Module 3: Medicare Advantage Quality and Regression Discontinuity

Part 3: RD in Practice

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Econ 470 & HLTH 470

MA Data

```r
ma.data <- read_rds(here("data/final_ma_data.rds"))
```

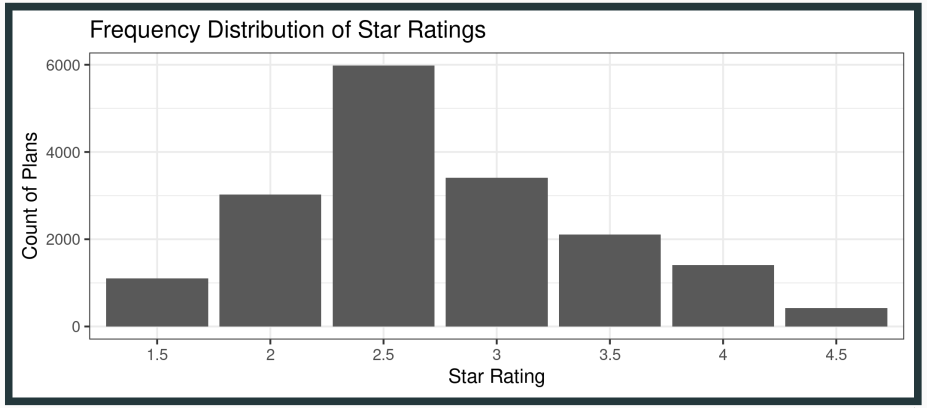
```r
ma.data.clean <- ma.data %>%
  filter(!is.na(avg_enrollment) & year==2009 & !is.na(partc_score))
```

Calculate raw average rating

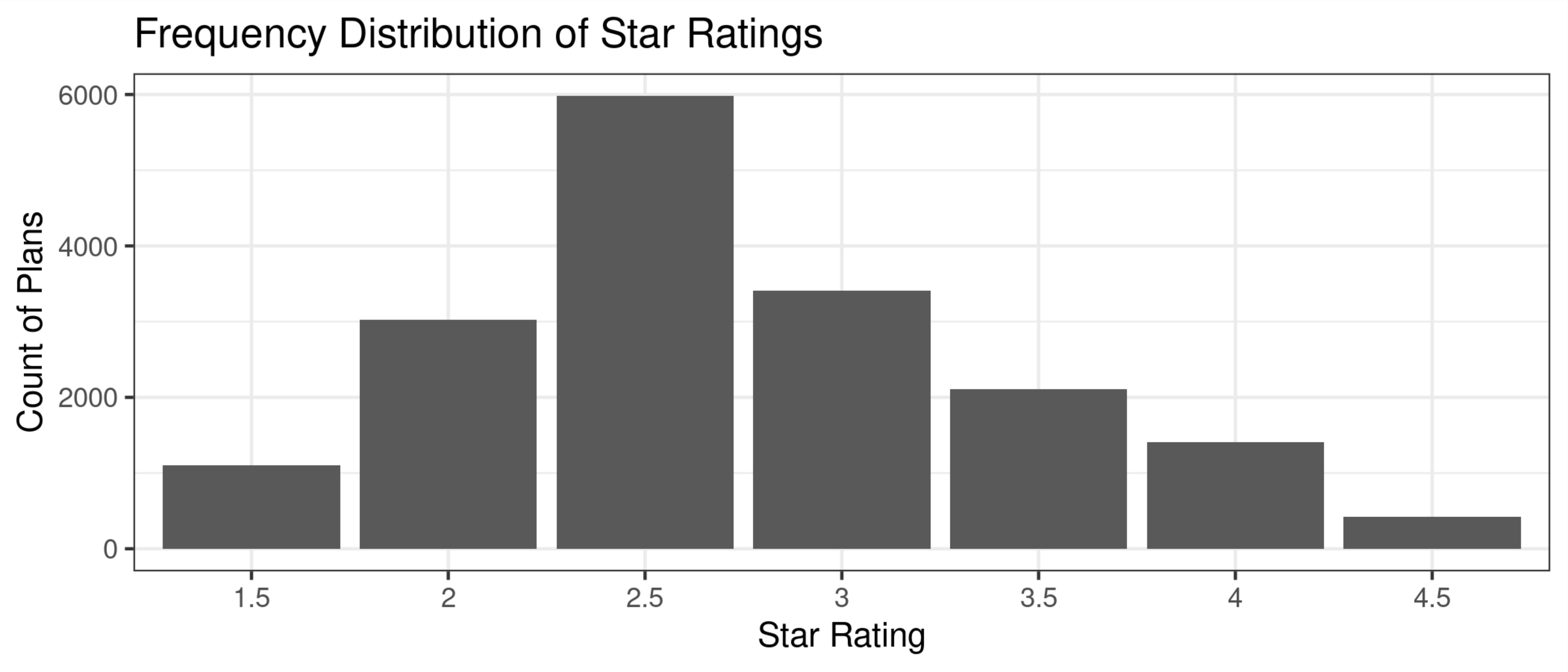
```
ma.data.clean ← ma.data.clean %>%
  mutate(raw_rating=rowMeans(
    cbind(breastcancer_screen,rectalcancer_screen,cv_cholscreen,diabetes_cholscreen,
          glaucoma_test,monitoring,flu_vaccine,pn_vaccine,physical_health,
          mental_health,osteo_test,physical_monitor,primaryaccess,
          hospital_followup,depression_followup,nodelays,carequickly,
          overallrating_care,overallrating_plan,calltime,
          doctor_communicate,customer_service,osteo_manage,
          diabetes_eye,diabetes_kidney,diabetes_bloodsugar,
          diabetes_chol,antidepressant,bloodpressure,ra_manage,
          copd_test,betablocker,bladder,falling,appeals_timely,
          appeals_review),
    na.rm=T)) %>%
  select(contractid, planid, fips, avg_enrollment, first_enrollment,
         last_enrollment, state, county, raw_rating, partc_score,
         avg_eligibles, avg_enrolled, premium_partc, risk_ab, Star_Rating,
         bid, avg_ffscost, ma_rate)
```

