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Description

`prtest` performs tests on the equality of proportions using large-sample statistics. The test can be performed for one sample against a hypothesized population value or for no difference in population proportions estimated from two samples. Clustered data are supported.

`prtesti` is the immediate form of `prtest`; see [\[U\] 19 Immediate commands](#).

Quick start

One-sample test that the proportion of 1s in `v` is equal to 0.1

```
prtest v == 0.1
```

Same as above, but using the 90% confidence level and adjusting for clustering with clusters defined by `cvar` and an intraclass correlation of 0.5

```
prtest v == 0.1, level(90) cluster(cvar) rho(0.5)
```

Test that the proportion of 1s in `v` is equal between two groups defined by `catvar`

```
prtest v, by(catvar)
```

Same as above, and adjust for clustering with clusters defined by `cvar` and an intraclass correlation of 0.5 in the two groups

```
prtest v, by(catvar) cluster(cvar) rho(0.5)
```

Test equality of proportions between `v1` and `v2`

```
prtest v1 == v2
```

Test $p_1 = p_2$ if $\hat{p}_1 = 0.10$, $\hat{p}_2 = 0.17$, $n_1 = 29$, and $n_2 = 36$

```
prtesti 29 0.10 36 0.17
```

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Syntax

One-sample test of proportion

```
prtest varname == #p [if] [in] [, onesampleopts]
```

Two-sample test of proportions using groups

```
prtest varname [if] [in], by(groupvar) [twosamplegropts]
```

Two-sample test of proportions using variables

```
prtest varname1 == varname2 [if] [in] [, level(#)]
```

Immediate form of one-sample test of proportion

```
prtesti #obs1 #p1 #p2 [, level(#) count]
```

Immediate form of two-sample test of proportions

```
prtesti #obs1 #p1 #obs2 #p2 [, level(#) count]
```

onesampleopts

Description

Main

<u>level</u> (#)	confidence level; default is <code>level(95)</code>
<code>cluster</code> (<i>varname</i>)	variable defining the clusters
<u>rho</u> (#)	intraclass correlation

twosamplegropts

Description

Main

* <code>by</code> (<i>groupvar</i>)	variable defining the groups
<u>level</u> (#)	confidence level; default is <code>level(95)</code>
<code>cluster</code> (<i>varname</i>)	variable defining the clusters
<u>rho</u> (#)	common intraclass correlation
<u>rho1</u> (#)	intraclass correlation for group 1
<u>rho2</u> (#)	intraclass correlation for group 2

*`by`(*groupvar*) is required.

`by` is allowed with `prtest`, and `collect` is allowed with `prtest` and `prtesti`; see [U] [11.1.10 Prefix commands](#).

Options for prtest

Main

`by`(*groupvar*) specifies a numeric variable that contains the group information for a given observation. This variable must have only two values. Do not confuse the `by()` option with the `by` prefix; both may be specified.

`level(#)` specifies the confidence level, as a percentage, for confidence intervals. The default is `level(95)` or as set by `set level`; see [U] 20.8 Specifying the width of confidence intervals.

`cluster(varname)` specifies the variable that identifies clusters. The `cluster()` option is required to adjust the computation for clustering.

`rho(#)` specifies the intraclass correlation for a one-sample test or the common intraclass correlation for a two-sample test. The `rho()` option is required to adjust the computation for clustering for a one-sample test.

`rho1(#)` specifies the intraclass correlation of the first group for a two-sample test using groups. The `rho()` option or both `rho1()` and `rho2()` options are required to adjust the computation for clustering.

`rho2(#)` specifies the intraclass correlation of the second group for a two-sample test using groups. The `rho()` option or both `rho1()` and `rho2()` options are required to adjust the computation for clustering.

Options for prtesti

`level(#)` specifies the confidence level, as a percentage, for confidence intervals. The default is `level(95)` or as set by `set level`; see [U] 20.8 Specifying the width of confidence intervals.

