

ratio — Estimate ratios

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Description

`ratio` produces estimates of ratios, along with standard errors.

Quick start

Estimate, standard error, and 95% confidence interval for the ratio of `v1` to `v2`

```
ratio v1/v2
```

With bootstrap standard errors

```
ratio v1/v2, vce(bootstrap)
```

Ratios of `v1` to `v2` and `v3` to `v2`

```
ratio (v1/v2) (v3/v2)
```

Same as above, but name the ratios `ratio1` and `ratio2`

```
ratio (ratio1: v1/v2) (ratio2: v3/v2)
```

Test that `ratio1` is equal to `ratio2`

```
test ratio1 = ratio2
```

Ratio of `v1` to `v2` over strata defined by levels of `svar`

```
ratio v1/v2, over(svar)
```

Direct standardization across categories `cvar`, weighting by standardization weight `wvar`

```
ratio v1/v2, stdize(cvar) stdweight(wvar)
```

Menu

Statistics > Summaries, tables, and tests > Summary and descriptive statistics > Ratios

Syntax

Basic syntax

```
ratio [name:] varname [/] varname
```

Full syntax

```
ratio ([name:] varname [/] varname)
      ([(name:] varname [/] varname) ...] [if] [in] [weight] [, options]
```

options

Description

Model

<code><u>stdize</u>(<i>varname</i>)</code>	variable identifying strata for standardization
<code><u>stdweight</u>(<i>varname</i>)</code>	weight variable for standardization
<code><u>nostdrescale</u></code>	do not rescale the standard weight variable

if/in/over

<code><u>over</u>(<i>varlist</i>)</code>	group over subpopulations defined by <i>varlist</i>
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SE/Cluster

<code><u>vce</u>(<i>vcetype</i>)</code>	<i>vcetype</i> may be <u>linearized</u> , <u>cluster</u> <i>clustvar</i> , <u>bootstrap</u> , or <u>jackknife</u>
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Reporting

<code><u>level</u>(#)</code>	set confidence level; default is <code>level(95)</code>
<code><u>noheader</u></code>	suppress table header
<code><u>nolegend</u></code>	suppress table legend
<code><u>display_options</u></code>	control column formats, line width, display of empty cells, and factor-variable labeling
<code><u>coeflegend</u></code>	display legend instead of statistics

`bootstrap`, `collect`, `jackknife`, `mi estimate`, `rolling`, `statsby`, and `svy` are allowed; see [U] 11.1.10 **Prefix commands**.

`vce(bootstrap)` and `vce(jackknife)` are not allowed with the `mi estimate` prefix; see [MI] **mi estimate**.

Weights are not allowed with the `bootstrap` prefix; see [R] **bootstrap**.

`vce()` and weights are not allowed with the `svy` prefix; see [SVY] **svy**.

`fweights`, `iweights`, and `pweights` are allowed; see [U] 11.1.6 **weight**.

`coeflegend` does not appear in the dialog box.

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

Options

Model

`stdize(varname)` specifies that the point estimates be adjusted by direct standardization across the strata identified by *varname*. This option requires the `stdweight()` option.

`stdweight(varname)` specifies the weight variable associated with the standard strata identified in the `stdize()` option. The standardization weights must be constant within the standard strata.

`nostdrescale` prevents the standardization weights from being rescaled within the `over()` groups. This option requires `stdize()` but is ignored if the `over()` option is not specified.

if/in/over

`over(varlist)` specifies that estimates be computed for multiple subpopulations, which are identified by the different values of the variables in *varlist*. Only numeric, nonnegative, integer-valued variables are allowed in `over(varlist)`.

SE/Cluster

`vce(vcetype)` specifies the type of standard error reported, which includes types that are derived from asymptotic theory (`linearized`), that allow for intragroup correlation (`cluster clustvar`), and that use bootstrap or jackknife methods (`bootstrap`, `jackknife`); see [R] [vce_option](#).

`vce(linearized)`, the default, uses the linearized or sandwich estimator of variance.