Distribution of star ratings

```
ma.data.clean %>%
  ggplot(aes(x=as.factor(Star_Rating))) +
  geom_bar() +
  labs(
    x="Star Rating",
    y="Count of Plans",
    title="Frequency Distribution of Star Ratings"
  ) + theme_bw()
```



Distribution of star ratings



Enrollments and star ratings

```
##
## Call:
## lm(formula = avg_enrollment ~ factor(Star_Rating), data = ma.data.clean)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##   -627   -388   -214    -51  41908
##
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)               87.31      43.32   2.016  0.04387 *
## factor(Star_Rating)2      32.75      50.62   0.647  0.51758
## factor(Star_Rating)2.5   194.65      47.15   4.128 3.67e-05 ***
## factor(Star_Rating)3     433.95      49.84   8.707  < 2e-16 ***
## factor(Star_Rating)3.5   470.91      53.47   8.808  < 2e-16 ***
## factor(Star_Rating)4     552.30      57.91   9.538  < 2e-16 ***
## factor(Star_Rating)4.5   272.36      82.68   3.294  0.00099 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1440 on 17451 degrees of freedom
## Multiple R-squared:  0.01559,    Adjusted R-squared:  0.01526
## F-statistic: 46.07 on 6 and 17451 DF,  p-value: < 2.2e-16
```

