

Step-by-Step Guidelines for Propensity Score Weighting with Three or More Groups

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Motivating example

- **Case study:** To estimate the relative causal effect of MET/CBT5 vs “usual care” vs SCY
 - Data from 3 SAMSHA CSAT discretionary grants

MET/CBT5

- Observational
- MET/CBT5 at 37 EAT sites
- N = 2459
- 2003/04 - 2007

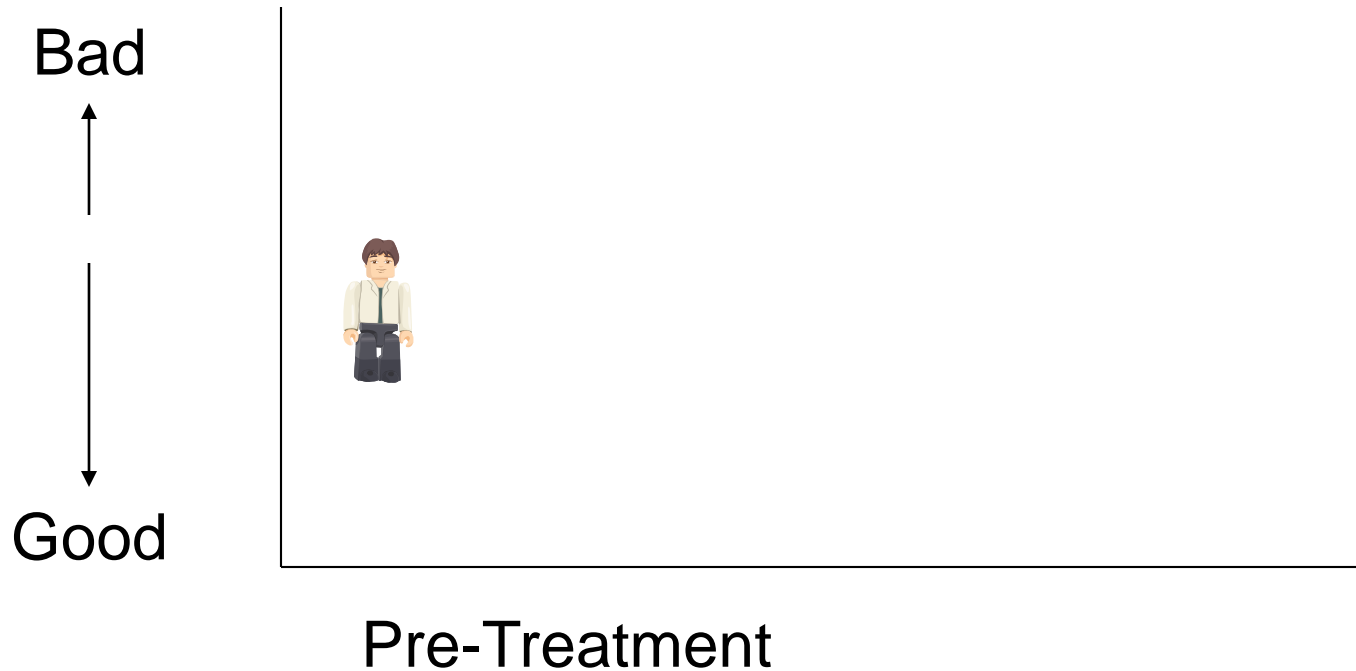
“Usual Care”

- Observational
- “Usual care” at 4 ATM sites
- N = 444
- 1998 - 1999

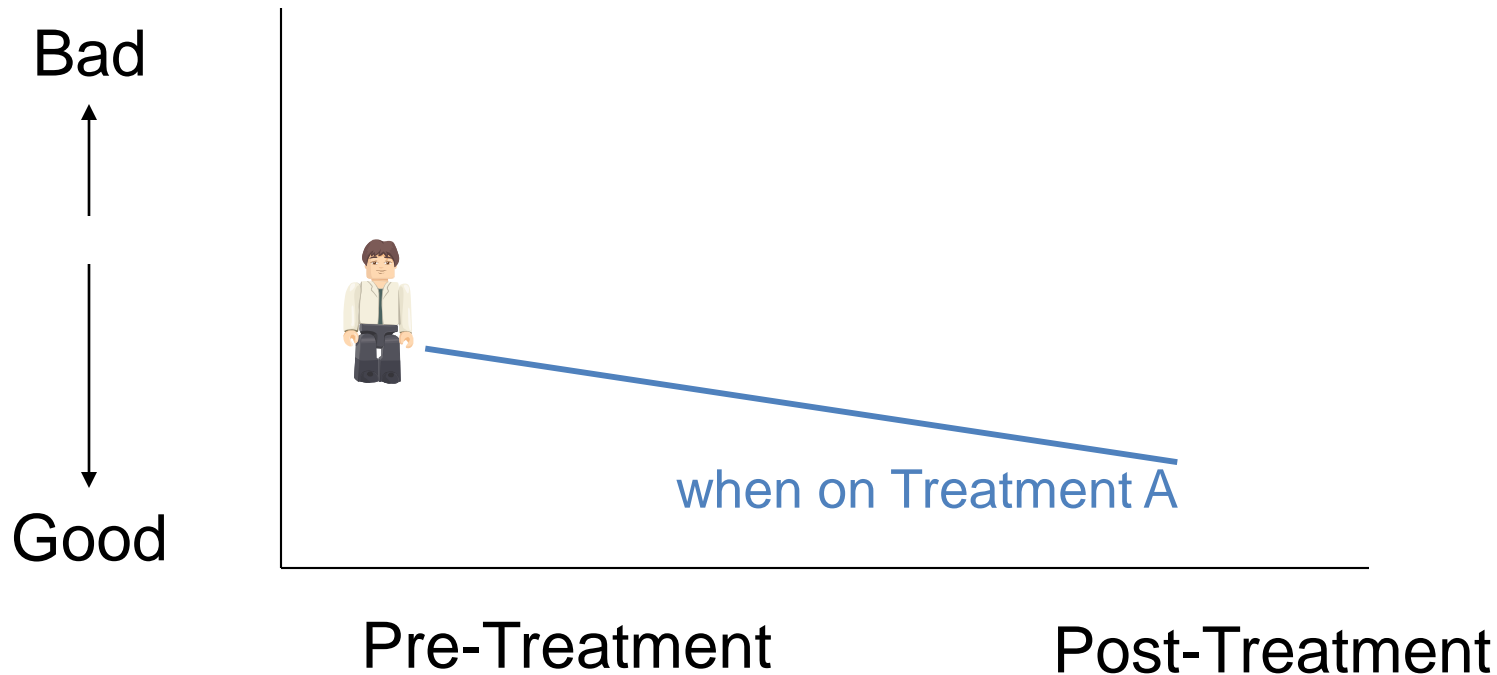
SCY

- Observational
- Community strengthening at 8 SCY sites
- N = 1351
- 2001 - 2002

