                    40.000       40.000
## rho (h/b)                       1.000        1.000
## Unique Obs.                        48           48
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     6.990     0.603    11.589     0.000     [5.808 , 8.172]
##         Robust         -         -     5.753     0.000     [3.887 , 7.905]
## =============================================================================
```

Switching from using mserd to set bandwidth to manually setting it to 40 (which increases the bandwitd from ~10 to 40) increases the estimated effect at the cutoff.

e) covs

covs "specifies additional covariates to be used for estimation and inference" (CRAN documentation)

```r
summary(rdrobust(Y, X))
```

```
## Sharp RD estimates using local polynomial regression.
##
## Number of Obs.                     96
## BW type                         mserd
## Kernel                     Triangular
## VCE method                         NN
##
## Number of Obs.                     48            48
## Eff. Number of Obs.                 9            10
## Order est. (p)                      1             1
## Order bias  (q)                     2             2
## BW est. (h)                     9.819         9.819
## BW bias (b)                    16.336        16.336
## rho (h/b)                       0.601         0.601
## Unique Obs.                        48            48
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     4.258     2.649     1.607     0.108    [-0.934 , 9.450]
##         Robust         -         -     1.274     0.203    [-2.097 , 9.889]
## =============================================================================
```

The estimation at the cuttoff decreases when covariates are not included.

f) first month dropped

```r
# drop first month
my_data_f <- my_data %>%
  filter(firstmonth == F)

# Estimate RD using rdrobust add-on package
Y.f <- my_data_f$cod_any
X.f <- my_data_f$agemo_mda
summary(rdrobust(Y.f, X.f))
```

```
## Sharp RD estimates using local polynomial regression.
##
## Number of Obs.                     95
## BW type                         mserd
## Kernel                     Triangular
## VCE method                         NN
##
## Number of Obs.                     48            47
## Eff. Number of Obs.                 9             9
## Order est. (p)                      1             1
## Order bias  (q)                     2             2
## BW est. (h)                     9.293         9.293
## BW bias (b)                    16.478        16.478
## rho (h/b)                       0.564         0.564
## Unique Obs.                        48            47
```

```
##
## =============================================================================
##          Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##    Conventional     5.665     2.614     2.168     0.030     [0.543 , 10.788]
##          Robust         -         -     1.707     0.088    [-0.796 , 11.539]
## =============================================================================
```

The effect decreases when the first month is not included, but is persistent.

g) R Honest

Bandwidth's optimization criteria is MSE

```r
RDHonest(cod_any ~ agemo_mda, data = my_data_f, kern = "triangular", M = 0.1, opt.criterion = "MSE")
```

```
## Maximal leverage is large: 0.36.
## Inference may be inaccurate. Consider using bigger bandwidth.

## Call:
## RDHonest(formula = cod_any ~ agemo_mda, data = my_data_f, M = 0.1,
##     kern = "triangular", opt.criterion = "MSE")
##
##
## Estimates (using Holder class):
##           Parameter Estimate Std. Error Maximum Bias    Confidence Interval
##  Sharp RD Parameter 5.653735   3.274642    0.8019141 (-0.9523695, 12.25984)
##
## Onesided CIs:  (-Inf, 11.84196), (-0.5344857, Inf)
## Bandwidth: 7.312002, Kernel: triangular
## Number of effective observations: 11.07489
## Maximal leverage for sharp RD Parameter: 0.361864
## Smoothness constant M:      0.1
```

Bandwidth's optimization criteria is MSE. The estimate at the cutoff is slightly lower and the CI is less precise.

h) smoothness parameter

Smoothness is related to bandwidth.

```r
RDHonest(cod_any ~ agemo_mda, data = my_data_f, kern = "triangular", M = .02)
```

```
## Maximal leverage is large: 0.23.
## Inference may be inaccurate. Consider using bigger bandwidth.

