Introducción a la inferencia causal y los efectos de tratamiento

9 de julio, 2025

Temas

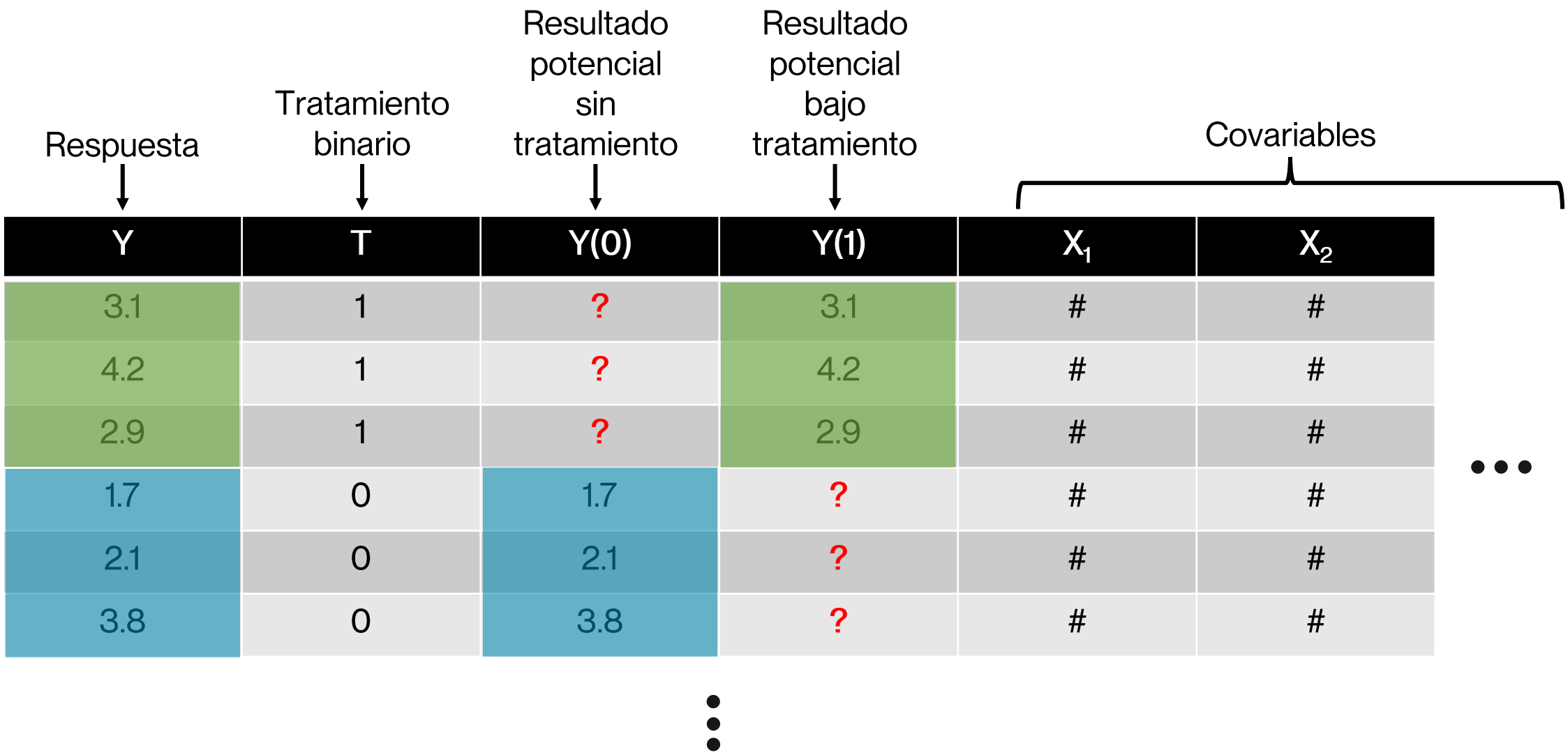
Parte I: Introducción y conceptos

- Resultados potenciales
- El problema fundamental de la inferencia causal
- El efecto promedio de tratamiento
- Datos experimentales y observacionales

Parte II: Comandos **`teffects`**

- Modelos de respuesta con **`teffects ra`**
- Modelos de tratamiento con **`teffects ipw`**
- Estimación doblemente robusta con **`teffects ipwra`** y **`teffects aipw`**
- Pareamiento con **`teffects nnmatch`** y **`teffects psmatch`**
- Herramientas de posestimación
- Bonus: efectos heterogéneos con **`cate`**
- Bonus: selección de covariables con **`telasso`**
- Bonus: análisis de supervivencia con **`stteffects`**
- Bonus: mediación con **`mediate`**

Parte I: Introducción y conceptos

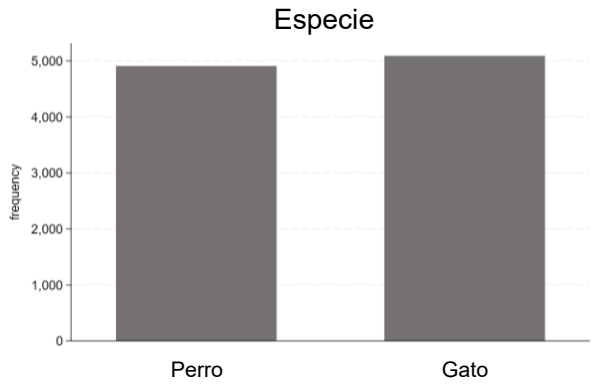

Respuesta
Tratamiento binario
Resultado potencial sin tratamiento
Resultado potencial bajo tratamiento
Covariables
Y
T
Y(0)
Y(1)
X_1
X_2
3.1 1 ? 3.1 # #
4.2 1 ? 4.2 # #
2.9 1 ? 2.9 # #
1.7 0 1.7 ? # #
2.1 0 2.1 ? # #
3.8 0 3.8 ? # #

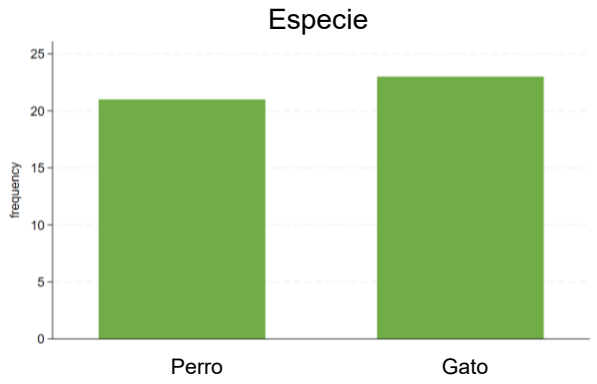
Y	Y(0)	Y(1)
3.1	?	3.1
4.2	?	4.2
2.9	?	2.9
1.7	1.7	?
2.1	2.1	?
3.8	3.8	?

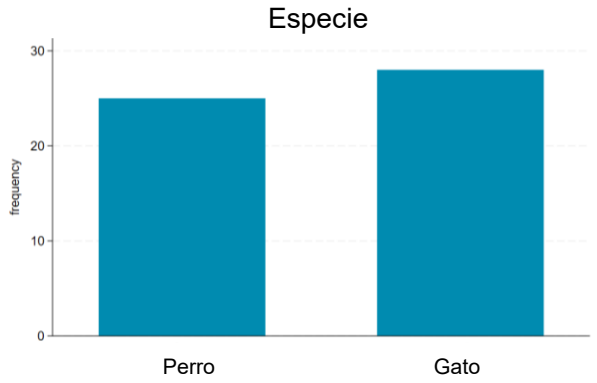
$$ATE = E[Y(1)] - E[Y(0)]$$

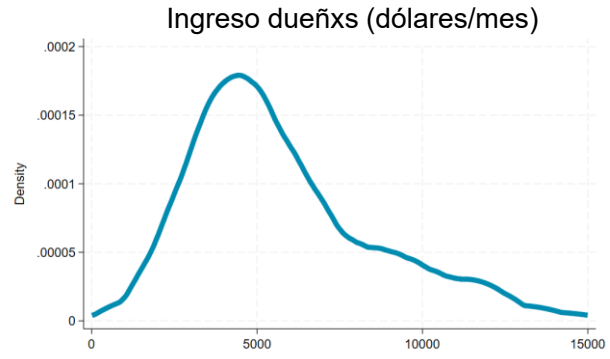
"Average Treatment Effect"
Efecto promedio de tratamiento

Y	Y(0)	Y(1)
3.1	?	3.1
4.2	?	4.2
2.9	?	2.9
1.7	1.7	?
2.1	2.1	?
3.8	3.8	?

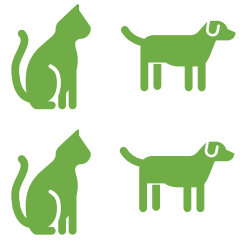




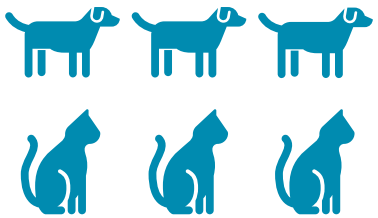




Población

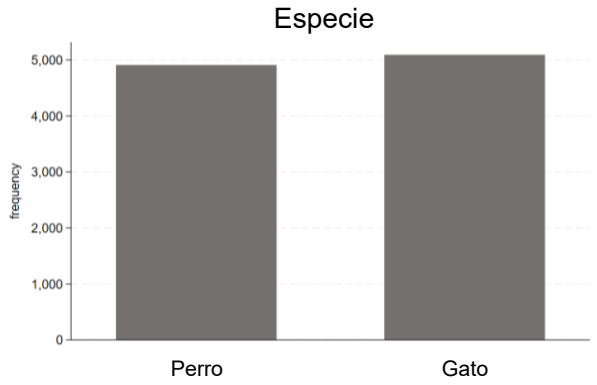


Tratados

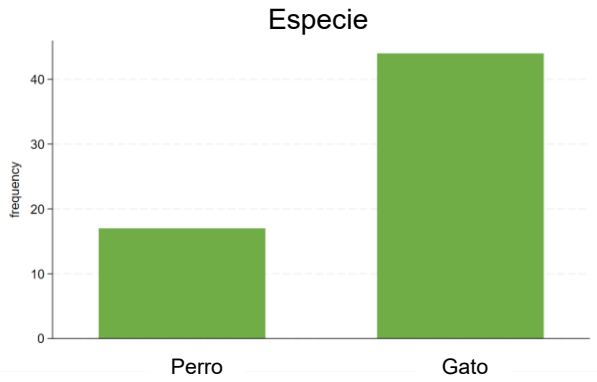


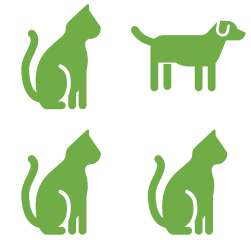
Controles

Y	Y(0)	Y(1)
3.1	?	3.1
4.2	?	4.2
2.9	?	2.9
1.7	1.7	?
2.1	2.1	?
3.8	3.8	?

