Using Propensity Scores

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Propensity scores

Matching

Weighting

Stratification

Direct Adjustment

…

estimand

Ingredients

- 150g unsalted butter, plus extra for greasing
- 150g plain chocolate, broken into pieces
- 150g plain flour
- ½ tsp baking powder
- ½ tsp bicarbonate of soda
- 200g light muscovado sugar
- 2 large eggs

Method

1. Heat the oven to 160C/140C fan/gas 3. Grease and base line a 1 litre heatproof glass pudding basin and a 450g loaf tin with baking parchment.

2. Put the butter and chocolate into a saucepan and melt over a low heat, stirring. When the chocolate has all melted remove from the heat.

estimator

estimate

Image source: Simon Grund

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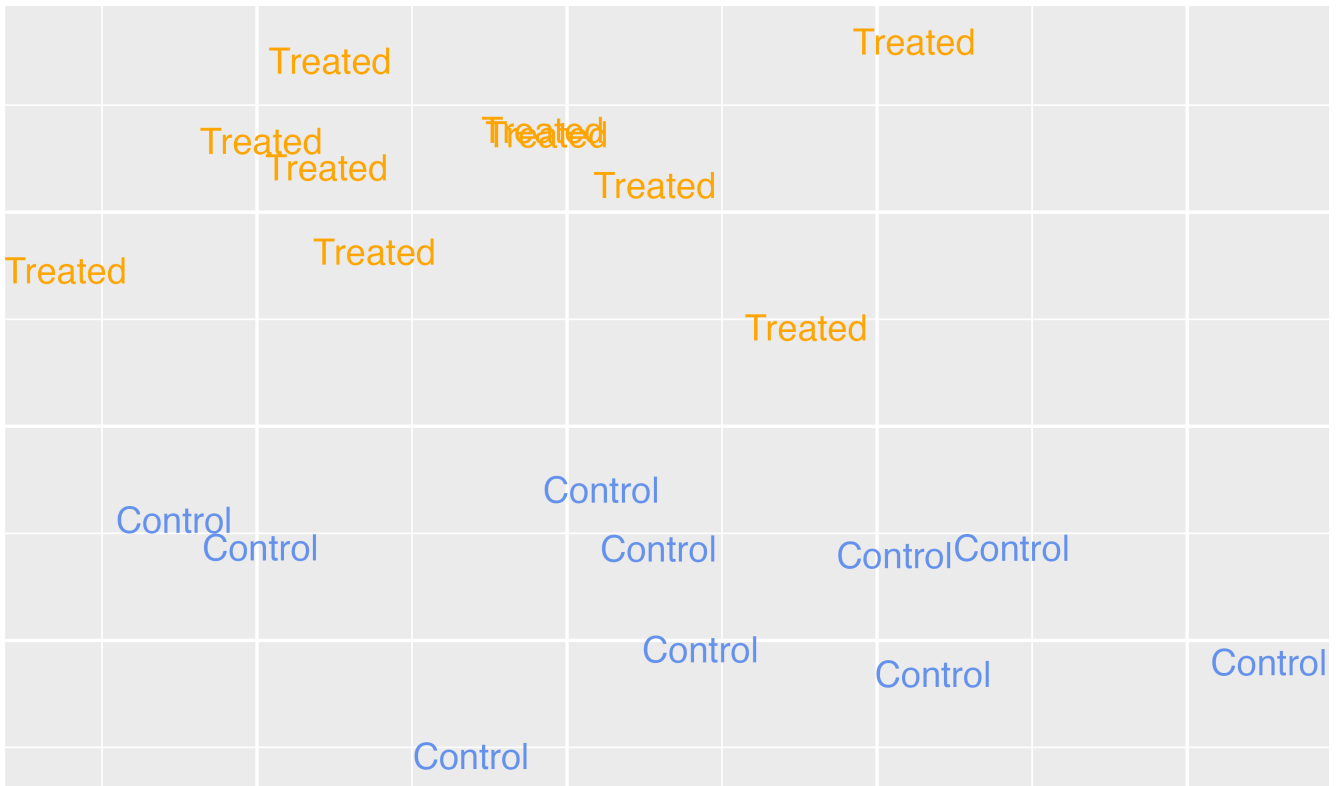
Target estimands

Average Treatment Effect (ATE)

