# Step-by-Step Guidelines for Propensity Score Weighting with Two Groups

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# Four key steps

1) Choose the primary treatment effect of interest (ATE or ATT)
2) Estimate propensity score (ps) weights
3) Evaluate the quality of the ps weights
4) Estimate the treatment effect

# Case study

- Aim: To estimate the causal effect of MET/CBT5 versus "usual care"
  - Data from 2 SAMSHA CSAT discretionary grants

**MET/CBT5**

- Longitudinal, observational
- 37 sites from EAT study
- N = 2459

**"Usual Care"**

- Longitudinal, observational
- 4 sites from ATM study
- N = 444

# Case study

- Aim: To estimate the causal effect of MET/CBT5 versus "usual care"
  - Data from 2 SAMSHA CSAT discretionary grants

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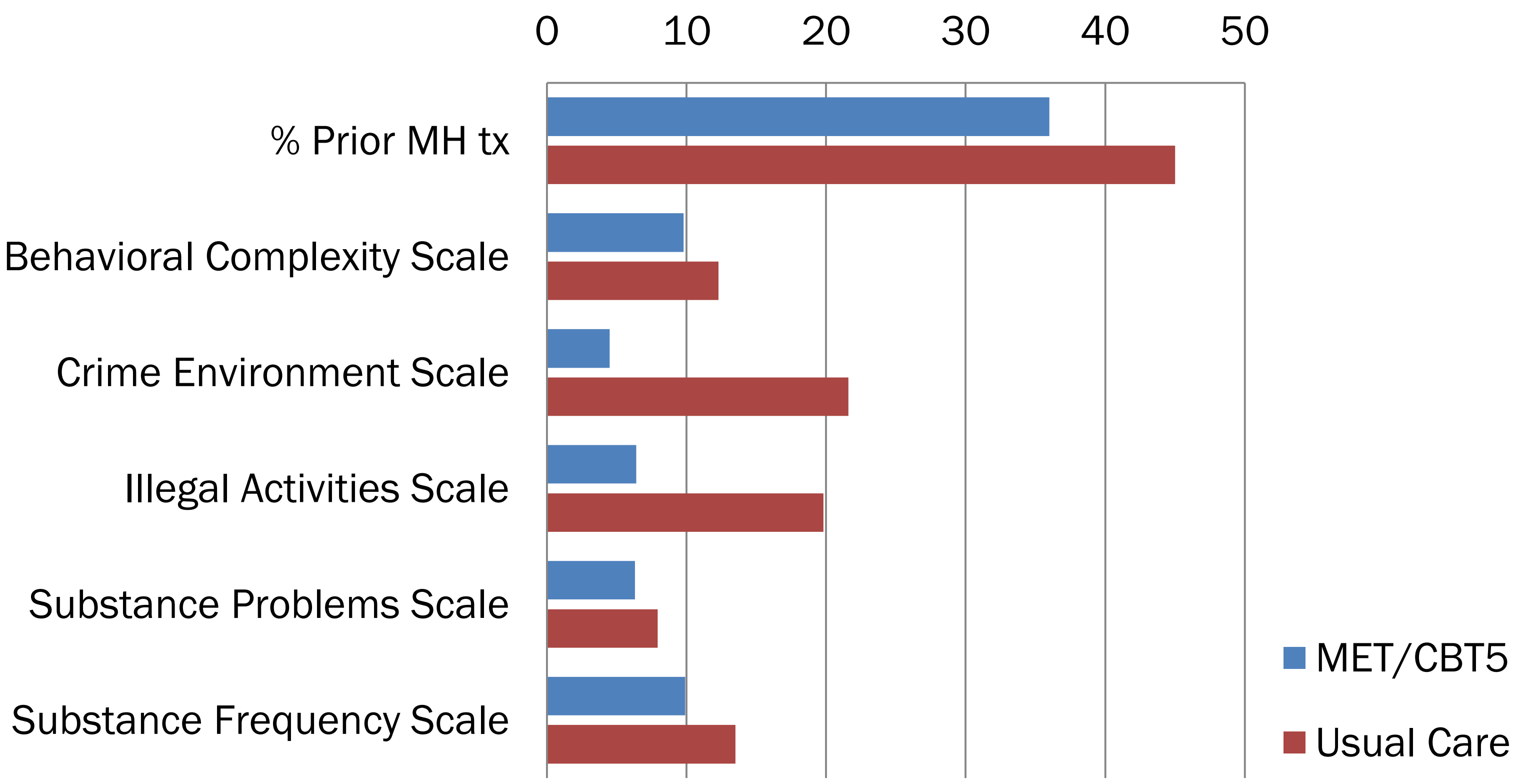
- N = 2459

**"Usual Care"**

- Longitudinal, observational
- 4 sites from ATM study
- N = 444

**All youth assessed with the GAIN at baseline, 6 months, and 12 months**

# Selection exists: Various meaningful ways in which the groups differ



# Step 1: Choose the primary treatment effect (ATE or ATT)

- Today, we chose to focus on estimating an ATT-type estimand
  - Want to draw inferences about the effect of treatment for individuals in the control condition (so really ATC)
  - In this case, we can just flip treatment indicator so 1 = usual care and 0 = MET/CBT5 to get the needed ATT estimand for the control group

- Why?
  - Youth in the community are different from those targeted to receive MET/CBT5 in the EAT study
  - Thus, the policy question we want to address is

How would youth like those receiving "usual care" in the community have fared had they received MET/CBT5?

