

**svy brr** — Balanced repeated replication for survey data

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## Description

`svy brr` performs balanced repeated replication (BRR) estimation of specified statistics (or expressions) for a Stata command or a user-written command. The command is executed once for each replicate using sampling weights that are adjusted according to the BRR methodology. Any Stata estimation command listed in [\[SVY\] svy estimation](#) may be used with `svy brr`. User-written commands that meet the requirements in [\[P\] program properties](#) may also be used.

## Quick start

Estimate population mean of `v1` using BRR standard-error estimates with sampling weight `wvar1` and replicate weights in variables with prefix `rwvar`

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

BRR estimate of the standard error of the difference between the means of `v2` and `v3`

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

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

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

Same as above

```
brr 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 > Balanced repeated replications estimation

## Syntax

[*svy*] **brr** *exp\_list* [, *svy\_options brr\_options eform\_option*] : *command*

<i>svy_options</i>	Description
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if/in

<b>subpop</b> ([ <i>varname</i> ] [ <i>if</i> ])	identify a subpopulation
--	--------------------------

Reporting

<b>level</b> (#)	set confidence level; default is <code>level(95)</code>
<b>noheader</b>	suppress table header
<b>nolegend</b>	suppress table legend
<b>noadjust</b>	do not adjust model Wald statistic
<b>nocnsreport</b>	do not display constraints
<i>display_options</i>	control columns and column formats, row spacing, line width, display of omitted variables and base and empty cells, and factor-variable labeling
<b>coeflegend</b>	display legend instead of statistics

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

<i>brr_options</i>	Description
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Main

<b>hadamard</b> ( <i>matrix</i> )	Hadamard matrix
<b>fay</b> (#)	Fay's adjustment

Options

<b>saving</b> ( <i>filename</i> [, ...])	save results to <i>filename</i> ; save statistics in double precision; save results to <i>filename</i> every # replications
<b>mse</b>	use MSE formula for variance

Reporting

<b>verbose</b>	display the full table legend
<b>nodots</b>	suppress replication dots
<b>noisily</b>	display any output from <i>command</i>
<b>trace</b>	trace <i>command</i>
<b>title</b> ( <i>text</i> )	use <i>text</i> as title for BRR results

Advanced

<b>nodrop</b>	do not drop observations
<b>reject</b> ( <i>exp</i> )	identify invalid results
<b>dof</b> (#)	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.

*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](#).

### Main

`hadamard(matrix)` specifies the Hadamard matrix to be used to determine which PSUs are chosen for each replicate.

`fay(#)` specifies Fay's adjustment (Judkins 1990), where  $0 \leq \# \leq 2$ , but excluding 1. This option overrides the `fay(#)` option of `svyset`; see [SVY] [svyset](#).

### Options

`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` indicates that *filename* be overwritten if it exists. This option does not appear in the dialog box.

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

## Reporting

**verbose** requests that the full table legend be displayed.

**nodots** suppresses display of the replication dots. By default, one dot character is printed for each successful replication. A red ‘x’ is printed if *command* returns with an error, and ‘e’ is printed if one of the values in *exp\_list* is missing.

**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 BRR results; the default title is “BRR 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,  $df = N_{psu} - N_{strata}$ .

## Remarks and examples

[stata.com](http://stata.com)

BRR was first introduced by [McCarthy \(1966, 1969a, 1969b\)](#) as a method of variance estimation for designs with two PSUs in every stratum. The BRR variance estimator tends to give more reasonable variance estimates for this design than the linearized variance estimator, which can result in large values and undesirably wide confidence intervals.

In BRR, the model is fit multiple times, once for each of a balanced set of combinations where one PSU is dropped from each stratum. The variance is estimated using the resulting replicated point estimates. Although the BRR method has since been generalized to include other designs, Stata’s implementation of BRR requires two PSUs per stratum.

To protect the privacy of survey participants, public survey datasets may contain replicate-weight variables instead of variables that identify the PSUs and strata. These replicate-weight variables are adjusted copies of the sampling weights. For BRR, the sampling weights are adjusted for dropping one PSU from each stratum; see [\[SVY\] variance estimation](#) for more details.

### ► Example 1: BRR replicate-weight variables

The survey design for the NHANES II data ([McDowell et al. 1981](#)) is specifically suited to BRR; there are two PSUs in every stratum.