`count` specifies that integer counts instead of proportions be used in the immediate forms of `prtest`. In the first syntax, `prtesti` expects that $\#_{\text{obs1}}$ and $\#_{p1}$ are counts— $\#_{p1} \leq \#_{\text{obs1}}$ —and $\#_{p2}$ is a proportion. In the second syntax, `prtesti` expects that all four numbers are integer counts, that $\#_{\text{obs1}} \geq \#_{p1}$, and that $\#_{\text{obs2}} \geq \#_{p2}$.

Remarks and examples

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

Remarks are presented under the following headings:

Tests of proportions
Adjust for clustering
Immediate form

Tests of proportions

The `prtest` output follows the output of `ttest` in providing a lot of information. Each proportion is presented along with a confidence interval. The appropriate one- or two-sample test is performed, and the two-sided and both one-sided results are included at the bottom of the output. For a two-sample test, the calculated difference is also presented with its confidence interval. This command may be used for both large-sample testing and large-sample interval estimation. For one-sample tests of proportions with small-sample sizes and to obtain exact p -values, researchers should use `bitest`; see [R] [bitest](#).

► Example 1: One-sample test of proportion

In the first form, `prtest` tests whether the mean of the sample is equal to a known constant. Assume that we have a sample of 74 automobiles. We wish to test whether the proportion of automobiles that are foreign is different from 40%.

```
. use https://www.stata-press.com/data/r18/auto
(1978 automobile data)
```

```
. prtest foreign == 0.4
One-sample test of proportion                Number of obs   =       74

Variable |          Mean   Std. err.          [95% conf. interval]
-----+-----
foreign |   .2972973   .0531331   .1931583   .4014363

p = proportion(foreign)                    z = -1.8034
H0: p = 0.4
Ha: p < 0.4                Ha: p != 0.4                Ha: p > 0.4
Pr(Z < z) = 0.0357        Pr(|Z| > |z|) = 0.0713        Pr(Z > z) = 0.9643
```

The test indicates that we cannot reject the hypothesis that the proportion of foreign automobiles is 0.40 at the 5% significance level.



► **Example 2: Two-sample test of proportions**

We have two headache remedies that we give to patients. Each remedy’s effect is recorded as 0 for failing to relieve the headache and 1 for relieving the headache. We wish to test the equality of the proportion of people relieved by the two treatments.

```
. use https://www.stata-press.com/data/r18/cure
. prtest cure1 == cure2
Two-sample test of proportions                cure1: Number of obs =    50
                                           cure2: Number of obs =    59

Variable |          Mean   Std. err.      z   P>|z|   [95% conf. interval]
-----+-----
cure1    |   .52          .0706541   .3815205   .6584795
cure2    |   .7118644    .0589618   .5963013   .8274275

diff     |  -.1918644    .0920245   -2.06   0.039   -.372229   -.0114998
under H0: |             .0931155                0.039

diff = prop(cure1) - prop(cure2)                    z = -2.0605
H0: diff = 0
Ha: diff < 0                Ha: diff != 0                Ha: diff > 0
Pr(Z < z) = 0.0197        Pr(|Z| > |z|) = 0.0394        Pr(Z > z) = 0.9803
```

We find that the proportions are statistically different from each other at any level greater than 3.9%.



Adjust for clustering

When observations are not independent and can be grouped into clusters, we need to adjust for clustering in a proportion test. For example, in a cluster randomized design, groups of individuals are randomized instead of individuals. To adjust for clustering, we need to specify the cluster identifier variable in the `cluster()` option. In the case of a one-sample proportion test, we need to also specify the intraclass correlation in the `rho()` option. In the case of a two sample proportions test, we need to also specify the common population intraclass correlation in the `rho()` option or group-specific population intraclass correlations in the `rho1()` and `rho2()` options.