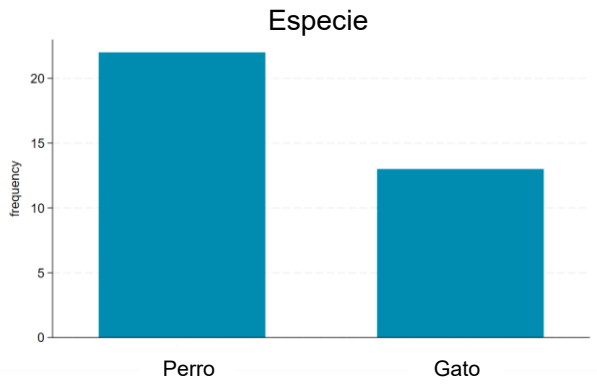


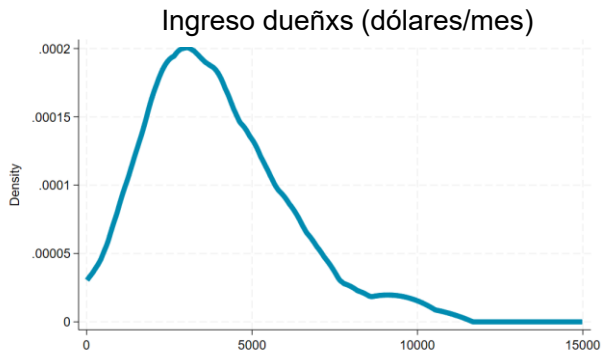
Población

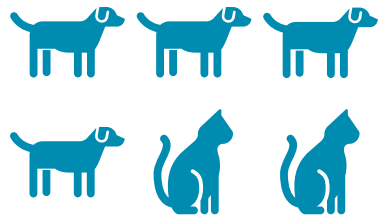




Tratados

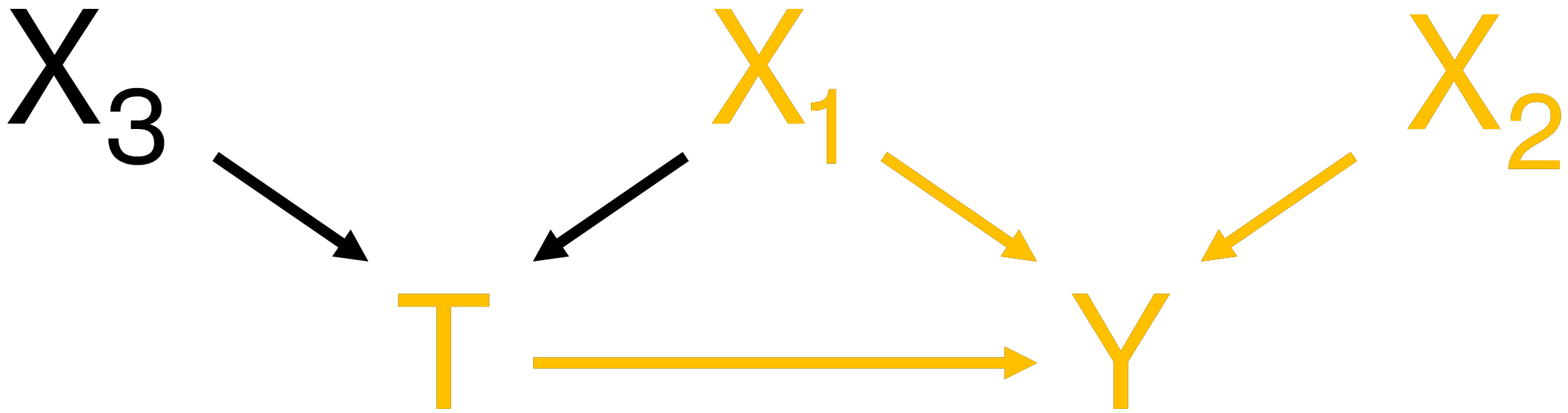




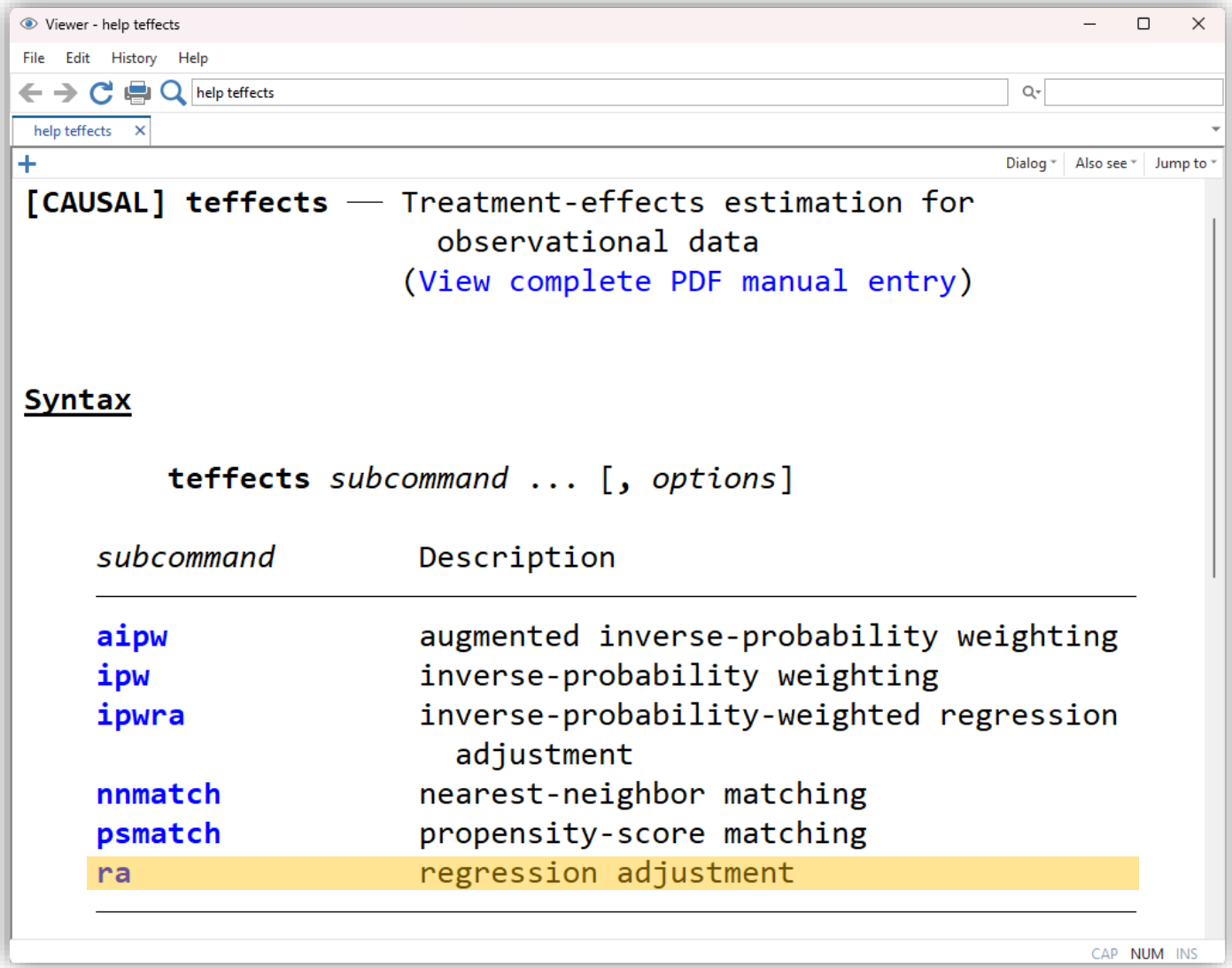


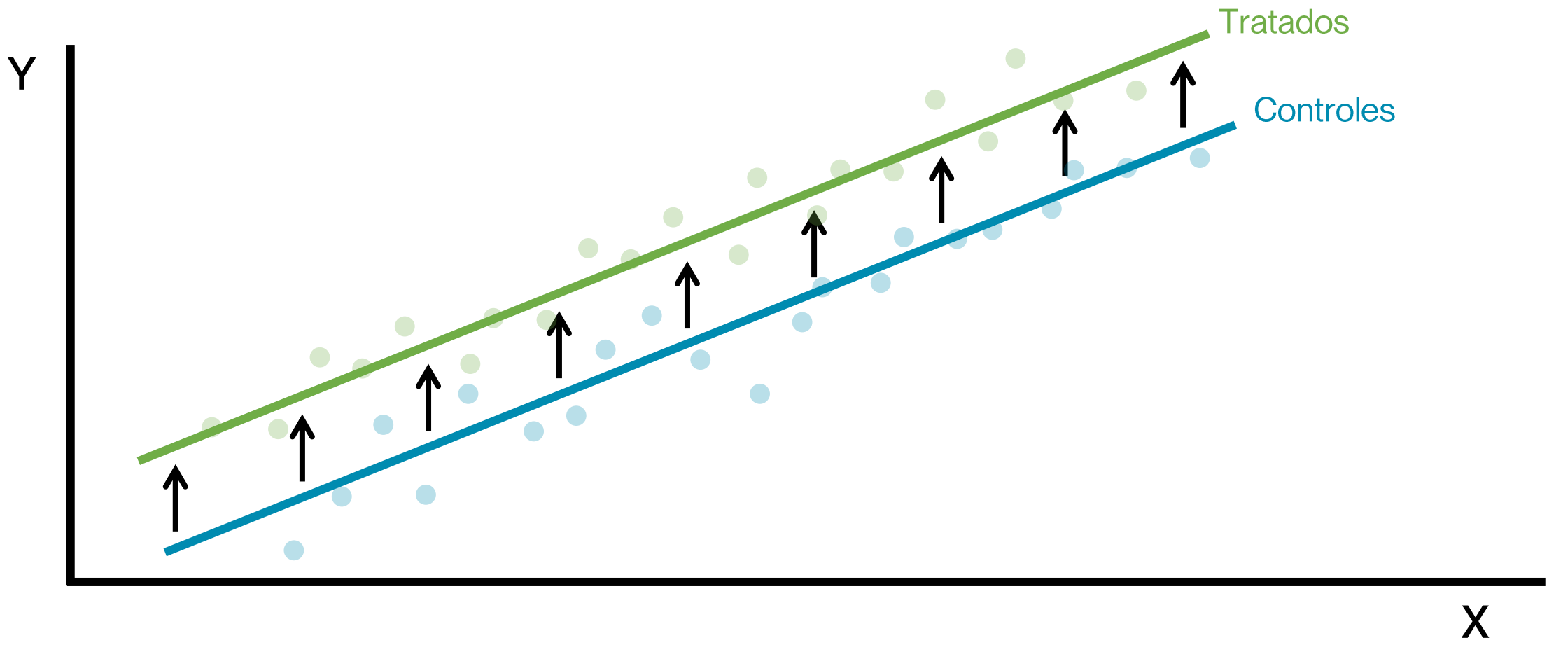
Controles

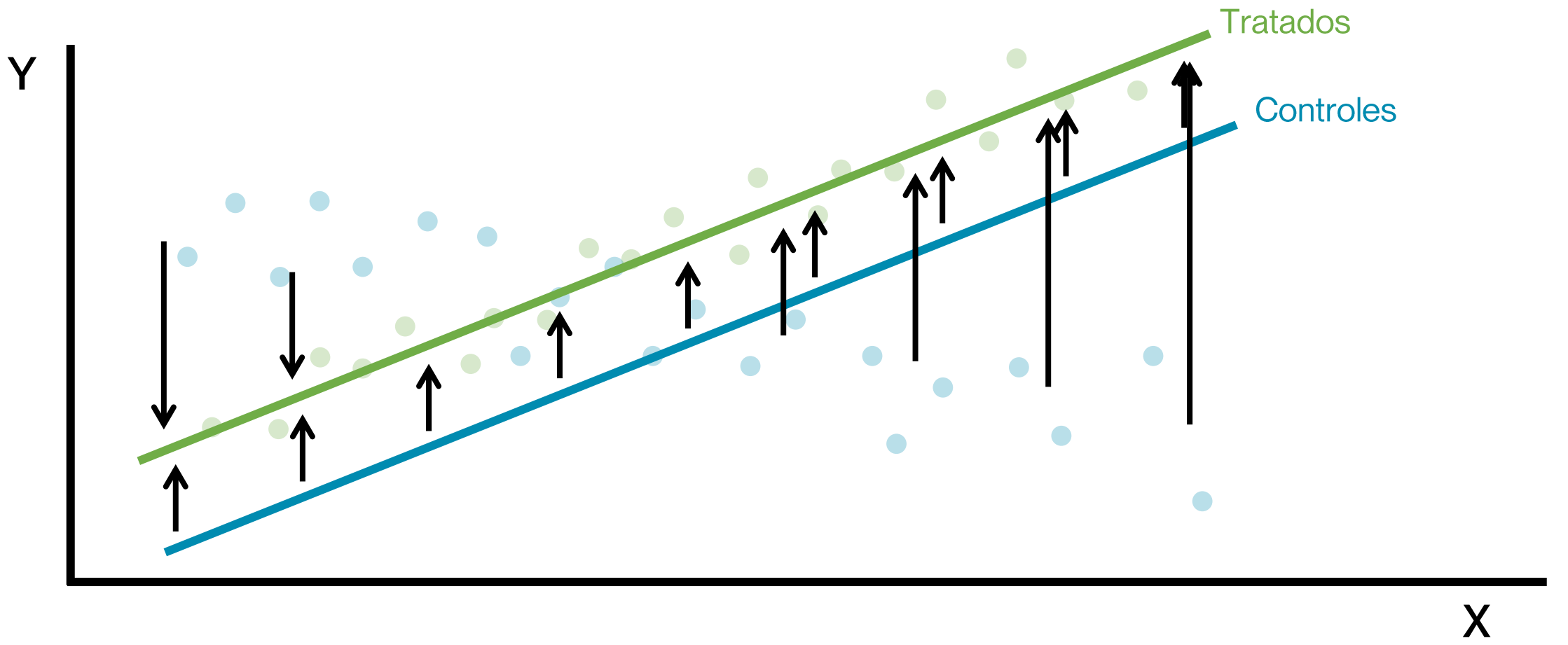
Parte II: Los comandos `teffects`

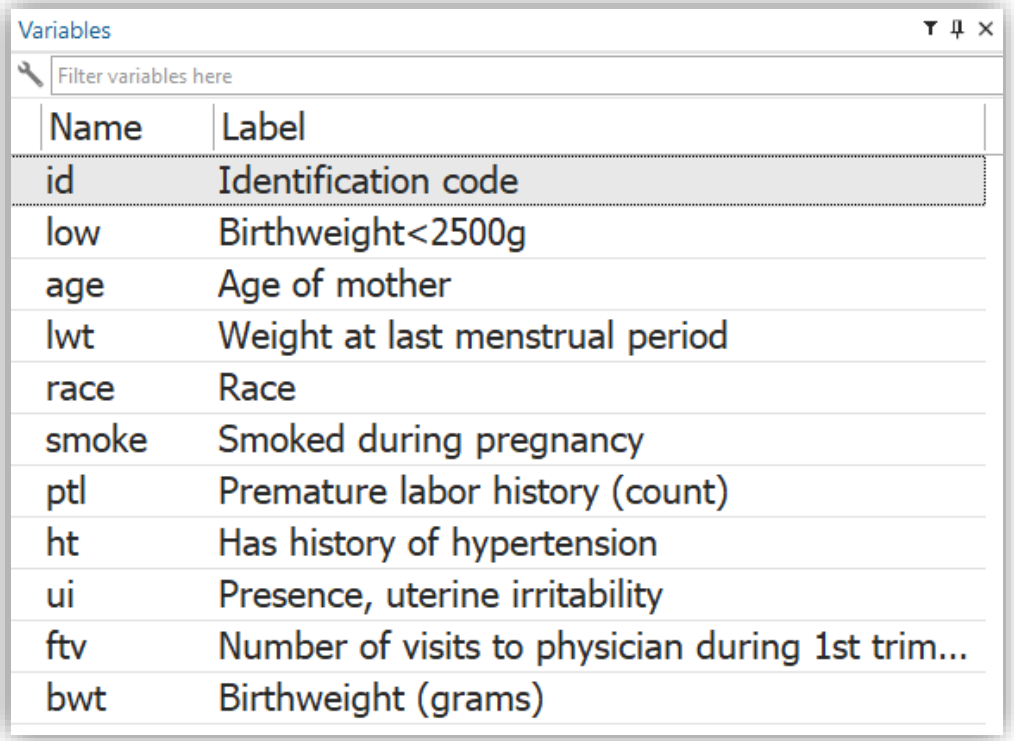


$$Y = f(T, \boldsymbol{X}_1, \boldsymbol{X}_2) + \epsilon_Y$$


Viewer - help teffects
File Edit History Help
help teffects
help teffects
Dialog Also see Jump to
[CAUSAL] teffects — Treatment-effects estimation for observational data
(View complete PDF manual entry)
Syntax
teffects subcommand ... [, options]
subcommand Description
aipw augmented inverse-probability weighting
ipw inverse-probability weighting
ipwra inverse-probability-weighted regression adjustment
nnmatch nearest-neighbor matching
psmatch propensity-score matching
ra regression adjustment
CAP NUM INS


Tratados
Controles
Y
X


Tratados
Controles
Y
X


Variables
Filter variables here
Name
Label
id
Identification code
low
Birthweight<2500g
age
Age of mother
lwt
Weight at last menstrual period
race
Race
smoke
Smoked during pregnancy
ptl
Premature labor history (count)
ht
Has history of hypertension
ui
Presence, uterine irritability
ftv
Number of visits to physician during 1st trim...
bwt
Birthweight (grams)

```
. webuse lbw
```

```
Treatment-effects estimation                    Number of obs     =        189
Estimator      : regression adjustment
Outcome model  : linear
Treatment model: none
```

bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	**-242.198**	**103.4367**	**-2.34**	**0.019**	**-444.9303**	**-39.4657**
POmean						
smoke Nonsmoker	**3020.813**	**73.21419**	**41.26**	**0.000**	**2877.316**	**3164.31**