# Step 2: Estimate the ps weights

- Only 1 command needed for this step
- Binary treatment command in TWANG currently available in R, SAS and STATA
- Also have a user-friendly Shiny app

# STATA CODE SLIDES

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

# Command to estimate ps weights in Stata

- **use aod_big,clear** ⟵ **Specifies name of dataset**
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

# Command to estimate ps weights in Stata

**Specifies name of treatment variable (for ATT, it should = targeted group)**

- use aod_big,clear
- ps **atm** age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm **age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx,** ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\ [illegible] /
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies list of pretreatment covariates to balance on**

# Command to estimate ps weights in Stata

**Specifies categorical variable race4g as i.race4g**

- use aod_big,clear
- ps atm age female **i.race4g** sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  **ntrees(5000)** stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies the maximum number of iterations used by GBM. Should be large (5000 to 10000)**

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) **stopmethod(es.max)** estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies the criteria for choosing the optimal number of iterations. Available choices include mean or max ES and mean or max KS statistics**

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) **estimand(ATT)** ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies primary estimand of interest (ATT or ATE)**

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  **rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe)** ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies the R executable by name and path**

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  **objpath(C:\Users\sliu002\Desktop\twang\webinar twang)** ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies folder where outputted data and plots will go**

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  **plotname(binary_twang_att.pdf)**
- balance, unweighted weighted
- save subdata_twogrp_att_wgts,replace

**Specifies name of file where diagnostic plots will go**

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
  ntrees(5000) stopmethod(es.max) estimand(ATT) ///
  rcmd(C:\Program Files\R\R-3.0.3\bin\Rscript.exe) ///
  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- **balance, unweighted weighted** ⟵ **Print unweighted and weighted balance tables in the output window**
- save subdata_twogrp_att_wgts,replace

# Command to estimate ps weights in Stata

- use aod_big,clear
- ps atm age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx, ///
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  objpath(C:\Users\sliu002\Desktop\twang\webinar twang) ///
  plotname(binary_twang_att.pdf)
- balance, unweighted weighted
- **save subdata_twogrp_att_wgts,replace** ⟵

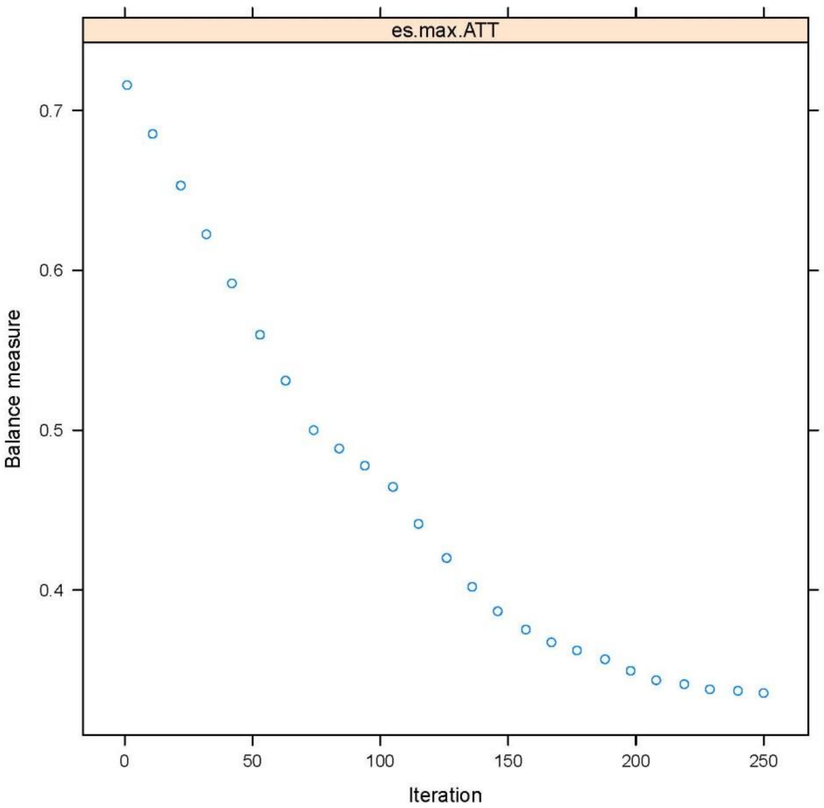
**Specifies name of outputted dataset with ps weights**

# Step 3: Evaluate the quality of the ps weights

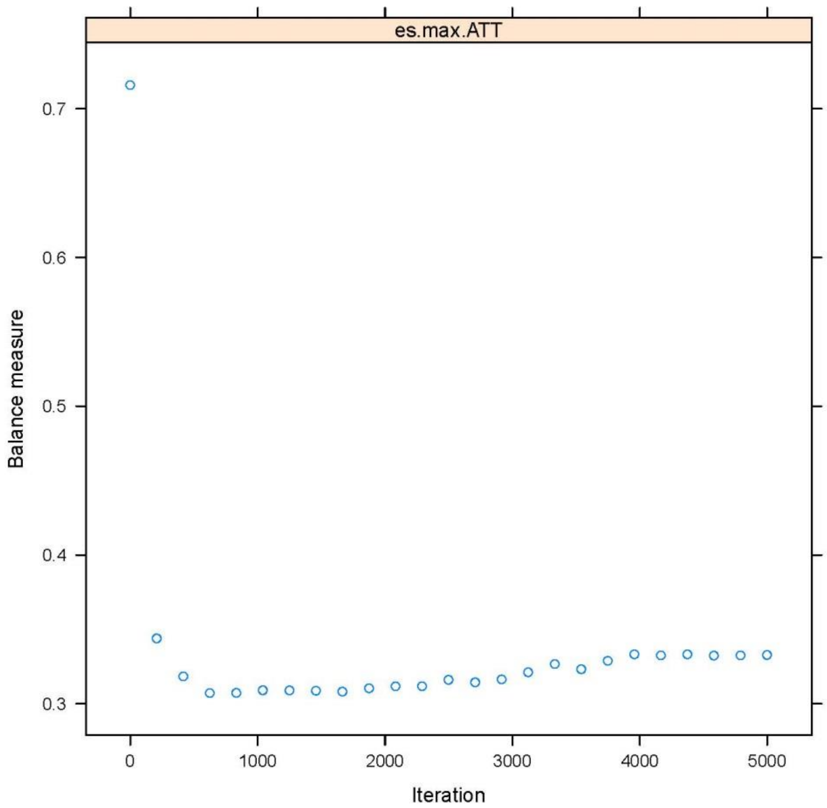
- Key issues that should be checked:
  - Convergence = did the algorithm run long enough
  - Balance = how well matched the two groups look after weighting
  - Overlap = whether there is evidence that the distributions of the pretreatment covariates in the two groups line up well