▷ Example 3: One-sample test of proportion, adjusting for clusters

Consider data from [Hujoel, Moulton, and Loesche \(1990\)](#) on the accuracy of an enzymatic diagnostic test (EDT) of bacterial infections for 29 patients with multiple sites. The EDT was conducted on each site, a specific area in a patient's mouth, to determine infection by two strings of bacteria. A separate reference test was also conducted on each site with an antibody assay against the two strings of bacteria. The data record whether there was a positive EDT result at each infected site, a true positive result.

We want to test whether the proportion of infected sites that were correctly diagnosed by the EDT is different from 0.6. Because we have multiple infections per patient, we cluster by the patient-identifier `subject` and use a value of 0.2 from [Ahn, Heo, and Zhang \(2015, 33\)](#) for the intrapatient correlation.

To perform the test, we specify the `cluster(subject)` and `rho(0.2)` options:

```
. use https://www.stata-press.com/data/r18/infection
(Target infections detected by EDT (Hujoel, Moulton, and Loesche 1990))
. prtest infect == 0.6, cluster(subject) rho(0.2)

One-sample test of proportion                Number of obs      =       142
Cluster variable: subject                    Number of clusters =        29
                                             Avg. cluster size  =        4.90
                                             CV cluster size   =       0.2419
                                             Intraclass corr.  =       0.2000
```

Variable	Mean	Std. err.	[95% conf. interval]	
<code>infection</code>	.6619718	.0537974	.5565308	.7674129

```
p = proportion(infection)                z = 1.1123
H0: p = 0.6
Ha: p < 0.6                               Ha: p != 0.6                               Ha: p > 0.6
Pr(Z < z) = 0.8670                        Pr(|Z| > |z|) = 0.2660                       Pr(Z > z) = 0.1330
```

We do not find statistical evidence to reject the null hypothesis of $H_0: P_{\text{infection}} = 0.6$ versus the two-sided alternative $H_a: P_{\text{infection}} \neq 0.6$ at the 5% significance level; the p -value = 0.2660 > 0.05. ◀

▷ Example 4: Two-sample test of proportions using groups, adjusting for clusters

Consider a dataset provided by [Hayes and Moulton \(2009\)](#), which contains a random subsample of the original participants in a cluster randomized trial of a pneumococcal conjugate vaccine in American Indian populations in the southwestern United States. There are two groups of infants with 18 clusters in each group. The control group received a meningococcal C conjugate vaccine (MnCC), and the experimental group received the seven-valent pneumococcal conjugate vaccine (PnCRM7). The two groups are identified by the `vaccine` variable, and the `pneumonia` variable records 1 if an infant had at least one bacterial pneumonia episode and 0 otherwise. These data are originally from [O'Brien et al. \(2003\)](#).

We want to test the equality of the proportion of cases of pneumonia in the two vaccine groups. We assume a common known intraclass correlation of 0.02. To perform the test, we type

```
. use https://www.stata-press.com/data/r18/pneumoniact
(Bacterial pneumonia episodes data from CRT (Hayes and Moulton 2009))
. prtest pneumonia, by(vaccine) cluster(cluster) rho(0.02)
```

Two-sample test of proportions

Cluster variable: cluster

Group: MnCC

```
Number of obs      =      238
Number of clusters =       18
Avg. cluster size  =    13.22
CV cluster size    =    0.9605
Intraclass corr.   =    0.0200
```

Group: PnCRM7

```
Number of obs      =      211
Number of clusters =       18
Avg. cluster size  =    11.72
CV cluster size    =    0.7976
Intraclass corr.   =    0.0200
```

Group	Mean	Std. err.	z	P> z	[95% conf. interval]
MnCC	.2226891	.0329017			.1582029 .2871753
PnCRM7	.1658768	.0299027			.1072686 .224485
diff	.0568123	.04446			-.0303278 .1439524
	under H0:	.0447641	1.27	0.204	

```
diff = prop(MnCC) - prop(PnCRM7)          z = 1.2691
H0: diff = 0
```

```
Ha: diff < 0          Ha: diff != 0          Ha: diff > 0
Pr(Z < z) = 0.8978    Pr(|Z| > |z|) = 0.2044    Pr(Z > z) = 0.1022
```

We do not find statistical evidence to reject the null hypothesis of $H_0: P_{\text{diff}} = 0$ versus the two-sided alternative $H_a: P_{\text{diff}} \neq 0$ at the 5% significance level; the p -value = 0.2044 > 0.05.