```
. teffects ra (bwt age ui ptl) (smoke)
```

```
Treatment-effects estimation                    Number of obs      =        189
Estimator      : regression adjustment
Outcome model  : linear
Treatment model: none
```

bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke						
(Smoker vs Nonsmoker)	-242.198	103.4367	-2.34	0.019	-444.9303	-39.4657
POmean						
smoke						
Nonsmoker	3020.813	73.21419	41.26	0.000	2877.316	3164.31
OME0						
age	29.81673	12.65627	2.36	0.018	5.010903	54.62255
ui	-659.1187	218.8562	-3.01	0.003	-1088.069	-230.1684
ptl	-227.7906	242.3873	-0.94	0.347	-702.8609	247.2798
_cons	2470.17	293.4731	8.42	0.000	1894.974	3045.367
OME1						
age	-27.22703	17.43666	-1.56	0.118	-61.40225	6.948196
ui	-484.9099	210.1909	-2.31	0.021	-896.8765	-72.9433
ptl	-8.030069	155.4444	-0.05	0.959	-312.6954	296.6353
_cons	3484.73	411.8119	8.46	0.000	2677.593	4291.866

```
. teffects ra (bwt age ui ptl) (smoke), aequations
```

Treatment-effects estimation Number of obs = 189
Estimator : **regression adjustment**
Outcome model : **linear**
Treatment model: **none**

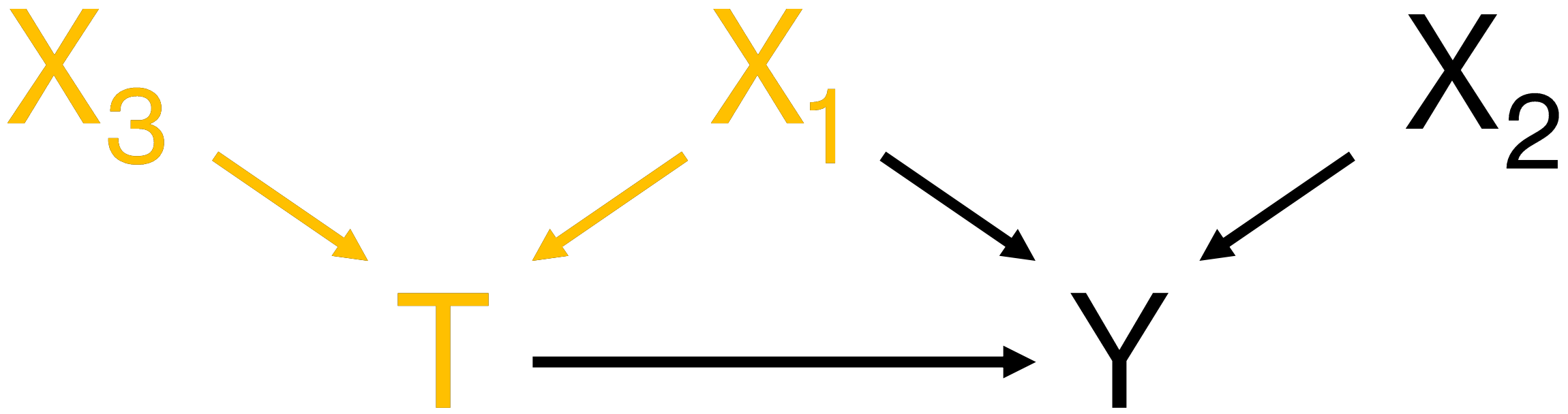
bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATET						
smoke (Smoker vs Nonsmoker)	-195.4551	119.916	-1.63	0.103	-430.4862	39.57594
POmean						
smoke Nonsmoker	2967.752	97.55975	30.42	0.000	2776.539	3158.966

```
. teffects ra (bwt age ui ptl) (smoke), atet
```

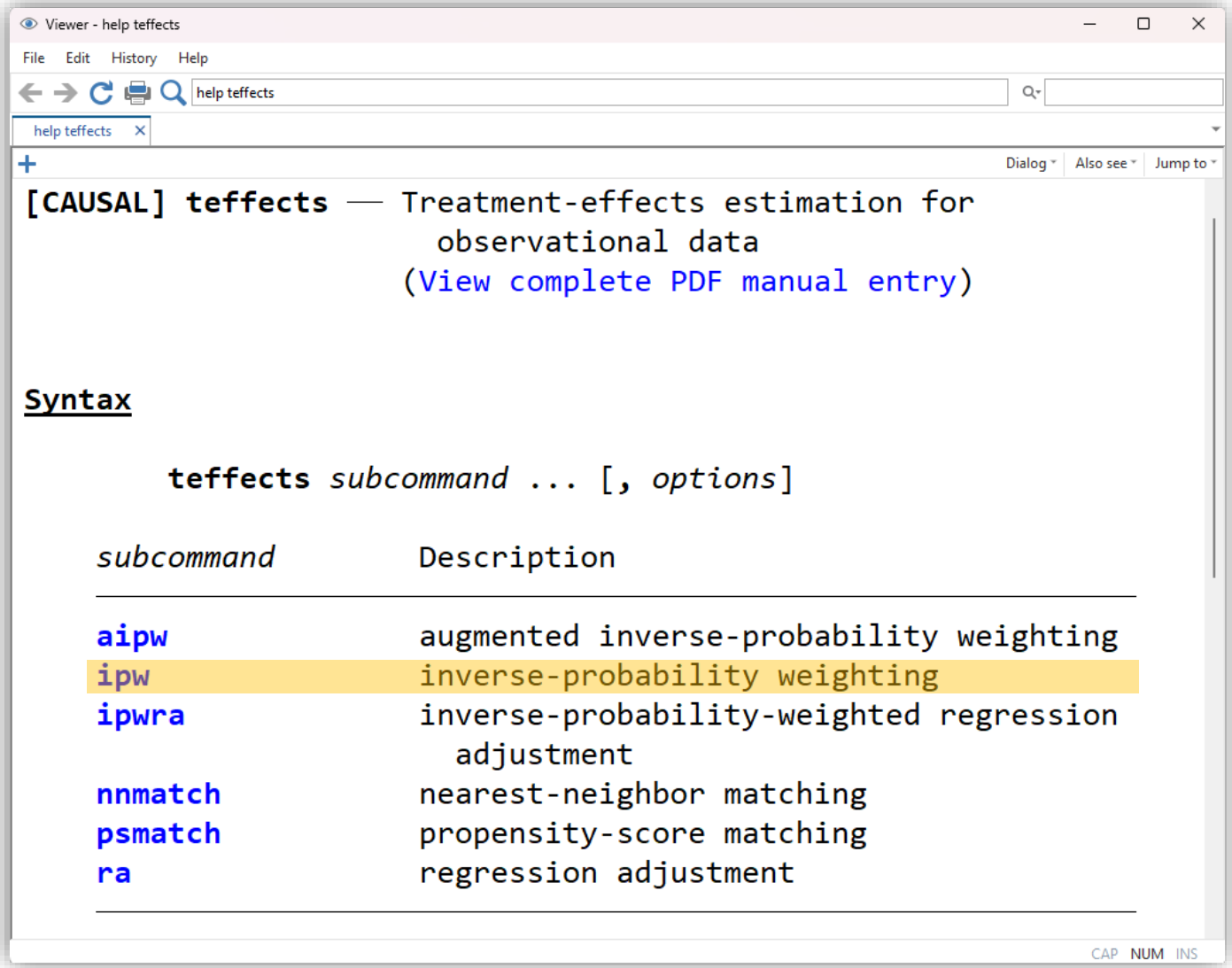
```
Treatment-effects estimation                    Number of obs     =        189
Estimator      : regression adjustment
Outcome model  : linear
Treatment model: none
```

bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
POmeans						
smoke						
Nonsmoker	3020.813	73.21419	41.26	0.000	2877.316	3164.31
Smoker	2778.615	74.72794	37.18	0.000	2632.151	2925.079

