



## Title

**scest** — Estimation for Synthetic Control Methods.

## Syntax

```
scest , dfname(string) [p(#) direc(string) Q(#) lb(#) name(string) opt(string)]
```

## Description

**scest** implements estimation procedures for Synthetic Control (SC) methods using least squares, lasso, ridge, or simplex-type constraints according to [Cattaneo, Feng, and Titiunik \(2021\)](#). The command is a wrapper of the companion Python package. As such, the user needs to have a running version of Python with the package installed. A tutorial on how to install Python and link it to Stata can be found [here](#).

Companion R and Python packages are described in [Cattaneo, Feng, Palomba and Titiunik \(2022\)](#).

Companion commands are: [scdata](#) for data preparation, [scpi](#) for inference procedures, and [scplot](#) for SC plots.

Related Stata, R, and Python packages useful for inference in SC designs are described in the following website:

<https://nppackages.github.io/scpi/>

For an introduction to synthetic control methods, see [Abadie \(2021\)](#) and references therein.

## Options

**dfname**(string) specifies the name of the Python object containing the processed data created with [scdata](#).

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Constraint

These options let the user specify the type of constraint to be imposed to estimate the SC weights. The user controls the lower bound on the weights (option **lb**), the norm of the weights to be constrained (option **p**), the direction of the constraint on the norm (option **dir**), and the size of the constraint on the norm (option **q**). Alternatively, some popular constraints can be selected through the option **name**. A detailed description of the popular constraints implemented can be found in [Cattaneo, Feng, Palomba and Titiunik \(2022\)](#).

**lb**(#) specifies the lower bound on the weights. The default is **lb(0)**.

**p**(#) sets the type of norm to be constrained. Options are:

- 0 no constraint on the norm of the weights is imposed.
- 1 a constraint is imposed on the L1 norm of the weights (the default).
- 2 a constraint is imposed on the L2 norm of the weights.

**direc**(string) specifies the direction of the constraint on the norm of the weights. Options are:

- <= the constraint on the norm of the weights is an inequality constraint.
- = the constraint on the norm of the weights is an equality constraint (the default).

**Q**(#) specifies the size of the constraint on the norm of the weights.

**name**(string) specifies the name of the constraint to be used. Options are:

- simplex** classic synthetic control estimator where the weights are constrained to be non-negative and their L1 norm must be equal to 1.
- lasso** weights are estimated using a Lasso-type penalization
- ridge** weights are estimated using a Ridge-type penalization.
- ols** weights are estimated without constraints using least squares

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## Others

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**opt**(string) a string specifying the stopping criteria used by the underlying optimizer (**nlopt**) for point estimation. The default is a sequential quadratic programming (SQP) algorithm for nonlinearly constrained gradient-based optimization ('SLSQP'). The default value is **opt("maxeval" = 5000, 'xtol\_rel' = 1e-8, 'xtol\_abs' = 1e-8, 'ftol\_rel' = 1e-12, 'ftol\_abs' = 1e-12, 'tol\_eq' = 1e-8, 'tol\_ineq' = 1e-8)**. In case a lasso-type constraint is implemented, a different optimizer (**cvxpy**) is used and stopping criteria cannot be changed.

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### Example: Germany Data

```
Setup
. use scpi_germany.dta

Prepare data
. scdata gdp, dfname("python_scddata") id(country) outcome(gdp) time(year)
  treatment(status) cointegrated

Estimate Synthetic Control with a simplex constraint
. scest, dfname("python_scddata") name(simplex)
```

### Stored results

**scest** stores the following in **e()**:

#### Scalars

<b>e(M)</b>	number of features
<b>e(KM)</b>	number of covariates used for adjustment
<b>e(J)</b>	number of donors
<b>e(T1)</b>	number of post-treatment periods
<b>e(q)</b>	size of the constraint on the norm

#### Macros

<b>e(features)</b>	name of features
<b>e(outcomevar)</b>	name of outcome variable
<b>e(constant)</b>	logical indicating the presence of a common constant across features
<b>e(cointegrated_data)</b>	logical indicating cointegration
<b>e(p)</b>	type of norm of the weights used in constrained estimation
<b>e(dir)</b>	direction of the constraint on the norm of the weights
<b>e(name)</b>	name of constraint used in estimation

#### Matrices

<b>e(T0)</b>	number of pre-treatment periods per feature
<b>e(A)</b>	pre-treatment features of the treated unit
<b>e(B)</b>	pre-treatment features of the control units
<b>e(C)</b>	covariates used for adjustment
<b>e(pred)</b>	predicted values of the features of the treated unit
<b>e(res)</b>	residuals <b>e(A) - e(pred)</b>
<b>e(w)</b>	weights of the controls
<b>e(r)</b>	coefficients of the covariates used for adjustment
<b>e(beta)</b>	stacked version of <b>e(w)</b> and <b>e(r)</b>
<b>e(Y_post)</b>	post-treatment outcome of the treated unit
<b>e(Y_post_fit)</b>	estimated post-treatment outcome of the treated unit
<b>e(Y_pre)</b>	pre-treatment outcome of the treated unit
<b>e(Y_pre_fit)</b>	estimate pre-treatment outcome of the treated unit

### References

- Abadie, A. 2021. Using synthetic controls: Feasibility, data requirements, and methodological aspects. *Journal of Economic Literature*, 59(2), 391-425.
- Cattaneo, M. D., Feng, Y., and Titiunik, R. 2021. Prediction Intervals for Synthetic Sontrol Methods. *Journal of the American Statistical Association*, 116(536), 1865-1880.
- Cattaneo, M. D., Feng, Y., Palomba F., and Titiunik, R. 2022. scpi: Uncertainty Quantification for Synthetic Control Estimators, arXiv:2202.05984..

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