```

. use http://www.stata-press.com/data/r14/nhanes2
. svydescribe
Survey: Describing stage 1 sampling units
    pweight: finalwgt
        VCE: linearized
Single unit: missing
Strata 1: strata
    SU 1: psu
    FPC 1: <zero>

```

Stratum	#Units	#Obs	#Obs per Unit		
			min	mean	max
1	2	380	165	190.0	215
2	2	185	67	92.5	118
3	2	348	149	174.0	199
4	2	460	229	230.0	231
5	2	252	105	126.0	147
<i>(output omitted)</i>					
29	2	503	215	251.5	288
30	2	365	166	182.5	199
31	2	308	143	154.0	165
32	2	450	211	225.0	239
31	62	10,351	67	167.0	288

Here is a privacy-conscious dataset equivalent to the one above; all the variables and values remain, except `strata` and `psu` are replaced with BRR replicate-weight variables. The BRR replicate-weight variables are already `svyset`, and the default method for variance estimation is `vce(brr)`.

```

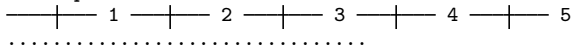
. use http://www.stata-press.com/data/r14/nhanes2brr
. svyset
    pweight: finalwgt
        VCE: brr
        MSE: off
    brrweight: brr_1 brr_2 brr_3 brr_4 brr_5 brr_6 brr_7 brr_8 brr_9 brr_10
              brr_11 brr_12 brr_13 brr_14 brr_15 brr_16 brr_17 brr_18 brr_19
              brr_20 brr_21 brr_22 brr_23 brr_24 brr_25 brr_26 brr_27 brr_28
              brr_29 brr_30 brr_31 brr_32
Single unit: missing
Strata 1: <one>
    SU 1: <observations>
    FPC 1: <zero>

```

Suppose that we were interested in the population ratio of weight to height. Here we use `total` to estimate the population totals of `weight` and `height` and the `svy brr` prefix to estimate their ratio and variance; we use `total` instead of `ratio` (which is otherwise preferable here) to illustrate how to specify an `exp_list`.

```
. svy brr WtoH = (_b[weight]/_b[height]): total weight height
(running total on estimation sample)
```

BRR replications (32)



```
BRR results                                Number of obs    =      10,351
                                           Population size  =  117,157,513
                                           Replications     =       32
                                           Design df       =       31
```

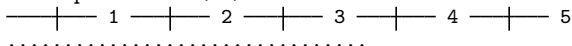
```
command: total weight height
         WtoH:  _b[weight]/_b[height]
```

	BRR		t	P> t	[95% Conf. Interval]	
	Coef.	Std. Err.				
WtoH	.4268116	.0008904	479.36	0.000	.4249957	.4286276

The mse option causes svy brr to use the MSE form of the BRR variance estimator. This variance estimator will tend to be larger than the previous because of the addition of the familiar squared bias term in the MSE; see [SVY] variance estimation for more details. The header for the column of standard errors in the table of results is BRR \* for the BRR variance estimator using the MSE formula.

```
. svy brr WtoH = (_b[weight]/_b[height]), mse: total weight height
(running total on estimation sample)
```

BRR replications (32)



```
BRR results                                Number of obs    =      10,351
                                           Population size  =  117,157,513
                                           Replications     =       32
                                           Design df       =       31
```

```
command: total weight height
         WtoH:  _b[weight]/_b[height]
```

	BRR *		t	P> t	[95% Conf. Interval]	
	Coef.	Std. Err.				
WtoH	.4268116	.0008904	479.36	0.000	.4249957	.4286276

The bias term here is too small to see any difference in the standard errors.



### Example 2: Survey data without replicate-weight variables

For survey data with the PSU and strata variables but no replication weights, svy brr can compute adjusted sampling weights within its replication loop. Here the hadamard() option must be supplied with the name of a Stata matrix that is a Hadamard matrix of appropriate order for the number of strata in your dataset (see the following technical note for a quick introduction to Hadamard matrices).

There are 31 strata in nhanes2.dta, so we need a Hadamard matrix of order 32 (or more) to use svy brr with this dataset. Here we use h32 (from the following technical note) to estimate the population ratio of weight to height by using the BRR variance estimator.