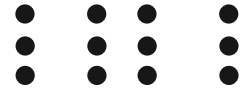
```
. teffects ra (bwt age ui ptl) (smoke), pom
```



$$T = g(\boldsymbol{X}_1, \boldsymbol{X}_3) + \epsilon_T$$


Viewer - help teffects
File Edit History Help
help teffects
help teffects
Dialog Also see Jump to
[CAUSAL] teffects — Treatment-effects estimation for observational data
(View complete PDF manual entry)
Syntax
teffects subcommand ... [, options]
subcommand Description
aipw augmented inverse-probability weighting
ipw inverse-probability weighting
ipwra inverse-probability-weighted regression adjustment
nnmatch nearest-neighbor matching
psmatch propensity-score matching
ra regression adjustment
CAP NUM INS

Y	Y(0)	Y(1)	T	p	w
3.1	?	3.1	1	#	1/p
4.2	?	4.2	1	#	1/p
2.9	?	2.9	1	#	1/p
1.7	1.7	?	0	#	1/(1-p)
2.1	2.1	?	0	#	1/(1-p)
3.8	3.8	?	0	#	1/(1-p)



$$\widehat{ATE} = \hat{E}[Y(1)] - \hat{E}[Y(0)]$$

```
Treatment-effects estimation                   Number of obs      =        189
Estimator      : inverse-probability weights
Outcome model  : weighted mean
Treatment model: logit
```

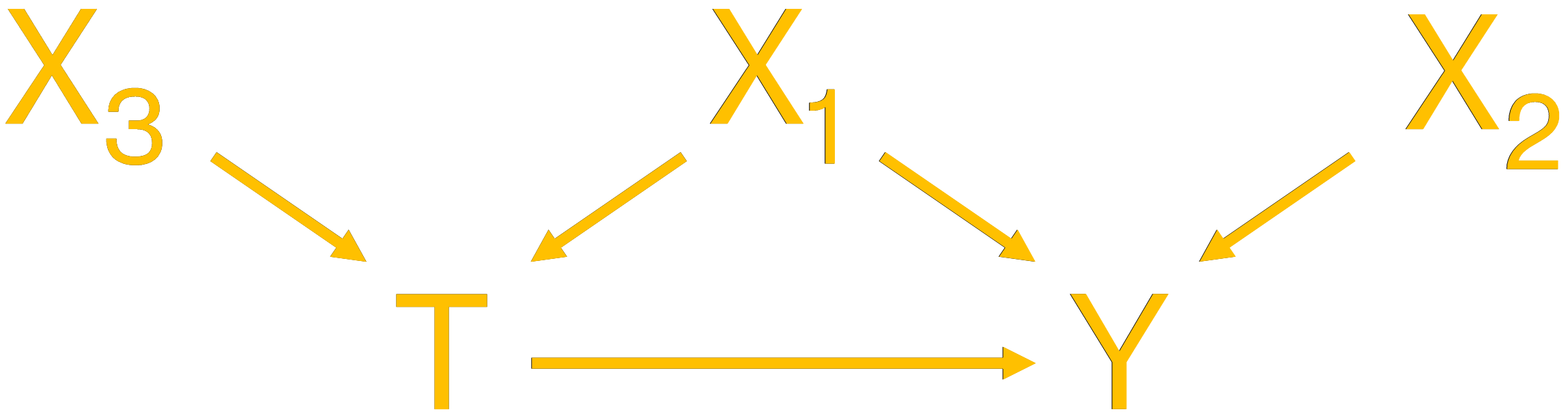
bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	-279.9708	102.4713	-2.73	0.006	-480.8108	-79.13082
POmean						
smoke Nonsmoker	3050.078	68.74209	44.37	0.000	2915.346	3184.81

```
. teffects ipw (bwt) (smoke age ftv)
```

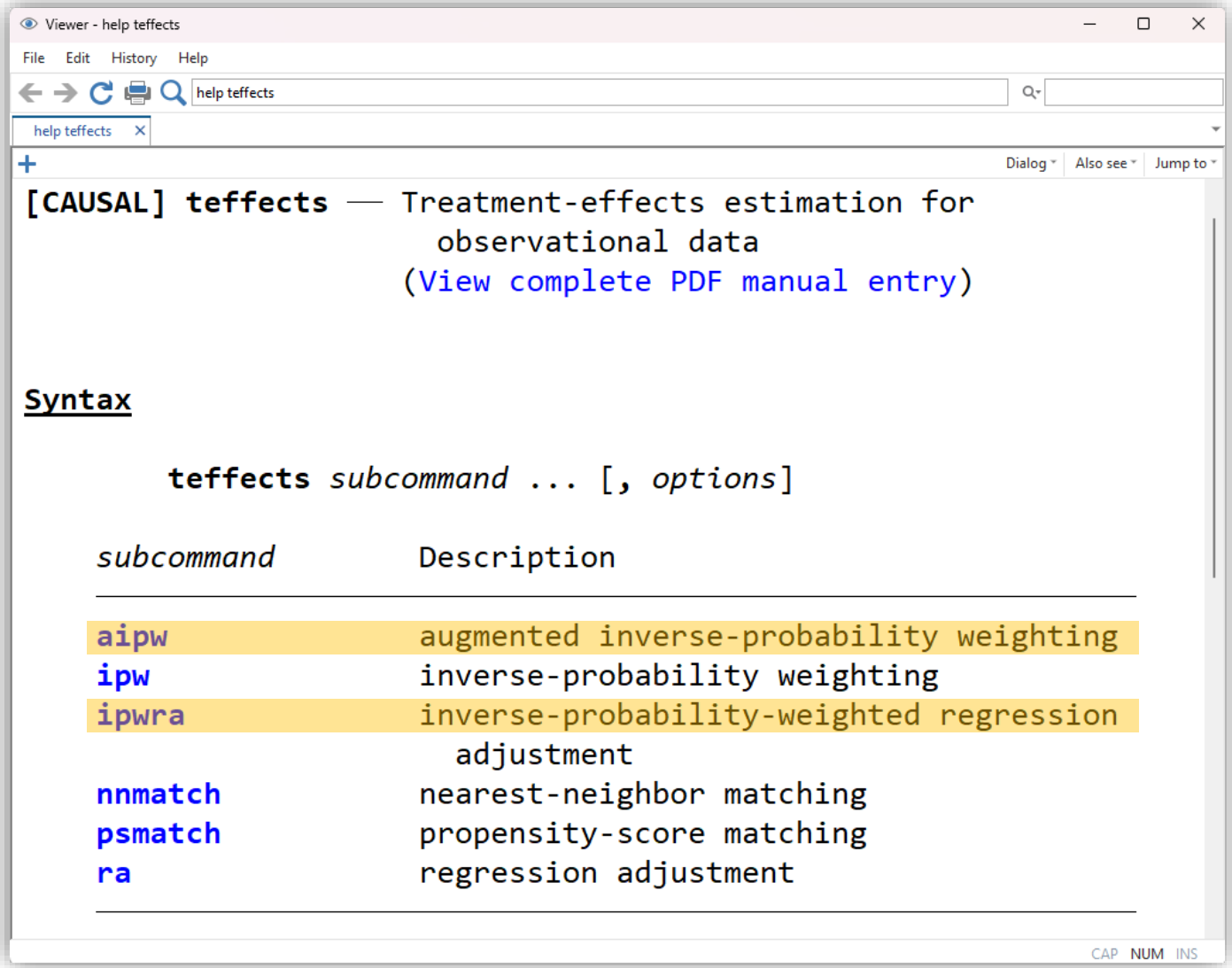
```
Treatment-effects estimation                   Number of obs      =        189
Estimator      : inverse-probability weights
Outcome model  : weighted mean
Treatment model: logit
```

bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	-279.9708	102.4713	-2.73	0.006	-480.8108	-79.13082
POmean						
smoke Nonsmoker	3050.078	68.74209	44.37	0.000	2915.346	3184.81
TME1						
age	-.0157273	.0284615	-0.55	0.581	-.0715109	.0400563
ftv	-.0380275	.155715	-0.24	0.807	-.3432233	.2671683
_cons	-.0463427	.6640162	-0.07	0.944	-1.347791	1.255105

```
. teffects ipw (bwt) (smoke age ftv), aequations
```



$$T = g(\boldsymbol{X}_1, \boldsymbol{X}_3) + \epsilon_T \qquad Y = f(T, \boldsymbol{X}_1, \boldsymbol{X}_2) + \epsilon_Y$$


Viewer - help teffects
File Edit History Help
help teffects
help teffects
Dialog Also see Jump to
[CAUSAL] teffects — Treatment-effects estimation for observational data
(View complete PDF manual entry)
Syntax
teffects subcommand ... [, options]
subcommand Description
aipw augmented inverse-probability weighting
ipw inverse-probability weighting
ipwra inverse-probability-weighted regression adjustment
nnmatch nearest-neighbor matching
psmatch propensity-score matching
ra regression adjustment
CAP NUM INS

```
Treatment-effects estimation                    Number of obs      =        189
Estimator      : augmented IPW
Outcome model  : linear by ML
Treatment model: logit
```

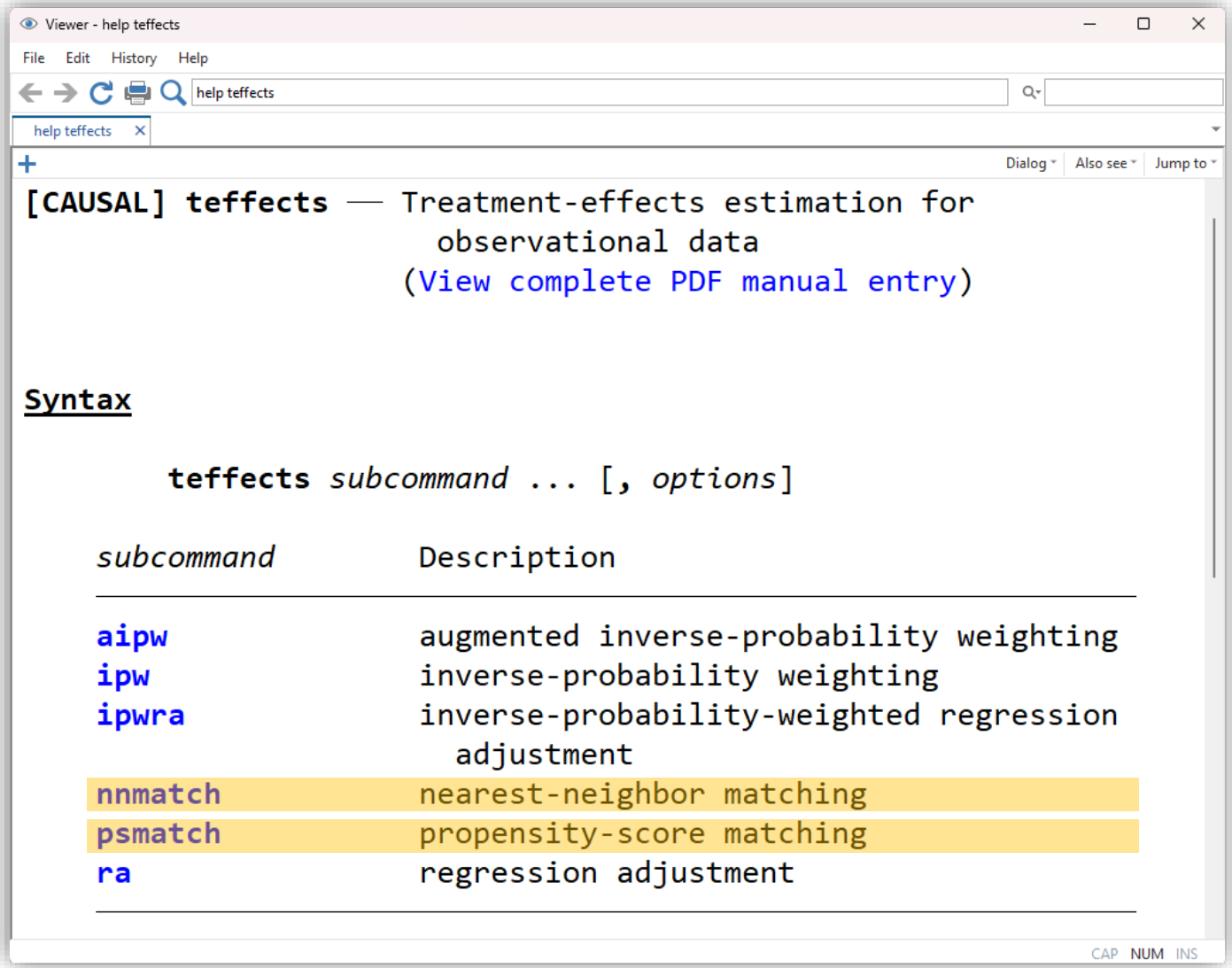
bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	-239.6607	103.1649	-2.32	0.020	-441.8601	-37.46131
POmean						
smoke Nonsmoker	3020.753	73.35362	41.18	0.000	2876.983	3164.524

```
. teffects aipw (bwt age ui ptl) (smoke age ftv)
```