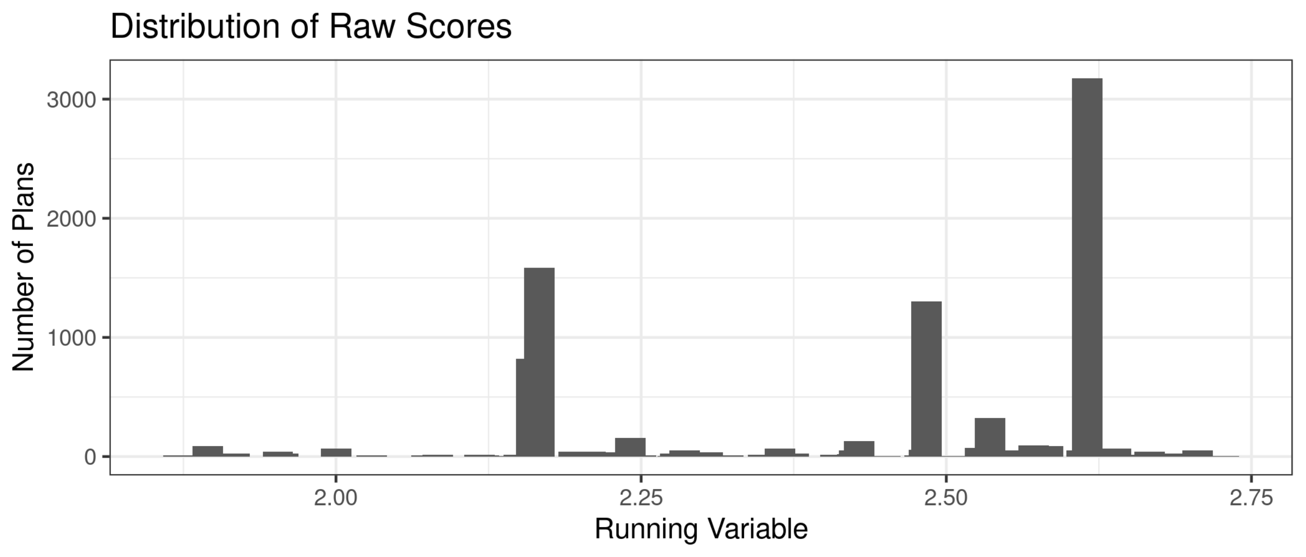
Problems

- Certainly not the effect of a higher rating...
- Lots of things unobserved, like
  - actual quality
  - perceived quality
  - prices

Effect of 3-star rating

```r
ma.rd1 <- ma.data.clean %>%
  filter(Star_Rating==2 | Star_Rating==2.5)
```

```r
ma.rd1 %>% ggplot(aes(x=raw_rating)) +
  geom_bar(width=.025) + theme_bw() +
  labs(
    x="Running Variable",
    y="Number of Plans",
    title="Distribution of Raw Scores"
  )
```



Note about scores

CMS does more than just an average…

- variance across individual metrics
- high variance is punished, low variance rewarded

RD estimates

```r
ma.rd1 <- ma.rd1 %>%
  mutate(score = raw_rating - 2.25,
         treat = (score>=0),
         window1 = (score>=-.175 & score<=.175),
         window2 = (score>=-.125 & score<=.125),
         mkt_share = avg_enrollment/avg_eligibles,
         ln_share = log(mkt_share),
         score_treat=score*treat)
star25.1 <- lm(mkt_share ~ score + treat, data=ma.rd1)
star25.2 <- lm(mkt_share ~ score + treat, data= (ma.rd1 %>% filter(window1==TRUE)))
star25.3 <- lm(mkt_share ~ score + treat + score_treat, data= (ma.rd1 %>% filter(window1==TRUE)))
star25.4 <- lm(mkt_share ~ score + treat + score_treat, data= (ma.rd1 %>% filter(window2==TRUE)))
est1 <- as.numeric(star25.1$coef[3])
est2 <- as.numeric(star25.2$coef[3])
est3 <- as.numeric(star25.3$coef[3])
est4 <- as.numeric(star25.4$coef[3])
```

RD estimates

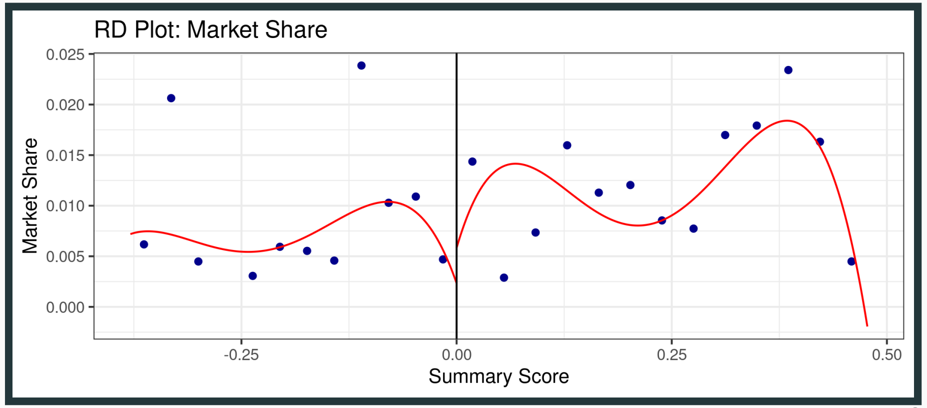
	mkt_share			
	(1)	(2)	(3)	(4)
Raw Score	0.030***	-0.044***	-0.066***	-0.085***
	(0.002)	(0.009)	(0.012)	(0.013)
Treatment	-0.008***	0.009***	0.008***	0.006***
	(0.001)	(0.002)	(0.002)	(0.002)
Score x Treat			0.049***	0.125***
			(0.019)	(0.026)
Bandwith	0.5	0.175	0.175.	0.125