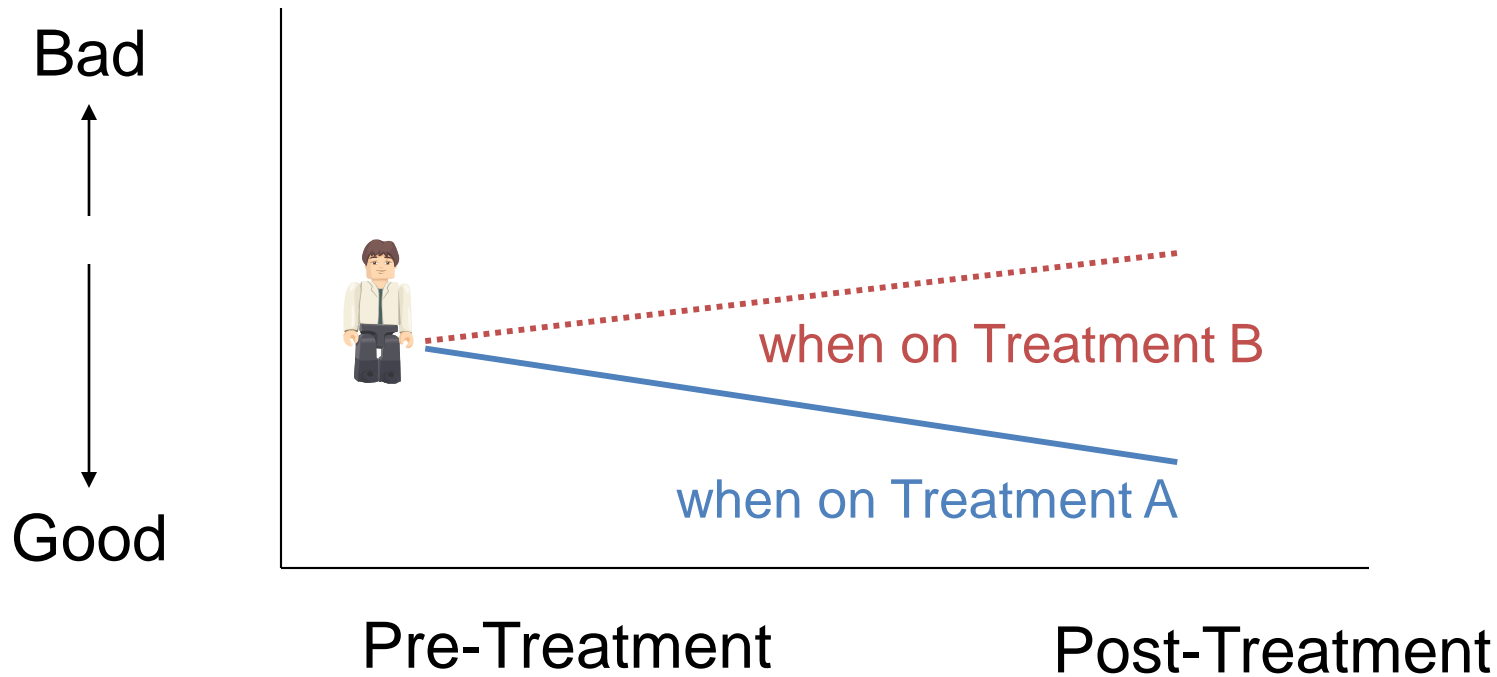
How do we get a causal effect estimate?



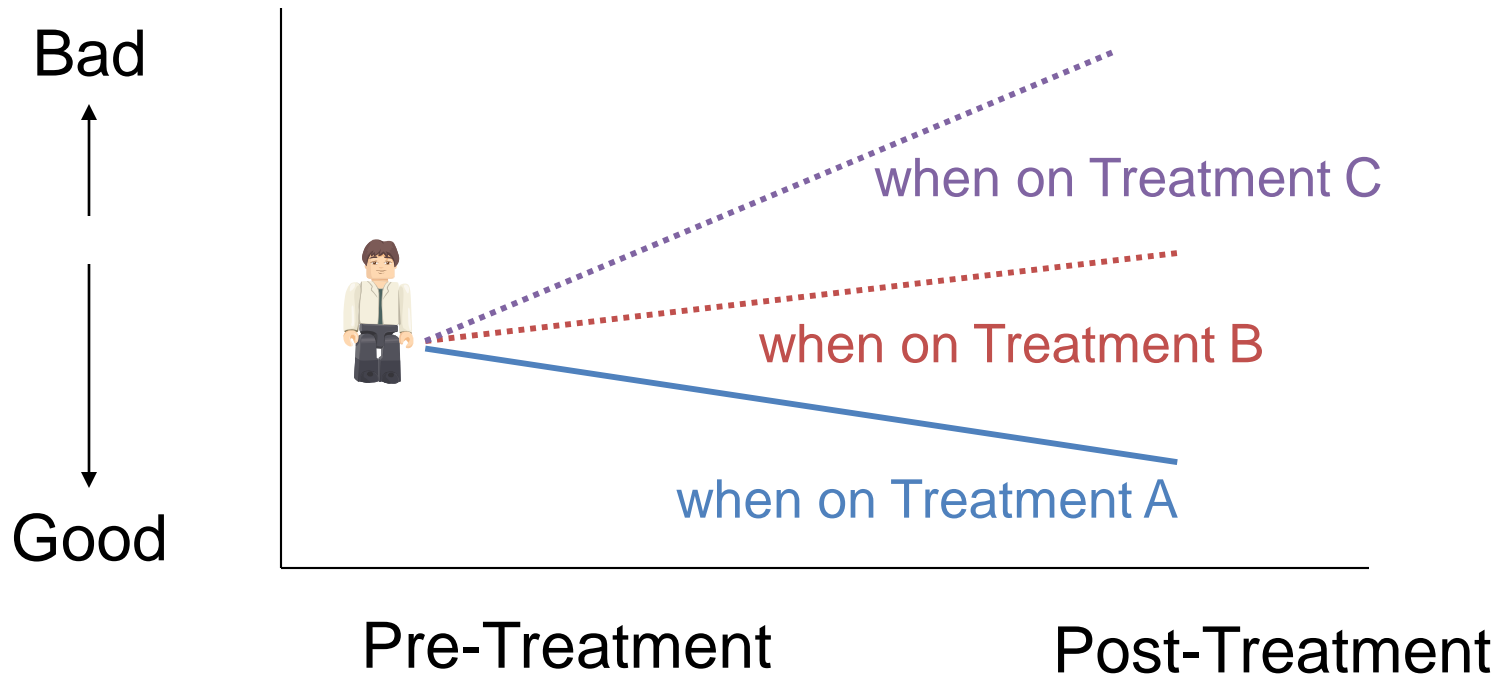
How do we get a causal effect estimate?



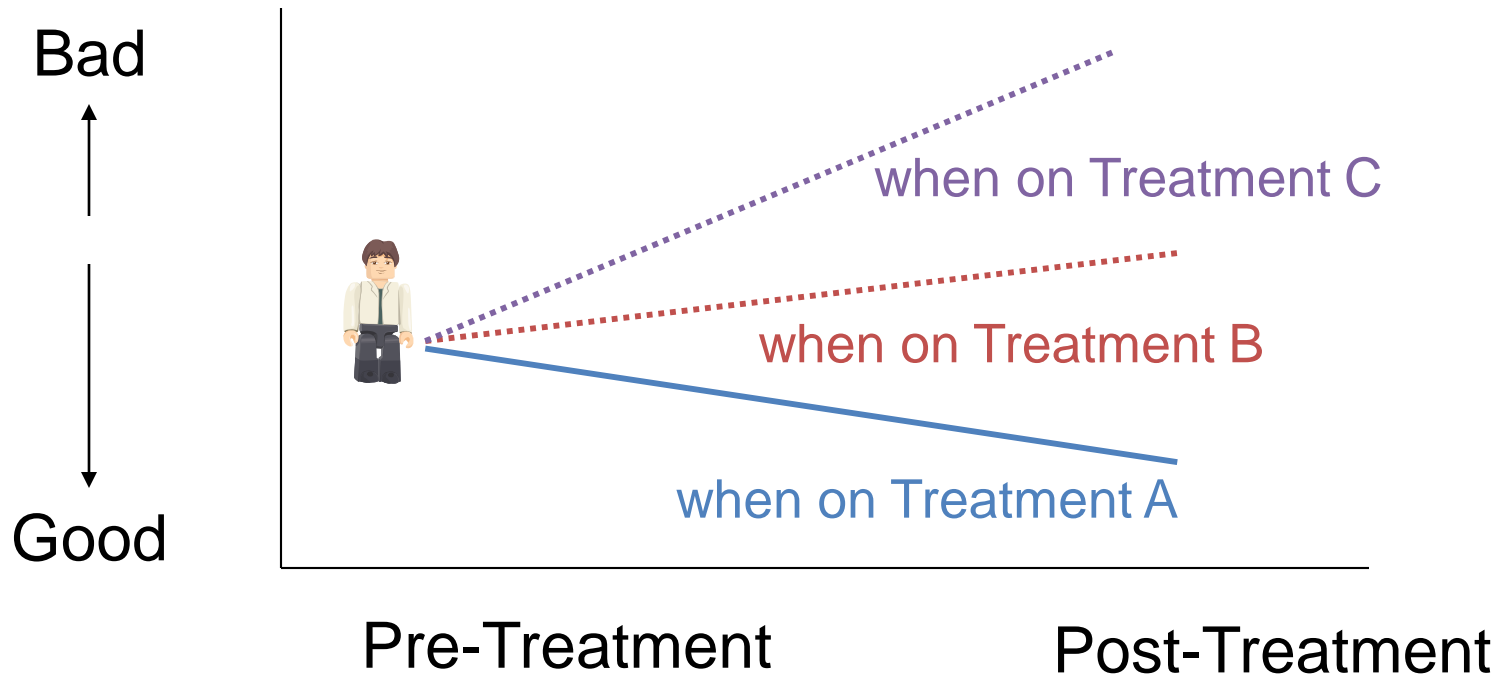
How do we get a causal effect estimate?



