Title

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	
stdize(*varname*)	variable identifying strata for standardization
stdweight(*varname*)	weight variable for standardization
nostdrescale	do not rescale the standard weight variable
if/in/over	
over(*varlist*)	group over subpopulations defined by *varlist*
SE/Cluster	
vce(*vcetype*)	*vcetype* may be linearized, cluster *clustvar*, bootstrap, or jackknife
Reporting	
level(*#*)	set confidence level; default is level(95)
noheader	suppress table header
nolegend	suppress table legend
display_options	control column formats, line width, display of empty cells, and factor-variable labeling
coeflegend	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 nolstretch; 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

stata.com

▷ 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

--------------------------------------------------------------
             |             Linearized
             |      Ratio   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.

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▷ 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

--------------------------------------------------------------
             |             Linearized
             |      Ratio   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

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

Macros

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

Matrices

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

Functions

e(sample)	marks estimation sample

In addition to the above, the following is stored in r():

Matrices

r(table)	matrix containing the coefficients with their standard errors, test statistics, p-values, and confidence intervals

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 $\widehat{R} = \widehat{Y}/\widehat{X}$ (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 $\widehat{R}$ is

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

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

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

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 jth 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

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

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

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

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

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

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

The standardized ratio estimator

Let D_g denote the set of sampled observations that belong to the gth standard stratum and define $I_{D_g}(j)$ to indicate if the jth observation is a member of the gth 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 gth standard stratum, thus $\pi_1 + \cdots + \pi_{L_D} = 1$. 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 jth 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 jth observation falls within the subpopulation.

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

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

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

For suggested citations, see the FAQ on citing Stata documentation.