# Step 3: Checking convergence

Bad Convergence




Good Convergence



# Step 3: Checking balance

- TWANG has numerous diagnostics for assessing balance

# Step 3: Checking balance with tables

# Step 3: Checking balance with tables
# Unweighted balance table

Unweighted

| | txmn | txsd | ctmn | ctsd | stdeffsz | stat | p | ks | kspval |
|---|---|---|---|---|---|---|---|---|---|
| _ | | | | | | | | | |
| age | 15.82 | 1.088 | 15.54 | 1.573 | .255 | 4.59 | 0 | .116 | 0 |
| bcs | 12.26 | 7.405 | 9.832 | 7.776 | .328 | 6.309 | 0 | .177 | 0 |
| ces | .242 | .363 | .052 | .177 | .524 | 10.81 | 0 | .262 | 0 |
| eps | .279 | .191 | .208 | .185 | .373 | 7.267 | 0 | .186 | 0 |
| female | .214 | .411 | .315 | .465 | -.246 | -4.666 | 0 | .101 | .001 |
| ias | .224 | .19 | .087 | .109 | .719 | 14.73 | 0 | .485 | 0 |
| imds | 7.723 | 8.234 | 7.831 | 8.515 | -.013 | -.253 | .8 | .03 | .874 |
| prmhtx | .449 | .498 | .367 | .482 | .164 | 3.202 | .001 | .082 | .012 |
| sds | 3.099 | 2.332 | 2.338 | 2.22 | .327 | 6.382 | 0 | .147 | 0 |
| sfs | .145 | .147 | .109 | .123 | .246 | 4.889 | 0 | .12 | 0 |
| sps | 7.93 | 4.454 | 6.311 | 4.268 | .364 | 7.1 | 0 | .141 | 0 |
| race4g | | | | | | | | | |
| 1 | .673 | .469 | .51 | .5 | .349 | 21.45 | 0 | .163 | 0 |
| 2 | .135 | .342 | .081 | .273 | .157 | . | . | .054 | 0 |
| 3 | .097 | .296 | .241 | .428 | -.487 | . | . | .144 | 0 |
| 4 | .092 | .29 | .168 | .374 | -.261 | . | . | .076 | 0 |
| Missingn~s | | | | | | | | | |
| bcs | 0 | 0 | .002 | .049 | -.054 | -37.83 | 0 | .002 | .297 |
| eps | 0 | 0 | .002 | .04 | -.044 | -32.14 | 0 | .002 | .395 |
| ias | 0 | 0 | .009 | .094 | -.103 | -72.54 | 0 | .009 | .045 |
| imds | 0 | 0 | .002 | .04 | -.044 | -32.14 | 0 | .002 | .395 |
| prmhtx | .002 | .047 | .007 | .083 | -.059 | -1.093 | .275 | .005 | .25 |
| race4g | .002 | .047 | 0 | 0 | .048 | . | . | .002 | 0 |
| sds | 0 | 0 | .004 | .06 | -.066 | -47.38 | 0 | .004 | .201 |
| sps | 0 | 0 | .001 | .035 | -.038 | -27.37 | 0 | .001 | .461 |

# Step 3: Checking balance with tables
# Unweighted balance table

Unweighted

| | txmn | txsd | ctmn | ctsd | stdeffsz | stat | p | ks | kspval |
|---|---|---|---|---|---|---|---|---|---|
| _ | | | | | | | | | |
| age | 15.82 | 1.088 | 15.54 | 1.573 | .255 | 4.59 | 0 | .116 | 0 |
| bcs | 12.26 | 7.405 | 9.832 | 7.776 | .328 | 6.309 | 0 | .177 | 0 |
| ces | .242 | .363 | .052 | .177 | .524 | 10.81 | 0 | .262 | 0 |
| eps | .279 | .191 | .208 | .185 | .373 | 7.267 | 0 | .186 | 0 |
| female | .214 | .411 | .315 | .465 | -.246 | -4.666 | 0 | .101 | .001 |
| ias | .224 | .19 | .087 | .109 | .719 | 14.73 | 0 | .485 | 0 |
| imds | 7.723 | 8.234 | 7.831 | 8.515 | -.013 | -.253 | .8 | .03 | .874 |
| prmhtx | .449 | .498 | .367 | .482 | .164 | 3.202 | .001 | .082 | .012 |
| sds | 3.099 | 2.332 | 2.338 | 2.22 | .327 | 6.382 | 0 | .147 | 0 |
| sfs | .145 | .147 | .109 | .123 | .246 | 4.889 | 0 | .12 | 0 |
| sps | 7.93 | 4.454 | 6.311 | 4.268 | .364 | 7.1 | 0 | .141 | 0 |
| race4g | | | | | | | | | |
| 1 | .673 | .469 | .51 | .5 | .349 | 21.45 | 0 | .163 | 0 |
| 2 | .135 | .342 | .081 | .273 | .157 | . | . | .054 | 0 |
| 3 | .097 | .296 | .241 | .428 | -.487 | . | . | .144 | 0 |
| 4 | .092 | .29 | .168 | .374 | -.261 | . | . | .076 | 0 |
| Missingn~s | | | | | | | | | |
| bcs | 0 | 0 | .002 | .049 | -.054 | -37.83 | 0 | .002 | .297 |
| eps | 0 | 0 | .002 | .04 | -.044 | -32.14 | 0 | .002 | .395 |
| ias | 0 | 0 | .009 | .094 | -.103 | -72.54 | 0 | .009 | .045 |
| imds | 0 | 0 | .002 | .04 | -.044 | -32.14 | 0 | .002 | .395 |
| prmhtx | .002 | .047 | .007 | .083 | -.059 | -1.093 | .275 | .005 | .25 |
| race4g | .002 | .047 | 0 | 0 | .048 | . | . | .002 | 0 |
| sds | 0 | 0 | .004 | .06 | -.066 | -47.38 | 0 | .004 | .201 |
| sps | 0 | 0 | .001 | .035 | -.038 | -27.37 | 0 | .001 | .461 |