How do we get a causal effect estimate?



How do we get a causal effect estimate?



Now even more potential outcomes/counterfactuals and more treatment effects that might be of interest

Expand potential outcomes for J treatments

- J potential outcomes for each study participant
 - Potential outcome after receiving treatment 1, ... J = Y_1, \dots, Y_J
- Y_1, \dots, Y_J exist for all individuals in the population regardless of the treatment they actually received
- Still only one of these outcomes observed for each participant

Primary types of causal effects

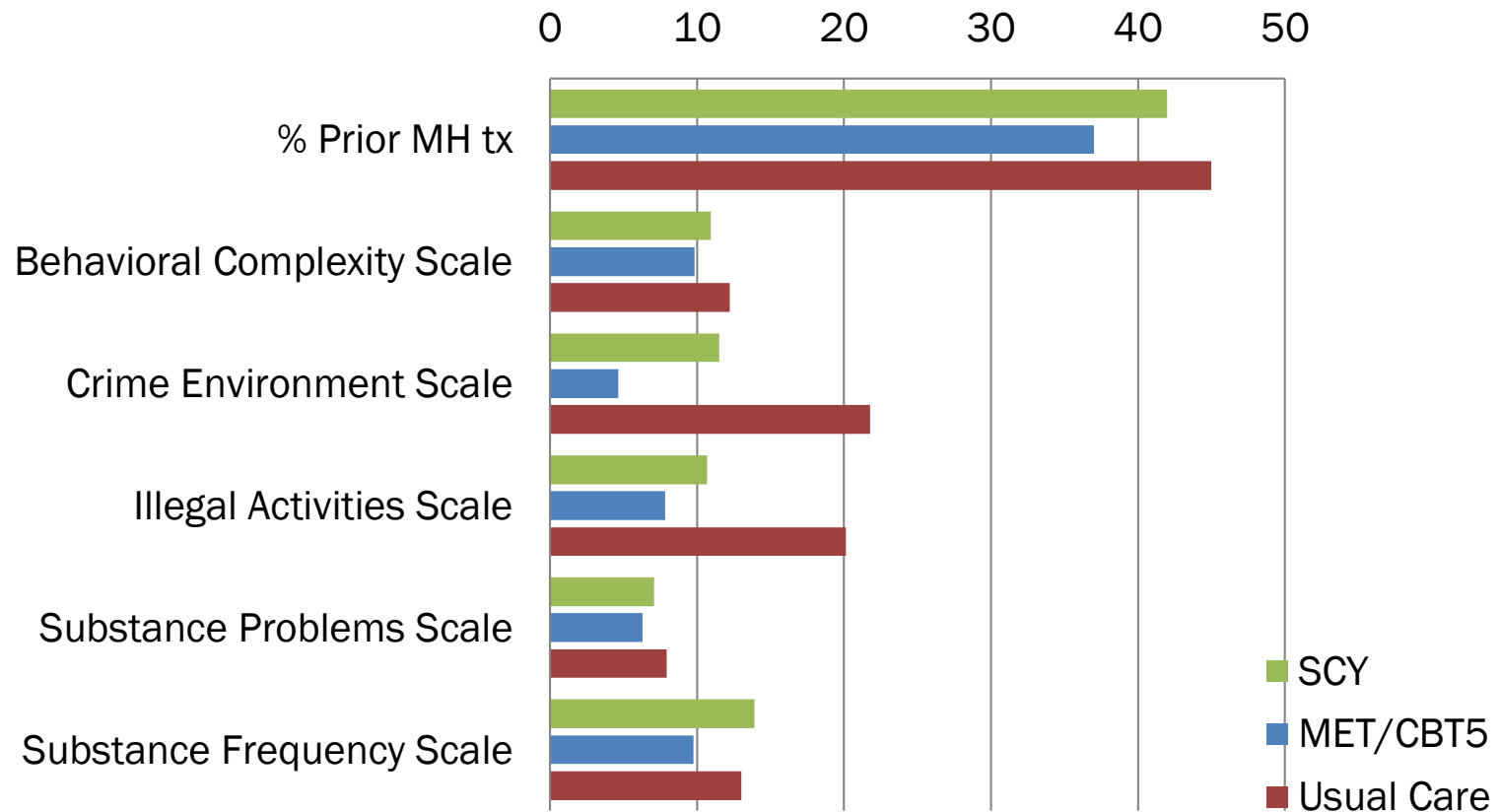
- Average treatment effect in the population (ATE)
 - Answers the question:
 - *What is the relative effectiveness of all the treatments on average in the population?*
 - $E(Y_1 - Y_2), E(Y_1 - Y_3), \dots, E(Y_1 - Y_J), E(Y_2 - Y_3), \text{ etc.}$
- Average treatment effect in the treated population (ATT)
 - Answers the question:
 - *How would those who received a particular treatment have done had they received any of the other treatments?*
 - $E(Y_1 - Y_2|Z = 1), E(Y_1 - Y_3|Z = 1), \dots, E(Y_1 - Y_J|Z = 1)$

Primary types of causal effects: case study

- Average treatment effect in the population (ATE)
 - Answers the question:
 - *What is the relative effectiveness of MET/CBT5, usual care, and SCY on average in the population?*
 - $E(Y_1 - Y_2), E(Y_1 - Y_3), \dots, E(Y_1 - Y_J), E(Y_2 - Y_3)$, etc.
- Average treatment effect in the treated population (ATT)
 - Answers the question:
 - *How would youth like those who received usual care have done had they received MET/CBT5 or SCY?*
 - $E(Y_1 - Y_2|Z = 1), E(Y_1 - Y_3|Z = 1), \dots, E(Y_1 - Y_J|Z = 1)$

Biggest challenge to causal estimation is selection effects

- Selection occurs when the people getting the treatments being compared differ



Propensity scores with more than 2 groups

- Let Z denote the categorical treatment assignment measure (values = $1, \dots, J$)
- Propensity score is an individual's probability of receiving one of the treatments given pretreatment characteristics
 - $p_j(X) = \Pr(Z = j|X)$
- Propensity scores still have balancing property
 - All needed to control for pretreatment differences between the groups
 - Assumes no unobserved differences between groups and overlap (**strong ignorability**)

Weighting with more than 2 groups

- For ATE:
 - weight individuals in each sample by the inverse probability of receiving the treatment they received
 - For an individual receiving treatment j , the weight equals $1/p_j(X)$
- For ATT:
 - weight individuals in each sample by the ratio of the probability receiving the target treatment to the probability of receiving the treatment they received
 - For an individual receiving treatment j and where target treatment equals j^* , the weight equals $p_{j^*}(X)/p_j(X)$

STEP-BY-STEP GUIDELINES

Four Key Steps

- 1) Choose the primary treatment effect of interest (ATEs or ATTs)
- 2) Estimate propensity score (ps) weights
- 3) Evaluate the quality of the ps weights
- 4) Estimate the treatment effects

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

- Today, we chose to focus on estimating ATE
- Why?
 - We want to know how well each treatment is doing in general
 - Thus, the policy question we want to address is:
What are the relative causal treatment effects of MET/CBT5, SCY, and usual care on average for youth in our population?