Reporting

`level(#)`; see [R] [Estimation options](#).

`noheader` prevents the table header from being displayed. This option implies `nolegend`.

`nolegend` prevents the table legend identifying the ratios from being displayed.

display_options: `vsquish`, `noemptycells`, `nofvlabel`, `fvwrap(#)`, `fvwrapon(style)`, `cformat(%fmt)`, and `no1stretch`; see [R] [Estimation options](#).

The following option is available with `ratio` but is not shown in the dialog box:

`coeflegend`; see [R] [Estimation options](#).

Remarks and examples

▷ Example 1

Using the fuel data from [example 3](#) of [R] `ttest`, we estimate the ratio of mileage for the cars without the fuel treatment (`mpg1`) to those with the fuel treatment (`mpg2`).

```
. use https://www.stata-press.com/data/r18/fuel
. ratio myratio: mpg1/mpg2
Ratio estimation                               Number of obs = 12
      myratio: mpg1/mpg2
```

	Ratio	Linearized std. err.	[95% conf. interval]	
myratio	.9230769	.032493	.8515603	.9945936

Using these results, we can test to see if this ratio is significantly different from one.

```
. test myratio = 1
( 1) myratio = 1
      F( 1, 11) = 5.60
      Prob > F = 0.0373
```

We find that the ratio is different from one at the 5% significance level but not at the 1% significance level.



▷ Example 2

Using state-level census data, we want to test whether the marriage rate is equal to the deathrate.

```
. use https://www.stata-press.com/data/r18/census2
(1980 Census data by state)
. ratio (deathrate: death/pop) (marrate: marriage/pop)
Ratio estimation                               Number of obs = 50
      deathrate: death/pop
      marrate: marriage/pop
```

	Ratio	Linearized std. err.	[95% conf. interval]	
deathrate	.0087368	.0002052	.0083244	.0091492
marrate	.0105577	.0006184	.009315	.0118005

```
. test deathrate = marrate
( 1) deathrate - marrate = 0
      F( 1, 49) = 6.93
      Prob > F = 0.0113
```



Stored results

ratio stores the following in `e()`:

Scalars

<code>e(N)</code>	number of observations
<code>e(N_over)</code>	number of subpopulations
<code>e(N_stdize)</code>	number of standard strata
<code>e(N_clust)</code>	number of clusters
<code>e(k_eq)</code>	number of equations in <code>e(b)</code>
<code>e(df_r)</code>	sample degrees of freedom
<code>e(rank)</code>	rank of <code>e(V)</code>

Macros

<code>e(cmd)</code>	<code>ratio</code>
<code>e(cmdline)</code>	command as typed
<code>e(varlist)</code>	<i>varlist</i>
<code>e(stdize)</code>	<i>varname</i> from <code>stdize()</code>
<code>e(stdweight)</code>	<i>varname</i> from <code>stdweight()</code>
<code>e(wtype)</code>	weight type
<code>e(wexp)</code>	weight expression
<code>e(title)</code>	title in estimation output
<code>e(clustvar)</code>	name of cluster variable
<code>e(over)</code>	<i>varlist</i> from <code>over()</code>
<code>e(namelist)</code>	ratio identifiers
<code>e(vce)</code>	<i>vcetype</i> specified in <code>vce()</code>
<code>e(vcetype)</code>	title used to label Std. err.
<code>e(properties)</code>	<code>b V</code>
<code>e(estat_cmd)</code>	program used to implement <code>estat</code>
<code>e(marginsnotok)</code>	predictions disallowed by <code>margins</code>

Matrices

<code>e(b)</code>	vector of ratio estimates
<code>e(V)</code>	(co)variance estimates
<code>e(_N)</code>	vector of numbers of nonmissing observations
<code>e(_N_stdsum)</code>	number of nonmissing observations within the standard strata
<code>e(_p_stdize)</code>	standardizing proportions
<code>e(error)</code>	error code corresponding to <code>e(b)</code>

Functions

<code>e(sample)</code>	marks estimation sample
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In addition to the above, the following is stored in `r()`:

Matrices

<code>r(table)</code>	matrix containing the coefficients with their standard errors, test statistics, <i>p</i> -values, and confidence intervals
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Note that results stored in `r()` are updated when the command is replayed and will be replaced when any `r`-class command is run after the estimation command.