◀

Immediate form

► Example 5: Immediate form of one-sample test of proportion

`prtesti` is like `prtest`, except that you specify summary statistics rather than variables as arguments. For instance, we are reading an article that reports the proportion of registered voters among 50 randomly selected eligible voters as 0.52. We wish to test whether the proportion is 0.7:

```
. prtesti 50 0.52 0.70
```

One-sample test of proportion

x: Number of obs = 50

	Mean	Std. err.	[95% conf. interval]
x	.52	.0706541	.3815205 .6584795

```
p = proportion(x)          z = -2.7775
H0: p = 0.7
```

```
Ha: p < 0.7          Ha: p != 0.7          Ha: p > 0.7
Pr(Z < z) = 0.0027    Pr(|Z| > |z|) = 0.0055    Pr(Z > z) = 0.9973
```

◀

▶ Example 6: Immediate form of two-sample test of proportions

To judge teacher effectiveness, we wish to test whether the same proportion of people from two classes will answer an advanced question correctly. In the first classroom of 30 students, 40% answered the question correctly, whereas in the second classroom of 45 students, 67% answered the question correctly.

```
. prtesti 30 0.4 45 0.67
```

Two-sample test of proportions

x: Number of obs = 30

y: Number of obs = 45

	Mean	Std. err.	z	P> z	[95% conf. interval]
x	.4	.0894427			.2246955 .5753045
y	.67	.0700952			.532616 .807384
diff	-.27	.1136368			-.4927241 -.0472759
	under H0:	.1169416	-2.31	0.021	

diff = prop(x) - prop(y)

z = -2.3088

H0: diff = 0

Ha: diff < 0

Pr(Z < z) = 0.0105

Ha: diff != 0

Pr(|Z| > |z|) = 0.0210

Ha: diff > 0

Pr(Z > z) = 0.9895

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Stored results

One-sample `prtest` and `prtesti` store the following in `r()`:

Scalars

<code>r(N)</code>	sample size
<code>r(P)</code>	sample proportion
<code>r(se)</code>	standard error of sample proportion
<code>r(lb)</code>	lower confidence bound of sample proportion
<code>r(ub)</code>	upper confidence bound of sample proportion
<code>r(z)</code>	z statistic
<code>r(p_l)</code>	lower one-sided p-value
<code>r(p)</code>	two-sided p-value
<code>r(p_u)</code>	upper one-sided p-value
<code>r(level)</code>	confidence level

Cluster-adjusted one-sample `prtest` also stores the following in `r()`:

Scalars

<code>r(K)</code>	number of clusters K
<code>r(M)</code>	cluster size M
<code>r(rho)</code>	intraclass correlation
<code>r(CV_cluster)</code>	coefficient of variation for cluster sizes

Two-sample `prtest` and two-sample `prtesti` store the following in `r()`:

Scalars

<code>r(N1)</code>	sample size of population one
<code>r(N2)</code>	sample size of population two
<code>r(P1)</code>	sample proportion for population one
<code>r(P2)</code>	sample proportion for population two
<code>r(P_diff)</code>	difference of proportions
<code>r(se1)</code>	standard error of population-one sample proportion
<code>r(se2)</code>	standard error of population-two sample proportion