Treatment-effects estimation Number of obs = 189
Estimator : **augmented IPW**
Outcome model : **linear by ML**
Treatment model: **logit**

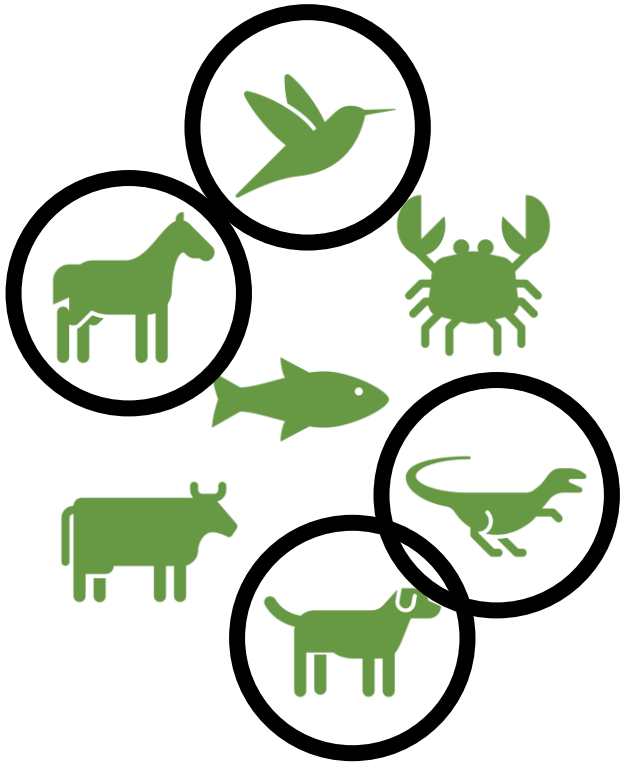
bwt	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	-239.6607	103.1649	-2.32	0.020	-441.8601	-37.46131
POmean						
smoke Nonsmoker	3020.753	73.35362	41.18	0.000	2876.983	3164.524
OME0						
age	29.81673	12.65627	2.36	0.018	5.010903	54.62255
ui	-659.1187	218.8562	-3.01	0.003	-1088.069	-230.1684
ptl	-227.7906	242.3873	-0.94	0.347	-702.8609	247.2798
_cons	2470.17	293.4731	8.42	0.000	1894.974	3045.367
OME1						
age	-27.22703	17.43666	-1.56	0.118	-61.40225	6.948196
ui	-484.9099	210.1909	-2.31	0.021	-896.8765	-72.9433
ptl	-8.030069	155.4444	-0.05	0.959	-312.6954	296.6353
_cons	3484.73	411.8119	8.46	0.000	2677.593	4291.866
TME1						
age	-.0157273	.0284615	-0.55	0.581	-.0715109	.0400563
ftv	-.0380275	.155715	-0.24	0.807	-.3432233	.2671683
_cons	-.0463427	.6640162	-0.07	0.944	-1.347791	1.255105

```
. teffects aipw (bwt age ui ptl) (smoke age ftv), aequations
```

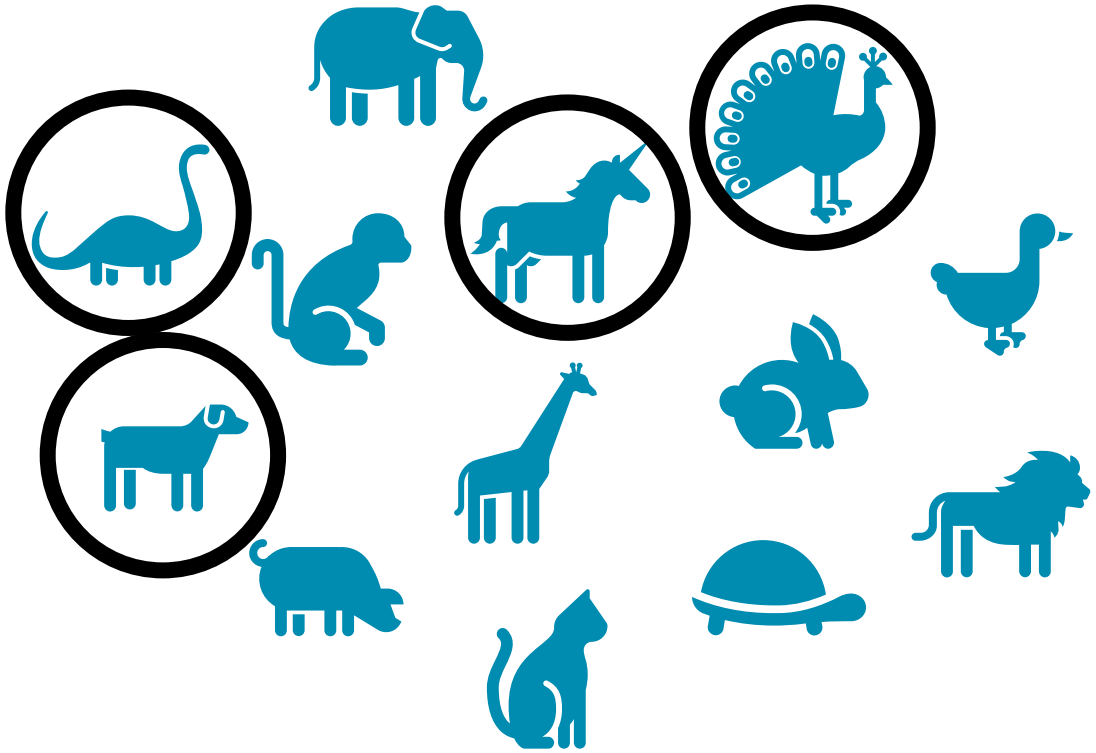

Viewer - help teffects
File Edit History Help
help teffects
help teffects
Dialog Also see Jump to
[CAUSAL] teffects — Treatment-effects estimation for observational data
(View complete PDF manual entry)
Syntax
teffects subcommand ... [, options]
subcommand Description
aipw augmented inverse-probability weighting
ipw inverse-probability weighting
ipwra inverse-probability-weighted regression adjustment
nnmatch nearest-neighbor matching
psmatch propensity-score matching
ra regression adjustment
CAP NUM INS

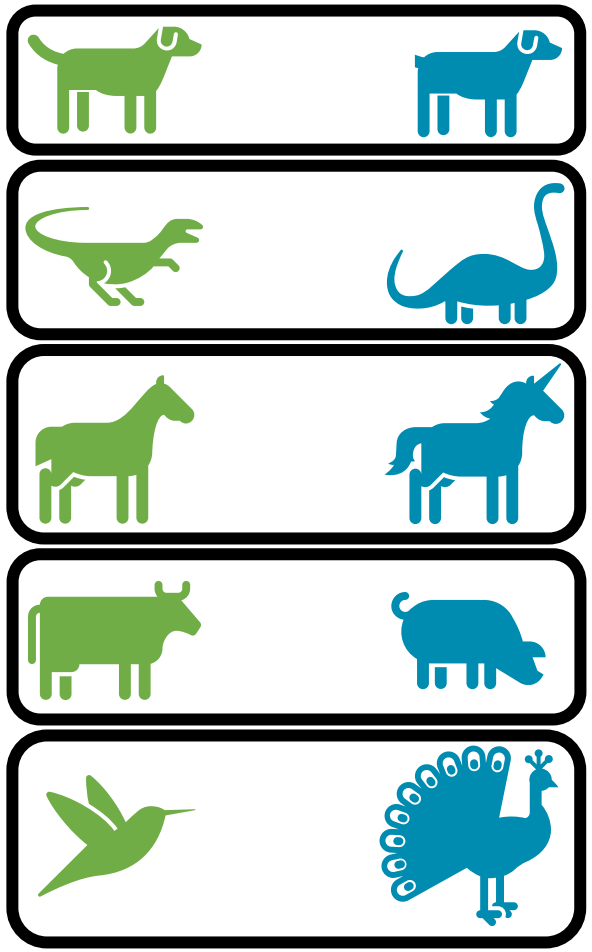
Y	Y(0)	Y(1)
3.1	?	3.1
4.2	?	4.2
2.9	?	2.9
1.7	1.7	?
2.1	2.1	?
3.8	3.8	?

Tratados



Controles





`teffects nnmatch`

- Cuál medida de distancia?
- Cuántas parejas?
- Tolerancia (caliper)?
- Emparejamiento exacto?

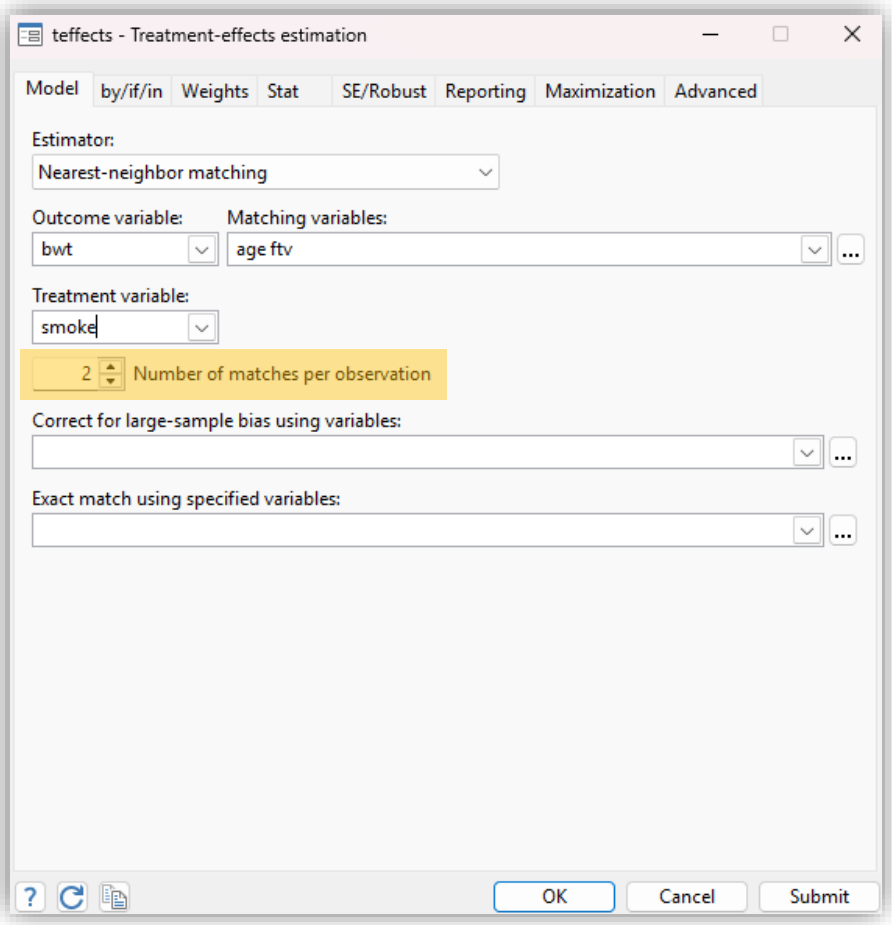
`teffects psmatch`

- Cuántas parejas?
- Tolerancia (caliper)?