Step 2: Estimate the ps weights

- Only 1 command needed for this step
- Multiple treatment command in TWANG currently available in R and SAS
 - Stata available in Fall 2015

Command to estimate ps weights in Stata

use import delimited "C:\Data\subdata.csv", clear

mnps trtvar ///

age female i.race4g sfs sps sds ias ces eps imds bcs prmhxtx ///

ntrees(5000) ///

stopmethod(es.max) ///

estimand(ATE) ///

rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///

objpath(C:\MyProjects\TWANG) ///

plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)

save C:\MyProjects\TWANG\subdata_wgts)


Command to estimate ps weights in Stata

trtvar is the treatment indicator; it must have 3 or more values and it must be a factor in R

```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)  
save C:\MyProjects\TWANG\subdata_wgts)
```

Command to estimate ps weights in Stata


Specifies list of pretreatment covariates to balance on



```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhxt ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)  
  
save C:\MyProjects\TWANG\subdata_wgts)
```

Command to estimate ps weights in Stata

Add i. before
categorical
variables like
race



Specifies list of
pretreatment
covariates
to balance on



```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)  
  
save C:\MyProjects\TWANG\subdata_wgts)
```

Command to estimate ps weights in Stata

```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhxtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG\Mul  
save C:\MyProjects\TWANG\subda
```

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

Command to estimate ps weights in Stata

```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) //  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG \MultiTwangA  
  
save C:\MyProjects\TWANG\subdata_wgts)
```

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

```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)  
  
save C:\MyProjects\TWANG\subdata_wgts)
```

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

Command to estimate ps weights in Stata

```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhxtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///  
objpath(C:\MyProjects\TWANG) ///  
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)  
save C:\MyProjects\TWANG\subdata_wgts)
```



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

Command to estimate ps weights in Stata


```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhxtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe)///  
objpath(C:\MyProjects\TWANG) ///  
plotname( C:\MyProjects\TWANG \MultiTwangATE.pdf)  
save C:\MyProjects\TWANG\subdata_wgts)
```



**Specifies
folder
where
outputted
data will
go**

Command to estimate ps weights in Stata

```
mnps trtvar ///  
age female i.race4g sfs sps sds ias ces eps imds bcs prmhxtx ///  
ntrees(5000) ///  
stopmethod(es.max) ///  
estimand(ATE) ///  
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe)///  
objpath(C:\MyProjects\TWANG)///  
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)  
save C:\MyProjects\TWANG\subdata_wgts)
```



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

Command to estimate ps weights in Stata

```
use import delimited "C:\Data\subdata.csv", clear
```

```
mnps trtvar ///
```

```
age female i.race4g sfs sps sds ias ces eps imds bcs prmhxtx ///
```

```
ntrees(5000) ///
```

```
stopmethod(es.max) ///
```


```
estimand(ATE) ///
```

```
rcmd(C:\Program Files\R\R-3.0.1\bin\R.exe) ///
```

```
objpath(C:\MyProjects\TWANG ) ///
```

```
plotname(C:\MyProjects\TWANG \MultiTwangATE.pdf)
```

```
save C:\MyProjects\TWANG\subdata_wgts)
```



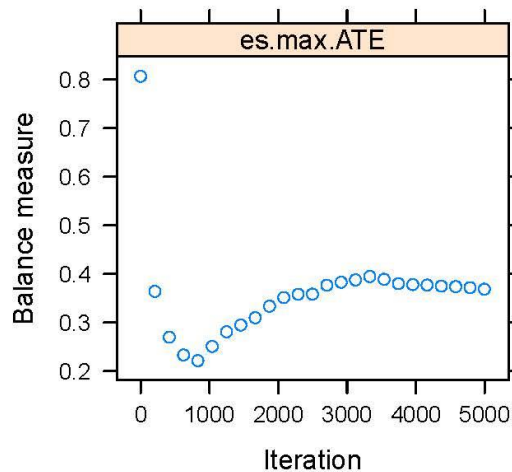
**Specifies
name of
outputted
dataset
with ps
weights**

Step 3: Evaluate the quality of the ps weights

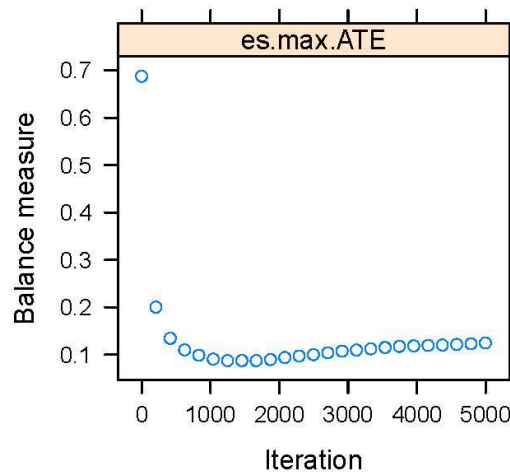
- Key issues that should be checked
 - **Convergence** = did the algorithm run long enough
 - **Balance** = how well matched the groups look after weighting
 - **Overlap** = whether there is evidence that the distributions of the pretreatment covariates in the groups line up well

Step 3: Checking convergence

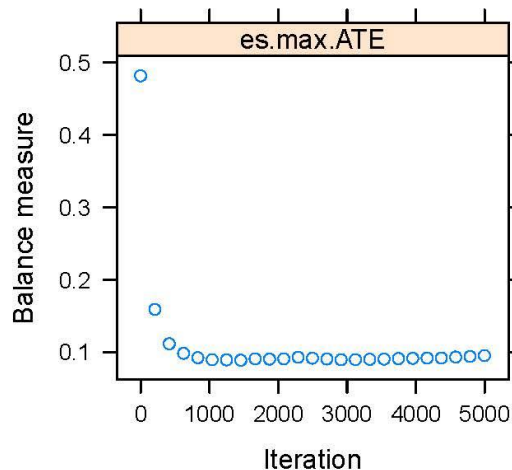
Balance for ATM against others



Balance for EAT against others



Balance for SCY against others



Note:

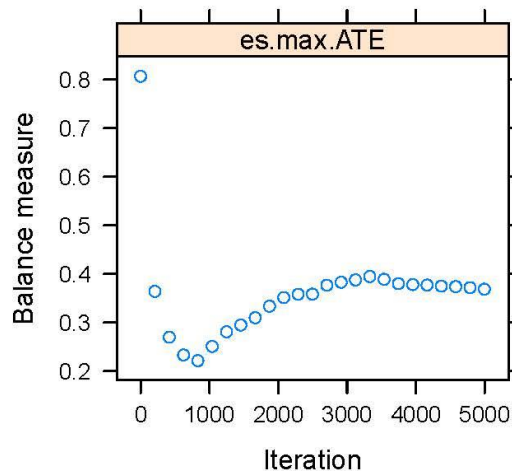
ATM = Usual care group

EAT = MET/CBT5 group

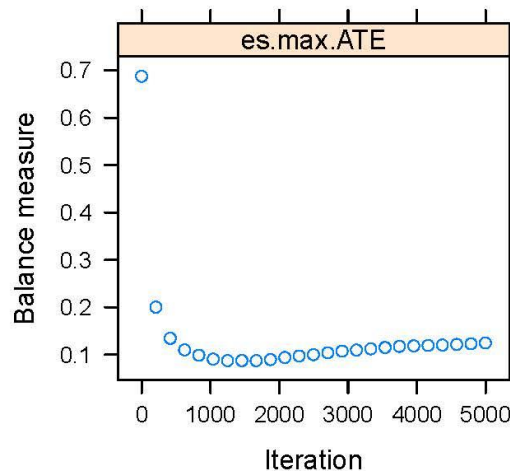
SCY = 3rd treatment grp

Step 3: Checking convergence

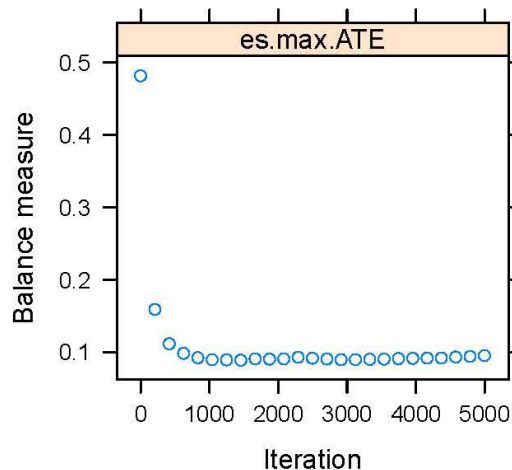
Balance for ATM against others



Balance for EAT against others



Balance for SCY against others



There are three convergence plots because there are three GBM fits

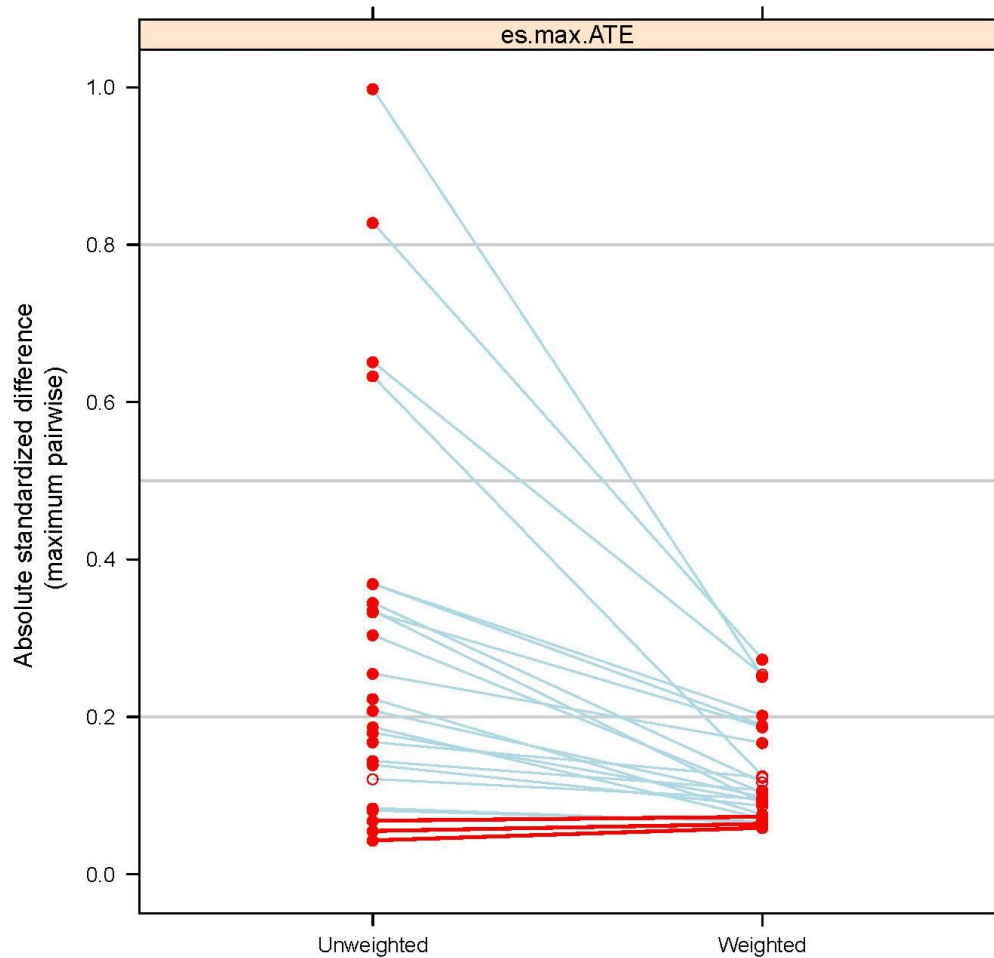
Step 3: Checking balance

- What does balance mean for more than 2 groups?
 - For ATE: All possible pairs of treatment conditions are balanced
 - For ATT: $J-1$ groups each balance with the target group of interest
- Multiple pairwise sets of balance metrics can be difficult to navigate if there are more than a 3 or 4 treatments, especially for ATE
 - There are J choose 2 pairs for ATE and $J-1$ for ATT
- Summarize over all pairs using the maximum of each pairwise balance metric for each covariate and then the maximum or mean across covariates
 - For p-values use the minimum

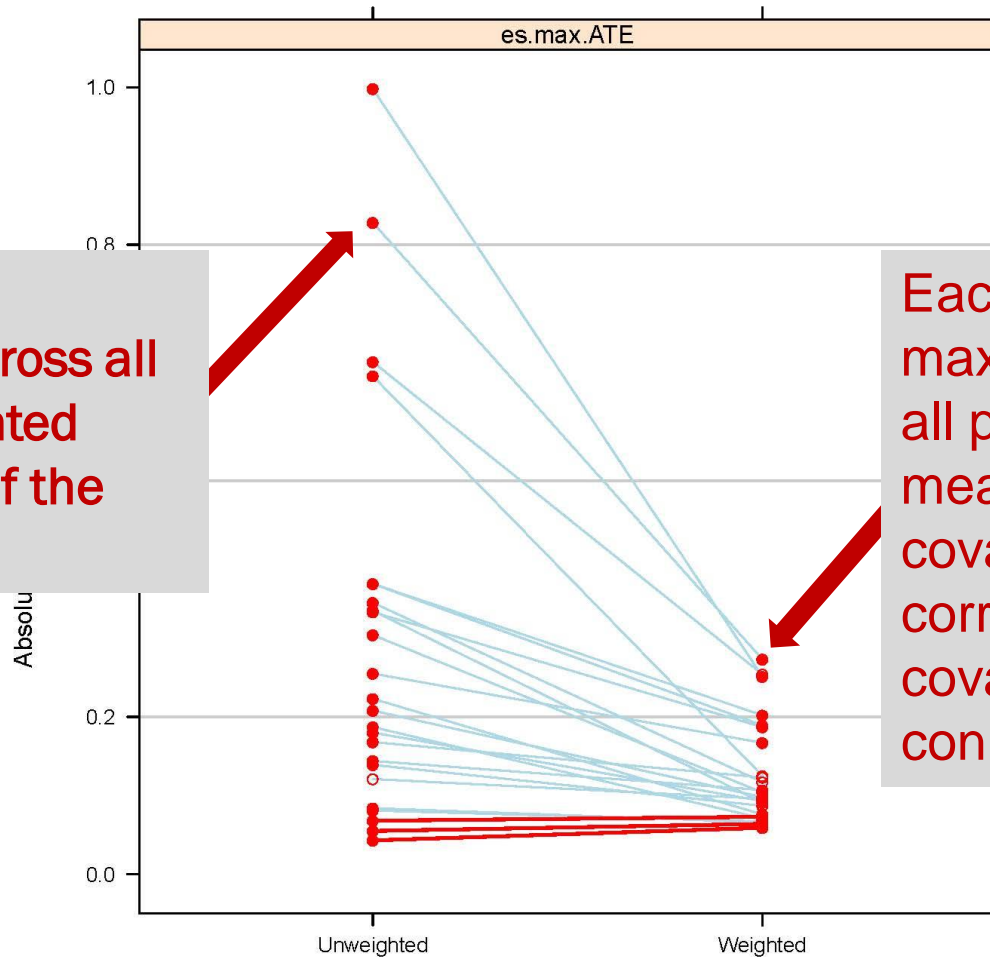
Step 3: Checking balance

- For more than 2 treatment groups, it is recommended to **check balance across groups** first and then to dive in if there appears to be a problem
- Summary measures one can use to assess balance in that first sweep
 - Maximum of the pairwise ES (or ASMDs)
 - Maximum of the pairwise KS or correspondingly the minimum of the pairwise KS statistic p -values
 - Also could use p -values from ANOVA's or joint F -tests to test if the means of the groups are different

Step 3: Checking balance graphically – Maximum ES plot



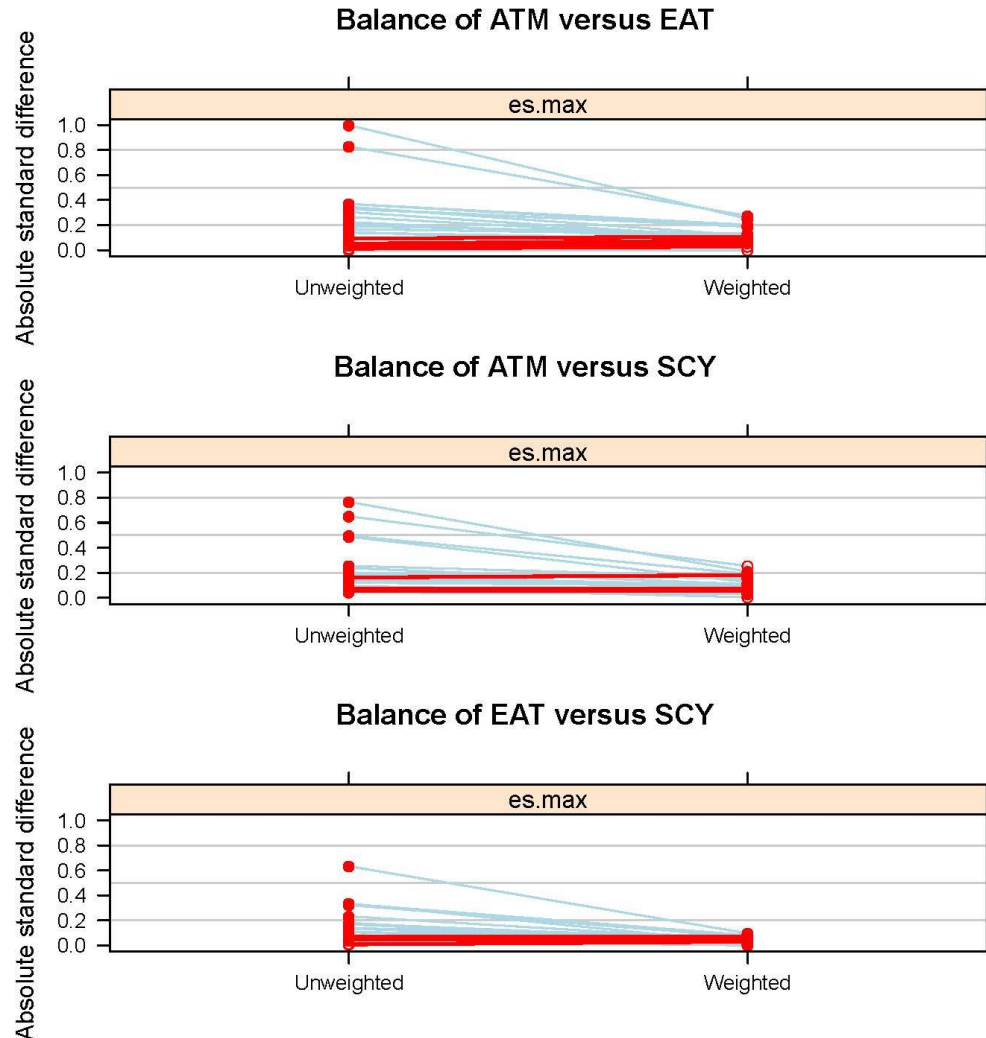
Step 3: Checking balance graphically – Maximum ES plot