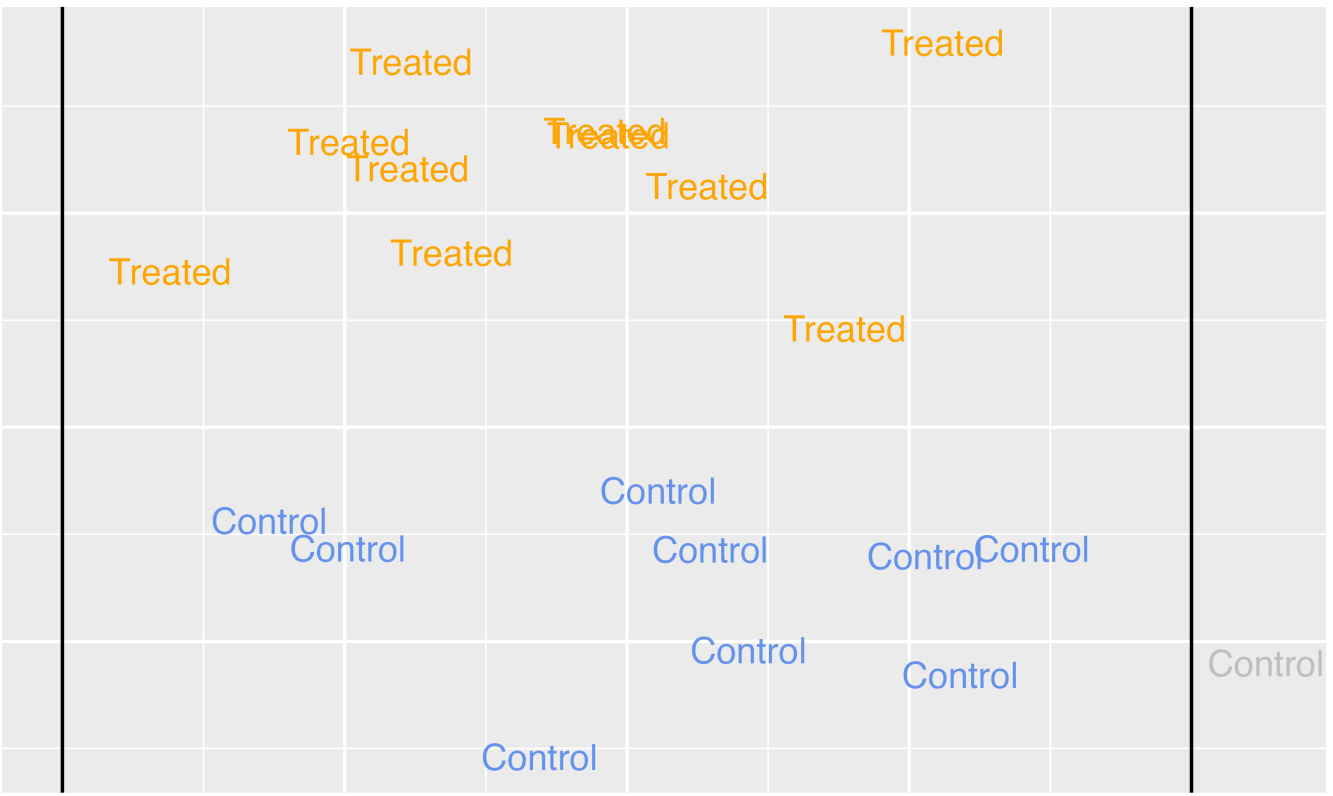


Target estimands

Estimand	Target population	Example Research Question
ATE	Full population	*Should we decide whether to have extra magic hours all mornings to change the wait time for Seven Dwarfs Mine Train between 5-6pm?* *Should a specific policy be applied to all eligible observations?*

Target estimands

Average Treatment Effect among the Treated (ATT)



Target estimands

Estimand	Target population	Example Research Question
ATT	Exposed (treated) observations	*Should we stop extra magic hours to change the wait time for Seven Dwarfs Mine Train between 5-6pm?*
		Should we stop our marketing campaign to those currently receiving it?
		Should medical providers stop recommending treatment for those currently receiving it?

Matching in R (ATT)

```r
library(MatchIt)
m <- matchit(
  qsmk ~ sex +
    race + age + I(age^2) + education +
    smokeintensity + I(smokeintensity^2) +
    smokeyrs + I(smokeyrs^2) + exercise +
    active + wt71 + I(wt71^2),
  data = nhefs_complete
)
m
```

```
A matchit object
 - method: 1:1 nearest neighbor matching without replacement
 - distance: Propensity score
             - estimated with logistic regression
 - number of obs.: 1566 (original), 806 (matched)
 - target estimand: ATT
 - covariates: sex, race, age, I(age^2), education,
smokeintensity, I(smokeintensity^2), smokeyrs, I(smokeyrs^2),
exercise, active, wt71, I(wt71^2)
```

