Title

sdtest — Variance-comparison tests

Syntax

One-sample variance-comparison test

> sdtest *varname* == # $\big[$ *if* $\big]$ $\big[$ *in* $\big]$ $\big[$, <u>l</u>evel(#) $\big]$

Two-sample variance-comparison test using groups

> sdtest *varname* $\big[$ *if* $\big]$ $\big[$ *in* $\big]$, by(*groupvar*) $\big[$ <u>l</u>evel(#) $\big]$

Two-sample variance-comparison test using variables

> sdtest *varname*$_1$ == *varname*$_2$ $\big[$ *if* $\big]$ $\big[$ *in* $\big]$ $\big[$, <u>l</u>evel(#) $\big]$

Immediate form of one-sample variance-comparison test

> sdtesti $\#_{obs}$ $\big\{$ $\#_{mean}$ | . $\big\}$ $\#_{sd}$ $\#_{val}$ $\big[$, <u>l</u>evel(#) $\big]$

Immediate form of two-sample variance-comparison test

> sdtesti $\#_{obs,1}$ $\big\{$ $\#_{mean,1}$ | . $\big\}$ $\#_{sd,1}$ $\#_{obs,2}$ $\big\{$ $\#_{mean,2}$ | . $\big\}$ $\#_{sd,2}$ $\big[$, <u>l</u>evel(#) $\big]$

Robust tests for equality of variances

> robvar *varname* $\big[$ *if* $\big]$ $\big[$ *in* $\big]$, by(*groupvar*)

> by is allowed with sdtest and robvar; see [D] **by**.

Menu

sdtest

Statistics > Summaries, tables, and tests > Classical tests of hypotheses > Variance-comparison test

sdtesti

Statistics > Summaries, tables, and tests > Classical tests of hypotheses > Variance-comparison test calculator

robvar

Statistics > Summaries, tables, and tests > Classical tests of hypotheses > Robust equal-variance test

Description

sdtest performs tests on the equality of standard deviations (variances). In the first form, sdtest tests that the standard deviation of *varname* is #. In the second form, sdtest performs the same test, using the standard deviations of the two groups defined by *groupvar*. In the third form, sdtest tests that $varname_1$ and $varname_2$ have the same standard deviation.

sdtesti is the immediate form of sdtest; see [U] **19 Immediate commands**.

Both the traditional F test for the homogeneity of variances and Bartlett's generalization of this test to K samples are sensitive to the assumption that the data are drawn from an underlying Gaussian distribution. See, for example, the cautionary results discussed by Markowski and Markowski (1990). Levene (1960) proposed a test statistic for equality of variance that was found to be robust under nonnormality. Then Brown and Forsythe (1974) proposed alternative formulations of Levene's test statistic that use more robust estimators of central tendency in place of the mean. These reformulations were demonstrated to be more robust than Levene's test when dealing with skewed populations.

robvar reports Levene's robust test statistic (W_0) for the equality of variances between the groups defined by *groupvar* and the two statistics proposed by Brown and Forsythe that replace the mean in Levene's formula with alternative location estimators. The first alternative (W_{50}) replaces the mean with the median. The second alternative replaces the mean with the 10% trimmed mean (W_{10}).

Options

level(#) specifies the confidence level, as a percentage, for confidence intervals of the means. The default is level(95) or as set by set level; see [U] **20.7 Specifying the width of confidence intervals**.

by(*groupvar*) specifies the *groupvar* that defines the groups to be compared. For sdtest, there should be two groups, but for robvar there may be more than two groups. Do not confuse the by() option with the by prefix; both may be specified.

Remarks and examples

[stata.com]

Remarks are presented under the following headings:

     Basic form
     Immediate form
     Robust test

Basic form

sdtest performs two different statistical tests: one testing equality of variances and the other testing that the standard deviation is equal to a known constant. Which test it performs is determined by whether you type a variable name or a number to the right of the equal sign.

▷ Example 1: One-sample test of variance

We have a sample of 74 automobiles. For each automobile, we know the mileage rating. We wish to test whether the overall standard deviation is 5 mpg:

```
. use http://www.stata-press.com/data/r13/auto
(1978 Automobile Data)
. sdtest mpg == 5
One-sample test of variance
```

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
mpg	74	21.2973	.6725511	5.785503	19.9569	22.63769

```
    sd = sd(mpg)                                        c = chi2 =  97.7384
Ho: sd = 5                                     degrees of freedom =       73

    Ha: sd < 5                    Ha: sd != 5                    Ha: sd > 5
  Pr(C < c) = 0.9717      2*Pr(C > c) = 0.0565         Pr(C > c) = 0.0283
```

◁

▷ Example 2: Variance ratio test

We are testing the effectiveness of a new fuel additive. We run an experiment on 12 cars, running each without and with the additive. The data can be found in [R] **ttest**. The results for each car are stored in the variables mpg1 and mpg2:

```
. use http://www.stata-press.com/data/r13/fuel
. sdtest mpg1==mpg2
Variance ratio test
```

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
mpg1	12	21	.7881701	2.730301	19.26525	22.73475
mpg2	12	22.75	.9384465	3.250874	20.68449	24.81551
combined	24	21.875	.6264476	3.068954	20.57909	23.17091

```
    ratio = sd(mpg1) / sd(mpg2)                                 f =    0.7054
Ho: ratio = 1                                  degrees of freedom =   11, 11

    Ha: ratio < 1                 Ha: ratio != 1                 Ha: ratio > 1
  Pr(F < f) = 0.2862      2*Pr(F < f) = 0.5725         Pr(F > f) = 0.7138
```

We cannot reject the hypothesis that the standard deviations are the same.