Methods and formulas

Methods and formulas are presented under the following headings:

The ratio estimator

Survey data

The survey ratio estimator

The standardized ratio estimator

The poststratified ratio estimator

The standardized poststratified ratio estimator

Subpopulation estimation

The ratio estimator

Let $R = Y/X$ be the ratio to be estimated, where Y and X are totals; see [R] total. The estimate for R is $\hat{R} = \hat{Y}/\hat{X}$ (the ratio of the sample totals). From the delta method (that is, a first-order Taylor expansion), the approximate variance of the sampling distribution of the linearized \hat{R} is

$$V(\hat{R}) \approx \frac{1}{\hat{X}^2} \left\{ V(\hat{Y}) - 2RCov(\hat{Y}, \hat{X}) + R^2V(\hat{X}) \right\}$$

Direct substitution of \hat{X} , \hat{R} , and the estimated variances and covariance of \hat{X} and \hat{Y} leads to the following variance estimator:

$$\hat{V}(\hat{R}) = \frac{1}{\hat{X}^2} \left\{ \hat{V}(\hat{Y}) - 2\hat{R}\widehat{Cov}(\hat{Y}, \hat{X}) + \hat{R}^2\hat{V}(\hat{X}) \right\} \quad (1)$$

Survey data

See [SVY] Variance estimation, [SVY] Direct standardization, and [SVY] Poststratification for discussions that provide background information for the following formulas.

The survey ratio estimator

Let Y_j and X_j be survey items for the j th individual in the population, where $j = 1, \dots, M$ and M is the size of the population. The associated population ratio for the items of interest is $R = Y/X$ where

$$Y = \sum_{j=1}^M Y_j \quad \text{and} \quad X = \sum_{j=1}^M X_j$$

Let y_j and x_j be the corresponding survey items for the j th sampled individual from the population, where $j = 1, \dots, m$ and m is the number of observations in the sample.

The estimator \hat{R} for the population ratio R is $\hat{R} = \hat{Y}/\hat{X}$, where

$$\hat{Y} = \sum_{j=1}^m w_j y_j \quad \text{and} \quad \hat{X} = \sum_{j=1}^m w_j x_j$$

and w_j is a sampling weight. The score variable for the ratio estimator is

$$z_j(\hat{R}) = \frac{y_j - \hat{R}x_j}{\hat{X}} = \frac{\hat{X}y_j - \hat{Y}x_j}{\hat{X}^2}$$

The standardized ratio estimator

Let D_g denote the set of sampled observations that belong to the g th standard stratum and define $I_{D_g}(j)$ to indicate if the j th observation is a member of the g th standard stratum; where $g = 1, \dots, L_D$ and L_D is the number of standard strata. Also, let π_g denote the fraction of the population that belongs to the g th standard stratum, thus $\pi_1 + \dots + \pi_{L_D} = 1$. Note that π_g is derived from the `stdweight()` option.

The estimator for the standardized ratio is

$$\widehat{R}^D = \sum_{g=1}^{L_D} \pi_g \frac{\widehat{Y}_g}{\widehat{X}_g}$$

where

$$\widehat{Y}_g = \sum_{j=1}^m I_{D_g}(j) w_j y_j$$

and \widehat{X}_g is similarly defined. The score variable for the standardized ratio is

$$z_j(\widehat{R}^D) = \sum_{g=1}^{L_D} \pi_g I_{D_g}(j) \frac{\widehat{X}_g y_j - \widehat{Y}_g x_j}{\widehat{X}_g^2}$$

The poststratified ratio estimator

Let P_k denote the set of sampled observations that belong to poststratum k , and define $I_{P_k}(j)$ to indicate if the j th observation is a member of poststratum k , where $k = 1, \dots, L_P$ and L_P is the number of poststrata. Also, let M_k denote the population size for poststratum k . P_k and M_k are identified by specifying the `poststrata()` and `postweight()` options on `svyset`; see [SVY] `svyset`.