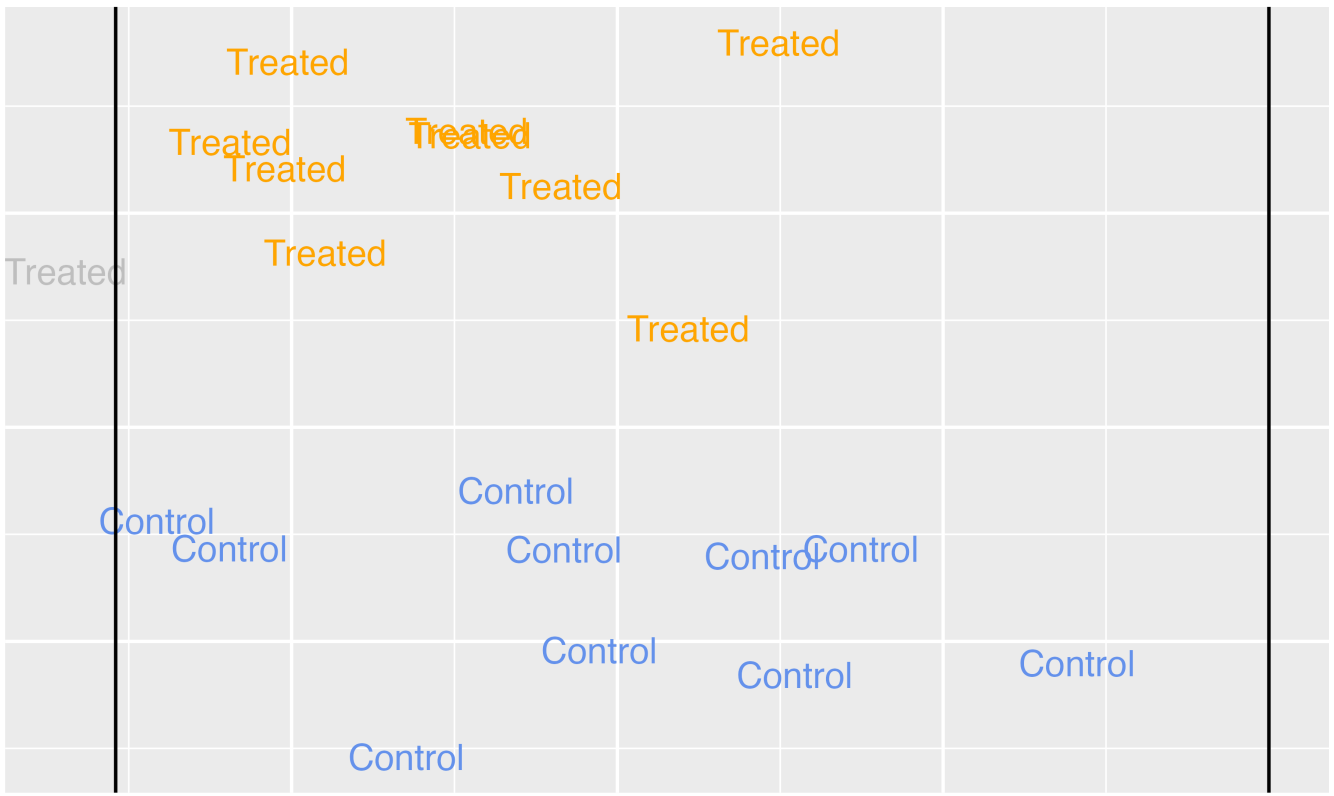
Matching in R (ATT)

```r
matched_data <- get_matches(m, id = "i")
as_tibble(matched_data)
```

```
# A tibble: 806 × 71
   i     subclass weights  seqn  qsmk death yrdth modth
   <chr> <fct>      <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 11    1              1   428     1     0    NA    NA
 2 1220  1              1 23045     0     0    NA    NA
 3 15    2              1   446     1     1    88     1
 4 1082  2              1 22294     0     0    NA    NA
 5 18    3              1   596     1     0    NA    NA
 6 534   3              1 14088     0     0    NA    NA
 7 23    4              1   618     1     0    NA    NA
 8 697   4              1 18085     0     0    NA    NA
 9 27    5              1   806     1     0    NA    NA
10 879   5              1 21128     0     0    NA    NA
# ℹ 796
```

Target estimands

Average Treatment Effect among the Controls (ATC)



Target estimands

Estimand	Target population	Example Research Question
ATU	Unexposed (control) observations	*Should we add extra magic hours for all days to change the wait time for Seven Dwarfs Mine Train between 5-6pm?* *Should we extend our marketing campaign to those not receiving it?* *Should medical providers extend treatment to those not currently receiving it?*

Matching in R (ATC)

```r
m <- matchit(
  qsmk ~ sex +
    race + age + I(age^2) + education +
    smokeintensity + I(smokeintensity^2) +
    smokeyrs + I(smokeyrs^2) + exercise +
    active + wt71 + I(wt71^2),
  data = nhefs_complete,
  estimand = "ATC"
)
m
```

```
A matchit object
 - method: 1:1 nearest neighbor matching without replacement
 - distance: Propensity score
             - estimated with logistic regression
 - number of obs.: 1566 (original), 806 (matched)
 - target estimand: ATC
 - covariates: sex, race, age, I(age^2), education,
smokeintensity, I(smokeintensity^2), smokeyrs, I(smokeyrs^2),
exercise, active, wt71, I(wt71^2)
```

Target estimands

Average Treatment Effect among the Matched (ATM)

Target estimands

Estimand	Target population	Example Research Question
ATM	Evenly matchable	*Are there some days we should change whether we are offering extra magic hours in order to change the wait time for Seven Dwarfs Mine Train between 5-6pm?* *Is there an effect of the exposure for some observations?* *Should those at clinical equipoise receive treatment?*

Matching in R (ATM)

```r
m <- matchit(
  qsmk ~ sex +
    race + age + I(age^2) + education +
    smokeintensity + I(smokeintensity^2) +
    smokeyrs + I(smokeyrs^2) + exercise +
    active + wt71 + I(wt71^2),
  data = nhefs_complete,
  link = "linear.logit",
  caliper = 0.1
)
m
```

Observations with propensity scores (on the linear logit scale) within 0.1 standard errors (the caliper) will be discarded