Highlights denotes rows with absolute ES > 0.10

# Step 3: Checking balance with tables
# Weighted balance table

Weighted: esmax

| | txmn | txsd | ctmn | ctsd | stdeffsz | stat | p | ks | kspval |
|---|---|---|---|---|---|---|---|---|---|
| _ | | | | | | | | | |
| age | 15.82 | 1.088 | 15.8 | 1.459 | .019 | .238 | .812 | .052 | .524 |
| bcs | 12.26 | 7.405 | 12.48 | 7.757 | -.03 | -.466 | .641 | .06 | .351 |
| ces | .242 | .363 | .131 | .284 | .305 | 4.32 | 0 | .152 | 0 |
| eps | .279 | .191 | .255 | .183 | .124 | 2.056 | .04 | .064 | .283 |
| female | .214 | .411 | .248 | .432 | -.084 | -1.311 | .19 | .035 | .929 |
| ias | .224 | .19 | .203 | .169 | .107 | 1.67 | .095 | .083 | .073 |
| imds | 7.723 | 8.234 | 8.396 | 8.509 | -.082 | -1.262 | .207 | .062 | .308 |
| prmhtx | .449 | .498 | .453 | .498 | -.008 | -.129 | .898 | .004 | 1 |
| sds | 3.099 | 2.332 | 2.898 | 2.245 | .086 | 1.312 | .19 | .049 | .6 |
| sfs | .145 | .147 | .148 | .144 | -.019 | -.283 | .778 | .049 | .605 |
| sps | 7.93 | 4.454 | 7.561 | 4.249 | .083 | 1.272 | .204 | .052 | .522 |