Interpretation

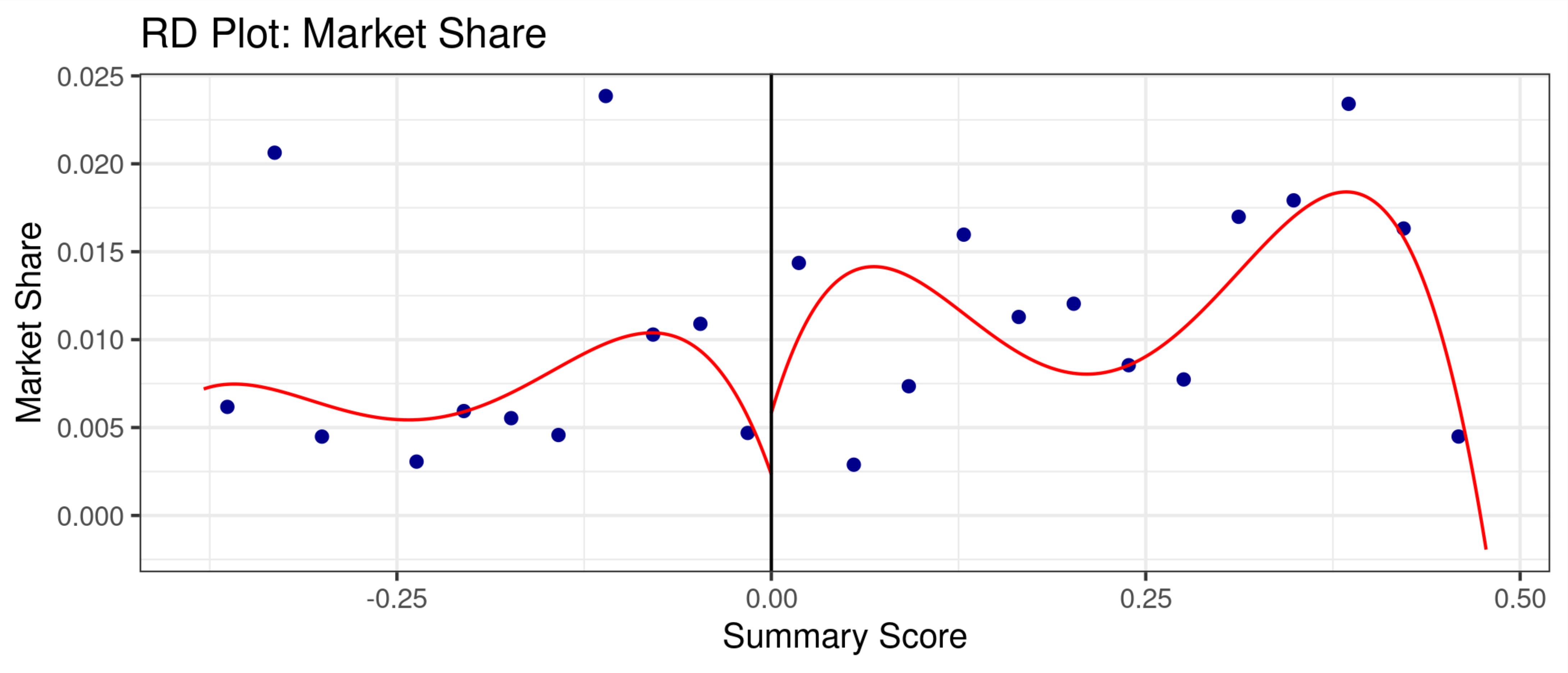
- OLS on full sample: -0.8% increase in market shares among 2.5-star plans versus 2-star plan
- RD on 0.175 bandwidth: 0.9% increase when imposing constant slopes, 0.8% increase when allowing for differential slopes
- RD on 0.125 bandwidth: 0.6% increase (again allowing for differential slopes)