Matching in R (ATM)

```
A matchit object
 - method: 1:1 nearest neighbor matching without replacement
 - distance: Propensity score [caliper]
             - estimated with logistic regression and linearized
 - caliper: <distance> (0.063)
 - number of obs.: 1566 (original), 780 (matched)
 - target estimand: ATT
 - covariates: sex, race, age, I(age^2), education,
smokeintensity, I(smokeintensity^2), smokeyrs, I(smokeyrs^2),
exercise, active, wt71, I(wt71^2)
```

Matching in R (ATM)

```r
matched_data <- get_matches(m, id = "i")
as_tibble(matched_data)
```

```
# A tibble: 780 × 71
   i     subclass weights  seqn  qsmk death yrdth modth
   <chr> <fct>      <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1 11    1              1   428     1     0    NA    NA
 2 1220  1              1 23045     0     0    NA    NA
 3 15    2              1   446     1     1    88     1
 4 1082  2              1 22294     0     0    NA    NA
 5 18    3              1   596     1     0    NA    NA
 6 534   3              1 14088     0     0    NA    NA
 7 23    4              1   618     1     0    NA    NA
 8 697   4              1 18085     0     0    NA    NA
 9 27    5              1   806     1     0    NA    NA
10 879   5              1 21128     0     0    NA    NA
# ℹ 770
```

Your Turn 1

Using the propensity scores you created in the previous exercise, create a "matched" data set using the ATM method with a caliper of 0.2.

