How can I compute power for contingency tables in Stata?

Authored by

stats writer

July 1, 2024

Contingency tables are used to display the relationship between two categorical variables. In order to determine the power of a contingency table in Stata, one must first understand the concept of power, which is the probability of detecting a true effect or relationship between variables. To compute power for contingency tables in Stata, one must use the "tabulate" command and specify the variables of interest. This will generate a contingency table and provide information on the observed frequencies and expected frequencies. Next, one can use the "power" command, which calculates the power of the contingency table based on a specified sample size, effect size, and significance level. This allows researchers to determine the minimum sample size needed to detect a significant relationship between the variables. By computing power for contingency tables in Stata, researchers can ensure that their study has enough statistical power to accurately detect any significant associations between variables.

How can I compute power for contingency tables in Stata? | Stata FAQ

There are many different programs that will compute power for contingency tables including online power calculators. This FAQ page will show you how to compute contingency table power using the Stata command power twoproportions.

The observed likelihood-ratio chi-square statistic can be used as an estimate of a noncentrality parameter parameter for a noncentral chi-square distribution. The noncentral chi-square distribution is the distribution under the alternative hypothesis.

To see how this works, consider a 2-by-2 contingency

table with a likelihood-ratio chi-square value of 4.6. The critical value of chi-square for 2-by-2 table with one degree of freedom is 3.84. Using the nchi2() function, which gives the cumulative noncentral chi-squared distribution, we can compute the power as follows.

display 1 - nchi2(1, 4.6, 3.84)

.57347213

This calculates a power of about .57. Notice that we haven't mentioned anything about the sample size. Say we double the sample size but multiplying each cell frequency by two. All of the cell proportions will remain the same but the chi-square value will double. Meaning, of course, that the noncentrality parameter is doubled. Here is what the power looks like if the sample size is doubled obtained by multiplying the noncentrality parameter by 2.

display 1 - nchi2(1, 2*4.6, 3.84)

.85848997

Doubling the sample size has increased the power to about .86. This means that we can get the power for any multiple of the sample size by multiplying the noncentrality parameter by a sample size factor. The power twoproportions command computes noncentrality for varying sample size factors to come up with estimates of power for the different sample sizes.

The power twoproportions command has the follwing syntax *for computing power*:

power twoproportions p1 p2, n1(numlist) n2(numlist)

where p1 and p2 are the two expected sample proportions, and n1(numlist) and n2(numlist) specify the number of observations in each group.

To compute the prospective power for a 2-by-2 table we need to come up with some reasonably good guesses as to how the observations will be distributed among the cells of the contingency table.
Let's say that in a sample of 100 subjects, we believe the row variable (e.g. treatment=control or experimental) will be split 70/30 between rows one and

two. And further, within the first row, we expect the proportions in the two columns (e.g. diseased=no or yes) to be .5 and .5 (35 and 35 obs) while within the second row, we expect the proportions to be .66 and .33 (20 and 10 obs).

We can use tabi with frequencies taken from our guesses to compute a likelihood-ratio chi-square.

tabi 35 35 20 10, row lrchi2

```
| col
row | 1 2 | Total
-----------+----------------------+----------
1 | 35 35 | 70
| 50.00 50.00 | 100.00
-----------+----------------------+----------
2 | 20 10 | 30
| 66.67 33.33 | 100.00
-----------+----------------------+----------
Total | 55 45 | 100
| 55.00 45.00 | 100.00
```

likelihood-ratio chi2(1) = 2.3963 Pr = 0.122

This table has 100 observations with a likelihood-ratio chi-square of 2.396 and a p-value of .122. We can get the power of this analysis by using power twoproportion, specifying the two proportions in either column, and the sample sizes in the rows.

power twoproportions .5 .3333, n1(70) n2(30) test(lrchi2)

Estimated power for a two-sample proportions test
Likelihood-ratio test
Ho: p2 = p1 versus Ha: p2 != p1

Study parameters:

alpha = 0.0500
N = 100
N1 = 70
N2 = 30
N2/N1 = 0.4286
delta = -0.1667 (difference)
p1 = 0.5000
p2 = 0.3333

Estimated power:

power = 0.3405

This shows that the power for the sample with our guesses is approximately .341. Now, let's see what happens to the power when we multiple each cell frequency by 2.

tabi 70 70 40 20, row lrchi2

| col
row | 1 2 | Total
-----------+----------------------+----------
1 | 70 70 | 140
| 50.00 50.00 | 100.00
-----------+----------------------+----------
2 | 40 20 | 60
| 66.67 33.33 | 100.00
-----------+----------------------+----------
Total | 110 90 | 200
| 55.00 45.00 | 100.00

likelihood-ratio chi2(1) = 4.7926 Pr = 0.029

power twoproportions .5 .3333, n1(140) n2(60) test(lrchi2)

Estimated power for a two-sample proportions test

Likelihood-ratio test
Ho: p2 = p1 versus Ha: p2 != p1

Study parameters:

alpha = 0.0500
N = 200
N1 = 140
N2 = 60
N2/N1 = 0.4286
delta = -0.1667 (difference)
p1 = 0.5000
p2 = 0.3333

Estimated power:

power = 0.5909

There are 200 observations and the power has increased to .591.