Built-in RD packages

```r
library(rdrobust)
rdplot(y=ma.rd1$mkt_share, x=ma.rd1$score, binselect="es",
       title="RD Plot: Market Share", x.label="Summary Score",
       y.label="Market Share", masspoints="off")
```



RD Plot



RD Plot: Market Share
Market Share
0.025
0.020
0.015
0.010
0.005
0.000
-0.25
0.00
0.25
0.50
Summary Score

Estimates from RD package

```
est1 <- rdrobust(y=ma.rd1$mkt_share, x=ma.rd1$score, c=0,
                 h=0.125, p=1, kernel="uniform", vce="hc0",
                 masspoints="off")
```

Estimates from RD package

```
## Call: rdrobust
##
## Number of Obs.                 9006
## BW type                      Manual
## Kernel                      Uniform
## VCE method                      HC0
##
## Number of Obs.                 3024         5982
## Eff. Number of Obs.            2702          260
## Order est. (p)                    1            1
## Order bias  (q)                   2            2
## BW est. (h)                   0.125        0.125
## BW bias (b)                   0.125        0.125
## rho (h/b)                     1.000        1.000
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     0.006     0.003     2.034     0.042     [0.000 , 0.012]
##         Robust         -         -     5.870     0.000     [0.024 , 0.049]
## =============================================================================
```

Optimal bandwidth

```
estopt <- rdrobust(y=ma.rd1$mkt_share, x=ma.rd1$score, c=0,
                 p=1, kernel="uniform", vce="hc0",
                 masspoints="off")
```

Estimates with optimal bandwidth

```
## Call: rdrobust
##
## Number of Obs.                  9006
## BW type                        mserd
## Kernel                       Uniform
## VCE method                       HC0
##
## Number of Obs.                  3024         5982
## Eff. Number of Obs.              234           91
## Order est. (p)                     1            1
## Order bias  (q)                    2            2
## BW est. (h)                    0.054        0.054
## BW bias (b)                    0.123        0.123
## rho (h/b)                      0.442        0.442
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     0.034     0.008     4.556     0.000     [0.020 , 0.049]
##         Robust         -         -     4.335     0.000     [0.018 , 0.049]
## =============================================================================
```

Estimates for other rating thresholds

```
summary(est225)
```

```
## Call: rdrobust
##
## Number of Obs.                   9006
## BW type                        Manual
## Kernel                        Uniform
## VCE method                        HC0
##
## Number of Obs.                   3024         5982
## Eff. Number of Obs.              2702          260
## Order est. (p)                      1            1
## Order bias  (q)                     2            2
## BW est. (h)                     0.125        0.125
## BW bias (b)                     0.125        0.125
## rho (h/b)                       1.000        1.000
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     0.006     0.003     2.034     0.042     [0.000 , 0.012]
##         Robust         -         -     5.870     0.000     [0.024 , 0.049]
## =============================================================================
```

Estimates for other rating thresholds

```
summary(est275)
```

```
## Call: rdrobust
##
## Number of Obs.                   9396
## BW type                        Manual
## Kernel                        Uniform
## VCE method                        HC0
##
## Number of Obs.                   5982         3414
## Eff. Number of Obs.               243         1502
## Order est. (p)                      1            1
## Order bias  (q)                     2            2
## BW est. (h)                     0.125        0.125
## BW bias (b)                     0.125        0.125
## rho (h/b)                       1.000        1.000
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     0.021     0.004     4.700     0.000     [0.012 , 0.029]
##         Robust         -         -     2.218     0.027     [0.003 , 0.050]
## =============================================================================
```

