svy bootstrap — Bootstrap for survey data

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### Description

dvy bootstrap performs nonparametric bootstrap estimation of specified statistics (or expressions) for a Stata command or a user-written program. The command is executed once for each replicate using sampling weights that are adjusted according to the bootstrap methodology. Any Stata estimation command listed in [SVY] svy estimation may be used with svy bootstrap. User-written programs that meet the requirements in [P] program properties may also be used.

### Quick start

Estimate population mean of v1 using bootstrap standard-error estimates and variables with prefix `rwvar` as the bootstrap replicate weights:

```
svyset [pweight=wvar1], bsrweight(rwvar*)
svy bootstrap _b: mean v1
```

Same as above:

```
svyset [pweight=wvar1], bsrweight(rwvar*) vce(bootstrap)
svy: mean v1
```

As above, and specify that 3 replicates were used to calculate each bootstrap replicate weight:

```
svy, bsn(3): mean v1
```

Bootstrap standard error of the difference between the means of v2 and v3 using either `svyset` command above:

```
svy bootstrap (_b[v2]-_b[v3]): mean v2 v3
```

As above, but name the result `diff` and save results from each replication to `mydata.dta`:

```
svy bootstrap diff=(_b[v2]-_b[v3]), saving(mydata): mean v2 v3
```

Note: Any estimation command meeting the requirements specified in the Description may be substituted for `mean` in the examples above.

### Menu

Statistics > Survey data analysis > Resampling > Bootstrap estimation
Syntax

```
svy bootstrap exp_list [ , svy_options bootstrap_options eform_option ] : command
```

### svy_options

**Description**

**if/in**
- **subpop([varname] [if])**: identify a subpopulation

**Reporting**
- **level(#)***: set confidence level; default is level(95)
- **noheader**: suppress table header
- **nolegend**: suppress table legend
- **noadjust**: do not adjust model Wald statistic
- **nocnsreport**: do not display constraints
- **display_options**
  - control columns and column formats, row spacing, line width, display of omitted variables and base and empty cells, and factor-variable labeling

**coeflegend**: display legend instead of statistics

*coeflegend* is not shown in the dialog boxes for estimation commands.

### bootstrap_options

**Description**

**Main**
- **bsn(#)***: bootstrap mean-weight adjustment

**Options**
- **saving(filename[, ...])**: save results to *filename*; save statistics in double precision; save results to *filename* every # replications
- **mse**: use MSE formula for variance

**Reporting**
- **verbose**: display the full table legend
- **nodots**: suppress replication dots
- **dots(#)***: display dots every # replications
- **noisily**: display any output from *command*
- **trace**: trace *command*
- **title(text)**: use *text* as title for bootstrap results

**Advanced**
- **nodrop**: do not drop observations
- **reject(exp)**: identify invalid results
- **dof(#)***: design degrees of freedom

svy requires that the survey design variables be identified using *svyset*; see [SVY] *svyset.*

*command* defines the statistical command to be executed. The *by* prefix cannot be part of *command.*

See [U] 20 Estimation and postestimation commands for more capabilities of estimation commands.

Warning: Using *if* or *in* restrictions will often not produce correct variance estimates for subpopulations. To compute estimates for subpopulations, use the *subpop()* option.

*svy bootstrap* requires that the bootstrap replicate weights be identified using *svyset.*
exp_list specifies the statistics to be collected from the execution of command. exp_list is required unless command has the svyb program property, in which case exp_list defaults to _b; see [P] program properties. The expressions in exp_list are assumed to conform to the following:

exp_list contains (name: elist)
   elist
   eexp

elist contains newvarname = (exp)
   (exp)
eexp is specname
   [eqno]specname

specname is _b
   _b[]
   _se
   _se[]
eqno is ##
name

exp is a standard Stata expression; see [U] 13 Functions and expressions.
Distinguish between [], which are to be typed, and [], which indicate optional arguments.