| race4g | | | | | | | | | |
| 1 | .673 | .469 | .666 | .472 | .016 | 1.083 | .362 | .007 | .362 |
| 2 | .135 | .342 | .105 | .307 | .087 | . | . | .03 | .362 |
| 3 | .097 | .296 | .12 | .325 | -.079 | . | . | .023 | .362 |
| 4 | .092 | .29 | .108 | .311 | -.055 | . | . | .016 | .362 |
| Missingn~s | | | | | | | | | |
| bcs | 0 | 0 | 0 | .013 | -.004 | -21.96 | 0 | 0 | .125 |
| eps | 0 | 0 | 0 | .005 | -.001 | -30.06 | 0 | 0 | .029 |
| ias | 0 | 0 | 0 | .012 | -.002 | -72.29 | 0 | 0 | 0 |
| imds | 0 | 0 | 0 | .005 | -.001 | -30.06 | 0 | 0 | .029 |
| prmhtx | .002 | .047 | .003 | .053 | -.007 | -.212 | .832 | .001 | .832 |
| race4g | .002 | .047 | 0 | 0 | .048 | . | . | .002 | .362 |
| sds | 0 | 0 | .002 | .041 | -.03 | -42.25 | 0 | .002 | .004 |
| sps | 0 | 0 | 0 | .011 | -.004 | -20.27 | 0 | 0 | .151 |

Highlights denote rows with absolute ES > 0.10

# Step 3: Checking balance graphically

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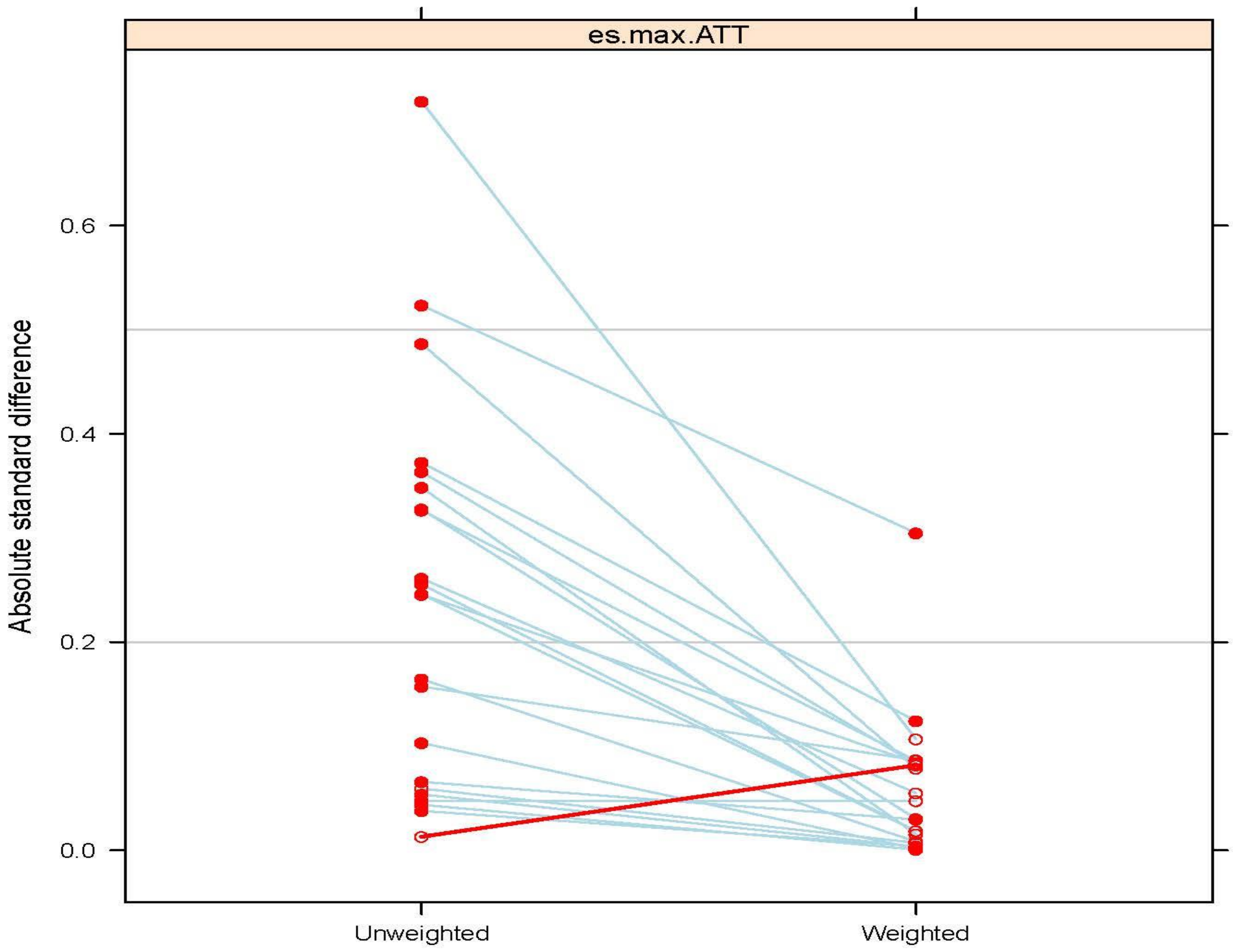
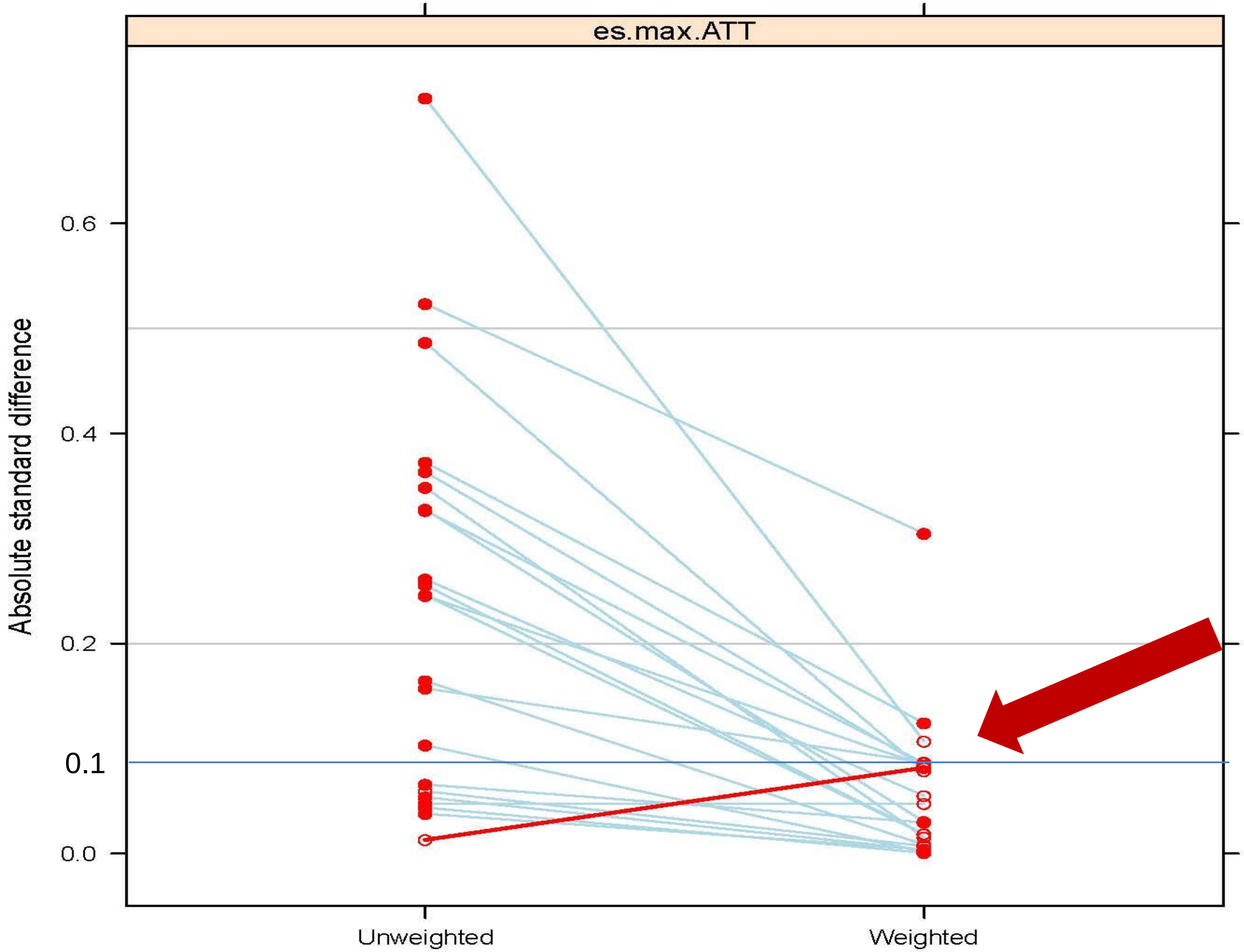
# ES plot