Estimates for other rating thresholds

```r
summary(est325)
```

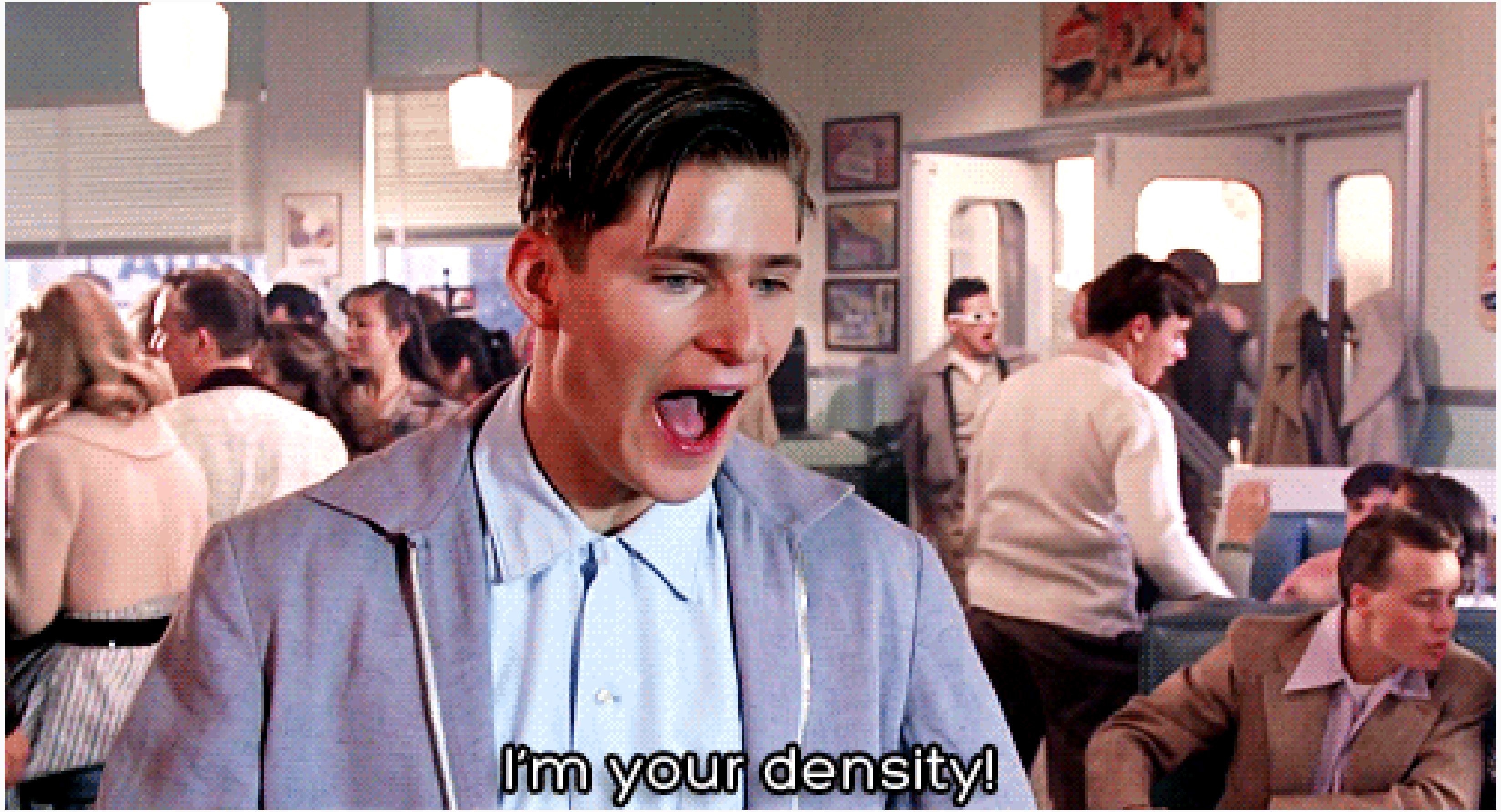
```
## Call: rdrobust
##
## Number of Obs.                 5525
## BW type                      Manual
## Kernel                      Uniform
## VCE method                      HC0
##
## Number of Obs.                 3826         1699
## Eff. Number of Obs.             888          629
## Order est. (p)                    1            1
## Order bias  (q)                   2            2
## BW est. (h)                   0.125        0.125
## BW bias (b)                   0.125        0.125
## rho (h/b)                     1.000        1.000
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional     0.016     0.004     4.568     0.000     [0.009 , 0.024]
##         Robust         -         -     7.504     0.000     [0.025 , 0.043]
## =============================================================================
```