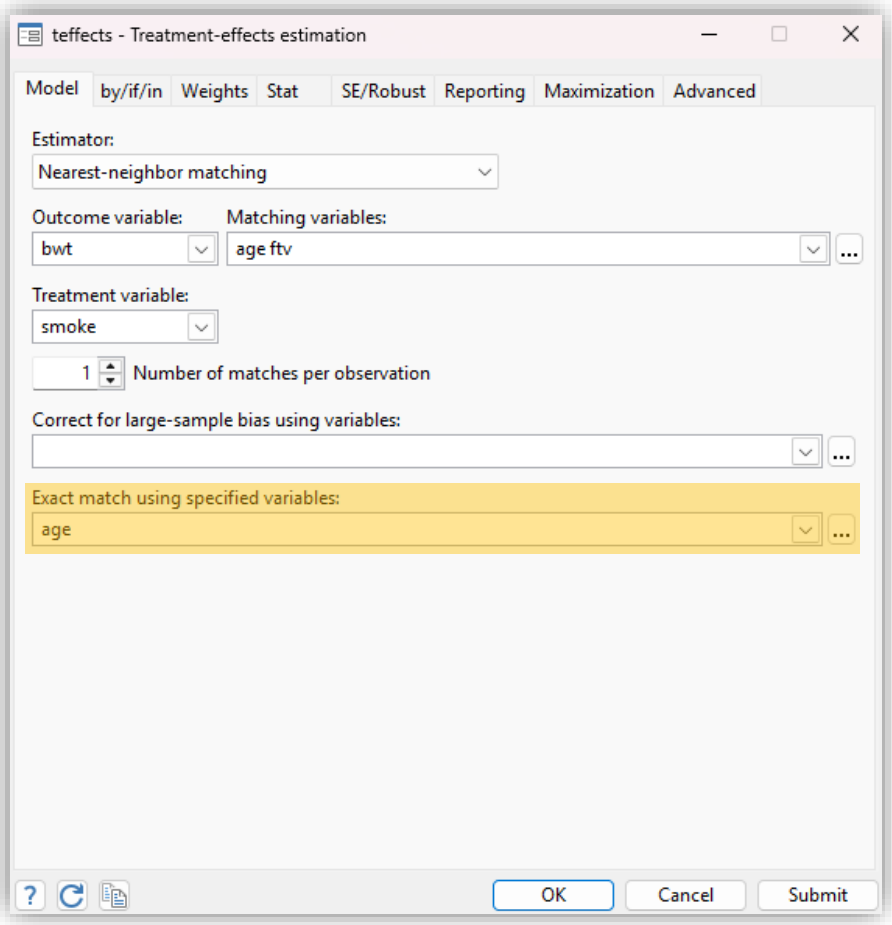
```
Treatment-effects estimation                   Number of obs      =        189
Estimator      : nearest-neighbor matching     Matches: requested =          1
Outcome model  : matching                                  min =          1
Distance metric: Mahalanobis                               max =          7
```

bwt	Coefficient	AI robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	**-315.9859**	**108.5831**	**-2.91**	**0.004**	**-528.8049**	**-103.167**

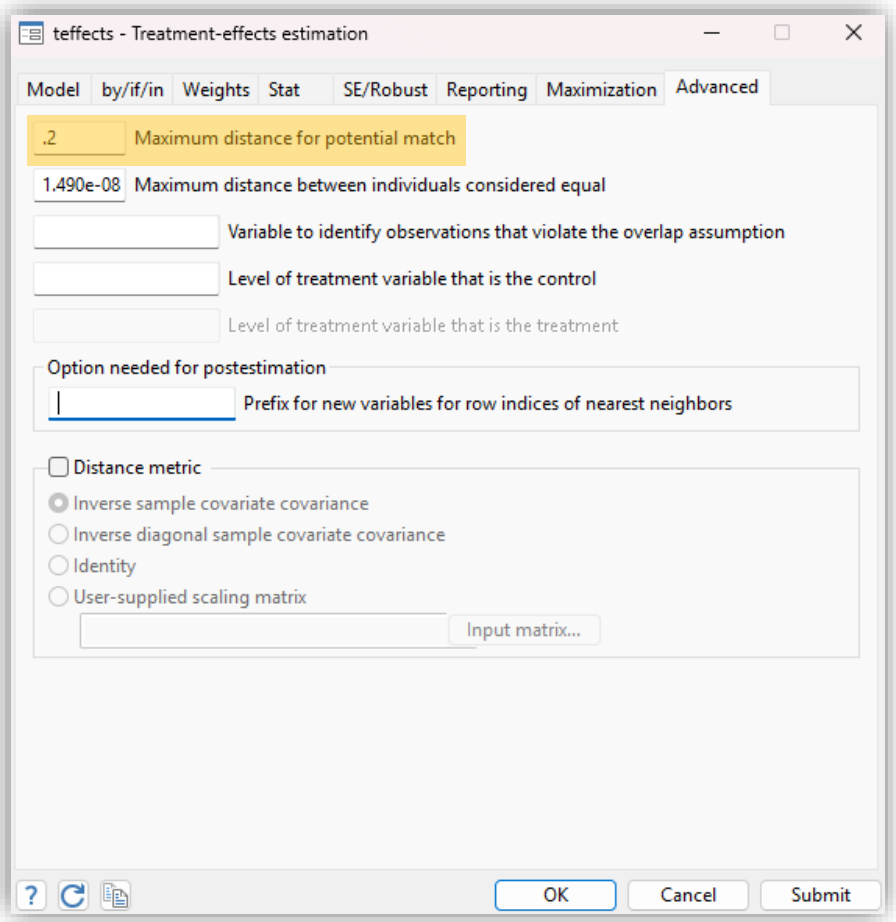
```
. teffects nnmatch (bwt age ftv) (smoke)
```



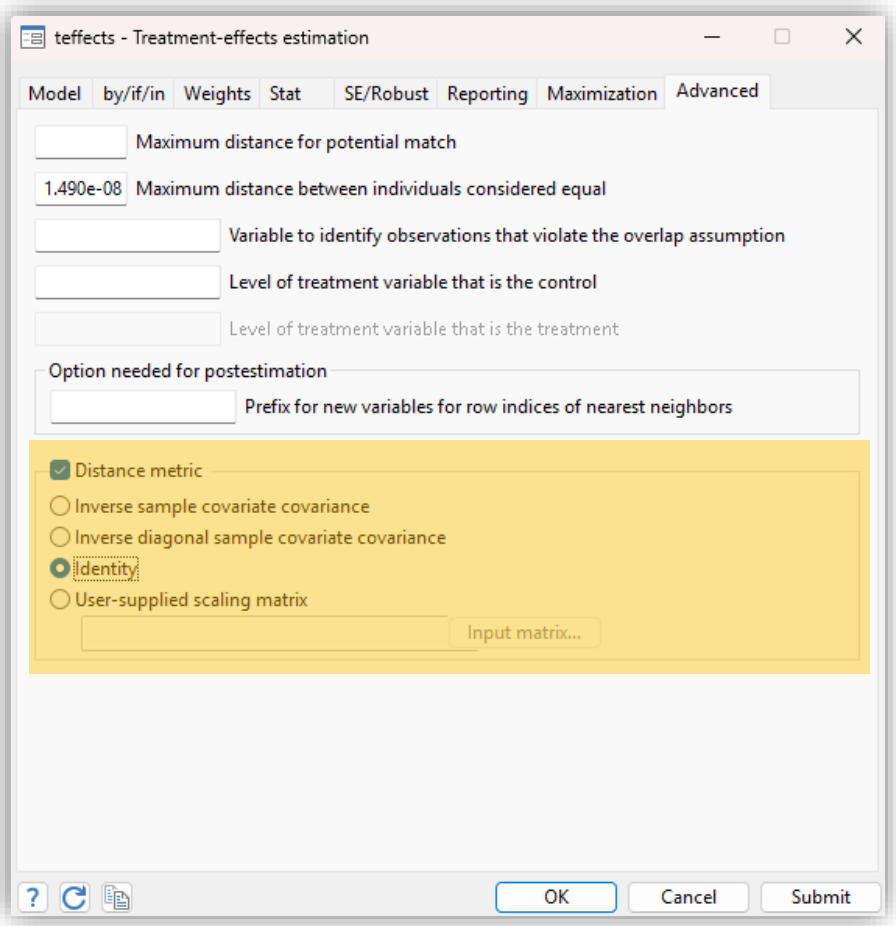

```
. teffects nnmatch (bwt age ftv) (smoke), nneighbor(2)
```




```
. teffects nnmatch (bwt age ftv) (smoke), ematch(age)
```




```
. teffects nnmatch (bwt age ftv) (smoke), caliper(.2)
```




```
. teffects nnmatch (bwt age ftv) (smoke), metric(euclidean)
```

```
Treatment-effects estimation                   Number of obs      =        189
Estimator      : propensity-score matching     Matches: requested =          1
Outcome model  : matching                                  min =          1
Treatment model: logit                                     max =          7
```

bwt	Coefficient	AI robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
smoke (Smoker vs Nonsmoker)	**-318.7534**	**115.9251**	**-2.75**	**0.006**	**-545.9624**	**-91.54439**

```
. teffects psmatch (bwt) (smoke age ftv)
```

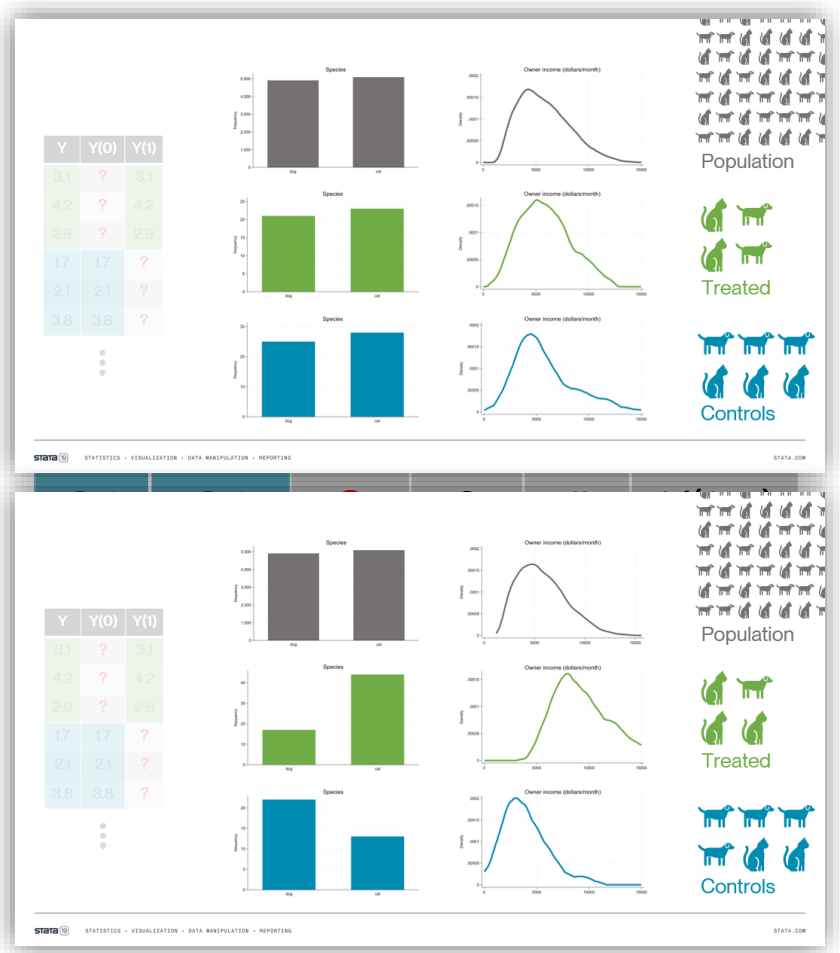
Command	Estimand	Outcome types	Treatment types	Models specified
`teffects ra`	ATE ATET POM	continuous binary count fractional nonnegative	binary multivalued	outcome
`teffects ipw`	ATE ATET POM	continuous binary count fractional nonnegative	binary multivalued	treatment
`teffects ipwra`	ATE ATET POM	continuous binary count fractional nonnegative	binary multivalued	outcome treatment
`teffects aipw`	ATE ATET POM	continuous binary count fractional nonnegative	binary multivalued	outcome treatment
`teffects psmatch`	ATE ATET	continuous binary count fractional nonnegative	binary	treatment
`teffects nnmatch`	ATE ATET	continuous binary count fractional nonnegative	binary	outcome*

*`nnmatch` includes covariates for modeling the outcome but does not require specification of a functional form for the outcome model.