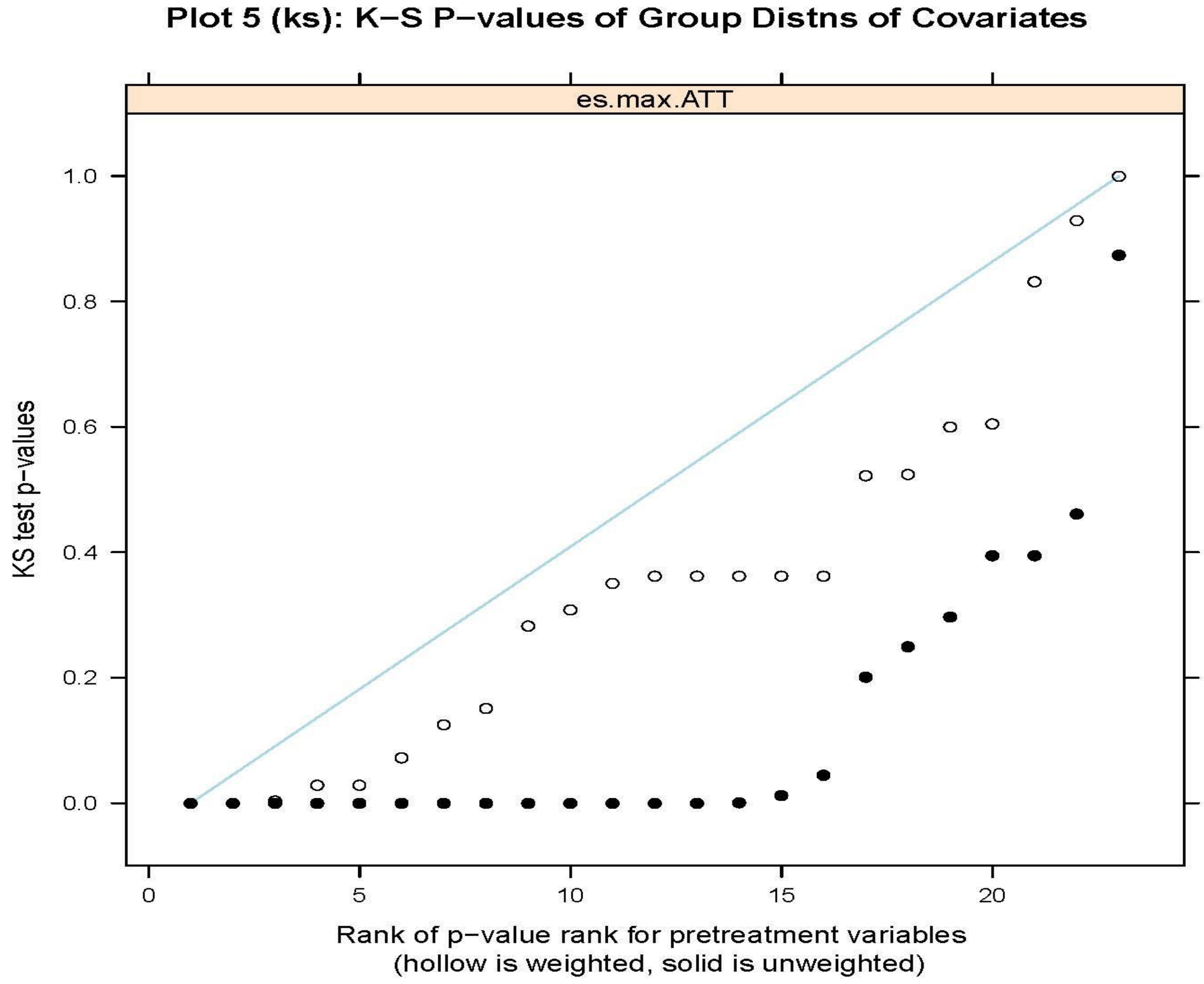


# Step 3: Checking balance graphically
# ES plot

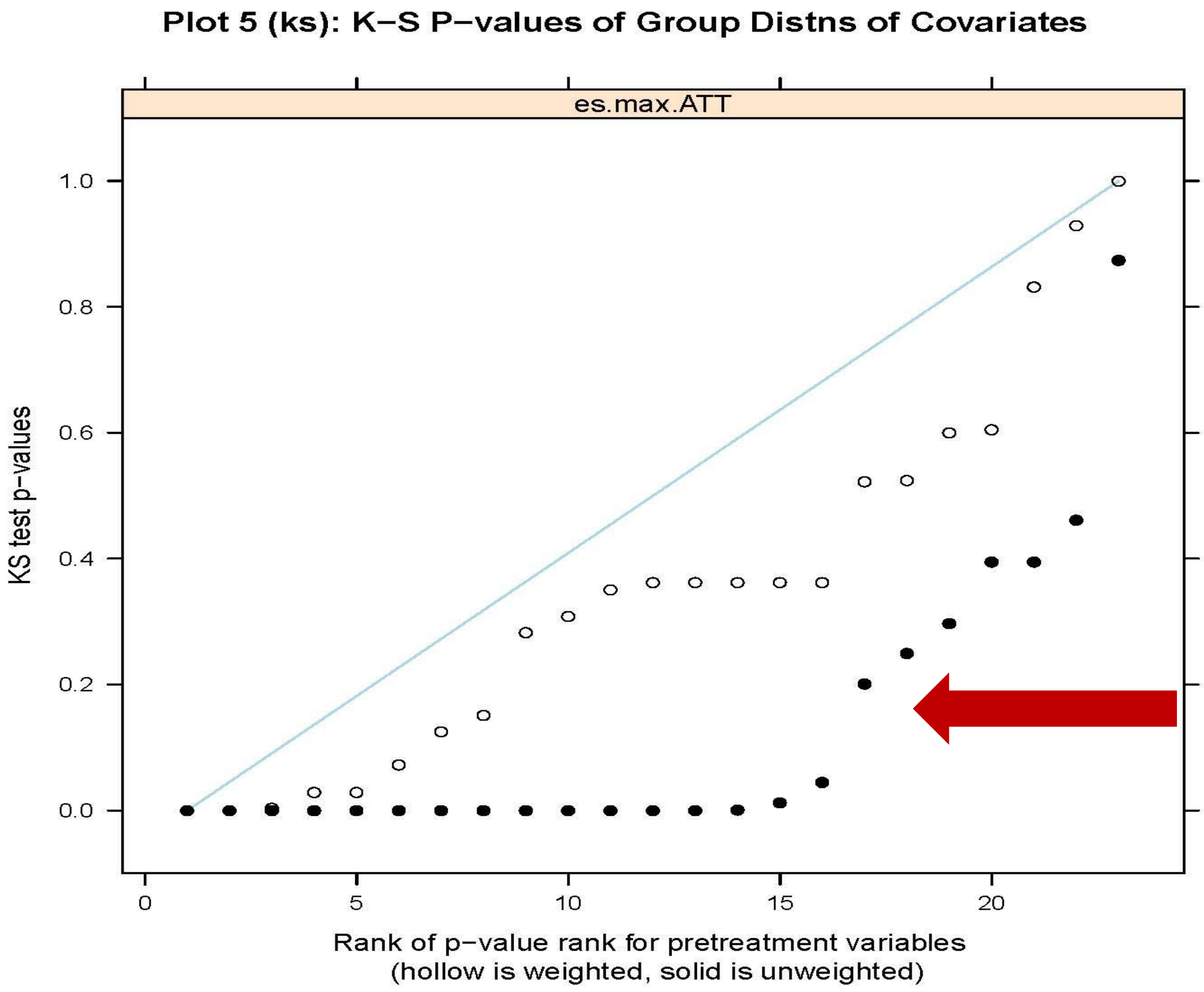



Want as many dots as possible to go below 0.10 after weighting

# Step 3: Checking balance graphically KS