<code>r(se_diff)</code>	standard error of the difference of proportions
<code>r(se_diff0)</code>	standard error of the difference of proportions under H_0
<code>r(lb1)</code>	lower confidence bound of population-one sample proportion
<code>r(ub1)</code>	upper confidence bound of population-one sample proportion
<code>r(lb2)</code>	lower confidence bound of population-two sample proportion
<code>r(ub2)</code>	upper confidence bound of population-two sample proportion
<code>r(lb_diff)</code>	lower confidence bound of the difference of proportions
<code>r(ub_diff)</code>	upper confidence bound of the difference of proportions
<code>r(z)</code>	z statistic
<code>r(p_l)</code>	lower one-sided p -value
<code>r(p)</code>	two-sided p -value
<code>r(p_u)</code>	upper one-sided p -value
<code>r(level)</code>	confidence level

Cluster-adjusted two-sample `prtest` using the `by()` option also stores the following in `r()`:

Scalars

<code>r(K1)</code>	population-one number of clusters K_1
<code>r(K2)</code>	population-two number of clusters K_2
<code>r(M1)</code>	population-one cluster size M_1
<code>r(M2)</code>	population-two cluster size M_2
<code>r(rho)</code>	common intraclass correlation
<code>r(rho1)</code>	population-one intraclass correlation
<code>r(rho2)</code>	population-two intraclass correlation
<code>r(CV_cluster1)</code>	population-one coefficient of variation for cluster sizes
<code>r(CV_cluster2)</code>	population-two coefficient of variation for cluster sizes

Methods and formulas

Remarks are presented under the following headings:

One-sample test

Two-sample test

For all the tests below, the test statistic z has an asymptotic standard normal distribution, and the p -value is computed as

$$p = \begin{cases} 1 - \Phi(z) & \text{for an upper one-sided test} \\ \Phi(z) & \text{for a lower one-sided test} \\ 2\{1 - \Phi(|z|)\} & \text{for a two-sided test} \end{cases}$$

where $\Phi(\cdot)$ is the cdf of a standard normal distribution and $|z|$ is an absolute value of z .

See [Acock \(2023, 158–164\)](#) for additional examples of tests of proportions using Stata.

One-sample test

Let n be the number of observations, \hat{p} be the observed proportion, and $\hat{q} = 1 - \hat{p}$.

The one-tailed and two-tailed tests of a population proportion use an asymptotically normally distributed test statistic calculated as

$$z = \frac{\hat{p} - p_0}{s_0}$$

where p_0 is the hypothesized proportion, $q_0 = 1 - p_0$, and $s_0 = \sqrt{p_0 q_0 / n}$ is the standard error of \hat{p} under the null hypothesis of $p = p_0$.

A large-sample $100(1 - \alpha)\%$ confidence interval for a proportion p is

$$\hat{p} \pm z_{1-\alpha/2}s$$

where $s = \sqrt{\hat{p}\hat{q}/n}$ and $z_{1-\alpha/2}$ is the $(1 - \alpha/2)$ th quantile of the standard normal distribution.

With clustered data, suppose that there are K clusters, each of size M_i such that $n = \sum_{i=1}^K M_i$. Let ρ be the intraclass correlation. Following [Ahn, Heo, and Zhang \(2015\)](#), we assume that the cluster sizes M_i are independent and identically distributed. Let C_{adj} be the adjustment to the standard error for clustered data,

$$C_{\text{adj}} = \sqrt{\sum_{i=1}^K M_i \{1 + \rho(M_i - 1)\} / n}$$

such that $s_{0,\text{cl}} = C_{\text{adj}}s_0$ and $s_{\text{cl}} = C_{\text{adj}}s$.