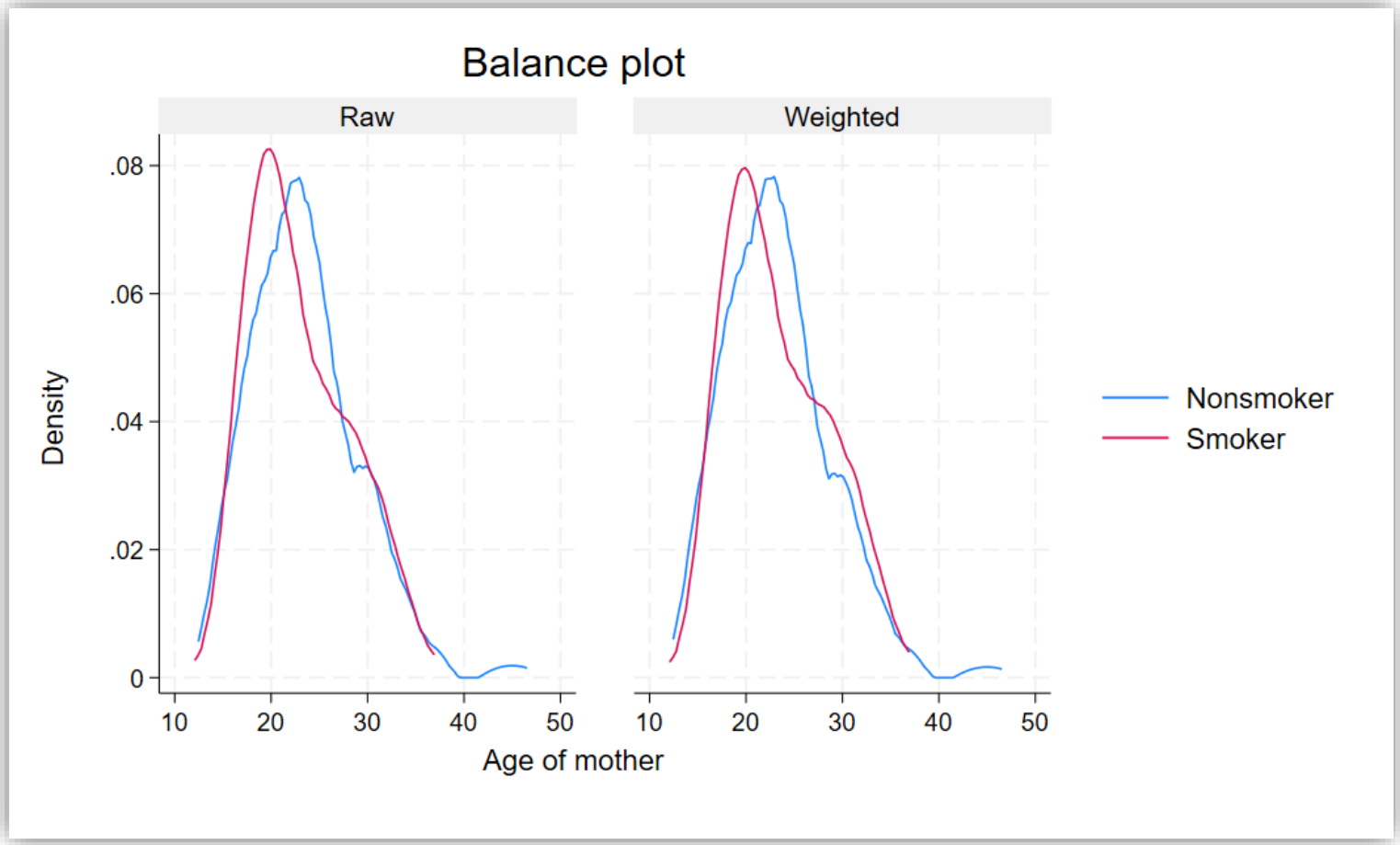
Covariate balance summary

	Raw	Weighted
Number of obs =	189	189.0
Treated obs =	74	94.5
Control obs =	115	94.5

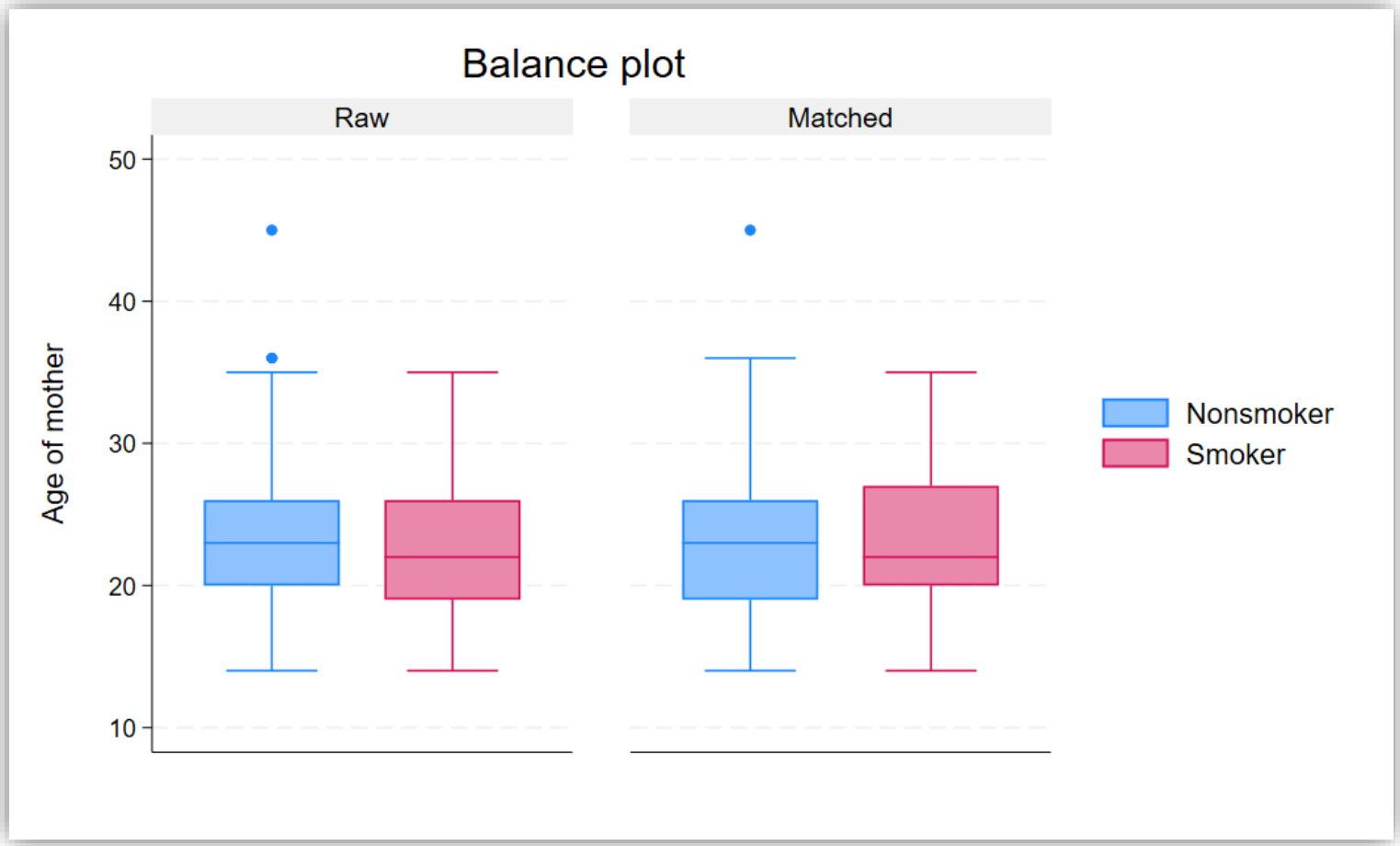
	Standardized differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
age	-.091251	-.0008564	.8521761	.8967359
ftv	-.0559412	.0080289	1.45373	1.585167




```
. teffects ipw (bwt) (smoke age ftv)
. tebalance summarize
```




```
. teffects ipw (bwt) (smoke age ftv)
. tebalance density age
```




```
. teffects psmatch (bwt) (smoke age ftv)
. tebalance box age
```

```
Overidentification test for covariate balance
H0: Covariates are balanced

         chi2(3)      =  .730127
         Prob > chi2  =   0.8661
```

```
. teffects aipw (bwt age ui ptl) (smoke age ftv)
. tebalance overid
```

Viewer - help cate

File Edit History Help

help cate

help cate

Dialog Also see Jump to

[CAUSAL] cate — Conditional average treatment-effects estimation
(View complete PDF manual entry)

Syntax

Partialing-out estimator

cate po (*ovar catevarlist*) (*tvar*) [*if*] [*in*] [, *options*]

Augmented inverse-probability weighting estimator

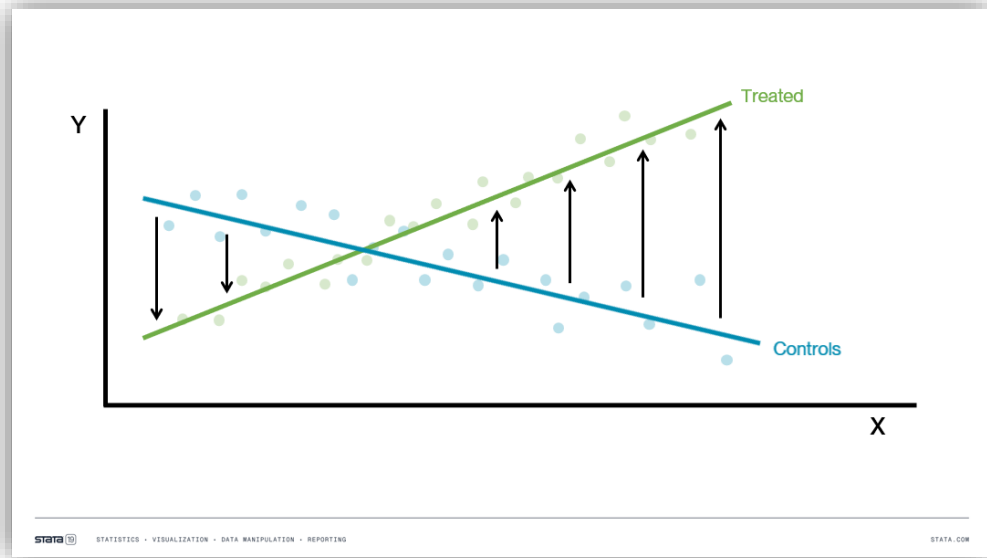
cate aipw (*ovar catevarlist*) (*tvar*) [*if*] [*in*] [, *options*]