plot



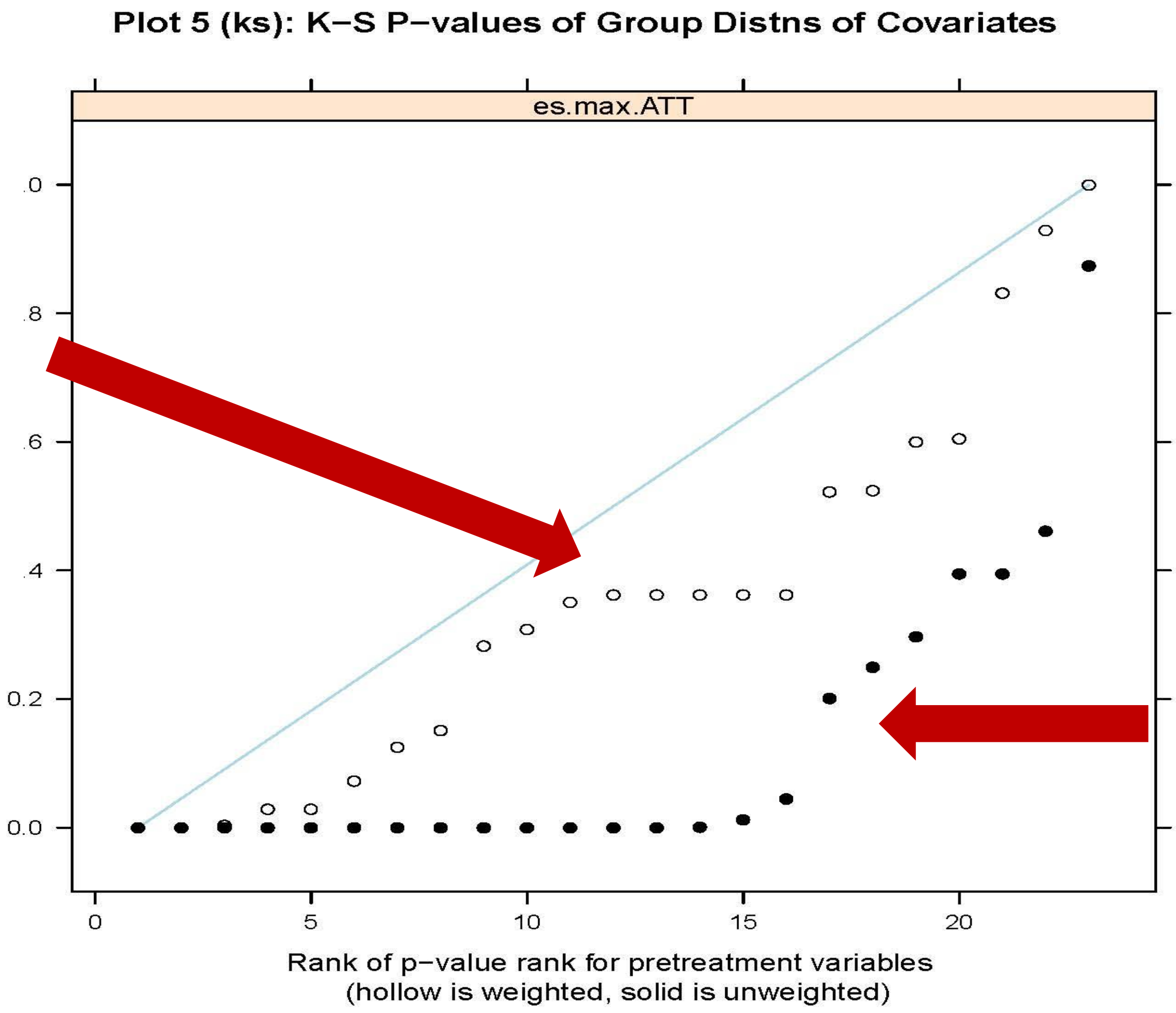
# Step 3: Checking balance graphically
# KS plot




Solid dots = unweighted p-values. Note many less than 0.05

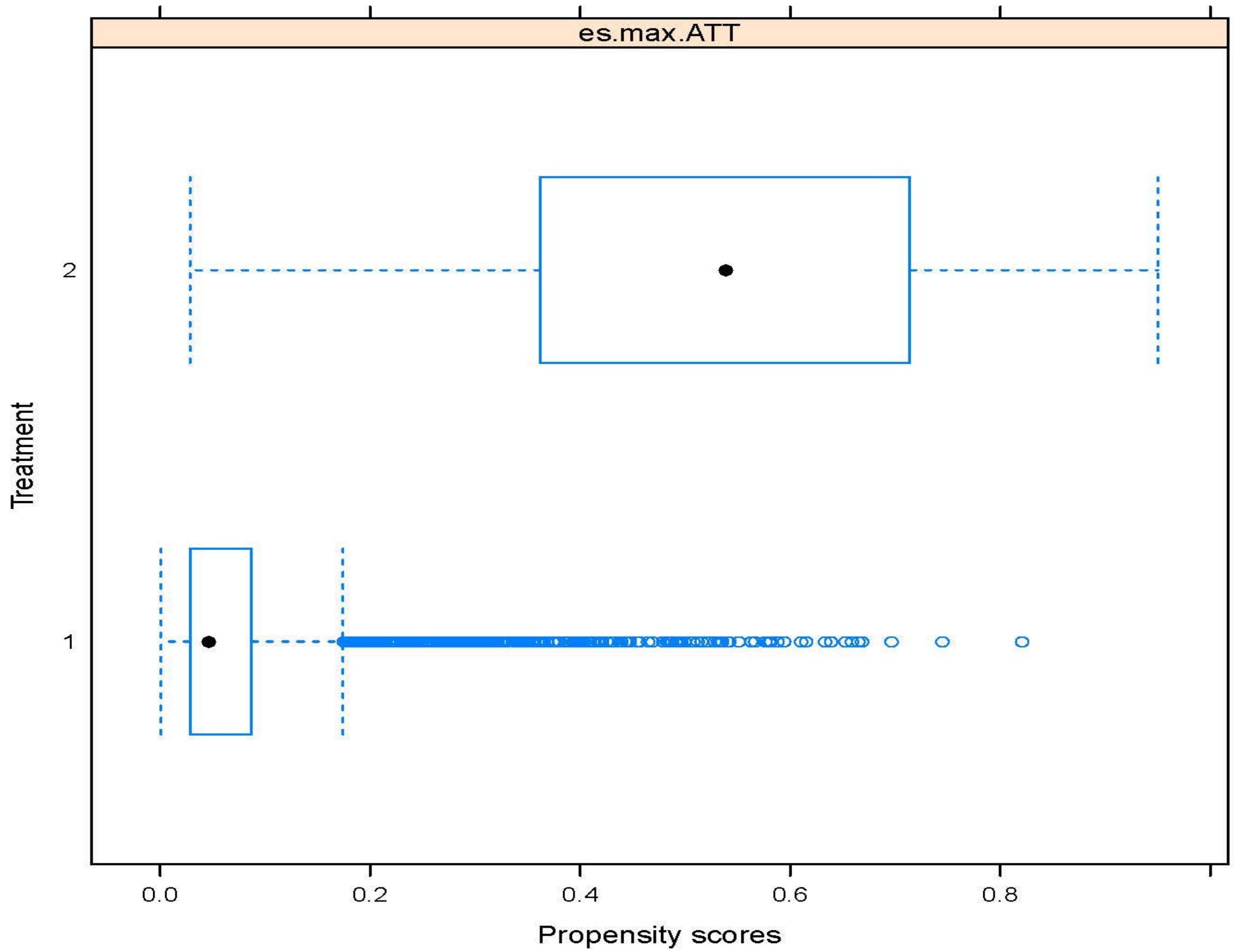
# Step 3: Checking balance graphically KS plot