Options

svy_options; see [SVY] svy.

bsn(#) specifies that # bootstrap replicate-weight variables were used to generate each bootstrap mean-weight variable specified in the bsrweight() option of svyset. The default is bsn(1). The bsn() option of svy bootstrap overrides the bsn() option of svyset; see [SVY] svyset.

saving(filename[, suboptions]) creates a Stata data file (.dta file) consisting of (for each statistic in exp_list) a variable containing the replicates.

double specifies that the results for each replication be saved as doubles, meaning 8-byte reals. By default, they are saved as floats, meaning 4-byte reals. This option may be used without the saving() option to compute the variance estimates by using double precision.

every(#) specifies that results be written to disk every #th replication. every() should be specified in conjunction with saving() only when command takes a long time for each replication. This will allow recovery of partial results should some other software crash your computer. See [P] postfile.

replace specifies that filename be overwritten if it exists. This option does not appear in the dialog box.

mse specifies that svy bootstrap compute the variance by using deviations of the replicates from the observed value of the statistics based on the entire dataset. By default, svy bootstrap computes the variance by using deviations of the replicates from their mean.
Reporting

verbose requests that the full table legend be displayed.

nodots and dots(#) specify whether to display replication dots. By default, one dot character is displayed for each successful replication. A red ‘x’ is displayed if command returns an error, and an ‘e’ is displayed if at least one value in exp_list is missing. You can also control whether dots are displayed using set dots; see [R] set.

nodots suppresses display of the replication dots.

dots(#) displays dots every # replications. dots(0) is a synonym for nodots.

noisily requests that any output from command be displayed. This option implies the nodots option.

trace causes a trace of the execution of command to be displayed. This option implies the noisily option.

title(text) specifies a title to be displayed above the table of bootstrap results; the default title is “Bootstrap results”.

eform_option; see [R] eform_option. This option is ignored if exp_list is not _b.

Advanced

nodrop prevents observations outside e(sample) and the if and in qualifiers from being dropped before the data are resampled.

reject(exp) identifies an expression that indicates when results should be rejected. When exp is true, the resulting values are reset to missing values.

dof(#) specifies the design degrees of freedom, overriding the default calculation, \( df = N_{\text{psu}} - N_{\text{strata}} \).

Remarks and examples


In the survey bootstrap, the model is fit multiple times, once for each of a set of adjusted sampling weights. The variance is estimated using the resulting replicated point estimates.

Example 1

Suppose that we need to estimate the average birthweight for the population represented by the National Maternal and Infant Health Survey (NMIHS) (Gonzalez, Krauss, and Scott 1992).

In [SVY] svy estimation, the dataset nmihs.dta contained the following design information:

- Primary sampling units are mothers; that is, PSUs are individual observations—there is no separate PSU variable.
- The finalwgt variable contains the sampling weights.
- The stratan variable identifies strata.
- There is no variable for the finite population correction.
nmihs_bs.dta is equivalent to nmihs.dta except that the stratum identifier variable stratan is replaced by bootstrap replicate-weight variables. The replicate-weight variables are already svyset, and the default method for variance estimation is vce(bootstrap).

```
. use https://www.stata-press.com/data/r16/nmihs_bs
. svyset
    pweight: finwgt
    VCE: bootstrap
    MSE: off
    bsrweight: bsrw1 .. bsrw1000
    Single unit: missing
    Strata 1: <one>
    SU 1: <observations>
    FPC 1: <zero>
```

Now we can use svy: mean to estimate the average birthweight for our population, and the standard errors will be estimated using the survey bootstrap.

```
. svy, nodots: mean birthwgt
Survey: Mean estimation
Number of obs = 9,946
Population size = 3,895,562
Replications = 1,000

<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Bootstrap</th>
<th>Normal-based</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Err.</td>
<td>[95% Conf. Interval]</td>
</tr>
<tr>
<td>birthwgt</td>
<td>3355.452</td>
<td>6.520637</td>
<td>3342.672</td>
</tr>
</tbody>
</table>
```

From these results, we are 95% confident that the mean birthweight for our population is between 3,343 and 3,368 grams.