The estimator for the poststratified ratio is

$$\widehat{R}^P = \frac{\widehat{Y}^P}{\widehat{X}^P}$$

where

$$\widehat{Y}^P = \sum_{k=1}^{L_P} \frac{M_k}{\widehat{M}_k} \widehat{Y}_k = \sum_{k=1}^{L_P} \frac{M_k}{\widehat{M}_k} \sum_{j=1}^m I_{P_k}(j) w_j y_j$$

and \widehat{X}^P is similarly defined. The score variable for the poststratified ratio is

$$z_j(\widehat{R}^P) = \frac{z_j(\widehat{Y}^P) - \widehat{R}^P z_j(\widehat{X}^P)}{\widehat{X}^P} = \frac{\widehat{X}^P z_j(\widehat{Y}^P) - \widehat{Y}^P z_j(\widehat{X}^P)}{(\widehat{X}^P)^2}$$

where

$$z_j(\widehat{Y}^P) = \sum_{k=1}^{L_P} I_{P_k}(j) \frac{M_k}{\widehat{M}_k} \left(y_j - \frac{\widehat{Y}_k}{\widehat{M}_k} \right)$$

and $z_j(\widehat{X}^P)$ is similarly defined.

The standardized poststratified ratio estimator

The estimator for the standardized poststratified ratio is

$$\widehat{R}^{DP} = \sum_{g=1}^{L_D} \pi_g \frac{\widehat{Y}_g^P}{\widehat{X}_g^P}$$

where

$$\widehat{Y}_g^P = \sum_{k=1}^{L_p} \frac{M_k}{\widehat{M}_k} \widehat{Y}_{g,k} = \sum_{k=1}^{L_p} \frac{M_k}{\widehat{M}_k} \sum_{j=1}^m I_{D_g}(j) I_{P_k}(j) w_j y_j$$

and \widehat{X}_g^P is similarly defined. The score variable for the standardized poststratified ratio is

$$z_j(\widehat{R}^{DP}) = \sum_{g=1}^{L_D} \pi_g \frac{\widehat{X}_g^P z_j(\widehat{Y}_g^P) - \widehat{Y}_g^P z_j(\widehat{X}_g^P)}{(\widehat{X}_g^P)^2}$$

where

$$z_j(\widehat{Y}_g^P) = \sum_{k=1}^{L_p} I_{P_k}(j) \frac{M_k}{\widehat{M}_k} \left\{ I_{D_g}(j) y_j - \frac{\widehat{Y}_{g,k}}{\widehat{M}_k} \right\}$$

and $z_j(\widehat{X}_g^P)$ is similarly defined.

Subpopulation estimation

Let S denote the set of sampled observations that belong to the subpopulation of interest, and define $I_S(j)$ to indicate if the j th observation falls within the subpopulation.

The estimator for the subpopulation ratio is $\widehat{R}^S = \widehat{Y}^S / \widehat{X}^S$, where

$$\widehat{Y}^S = \sum_{j=1}^m I_S(j) w_j y_j \quad \text{and} \quad \widehat{X}^S = \sum_{j=1}^m I_S(j) w_j x_j$$

Its score variable is

$$z_j(\widehat{R}^S) = I_S(j) \frac{y_j - \widehat{R}^S x_j}{\widehat{X}^S} = I_S(j) \frac{\widehat{X}^S y_j - \widehat{Y}^S x_j}{(\widehat{X}^S)^2}$$