Open dots = weighted p-values. Note getting larger and moving towards the diagonal line




Solid dots = unweighted p-values. Note many less than 0.05

# Step 3: Checking overlap



# Step 3: Checking overlap

Check for 0 (empty) cells on binary and categorical

| | MET/ CBT5 | Usual Care |
|---|---|---|
| Female | 774 | 95 |
| Race = 1 | 1254 | 299 |
| Race = 2 | 200 | 60 |
| Race = 3 | 592 | 43 |
| Race = 4 | 412 | 41 |
| Prior MH trt | 897 | 199 |

Compare the minimums and maximums

| | MET/ CBT5 | Usual Care |
|---|---|---|
| SFS | (0, 0.71) | (0, 0.65) |
| SPS | (0, 16) | (0, 16) |
| SDS | (0, 7) | (0, 7) |
| IAS | (0, 1) | (0, 1) |
| CES | (0, 1) | (0, 1) |
| EPS | (0, 0.98) | (0, 0.99) |
| IMDS | (0, 41) | (0, 34) |
| BCS | (0, 31) | (0, 31) |

Note: We haven't even begun to talk about the outcome yet

- Steps 1 to 3 do not involve any outcomes
- We first focus on dealing with selection/pre-treatment group differences
- Then, if we do a good job, we will move to outcome analyses

# Step 4: Estimate the treatment effect

- Estimate as difference in propensity score weighted means between the two groups of interest
  - Since we are using weights, we need to adjust our standard errors for the weighting
  - Analogous to fitting regression models with survey data with survey weights

# Step 4: Estimate the treatment effect

- Estimate as difference in propensity score weighted means between the two groups of interest
  - Since we are using weights, we need to adjust our standard errors for the weighting
  - Analogous to fitting regression models with survey data with survey weights

**We can use survey analysis commands in any software to estimate treatment effects**

# Step 4: Estimate the treatment effect (cont.)

Stata Code:

- use subdata_twogrp_att_wgts,clear
- reg sfs8p12 metcbt5[pweight=esmaxatt]

```
(sum of wgt is   7.3694e+02)

Linear regression                                      Number of obs =    2901
                                                       F(  1,  2899) =    4.69
                                                       Prob > F      =  0.0304
                                                       R-squared     =  0.0049
                                                       Root MSE      =  .13845
```

| sfs8p12 | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| metcbt5 | -.0198438 | .0091637 | -2.17 | 0.030 | -.0378119 | -.0018758 |
| _cons | .1141963 | .0066653 | 17.13 | 0.000 | .1011271 | .1272656 |

# Step 4: Estimate the treatment effect (cont.)

<u>Stata Code:</u>

- use subdata_twogrp_att_wgts,clear
- reg sfs8p12 metcbt5[pweight=esmaxatt]

```
(sum of wgt is   7.3694e+02)

Linear regression                                      Number of obs =    2901
                                                       F(  1,  2899) =    4.69
                                                       Prob > F      =  0.0304
                                                       R-squared     =  0.0049
                                                       Root MSE      =  .13845
```

| sfs8p12 | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| metcbt5 | -.0198438 | .0091637 | -2.17 | 0.030 | -.0378119 | -.0018758 |
| _cons | .1141963 | .0066653 | 17.13 | 0.000 | .1011271 | .1272656 |

**Results show that youth like those in "usual care" would have fared better had they received MET/CBT5**

# Comparison with unweighted treatment effect

<u>Stata Code:</u>

- use subdata_twogrp_att_wgts,clear
- reg sfs8p12 metcbt5

```
      Source |       SS       df       MS              Number of obs =    2901
-------------+------------------------------           F(  1,  2899) =   57.95
       Model |  .832622997     1  .832622997           Prob > F      =  0.0000
    Residual |  41.6553919  2899  .014368883           R-squared     =  0.0196
-------------+------------------------------           Adj R-squared =  0.0193
       Total |  42.4880148  2900   .01465104           Root MSE      =  .11987

------------------------------------------------------------------------------
     sfs8p12 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     metcbt5 |  -.0470548   .0061815    -7.61   0.000    -.0591753   -.0349343
       _cons |   .1141963   .0056888    20.07   0.000     .1030419    .1253508
------------------------------------------------------------------------------
```

# Comparison with unweighted treatment effect

<u>Stata Code:</u>

- use subdata_twogrp_att_wgts,clear
- reg sfs8p12 metcbt5

```
      Source |       SS       df       MS              Number of obs =    2901
-------------+------------------------------           F(  1,  2899) =   57.95
       Model |  .832622997     1  .832622997           Prob > F      =  0.0000
    Residual |  41.6553919  2899  .014368883           R-squared     =  0.0196
-------------+------------------------------           Adj R-squared =  0.0193
       Total |  42.4880148  2900   .01465104           Root MSE      =  .11987

------------------------------------------------------------------------------
     sfs8p12 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     metcbt5 |  -.0470548   .0061815    -7.61   0.000    -.0591753   -.0349343
       _cons |   .1141963   .0056888    20.07   0.000     .1030419    .1253508
------------------------------------------------------------------------------
```

- **Also shows significant evidence that youth in "usual care" have higher substance use frequency at 12-months than those in MET/CBT5**
- **Magnitude of the effect unweighted is double (-0.02 vs -0.047)**

# Step 4: Doubly robust estimation

- “Doubly robust” estimation is the preferred route for estimating causal treatment effects
  - Combines fitting a propensity score weighted regression model with the inclusion of additional pretreatment control covariates
  - As long as one piece is right (either the multivariate outcome model or the propensity score model), obtain consistent treatment effect estimates

# Step 4: Doubly robust estimation: Adding in covariates with lingering imbalances

Stata Code:

- use subdata_twogrp_att_wgts,clear
- reg sfs8p12 metcbt5 ces [pweight=esmaxatt]

```
(sum of wgt is   7.3694e+02)

Linear regression                               Number of obs =     2901
                                                F(  2,  2898) =     2.67
                                                Prob > F      =   0.0693
                                                R-squared     =   0.0070
                                                Root MSE      =   .13832
```

| sfs8p12 | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| metcbt5 | -.0219624 | .0096355 | -2.28 | 0.023 | -.0408555 | -.0030693 |
| ces | -.0191335 | .0161545 | -1.18 | 0.236 | -.050809 | .012542 |
| _cons | .118827 | .0078169 | 15.20 | 0.000 | .1034998 | .1341542 |