06:00

Propensity scores

Matching

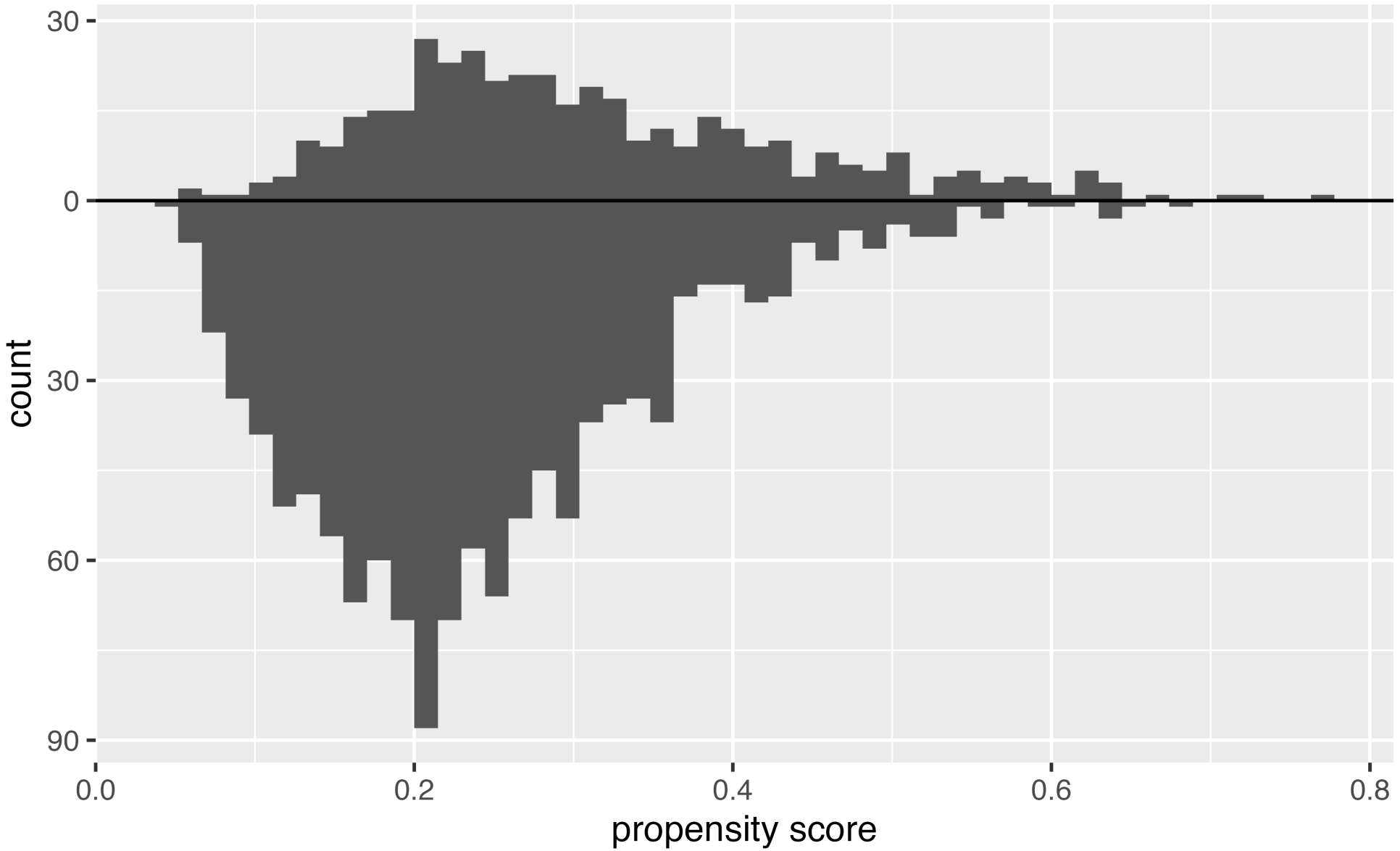
Weighting

Stratification

Direct Adjustment

…

Histogram of propensity scores

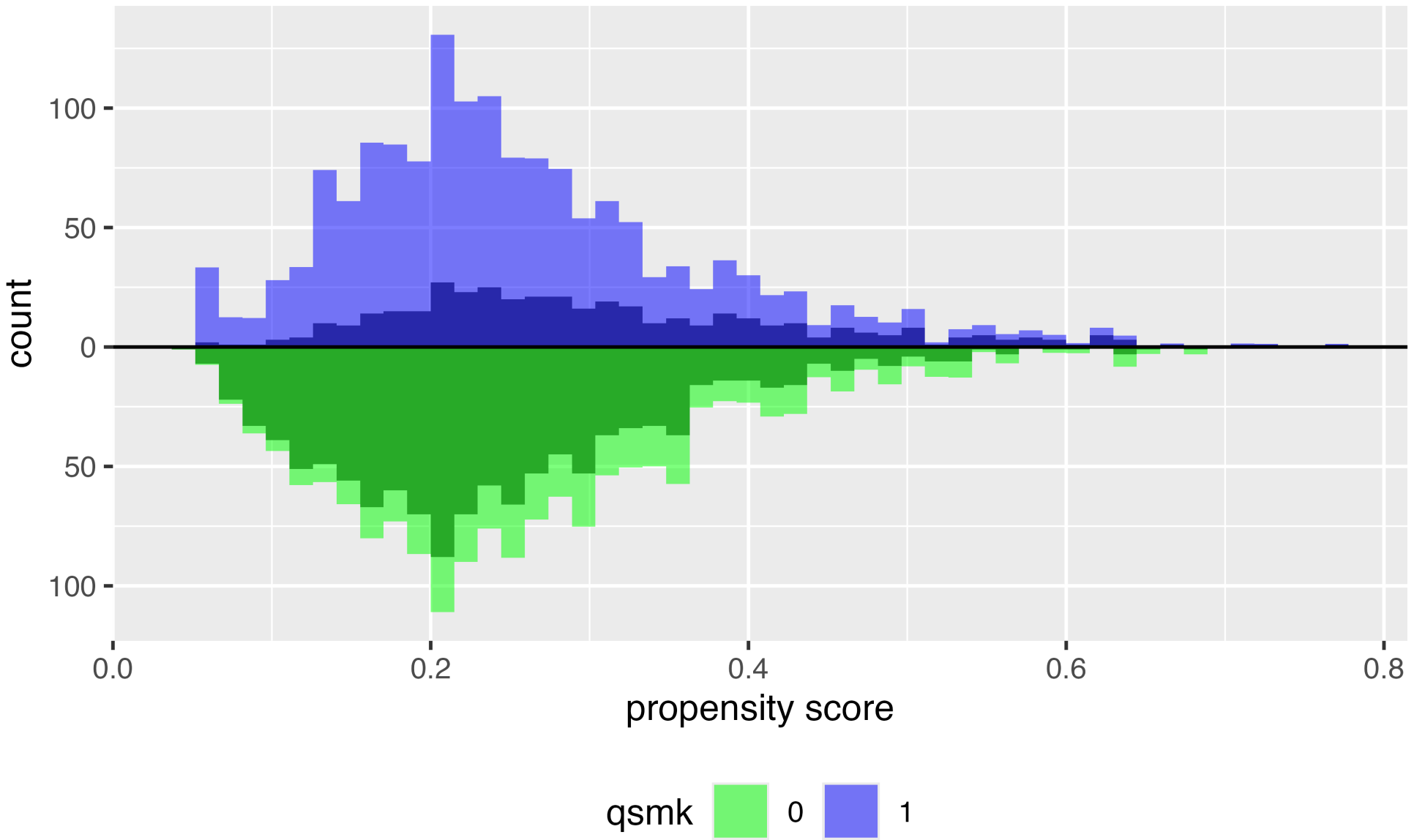


Target estimands: ATE

Average Treatment Effect (ATE)

```
1  (Z / p) + ((1 - Z) / (1 - p))
```

ATE



Target estimands: ATT & ATC

Average Treatment Effect Among the Treated (ATT)