Estimates for other rating thresholds

```
summary(est375)
```

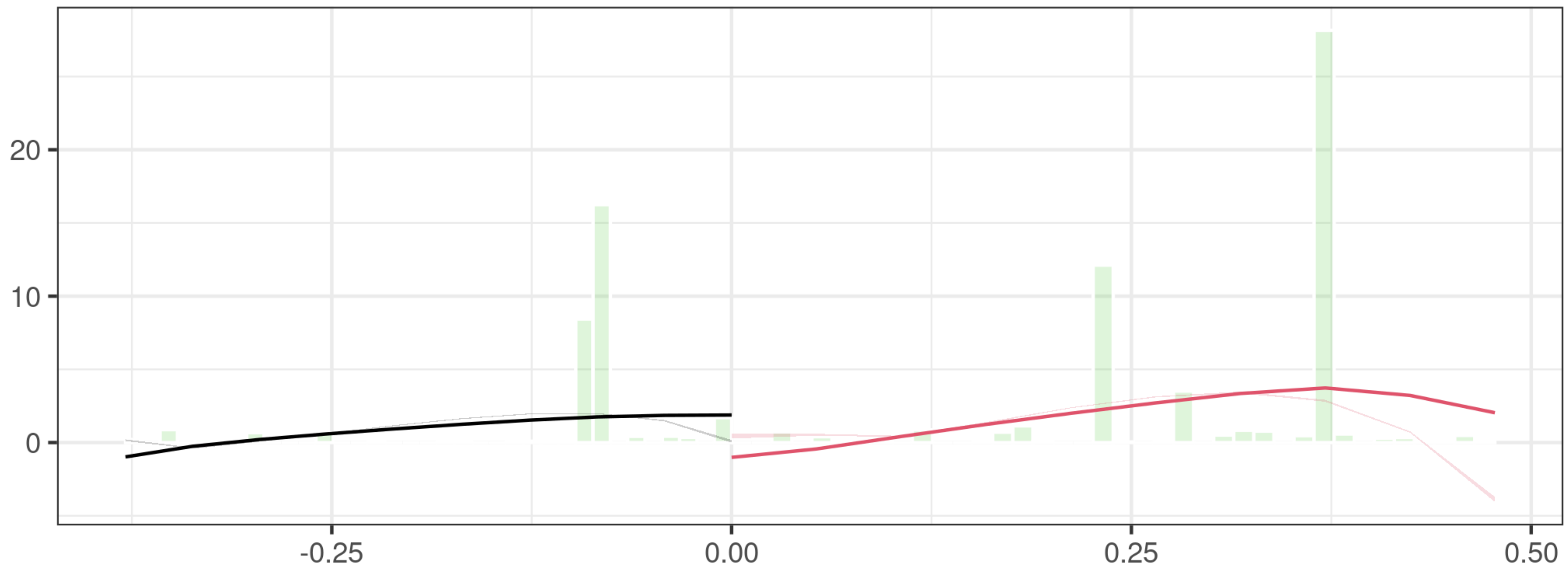
```
## Call: rdrobust
##
## Number of Obs.                 3515
## BW type                      Manual
## Kernel                      Uniform
## VCE method                      HC0
##
## Number of Obs.                 2625          890
## Eff. Number of Obs.             628          619
## Order est. (p)                    1            1
## Order bias  (q)                   2            2
## BW est. (h)                   0.125        0.125
## BW bias (b)                   0.125        0.125
## rho (h/b)                     1.000        1.000
##
## =============================================================================
##         Method     Coef. Std. Err.         z     P>|z|      [ 95% C.I. ]
## =============================================================================
##   Conventional    -0.004     0.003    -1.705     0.088    [-0.010 , 0.001]
##         Robust         -         -    -2.726     0.006    [-0.022 , -0.004]
## =============================================================================
```

Manipulation of the running variable



Manipulation of the running variable

```
dens225 <- rddensity(ma.rd225$score, c=0)
rdplotdensity(dens225, ma.rd225$score)
```