Each dot is the maximum ES across all pairs of unweighted means for one of the covariates

Each dot is the maximum ES across all pairs of weighted means for one of the covariates, corresponding covariates are connected with lines

Step 3: Checking balance graphically – Pairwise ES plots



Note:
ATM = Usual care group
EAT = MET/CBT5 group
SCY = 3rd treatment grp

Stata Code for ES plots

Maximum plot

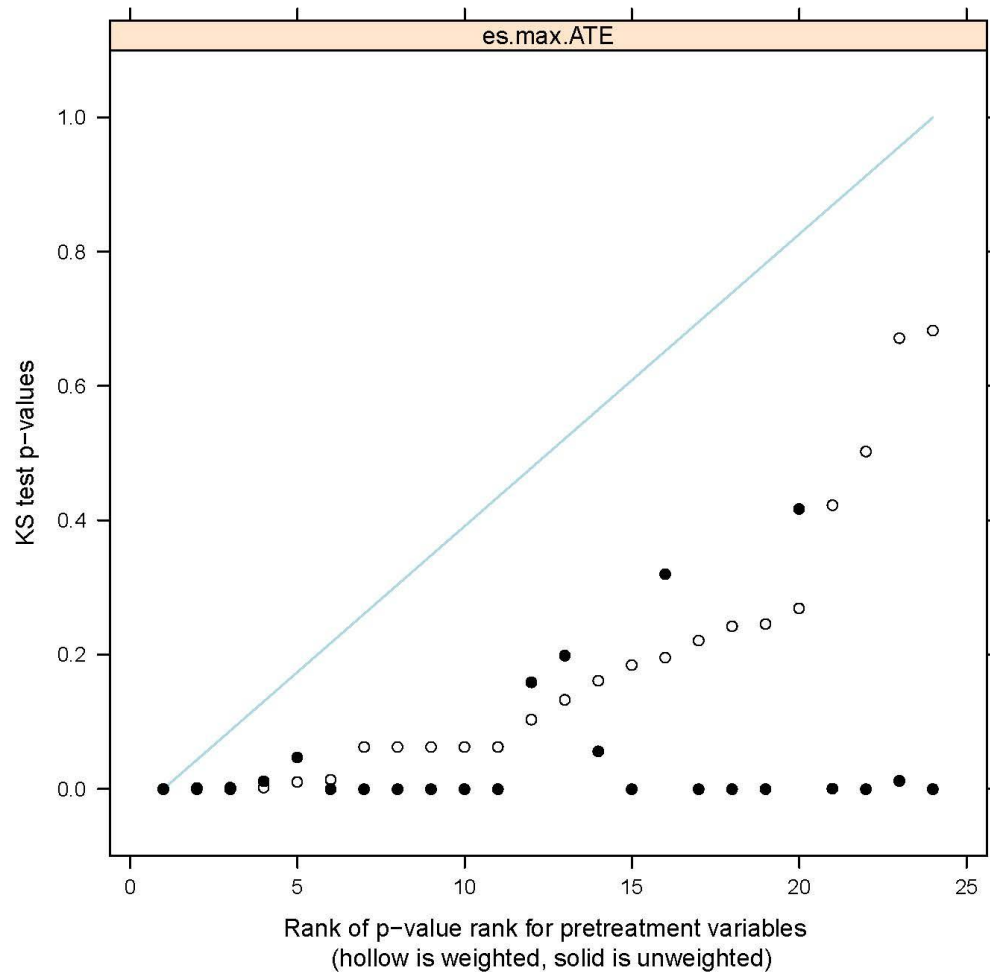
```
mnplot, plotname(mnps_example_plot_es_max.pdf) plots(3)
```

Pairwise plots

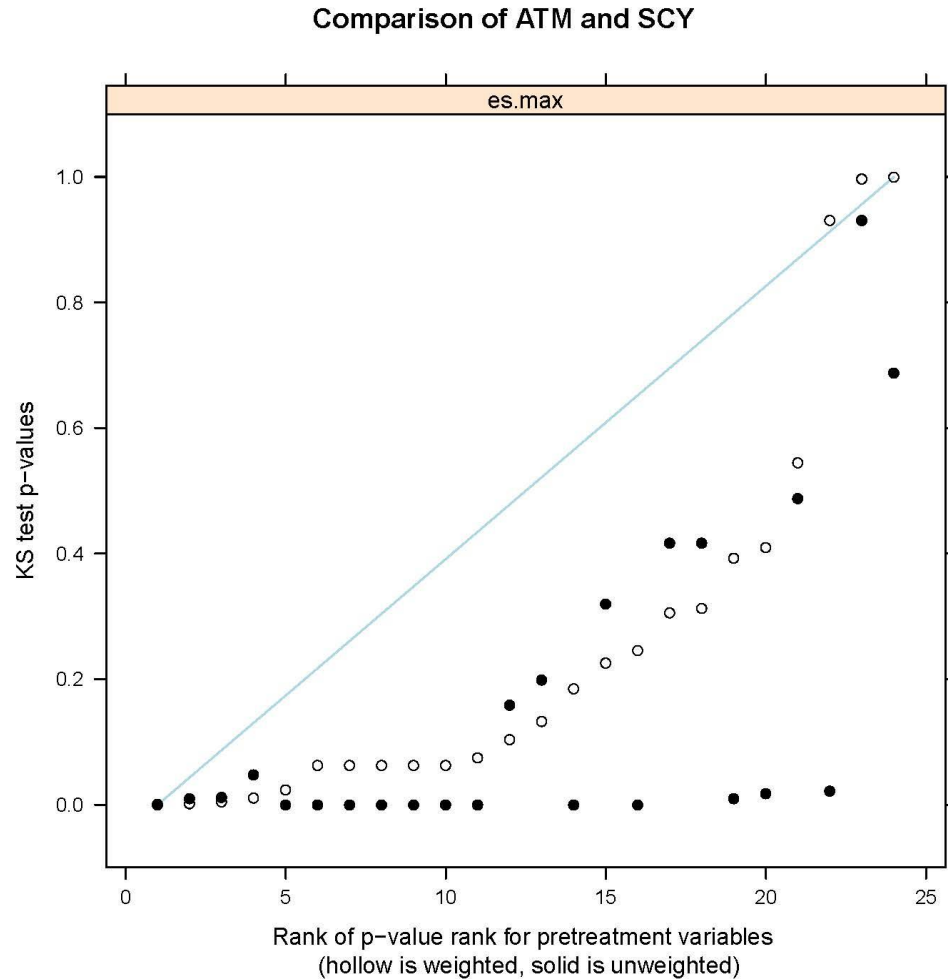
```
mnplot, plotname(mnps_example_plot_es_pairwise.pdf) ///  
plots(3) nopairwisemax figurerows(3)
```

Step 3: Checking balance graphically

- Minimum KS p-values plot



Step 3: Checking balance graphically – Pairwise KS plots



Stata Code for KS plots

Maximum plot

```
mnplot, plotname(mnps_example_plot_ks_max.pdf) ///  
plots(5)
```

Pairwise plots

```
mnplot, plotname(mnps_example_plot_ks_pairwise.pdf) ///  
plots(5) nopairwisemax ///  
multipage singleplot(2)
```