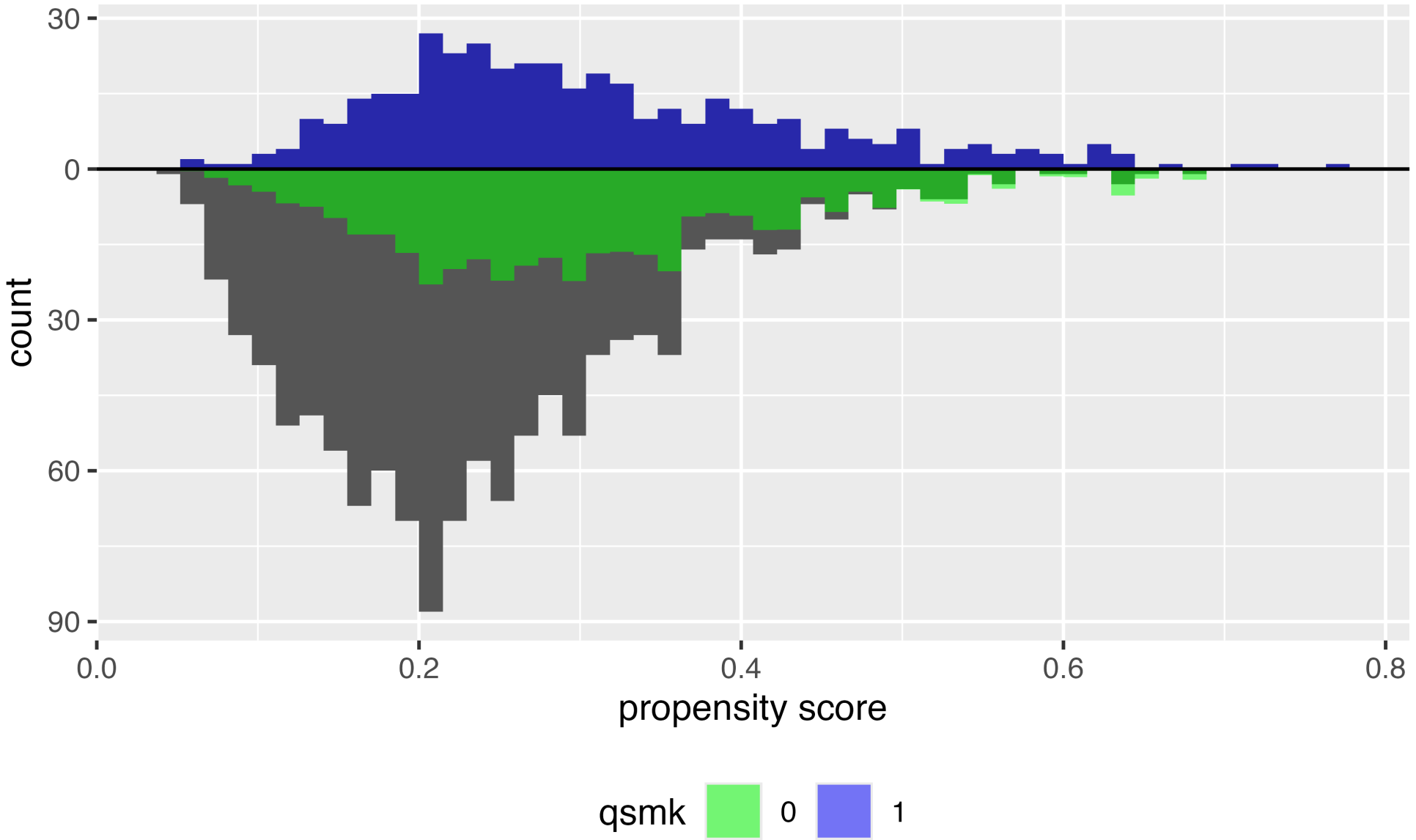
```
((p * Z) / p) + ((p * (1 - Z)) / (1 - p))
```

Target estimands: ATT & ATC

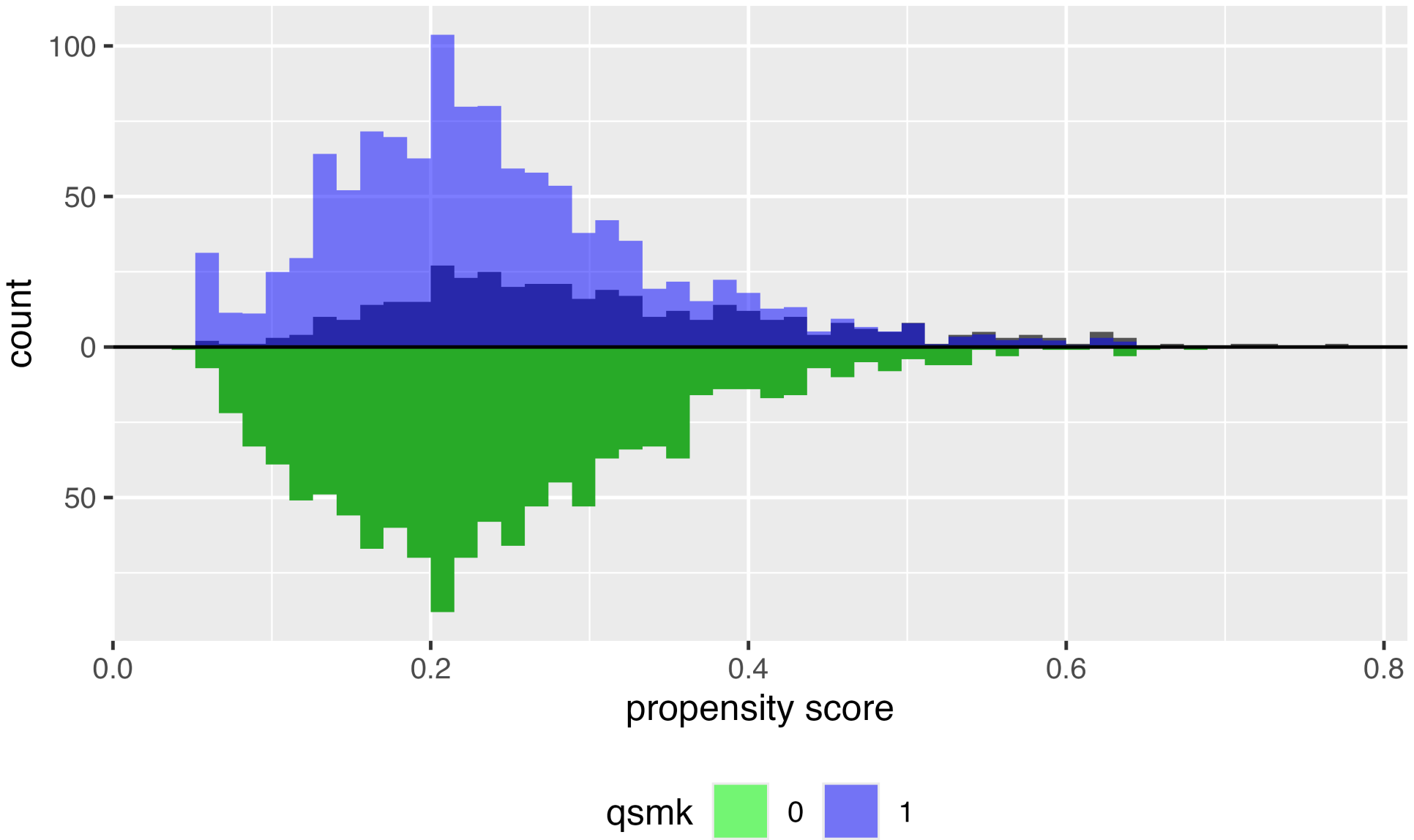
Average Treatment Effect Among the Controls (ATC)

```
1 (((1 - p) * Z) / p) + (((1 - p) * (1 - Z)) / (1 - p))
```