## Call:
## RDHonest(formula = cod_any ~ agemo_mda, data = my_data_f, M = 0.02,
##     kern = "triangular")
##
```

```
##
## Estimates (using Holder class):
##           Parameter Estimate Std. Error Maximum Bias  Confidence Interval
##  Sharp RD Parameter 6.246227   1.799326    0.4751389 (2.600018, 9.892437)
##
## Onesided CIs:  (-Inf, 9.680993), (2.811461, Inf)
## Bandwidth: 13.89258, Kernel: triangular
## Number of effective observations: 21.98909
## Maximal leverage for sharp RD Parameter: 0.2271839
## Smoothness constant M:     0.02
```

When the smoothness constant is M = 0.02, the CI for RHonest and rdrobust are more similar. Bandwidths are set to be ~13 This seems realistic to me given that it's close to the bandwiths used for the results published in AER. The point estimates are differnt, however.

Note that my dataset still has the first month dropped.

i) Bandwidtch = 40

```
RDHonest(cod_any ~ agemo_mda, data = my_data_f, kern = "triangular", h = 40)
```

```
## Using Armstong & Kolesar (2020) ROT for smoothness constant M
```

```
## Call:
##
## RDHonest(formula = cod_any ~ agemo_mda, data = my_data_f, kern = "triangular",
##     h = 40)
##
##
## Estimates (using Holder class):
##           Parameter Estimate Std. Error Maximum Bias   Confidence Interval
##  Sharp RD Parameter 6.990266   0.690811     23.53899 (-17.68501, 31.66554)
##
## Onesided CIs:  (-Inf, 31.66554), (-17.68501, Inf)
## Bandwidth:       40, Kernel: triangular
## Number of effective observations: 65.43485
## Maximal leverage for sharp RD Parameter: 0.08852342
## Smoothness constant M: 0.1366957
```

The effect increases significantly when bandwitdth is 40.

j) linear regression

i

```
#.f has the first month dropped
summary(rdrobust(Y.f, X.f), kern = "uniform")
```

```
## Sharp RD estimates using local polynomial regression.
##
```

```
## Number of Obs.                     95
## BW type                         mserd
## Kernel                     Triangular
## VCE method                         NN
##
## Number of Obs.                     48            47
## Eff. Number of Obs.                 9             9
## Order est. (p)                      1             1
## Order bias  (q)                     2             2
## BW est. (h)                     9.293         9.293
## BW bias (b)                    16.478        16.478
## rho (h/b)                       0.564         0.564
## Unique Obs.                        48            47
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     5.665     2.614     2.168     0.030     [0.543 , 10.788]
##         Robust         -         -     1.707     0.088    [-0.796 , 11.539]
## =============================================================================
```

ii

```
# Only looking at data the 9.293 months around the cutoff (bandwidth, h)
myData_j <- my_data_f %>%
  filter(abs(agemo_mda) <= 4.6) %>%
  mutate(agemo_mda_greater_0 = (agemo_mda>0))

# Regression
summary(lm(data = myData_j,
           formula = cod_any ~  agemo_mda*agemo_mda_greater_0))
```

```
##
## Call:
## lm(formula = cod_any ~ agemo_mda * agemo_mda_greater_0, data = myData_j)
##
## Residuals:
##        1        2        3        4        5        6        7        8
##  0.30434 -0.48358  0.05415  0.12509 -0.84196  0.69474  1.13638 -0.98917
## attr(,"label")
## [1] "total deaths"
## attr(,"format.stata")
## [1] "%9.0g"
##
## Coefficients:
##                                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)                          44.3536     1.1947  37.124 3.14e-06 ***
## agemo_mda                             0.7337     0.4363   1.682   0.1679
## agemo_mda_greater_0TRUE               5.4243     1.6896   3.210   0.0326 *
## agemo_mda:agemo_mda_greater_0TRUE     0.8769     0.6170   1.421   0.2283
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 0.9755 on 4 degrees of freedom
## Multiple R-squared:  0.9861, Adjusted R-squared:  0.9757
## F-statistic:  94.7 on 3 and 4 DF,  p-value: 0.0003598
```

Gamma two is 5.4243, which is very close to the effect near the cut off estimated using regression discontinuity ($\tau = 5.665$). Gamma two is an indicator for if and observation is treated, and the only observations are right before and right after the cutoff. It makes sense that an indicator for the cutoff would get similar results to an RD.

k) Explain, in words, how you could get the rdrobust estimate that uses the triangular kernel using OLS (hint: it would involve weights)

You would need to weight the observations near the cutoff more than the those near the edges. A simple way to do this would be to replicate observations near the cut off (on either side) and not replicate the observations that are further away from the cutoff that are still included. You could then follow the OLS procedure completed in j.ii with the data set that has replicates.