```

. use http://www.stata-press.com/data/r14/nhanes2
. svy brr, hadamard(h32): ratio (WtoH: weight/height)
(running ratio on estimation sample)
BRR replications (32)
-----|----- 1 -----|----- 2 -----|----- 3 -----|----- 4 -----|----- 5
.....
Survey: Ratio estimation
Number of strata =      31      Number of obs   =      10,351
Number of PSUs   =      62      Population size = 117,157,513
                                   Replications   =      32
                                   Design df       =      31

```

WtoH: weight/height

	BRR		
	Ratio	Std. Err.	[95% Conf. Interval]
WtoH	.4268116	.0008904	.4249957 .4286276

◀

## □ Technical note

A Hadamard matrix is a square matrix with  $r$  rows and columns that has the property

$$H_r' H_r = r I_r$$

where  $I_r$  is the identity matrix of order  $r$ . Generating a Hadamard matrix with order  $r = 2^p$  is easily accomplished. Start with a Hadamard matrix of order 2 ( $H_2$ ), and build your  $H_r$  by repeatedly applying Kronecker products with  $H_2$ . Here is the Stata code to generate the Hadamard matrix for the [previous example](#).

```

matrix h2 = (-1, 1 \ 1, 1)
matrix h32 = h2
forvalues i = 1/4 {
    matrix h32 = h2 # h32
}

```

`svy brr` consumes Hadamard matrices from left to right, so it is best to make sure that  $r$  is greater than the number of strata and that the last column is the one consisting of all 1s. This will ensure full orthogonal balance according to [Wolter \(2007\)](#).

□

## Stored results

In addition to the results documented in [SVY] **svy**, **svy brr** stores the following in `e()`:

### Scalars

<code>e(N_reps)</code>	number of replications
<code>e(N_misreps)</code>	number of replications with missing values
<code>e(k_exp)</code>	number of standard expressions
<code>e(k_eeexp)</code>	number of <code>_b/_se</code> expressions
<code>e(k_extra)</code>	number of extra estimates added to <code>_b</code>
<code>e(fay)</code>	Fay's adjustment

### Macros

<code>e(cmdname)</code>	command name from <i>command</i>
<code>e(cmd)</code>	same as <code>e(cmdname)</code> or <code>brr</code>
<code>e(vce)</code>	<code>brr</code>
<code>e(brrweight)</code>	<code>brrweight()</code> variable list

### Matrices

<code>e(b_brr)</code>	BRR means
<code>e(V)</code>	BRR variance estimates

When `exp_list` is `_b`, **svy brr** will also carry forward most of the results already in `e()` from *command*.

## Methods and formulas

See [SVY] **variance estimation** for details regarding BRR variance estimation.

## References

- Judkins, D. R. 1990. Fay's method for variance estimation. *Journal of Official Statistics* 6: 223–239.
- McCarthy, P. J. 1966. Replication: An approach to the analysis of data from complex surveys. In *Vital and Health Statistics*, series 2. Hyattsville, MD: National Center for Health Statistics.
- . 1969a. Pseudoreplication: Further evaluation and application of the balanced half-sample technique. In *Vital and Health Statistics*, series 2. Hyattsville, MD: National Center for Health Statistics.
- . 1969b. Pseudo-replication: Half-samples. *Revue de l'Institut International de Statistique* 37: 239–264.
- McDowell, A., A. Engel, J. T. Massey, and K. Maurer. 1981. Plan and operation of the Second National Health and Nutrition Examination Survey, 1976–1980. *Vital and Health Statistics* 1(15): 1–144.
- Wolter, K. M. 2007. *Introduction to Variance Estimation*. 2nd ed. New York: Springer.

## Also see

- [SVY] **svy postestimation** — Postestimation tools for `svy`
- [SVY] **svy bootstrap** — Bootstrap for survey data
- [SVY] **svy jackknife** — Jackknife estimation for survey data
- [SVY] **svy sdr** — Successive difference replication for survey data
- [U] **20 Estimation and postestimation commands**
- [SVY] **poststratification** — Poststratification for survey data
- [SVY] **subpopulation estimation** — Subpopulation estimation for survey data
- [SVY] **variance estimation** — Variance estimation for survey data