ATT



ATC



Target estimands: ATM & ATO

Average Treatment Effect Among the Evenly Matchable (ATM)

```
pmin(p, 1 - p) / (Z * p + (1 - Z) * (1 - p))
```

Target estimands: ATM & ATO

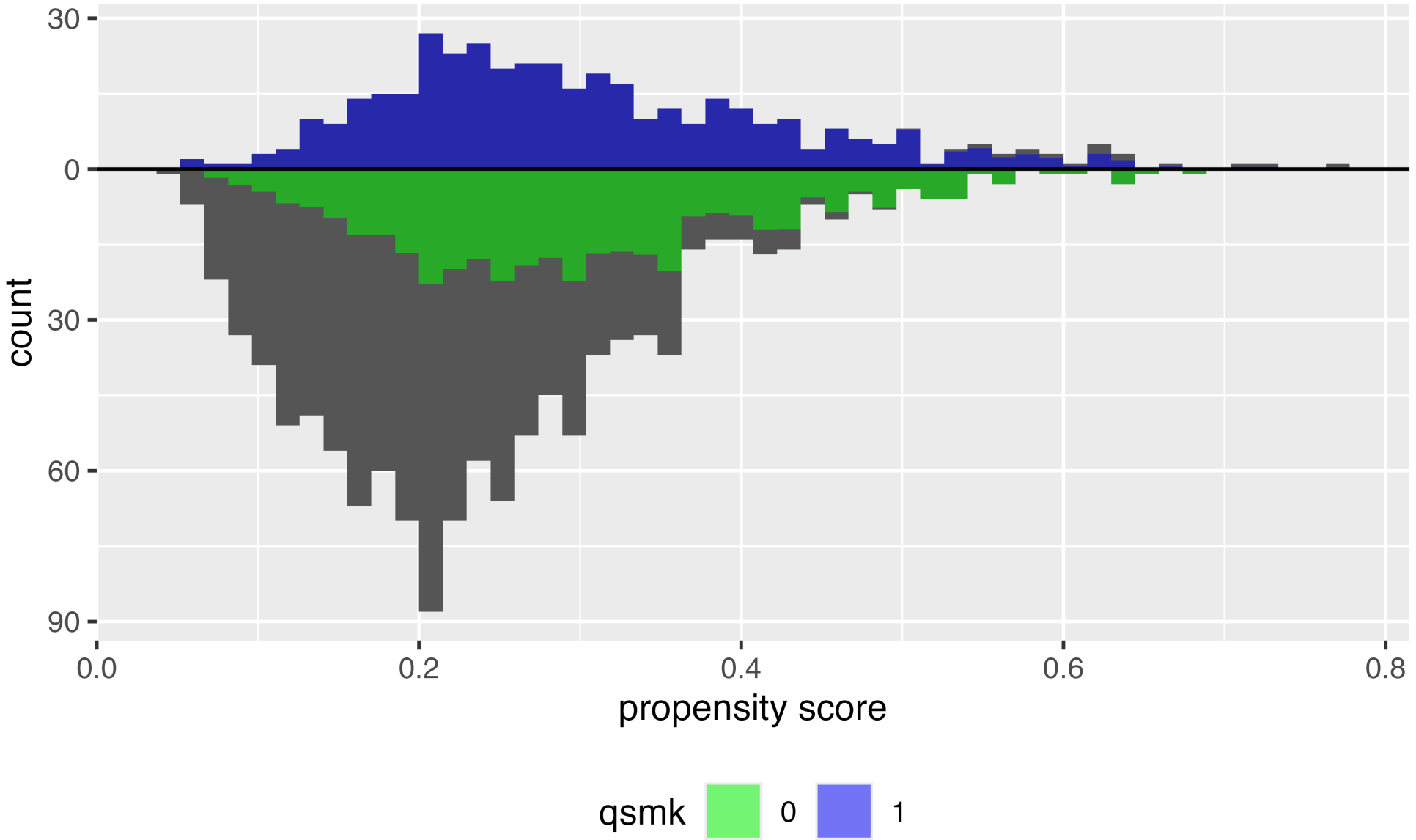
Average Treatment Effect Among the Overlap Population

```
1  (1 - p) * Z + p * (1 - Z)
```