The estimator for the standardized subpopulation ratio is

$$\widehat{R}^{DS} = \sum_{g=1}^{L_D} \pi_g \frac{\widehat{Y}_g^S}{\widehat{X}_g^S}$$

where

$$\widehat{Y}_g^S = \sum_{j=1}^m I_{D_g}(j) I_S(j) w_j y_j$$

and \widehat{X}_g^S is similarly defined. Its score variable is

$$z_j(\widehat{R}^{DS}) = \sum_{g=1}^{L_D} \pi_g I_{D_g}(j) I_S(j) \frac{\widehat{X}_g^S y_j - \widehat{Y}_g^S x_j}{(\widehat{X}_g^S)^2}$$

The estimator for the poststratified subpopulation ratio is

$$\widehat{R}^{PS} = \frac{\widehat{Y}^{PS}}{\widehat{X}^{PS}}$$

where

$$\widehat{Y}^{PS} = \sum_{k=1}^{L_P} \frac{M_k}{\widehat{M}_k} \widehat{Y}_k^S = \sum_{k=1}^{L_P} \frac{M_k}{\widehat{M}_k} \sum_{j=1}^m I_{P_k}(j) I_S(j) w_j y_j$$

and \widehat{X}^{PS} is similarly defined. Its score variable is

$$z_j(\widehat{R}^{PS}) = \frac{\widehat{X}^{PS} z_j(\widehat{Y}^{PS}) - \widehat{Y}^{PS} z_j(\widehat{X}^{PS})}{(\widehat{X}^{PS})^2}$$

where

$$z_j(\widehat{Y}^{PS}) = \sum_{k=1}^{L_P} I_{P_k}(j) \frac{M_k}{\widehat{M}_k} \left\{ I_S(j) y_j - \frac{\widehat{Y}_k^S}{\widehat{M}_k} \right\}$$

and $z_j(\widehat{X}^{PS})$ is similarly defined.

The estimator for the standardized poststratified subpopulation ratio is

$$\widehat{R}^{DPS} = \sum_{g=1}^{L_D} \pi_g \frac{\widehat{Y}_g^{PS}}{\widehat{X}_g^{PS}}$$

where

$$\widehat{Y}_g^{PS} = \sum_{k=1}^{L_p} \frac{M_k}{\widehat{M}_k} \widehat{Y}_{g,k}^S = \sum_{k=1}^{L_p} \frac{M_k}{\widehat{M}_k} \sum_{j=1}^m I_{D_g}(j) I_{P_k}(j) I_S(j) w_j y_j$$

and \widehat{X}_g^{PS} is similarly defined. Its score variable is

$$z_j(\widehat{R}^{DPS}) = \sum_{g=1}^{L_D} \pi_g \frac{\widehat{X}_g^{PS} z_j(\widehat{Y}_g^{PS}) - \widehat{Y}_g^{PS} z_j(\widehat{X}_g^{PS})}{(\widehat{X}_g^{PS})^2}$$

where

$$z_j(\widehat{Y}_g^{PS}) = \sum_{k=1}^{L_P} I_{P_k}(j) \frac{M_k}{\widehat{M}_k} \left\{ I_{D_g}(j) I_S(j) y_j - \frac{\widehat{Y}_{g,k}^S}{\widehat{M}_k} \right\}$$

and $z_j(\widehat{X}_g^{PS})$ is similarly defined.

References

- Cochran, W. G. 1977. *Sampling Techniques*. 3rd ed. New York: Wiley.
- Stuart, A., and J. K. Ord. 1994. *Kendall's Advanced Theory of Statistics: Distribution Theory, Vol. 1*. 6th ed. London: Arnold.

Also see

[R] **ratio postestimation** — Postestimation tools for ratio

[R] **mean** — Estimate means

[R] **proportion** — Estimate proportions

[R] **total** — Estimate totals

[MI] **Estimation** — Estimation commands for use with mi estimate

[SVY] **Direct standardization** — Direct standardization of means, proportions, and ratios

[SVY] **Poststratification** — Poststratification for survey data

[SVY] **Subpopulation estimation** — Subpopulation estimation for survey data

[SVY] **svy estimation** — Estimation commands for survey data

[SVY] **Variance estimation** — Variance estimation for survey data

[U] **20 Estimation and postestimation commands**

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