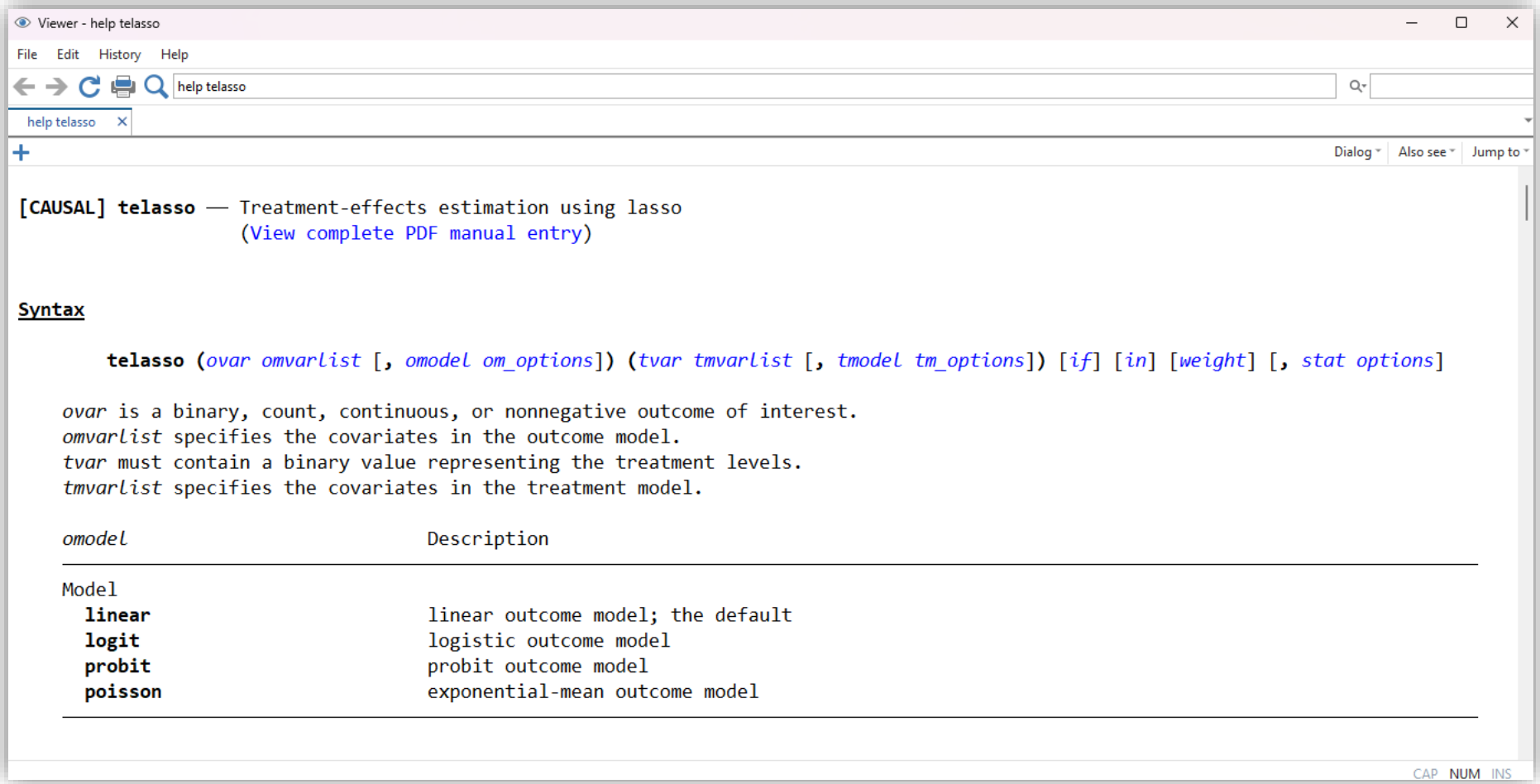
ovar is a continuous outcome of interest.

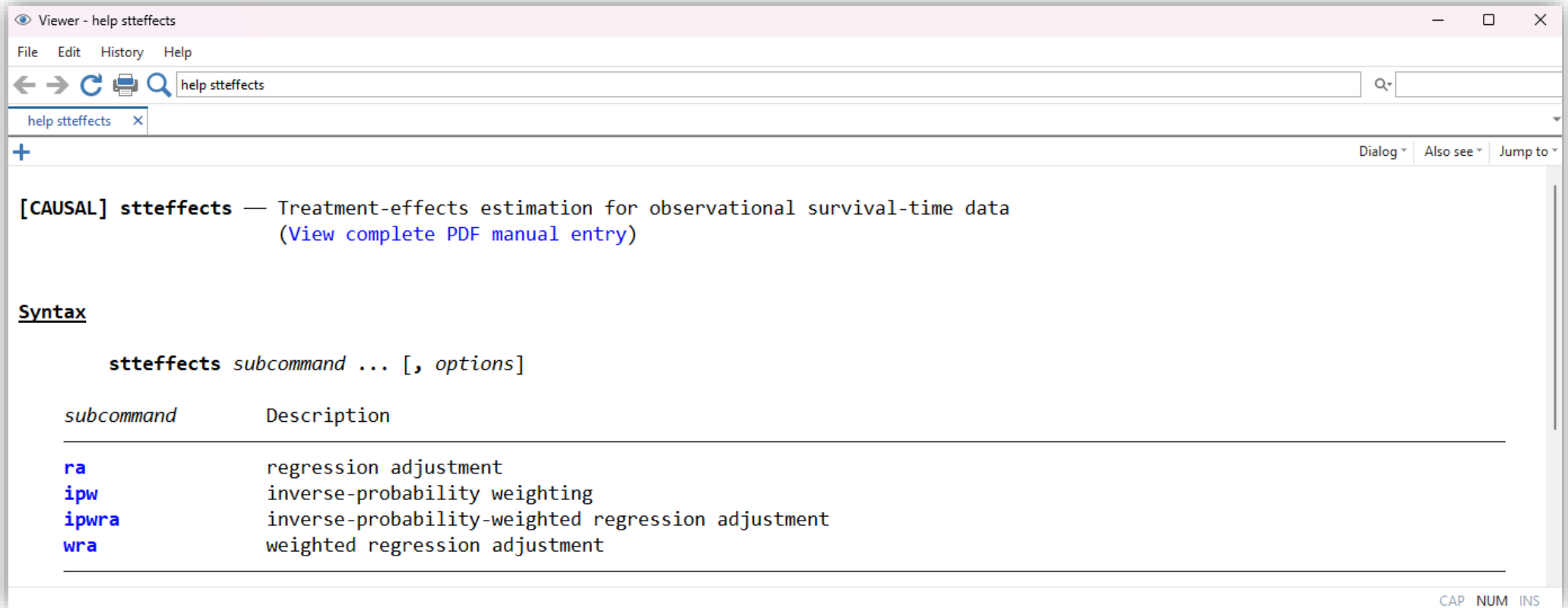
catevarlist specifies the covariates of the CATE model -- the conditioning variables for the treatment effects. *catevarlist* may contain factor variables; see fvvarlist.

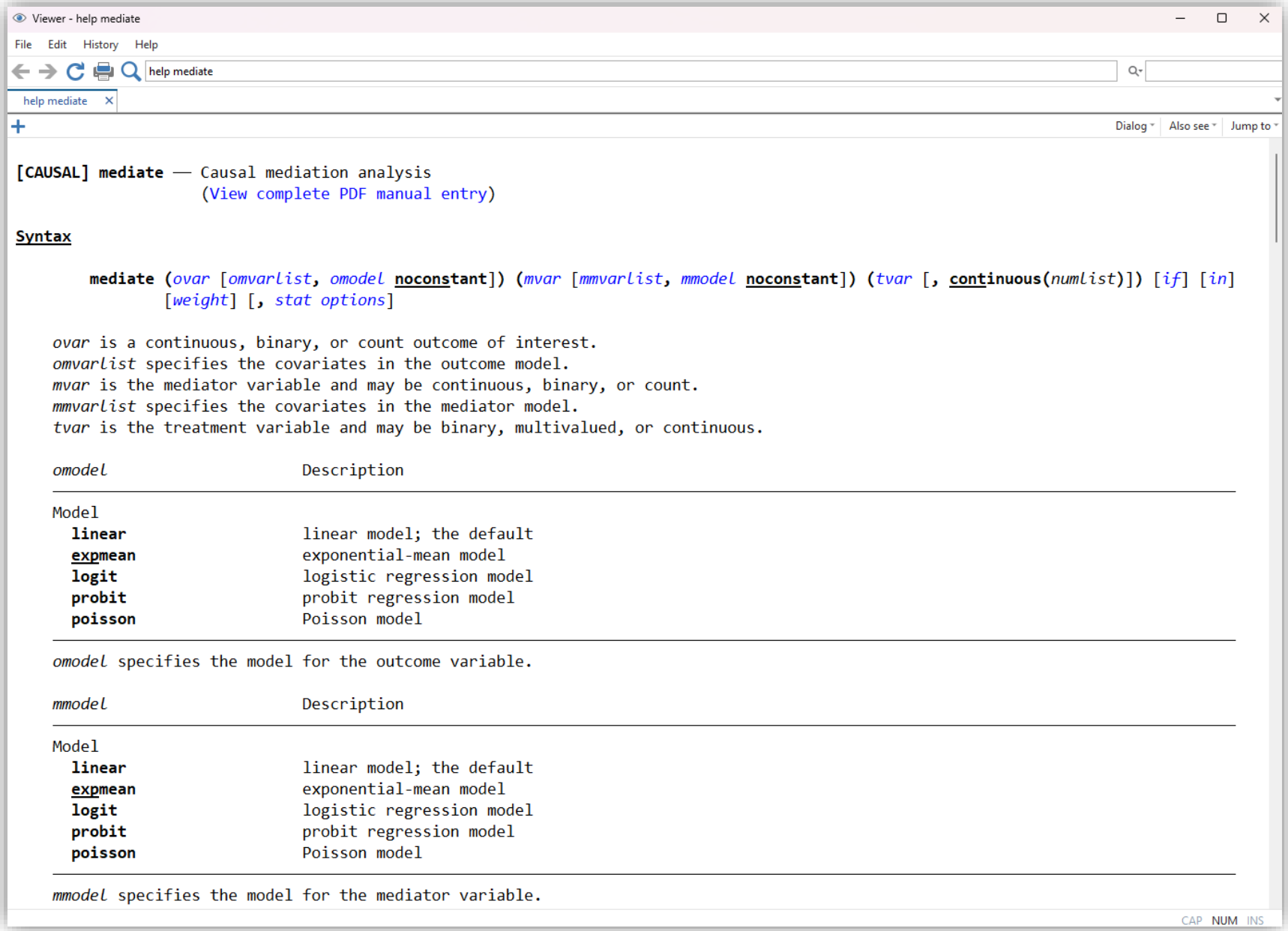
tvar must be a binary variable representing the treatment levels.

CAP NUM INS




Viewer - help telasso
File Edit History Help
help telasso
help telasso
Dialog
Also see
Jump to
[CAUSAL] telasso — Treatment-effects estimation using lasso
(View complete PDF manual entry)
Syntax
telasso (ovar omvarlist [, omodel om_options]) (tvar tmvarlist [, tmodel tm_options]) [if] [in] [weight] [, stat options]
ovar is a binary, count, continuous, or nonnegative outcome of interest.
omvarlist specifies the covariates in the outcome model.
tvar must contain a binary value representing the treatment levels.
tmvarlist specifies the covariates in the treatment model.
omodel
Description
Model
linear
linear outcome model; the default
logit
logistic outcome model
probit
probit outcome model
poisson
exponential-mean outcome model
CAP NUM INS


Viewer - help stteffects
File Edit History Help
help stteffects
help stteffects
Dialog
Also see
Jump to
[CAUSAL] stteffects — Treatment-effects estimation for observational survival-time data
(View complete PDF manual entry)
Syntax
stteffects subcommand ... [, options]
subcommand Description
ra regression adjustment
ipw inverse-probability weighting
ipwra inverse-probability-weighted regression adjustment
wra weighted regression adjustment
CAP NUM INS


Viewer - help mediate
File Edit History Help
help mediate
help mediate
Dialog Also see Jump to
[CAUSAL] mediate — Causal mediation analysis
(View complete PDF manual entry)
Syntax
mediate (ovar [omvarlist, omodel noconstant]) (mvar [mmvarlist, mmodel noconstant]) (tvar [, continuous(numlist)]) [if] [in]
[weight] [, stat options]
ovar is a continuous, binary, or count outcome of interest.
omvarlist specifies the covariates in the outcome model.
mvar is the mediator variable and may be continuous, binary, or count.
mmvarlist specifies the covariates in the mediator model.
tvar is the treatment variable and may be binary, multivalued, or continuous.
omodel Description
Model
linear linear model; the default
expmean exponential-mean model
logit logistic regression model
probit probit regression model
poisson Poisson model
omodel specifies the model for the outcome variable.
mmodel Description
Model
linear linear model; the default
expmean exponential-mean model
logit logistic regression model
probit probit regression model
poisson Poisson model
mmodel specifies the model for the mediator variable.
CAP NUM INS

Gracias por acompañarnos!

Instalación y uso de Stata: tech-support@stata.com
Actualización a StataNow: service@stata.com