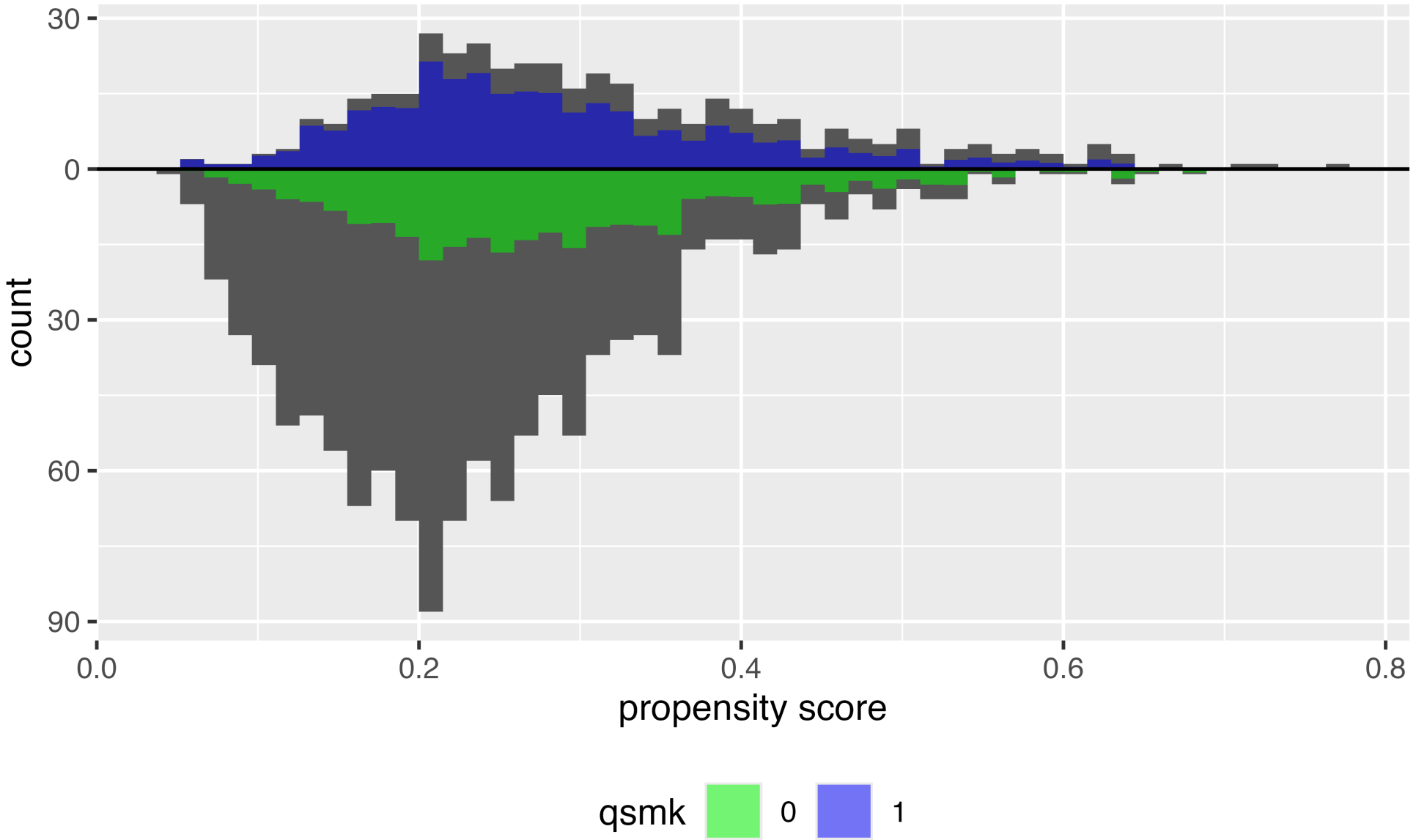
Target estimands

Estimand	Target population	Example Research Question
dATO	Overlap population	*Same as ATM*

ATM



ATO



ATE in R

Average Treatment Effect (ATE)

```
1 library(propensity)
2 df <- propensity_model |>
3   augment(type.predict = "response", data = nhefs_comple
4   mutate(w_ate = wt_ate(.fitted, qsmk))
```

Your Turn 2

Using the propensity scores you created in the previous exercise, add the ATE weights to your data frame

***Stretch*: Using the same propensity scores, create ATM weights**

06:00