To accommodate privacy concerns, many public-use datasets contain replicate-weight variables derived from the “mean bootstrap” described by Yung (1997). In the mean bootstrap, each adjusted weight is derived from more than one bootstrap sample. When replicate-weight variables for the mean bootstrap are svyset, the bsn() option identifying the number of bootstrap samples used to generate the adjusted-weight variables should also be specified. This number is used in the variance calculation; see [SVY] Variance estimation.

> Example 2

nmihs_mbs.dta is equivalent to nmihs.dta except that the strata identifier variable stratan is replaced by mean bootstrap replicate-weight variables. The replicate-weight variables and variance adjustment are already svyset, and the default method for variance estimation is vce(bootstrap).
Notice that the 200 mean bootstrap replicate-weight variables were generated from 5 bootstrap samples; in fact, the mean bootstrap weight variables in `nmihs_mbs.dta` were generated from the bootstrap weight variables in `nmihs_bs.dta`.

Here we use `svy: mean` to estimate the average birthweight for our population.

```
. svy, nodots: mean birthwgt
Survey: Mean estimation
Number of obs = 9,946
Population size = 3,895,562
Replications = 200

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<td>Mean</td>
<td>Std. Err.</td>
<td>[95% Conf. Interval]</td>
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<tr>
<td>birthwgt</td>
<td>3355.452</td>
<td>5.712574</td>
<td>3344.256</td>
</tr>
</tbody>
</table>
```

The standard error and confidence limits differ from the previous example. This merely illustrates that the mean bootstrap is not numerically equivalent to the standard bootstrap, even when the replicate-weight variables are generated from the same resampled datasets.
Stored results

In addition to the results documented in [SVY] svy, svy bootstrap stores the following in \( \mathbf{e}() \):

Scalars

\[
\begin{align*}
\text{e(N\_reps)} & \quad \text{number of replications} \\
\text{e(N\_misreps)} & \quad \text{number of replications with missing values} \\
\text{e(k\_exp)} & \quad \text{number of standard expressions} \\
\text{e(k\_eexp)} & \quad \text{number of \_b/\_se expressions} \\
\text{e(k\_extra)} & \quad \text{number of extra estimates added to \_b} \\
\text{e(bsn)} & \quad \text{bootstrap mean-weight adjustment}
\end{align*}
\]

Macros

\[
\begin{align*}
\text{e(cmdname)} & \quad \text{command name from command} \\
\text{e(cmd)} & \quad \text{same as e(cmdname) or bootstrap} \\
\text{e(vce)} & \quad \text{bootstrap} \\
\text{e(exp\#)} & \quad \text{\#th expression} \\
\text{e(bsrweight)} & \quad \text{bsrweight() variable list}
\end{align*}
\]

Matrices

\[
\begin{align*}
\text{e(b\_bs)} & \quad \text{bootstrap means} \\
\text{e(V)} & \quad \text{bootstrap variance estimates}
\end{align*}
\]

When \( \text{exp\_list} \) is \_b, svy bootstrap will also carry forward most of the results already in \( \mathbf{e}() \) from \text{command}.

Methods and formulas

See [SVY] Variance estimation for details regarding bootstrap variance estimation.

References


Stata Journal 10: 165–199.


Also see

[SVY] svy postestimation — Postestimation tools for svy
[SVY] svy brr — Balanced repeated replication for survey data
[SVY] svy jackknife — Jackknife estimation for survey data
[SVY] svy sdr — Successive difference replication for survey data
[SVY] Calibration — Calibration for survey data
[SVY] Poststratification — Poststratification for survey data
[SVY] Subpopulation estimation — Subpopulation estimation for survey data
[SVY] Variance estimation — Variance estimation for survey data
[R] bootstrap — Bootstrap sampling and estimation
[U] 20 Estimation and postestimation commands