In [R] **ttest**, we draw an important distinction between paired and unpaired data, which, in this example, means whether there are 12 cars in a before-and-after experiment or 24 different cars. For sdtest, on the other hand, there is no distinction. If the data had been unpaired and stored as described in [R] **ttest**, we could have typed sdtest mpg, by(treated), and the results would have been the same.

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Immediate form

▷ Example 3: sdtesti

Immediate commands are used not with data, but with reported summary statistics. For instance, to test whether a variable on which we have 75 observations and a reported standard deviation of 6.5 comes from a population with underlying standard deviation 6, we would type

```
. sdtesti 75 . 6.5 6
```

One-sample test of variance

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
x	75	.	.7505553	6.5	.	.

```
    sd = sd(x)                                          c = chi2 =   86.8472
Ho: sd = 6                                       degrees of freedom =       74

    Ha: sd < 6                    Ha: sd != 6                   Ha: sd > 6
  Pr(C < c) = 0.8542         2*Pr(C > c) = 0.2916         Pr(C > c) = 0.1458
```

The mean plays no role in the calculation, so it may be omitted.

To test whether the variable comes from a population with the same standard deviation as another for which we have a calculated standard deviation of 7.5 over 65 observations, we would type

```
. sdtesti 75 . 6.5 65 . 7.5
```

Variance ratio test

	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
x	75	.	.7505553	6.5	.	.
y	65	.	.9302605	7.5	.	.
combined	140	.	.	.	.	.

```
  ratio = sd(x) / sd(y)                                      f =    0.7511
Ho: ratio = 1                                    degrees of freedom =   74, 64

  Ha: ratio < 1                 Ha: ratio != 1                Ha: ratio > 1
 Pr(F < f) = 0.1172         2*Pr(F < f) = 0.2344         Pr(F > f) = 0.8828
```

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Robust test

▷ Example 4: robvar

We wish to test whether the standard deviation of the length of stay for patients hospitalized for a given medical procedure differs by gender. Our data consist of observations on the length of hospital stay for 1778 patients: 884 males and 894 females. Length of stay, lengthstay, is highly skewed (skewness coefficient $= 4.912591$) and thus violates Bartlett's normality assumption. Therefore, we use robvar to compare the variances.

```
. use http://www.stata-press.com/data/r13/stay
```
```
. robvar lengthstay, by(sex)
```

	Summary of Length of stay in days		
sex	Mean	Std. Dev.	Freq.
male	9.0874434	9.7884747	884
female	8.800671	9.1081478	894
Total	8.9432508	9.4509466	1778

```
W0  =  0.55505315   df(1, 1776)     Pr > F = 0.45635888
W50 =  0.42714734   df(1, 1776)     Pr > F = 0.51347664
W10 =  0.44577674   df(1, 1776)     Pr > F = 0.50443411
```

For these data, we cannot reject the null hypothesis that the variances are equal. However, Bartlett's test yields a significance probability of 0.0319 because of the pronounced skewness of the data.

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❑ Technical note

robvar implements both the conventional Levene's test centered at the mean and a median-centered test. In a simulation study, Conover, Johnson, and Johnson (1981) compare the properties of the two tests and recommend using the median test for asymmetric data, although for small sample sizes the test is somewhat conservative. See Carroll and Schneider (1985) for an explanation of why both mean- and median-centered tests have approximately the same level for symmetric distributions, but for asymmetric distributions the median test is closer to the correct level.

❑

Stored results

sdtest and sdtesti store the following in r():

Scalars
r(N)	number of observations
r(p_l)	lower one-sided p-value
r(p_u)	upper one-sided p-value
r(p)	two-sided p-value
r(F)	F statistic
r(sd)	standard deviation
r(sd_1)	standard deviation for first variable
r(sd_2)	standard deviation for second variable
r(df)	degrees of freedom
r(df_1)	numerator degrees of freedom
r(df_2)	denominator degrees of freedom
r(chi2)	χ^2

robvar stores the following in r():

Scalars
r(N)	number of observations
r(w50)	Brown and Forsythe's F statistic (median)
r(p_w50)	Brown and Forsythe's p-value
r(w0)	Levene's F statistic
r(p_w0)	Levene's p-value
r(w10)	Brown and Forsythe's F statistic (trimmed mean)
r(p_w10)	Brown and Forsythe's p-value (trimmed mean)
r(df_1)	numerator degrees of freedom
r(df_2)	denominator degrees of freedom

Methods and formulas

See Armitage et al. (2002, 149–153) or Bland (2000, 171–172) for an introduction and explanation of the calculation of these tests.

The test for $\sigma = \sigma_0$ is given by

$$\chi^2 = \frac{(n-1)s^2}{\sigma_0^2}$$

which is distributed as χ^2 with $n - 1$ degrees of freedom.

The test for $\sigma_x^2 = \sigma_y^2$ is given by

$$F = \frac{s_x^2}{s_y^2}$$

which is distributed as F with $n_x - 1$ and $n_y - 1$ degrees of freedom.

Let X_{ij} be the jth observation of X for the ith group. Let $Z_{ij} = |X_{ij} - \overline{X}_i|$, where $\overline{X}_i$ is the mean of X in the ith group. Levene's test statistic is

$$W_0 = \frac{\sum_i n_i (\overline{Z}_i - \overline{Z})^2 / (g - 1)}{\sum_i \sum_j (Z_{ij} - \overline{Z}_i)^2 / \sum_i (n_i - 1)}$$

where n_i is the number of observations in group i and g is the number of groups. W_{50} is obtained by replacing $\overline{X}_i$ with the ith group median of X_{ij}, whereas W_{10} is obtained by replacing $\overline{X}_i$ with the 10% trimmed mean for group i.

References

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Also see

[R] **ttest** — t tests (mean-comparison tests)