Step 3: Checking balance with tables:

Unweighted pairwise balance table

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	age	15.818	15.54	1.444	0.192	0	0.116	0	unw
2	ATM	EAT	female	0.214	0.315	0.451	0.223	0	0.101	0.001	unw
8	ATM	EAT	sfs	0.145	0.109	0.137	0.265	0	0.12	0	unw
9	ATM	EAT	sfs:<NA>	0	0	0.022	0	1	0	1	unw
...
25	ATM	SCY	age	15.818	15.45	1.444	0.255	0	0.118	0	unw
26	ATM	SCY	female	0.214	0.252	0.451	0.085	0.092	0.038	0.688	unw
32	ATM	SCY	sfs	0.145	0.154	0.137	0.07	0.235	0.045	0.488	unw
33	ATM	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.417	unw
...
49	EAT	SCY	age	15.54	15.45	1.444	0.062	0.057	0.046	0.048	unw
50	EAT	SCY	female	0.315	0.252	0.451	0.138	0	0.062	0.002	unw
56	EAT	SCY	sfs	0.109	0.154	0.137	0.335	0	0.143	0	unw
57	EAT	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.056	unw

Red highlights denote rows with absolute ES < 0.20

Note: ATM = Usual care group; EAT = MET/CBT5 group

Unweighted pairwise balance table for AOP example

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	age	15.818	15.54	1.444	0.192	0	0.116	0	unw
2	ATM	EAT	female	0.214	0.315	0.451	0.223	0	0.101	0.001	unw
8	ATM	EAT	sfs	0.005	0.000	0.007	0.000	0	0.12	0	unw
9	ATM	EAT	sfs:<NA>	0.000	0.000	0.000	0.000	0	0	1	unw
...
25	ATM	SCY	age	15.818	15.54	1.444	0.192	0	0.118	0	unw
26	ATM	SCY	female	0.214	0.315	0.451	0.223	0	0.038	0.688	unw
32	ATM	SCY	sfs	0.005	0.000	0.007	0.000	0	0.045	0.488	unw
33	ATM	SCY	sfs:<NA>	0.000	0.000	0.000	0.000	0	0.001	0.417	unw
...
49	EAT	SCY	age	15.818	15.54	1.444	0.192	0	0.046	0.048	unw
50	EAT	SCY	female	0.315	0.252	0.451	0.138	0	0.062	0.002	unw
56	EAT	SCY	sfs	0.109	0.154	0.137	0.335	0	0.143	0	unw
57	EAT	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.056	unw

stop_method variable
equal unw to indicate
unweighted
comparison

Red
highlights
denote rows
with
absolute ES
< 0.20

Note: ATM = Usual care group; EAT = MET/CBT5 group

Unweighted pairwise balance table for AOP example

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
1	ATM	EAT	age	15.818	15.54	1.444	0.192	0	0.116	0	unw
2	ATM	EAT	female	0.214	0.315	0.451	0.223	0	0.101	0.001	unw
8	ATM	EAT	sfs	0.145	0.109	0.137	0.265	0	0.12	0	unw
9	ATM	EAT	sfs:<NA>	0	0	0.022	0	1	0	1	unw
...
25	ATM	SCY	age	15.818	1	...	...	...	...	0	unw
26	ATM	SCY	female	0.214	0	...	...	...	...	0.688	unw
32	ATM	SCY	sfs	0.145	0	...	...	...	...	0.488	unw
33	ATM	SCY	sfs:<NA>	0	0	...	...	...	...	0.417	unw
...
49	EAT	SCY	age	15.54	1	...	...	...	...	0.048	unw
50	EAT	SCY	female	0.315	0.252	0.451	0.138	0	0.062	0.002	unw
56	EAT	SCY	sfs	0.109	0.154	0.137	0.335	0	0.143	0	unw
57	EAT	SCY	sfs:<NA>	0	0.001	0.022	0.068	0	0.001	0.056	unw

One group of
comparisons for
each group of
treatments

Red
highlights
denote rows
with
absolute ES
< 0.20

Note: ATM = Usual care group; EAT = MET/CBT5 group

Step 3: Checking balance with tables:

Weighted pairwise balance table

Obs	tmt1	tmt2	var	mean1	mean2	pop_sd	std_eff_sz	p	ks	ks_pval	stop_method
73	ATM	EAT	age	15.736	15.547	1.444	0.131	0.069	0.077	0.364	es.max
74	ATM	EAT	female	0.267	0.302	0.451	0.076	0.356	0.034	0.994	es.max
80	ATM	EAT	sfs	0.135	0.123	0.137	0.091	0.257	0.069	0.503	es.max
81	ATM	EAT	sfs:<NA>	0	0	0.022	0	1	0	1	es.max
...
97	ATM	SCY	age	15.736	15.495	1.444	0.167	0.025	0.088	0.246	es.max
98	ATM	SCY	female	0.267	0.269	0.451	0.004	0.965	0.002	1	es.max
104	ATM	SCY	sfs	0.135	0.125	0.137	0.073	0.373	0.068	0.544	es.max
105	ATM	SCY	sfs:<NA>	0	0.002	0.022	0.073	0	0.002	0.306	es.max
...
121	EAT	SCY	age	15.547	15.495	1.444	0.036	0.31	0.025	0.742	es.max
122	EAT	SCY	female	0.302	0.269	0.451	0.073	0.053	0.033	0.424	es.max
128	EAT	SCY	Sfs	0.123	0.125	0.137	0.018	0.605	0.019	0.957	es.max
129	EAT	SCY	sfs:<NA>	0	0.002	0.022	0.073	0	0.002	0.162	es.max

Red highlights denote rows with absolute ES < 0.20

Note: ATM = Usual care group; EAT = MET/CBT5 group

Step 3: Checking balance with tables:

Unweighted covariate balance table

Balance table: unw

Obsvar	max_std_eff_sz	min_p	max_ks	min_ks_pval	stop_method
1 age	0.255	0	0.118	0	unw
2 female	0.223	0	0.101	0.001	unw
3 race4g:1	0.651	0	0.324	0	unw
4 race4g:2	0.633	0	0.235	0	unw
5 race4g:3	0.345	0	0.144	0	unw
6 race4g:4	0.208	0	0.076	0	unw
7 race4g: <NA>	0.139	0	0.002	0	unw
8 sfs	0.335	0	0.143	0	unw
9 sfs: <NA>	0.068	0	0.001	0.056	unw
10 sps	0.369	0	0.141	0	unw
11 sps: <NA>	0.043	0	0.001	0.417	unw
12 sds	0.333	0	0.147	0	unw
13 sds: <NA>	0.18	0	0.015	0	unw
14 ias	0.998	0	0.485	0	unw
15 ias: <NA>	0.144	0	0.014	0.012	unw
16 ces	0.828	0	0.262	0	unw
17 eps	0.369	0	0.186	0	unw
18 eps: <NA>	0.081	0	0.004	0.199	unw
19 imds	0.187	0	0.081	0	unw
20 imds: <NA>	0.055	0	0.002	0.32	unw
21 bcs	0.304	0	0.177	0	unw
22 bcs: <NA>	0.084	0	0.004	0.159	unw
23 prmhxtx	0.168	0.001	0.082	0.012	unw
24 prmhxtx: <NA>	0.121	0.051	0.011	0.047	unw

Red highlights denote rows with absolute ES < 0.20

Step 3: Checking balance with tables:

Weighted covariate balance table

Balance table: es.max

Obs	var	max_std_eff_sz	min_p	max_ks	min_ks_pval	stop_method
25	age	0.167	0.025	0.088	0.246	es.max
26	female	0.076	0.053	0.034	0.424	es.max
27	race4g:1	0.254	0.063	0.126	0.063	es.max
28	race4g:2	0.125	0.063	0.046	0.063	es.max
29	race4g:3	0.117	0.063	0.049	0.063	es.max
30	race4g:4	0.098	0.063	0.036	0.063	es.max
31	race4g: <NA>	0.087	0.063	0.001	0.063	es.max
32	sfs	0.091	0.257	0.069	0.503	es.max
33	sfs: <NA>	0.073	0	0.002	0.162	es.max
34	sps	0.189	0.044	0.085	0.243	es.max
35	sps: <NA>	0.059	0	0.002	0.269	es.max
36	sds	0.187	0.053	0.087	0.221	es.max
37	sds: <NA>	0.093	0	0.008	0.002	es.max
38	ias	0.251	0.004	0.176	0	es.max
39	ias: <NA>	0.107	0	0.01	0.002	es.max
40	ces	0.273	0	0.154	0.002	es.max
41	eps	0.202	0.012	0.132	0.014	es.max
42	eps: <NA>	0.067	0	0.003	0.133	es.max
43	imds	0.071	0.242	0.046	0.68	es.max
44	imds: <NA>	0.064	0	0.003	0.196	es.max
45	bcs	0.104	0.233	0.094	0.184	es.max
46	bcs: <NA>	0.066	0	0.003	0.104	es.max
47	prmhtx	0.123	0.153	0.06	0.672	es.max
48	prmhtx: <NA>	0.096	0.035	0.009	0.011	es.max