Manipulation of the running variable

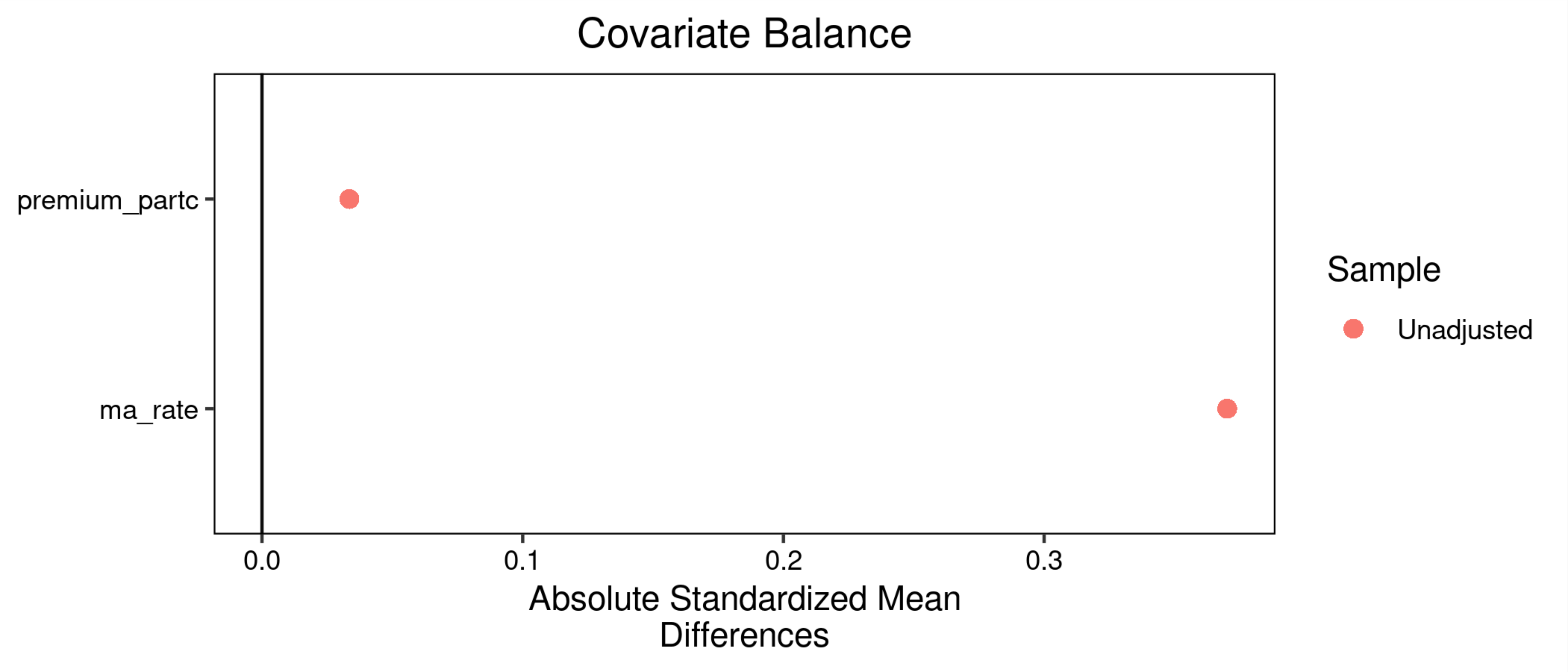
```
summary(dens275)
```

```
##
## Manipulation testing using local polynomial density estimation.
##
## Number of obs =       9396
## Model =               unrestricted
## Kernel =              triangular
## BW method =           estimated
## VCE method =          jackknife
##
## c = 0                 Left of c           Right of c
## Number of obs         5982                3414
## Eff. Number of obs    4113                2075
## Order est. (p)        2                   2
## Order bias (q)        3                   3
## BW est. (h)           0.228               0.228
##
## Method                T                   P > |T|
## Robust                33.7033             0
##
##
## P-values of binomial tests (H0: p=0.5).
##
```

Covariate balance

```r
match.dat <- matchit(treat~premium_partc + ma_rate,
                     data=ma.rd225 %>%
                       filter(window2==TRUE,
                              !is.na(treat),
                              !is.na(premium_partc),
                              !is.na(ma_rate)),
                     method=NULL, distance="mahalanobis")
```

Covariate balance



RD with discrete variables

- Allow for fewer mass points
- Assume random assignment between mass points
- Inference using Fisher's exact test