C_{adj} can be equivalently written as

$$C_{\text{adj}} = \sqrt{1 + \rho(\bar{M} - 1) + \rho\bar{M}\text{CV}_{\text{cl}}^2}$$

where $\bar{M} = \sum_{i=1}^K M_i / K$ is the average cluster size and CV_{cl} is the coefficient of variation for cluster sizes:

$$\text{CV}_{\text{cl}} = \frac{\sqrt{\sum_{i=1}^K (M_i - \bar{M})^2 / K}}{\bar{M}}$$

To adjust the test statistic z and the confidence interval for clustering, replace s_0 with $s_{0,\text{cl}}$ and s with s_{cl} in the corresponding formulas. In the presence of clustering, the test statistic z is asymptotically normally distributed conditional on the empirical distribution of M_i 's.

Two-sample test

Let n_1 be the number of observations in population one and n_2 be the number of observations in population two, \hat{p}_1 be the observed proportion in population one and \hat{p}_2 be the observed proportion in population two, and $\hat{q}_1 = 1 - \hat{p}_1$ and $\hat{q}_2 = 1 - \hat{p}_2$. Let x_1 and x_2 be the total number of successes in the two populations.

A test of the difference of two proportions uses an asymptotically normally distributed test statistic calculated as

$$z = \frac{\hat{p}_1 - \hat{p}_2}{s_{d0}}$$

where $s_{d0} = \sqrt{\hat{p}_p \hat{q}_p (1/n_1 + 1/n_2)}$ is the standard error of $\hat{p}_1 - \hat{p}_2$ under the null hypothesis of $p_1 = p_2$, with $\hat{p}_p = (x_1 + x_2) / (n_1 + n_2)$ and $\hat{q}_p = 1 - \hat{p}_p$.

The $100(1 - \alpha)\%$ confidence interval for the difference of two proportions is given by

$$(\hat{p}_1 - \hat{p}_2) \pm z_{1-\alpha/2} \sqrt{s_1^2 + s_2^2}$$

where $s_1 = \sqrt{\hat{p}_1 \hat{q}_1 / n_1}$ and $s_2 = \sqrt{\hat{p}_2 \hat{q}_2 / n_2}$ are the standard errors of the two sample proportions and $z_{1-\alpha/2}$ is the $(1 - \alpha/2)$ th quantile of the standard normal distribution.

With clustered data, suppose that there are K_1 and K_2 clusters in population one and population two with the corresponding average cluster sizes of \bar{M}_1 and \bar{M}_2 . Let ρ_1 and ρ_2 be the intraclass correlations and $CV_{cl,1}$ and $CV_{cl,2}$ be the coefficients of variation for cluster sizes for population one and population two. Let $C_{adj,1}$ and $C_{adj,2}$ be the adjustments to standard errors of the two sample proportions for clustered data, defined analogously to C_{adj} in *One-sample test* for each population.

Let $s_{d0,cl} = \sqrt{\hat{p}_p \hat{q}_p (C_{adj,1}^2 / n_1 + C_{adj,2}^2 / n_2)}$ be the standard error of $\hat{p}_1 - \hat{p}_2$ under the null hypothesis of $p_1 = p_2$ adjusted for clustered data. Also, let $s_{1,cl} = C_{adj,1} s_1$ and $s_{2,cl} = C_{adj,2} s_2$ be the standard errors of \hat{p}_1 and \hat{p}_2 adjusted for clustered data. To adjust the two-sample test statistic and the confidence interval for clustering, replace s_{d0} with $s_{d0,cl}$, s_1 with $s_{1,cl}$, and s_2 with $s_{2,cl}$ in the corresponding formulas.

References

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Also see

- [R] **bitest** — Binomial probability test
- [R] **proportion** — Estimate proportions
- [R] **ttest** — t tests (mean-comparison tests)
- [MV] **hotelling** — Hotelling's T^2 generalized means test
- [PSS-2] **power oneproportion** — Power analysis for a one-sample proportion test
- [PSS-2] **power oneproportion, cluster** — Power analysis for a one-sample proportion test, CRD
- [PSS-2] **power twoproportions** — Power analysis for a two-sample proportions test
- [PSS-2] **power twoproportions, cluster** — Power analysis for a two-sample proportions test, CRD

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