Red highlights denote rows with absolute ES < 0.20

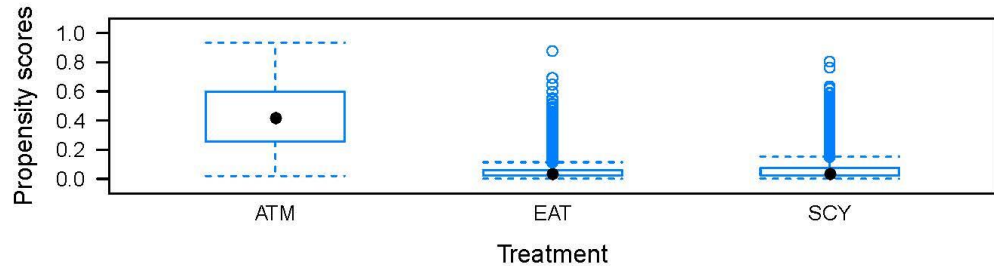
Step 3: Checking balance with tables

Stata code for previous 2 tables

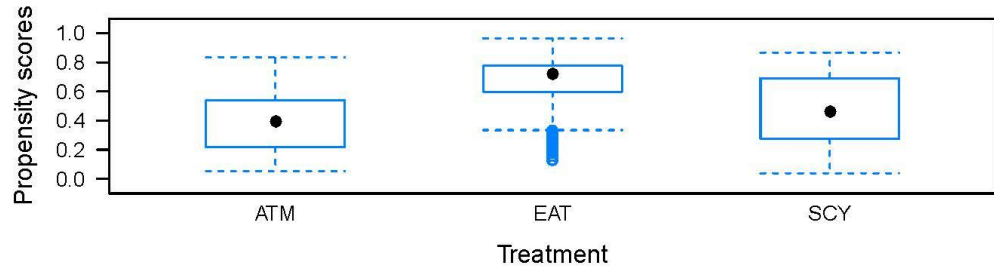
balance, unweighted weighted collapse(covariate)

Step 3: Checking overlap

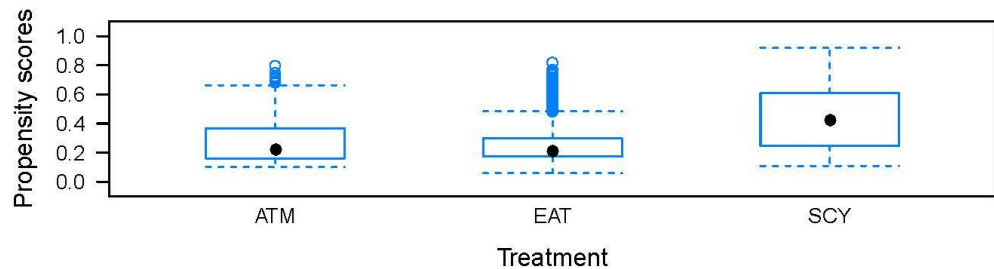
ATM propensity scores by Tx group



EAT propensity scores by Tx group



SCY propensity scores by Tx group



Note: ATM = Usual care group; EAT = MET/CBT5 group

Step 4: Estimate the treatment effect

Stata Code:

```
use C:\MyProjects\TWANG \subdata_wgts, clear
encode trtvar, generate(trtvar2)
svyset [pweight=esmaxate]
fvset base 1 trtvar2
svy: regress sfs8p12 i.trtvar2
```

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.111	0.013	8.81	<.0001
metcbt5	-0.039	0.013	-3	0.0027
scy	-0.036	0.013	-2.72	0.0065

Step 4: Estimate the treatment effect (cont.)

Stata Code:

```
use C:\MyProjects\TWANG \subdata_wgts, clear
endcode trtvar, generate(trtvar2)
svyset [pweight=esmaxate]
fvset base 1 trtvar2
svy: regress sfs8p12 i.trtvar2
```

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.111	0.013	8.81	<.0001
metcbt5	-0.039	0.013	-3	0.0027
scy	-0.036	0.013	-2.72	0.0065

Results show that youth would have fared better had they received either MET/CBT5 or SCY vs “usual care”

Comparison with unweighted treatment effect

Stata Code:

```
regress sfs8p12 i.trtvar2
```

Parameter Estimates
Parameter Standard

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.114	0.006	19.83	<.0001
metcbt5	1	-0.047	0.006	-7.52	<.0001
scy	1	-0.038	0.007	-5.65	<.0001

Comparison with unweighted treatment effect

Stata Code:

```
regress sfs8p12 i.trtvar2
```

Parameter Estimates
Parameter Standard

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.114	0.006	19.83	<.0001
metcbt5	1	-0.047	0.006	-7.52	<.0001
scy	1	-0.038	0.007	-5.65	<.0001

Similar evidence, though magnitude of the effect for MET/CBT5 vs usual care changes the most, likely because greatest pretreatment differences between MET/CBT5 and usual care

Step 4: Doubly robust estimation

Adding in covariates with lingering imbalances

Stata Code:

```
use C:\MyProjects\TWANG \subdata_wgts, clear
endcode trtvar, generate(trtvar2)
svyset [pweight=esmaxate]
fvset base 1 trtvar2
svy: regress sfs8p12 i.trtvar2 ces eps ias i.race4g
```

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.072	0.015	4.83	<.0001
metcbt5	-0.032	0.014	-2.38	0.0173
scy	-0.030	0.014	-2.22	0.0262
ces	-0.003	0.014	-0.25	0.8042
eps	0.048	0.020	2.35	0.0190
ias	0.128	0.027	4.79	<.0001
race4g 1	0.012	0.007	1.65	0.0993
race4g 2	-0.008	0.008	-0.99	0.3200
race4g 3	0.021	0.011	2.00	0.0451
race4g 4	0.000	0.000	.	.

Conclusions

- Propensity score weights improved balance on observed pretreatment covariates
- Greatest changes in treatment effect estimate comparing MET/CBT5 vs usual care
 - Likely because group of youth were more dissimilar than SCY vs usual care
- Doubly robust model which controlled for lingering imbalances provides our most robust inferences concerning causal effects



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Data acknowledgements

The development of these slides was funded by the National Institute of Drug Abuse grant number 1R01DA01569 (PIs: Griffin/McCaffrey) and was supported by the Center for Substance Abuse Treatment (CSAT), Substance Abuse and Mental Health Services Administration (SAMHSA) contract #270-07-0191 using data provided by the following grantees: Adolescent Treatment Model (Study: ATM; CSAT/SAMHSA contracts #270-98-7047, #270-97-7011, #277-00-6500, #270-2003-00006 and grantees: TI-11894, TI-11874; TI-11892), the Effective Adolescent Treatment (Study: EAT; CSAT/SAMHSA contract #270-2003-00006 and grantees: TI-15413, TI-15433, TI-15447, TI-15461, TI-15467, TI-15475, TI-15478, TI-15479, TI-15481, TI-15483, TI-15486, TI-15511, TI-15514, TI-15545, TI-15562, TI-15670, TI-15671, TI-15672, TI-15674, TI-15678, TI-15682, TI-15686, TI-15415, TI-15421, TI-15438, TI-15446, TI-15458, TI-15466, TI-15469, TI-15485, TI-15489, TI-15524, TI-15527, TI-15577, TI-15584, TI-15586, TI-15677), and the Strengthening Communities-Youth (Study: SCY; CSAT/SAMHSA contracts #277-00-6500, #270-2003-00006 and grantees: TI-13305, TI-13308, TI-13313, TI-13322, TI-13323, TI-13344, TI-13345, TI-13354). The authors thank these grantees and their participants for agreeing to share their data to support these secondary analyses. The opinions about these data are those of the authors and do not reflect official positions of the government or individual grantees.