Let's view the power for total samples sizes ranging from 100 to 500, using the same row ratio (70/30) and column proportions (.5 and .333) as before. We will specify a list of sample sizes within n1() and n2().

However, we must also specify the options parallel so that Stata will pair corresponding numbers in the numlists in n1() and n2() -- otherwise it will cross all the sample sizes in each list and calculate power for all crossings.

power twoproportions .5 .3333, n1(70 140 210 280 350) n2(30 60 90 120 150) test(lrchi2) parallel

+---+

| alpha power N N1 N2 delta p1 p2 |

|---|

| .05 .3405 100 70 30 -.1667 .5 .3333 |

| .05 .5909 200 140 60 -.1667 .5 .3333 |

| .05 .7648 300 210 90 -.1667 .5 .3333 |

| .05 .8722 400 280 120 -.1667 .5 .3333 |

| .05 .9335 500 350 150 -.1667 .5 .3333 |

+---+

We see the power estimates for N=100 and N=200 replicated from above. The power for a sample of 300 is about .76 while for
400 it is about .87.

We can use an alternate syntax to examine the effects

of varying total sample sizes and row ratios on power. We might not be sure exactly how many subjects we can recruit, nor what proportion can be allocated to the experimental group (perhaps the drug is costly). This alternate syntax is:

power twoproportions p1 p2, n(numlist) nratio(numlist)

where n(numlist) is a list of *total* sample sizes and nratio(numlist) is a list of row ratios. In the code below, we study power for total sample sizes ranging from 100 to 300 in increments of 100, with ratios of control to experimental group sizes ranging from 5 to 1 in increments of 1. We use the numlist syntax "begin(increment)end":

power twoproportions .5 .3333, n(100(100)300) nratio(5(-1)1)

+---+

| alpha power N N1 N2 nratio delta p1 p2 |

|---|

| .05 .2533 100 16 83 5 -.1667 .5 .3333 |

| .05 .2877 100 20 80 4 -.1667 .5 .3333 |

| .05 .3229 100 25 75 3 -.1667 .5 .3333 |

| .05 .362 100 33 66 2 -.1667 .5 .3333 |

| .05 .3924 100 50 50 1 -.1667 .5 .3333 |

| .05 .4466 200 33 166 5 -.1667 .5 .3333 |

| .05 .4989 200 40 160 4 -.1667 .5 .3333 |

| .05 .5581 200 50 150 3 -.1667 .5 .3333 |

| .05 .6215 200 66 133 2 -.1667 .5 .3333 |

| .05 .6691 200 100 100 1 -.1667 .5 .3333 |

| .05 .6071 300 50 250 5 -.1667 .5 .3333 |

| .05 .6648 300 60 240 4 -.1667 .5 .3333 |

| .05 .7295 300 75 225 3 -.1667 .5 .3333 |

| .05 .7958 300 100 200 2 -.1667 .5 .3333 |

| .05 .8371 300 150 150 1 -.1667 .5 .3333 |

+---+

We see that of course power increases as N grows from 100 to 300, but also as nratio decreases from 5 to 1. This suggests that balanced group allocation will yield more power.

All of the above results used the default alpha of .05. Imagine that we are afraid of making a false positive claim, so we set alpha to be 0.01 instead. If we change alpha to be

.01 the power will go down as shown in the next

example.

power twoproportions .5 .3333, n(100(100)300) nratio(5(-1)1) alpha(0.01)

alpha	power	N	N1	N2	nratio	delta	p1	p2
.01	.1033	100	16	83	5	-.1667	.5	.3333
.01	.1227	100	20	80	4	-.1667	.5	.3333
.01	.1434	100	25	75	3	-.1667	.5	.3333
.01	.1671	100	33	66	2	-.1667	.5	.3333
.01	.1846	100	50	50	1	-.1667	.5	.3333
.01	.2322	200	33	166	5	-.1667	.5	.3333
.01	.2732	200	40	160	4	-.1667	.5	.3333
.01	.3232	200	50	150	3	-.1667	.5	.3333
.01	.3812	200	66	133	2	-.1667	.5	.3333
.01	.4256	200	100	100	1	-.1667	.5	.3333
.01	.3725	300	50	250	5	-.1667	.5	.3333
.01	.4307	300	60	240	4	-.1667	.5	.3333
.01	.5026	300	75	225	3	-.1667	.5	.3333
.01	.585	300	100	200	2	-.1667	.5	.3333
.01	.6397	300	150	150	1	-.1667	.5	.3333

Reference

Satorra, A. and Sarris, W.E. 1985. Power of the likelihood ratio test in covariance structure analysis. Psychometrica, 50: 83-90.