Power of the `power` command in Stata 13

Yulia Marchenko

Director of Biostatistics
StataCorp LP

2013 UK Stata Users Group meeting

Outline

- Basic functionality of the power command
- Tables of results
- Automatic graphs
- GUI
- Adding your own methods (forthcoming)

The power command provides power and sample-size (PSS) analysis for hypothesis tests.

You can compute

- sample size given power and effect size
- power given sample size and effect size
- effect size given power and sample size

You can also

- express the magnitude of an effect of interest (or effect size) in multiple ways
- obtain results for multiple scenarios
- display multiple results in a table
- display multiple results on a graph
- use the PSS Control Panel for point-and-click analysis
- read about PSS in the new [PSS] manual

And,

- You will soon be able to add your own methods to the `power` command and have access to its features such as multiple-scenario support, tables, and graphs.

One-sample comparison of a

- Mean (one-sample *t* test)
- Proportion
- Correlation
- Variance

Two-sample comparison of independent

- Means (two-sample *t* test)
- Proportions
- Correlations
- Variances

Two-sample comparison of paired

- Means (paired *t* test)
- Proportions (McNemar's test)

Example

Suppose that school officials would like to study the performance of currently-enrolled students on a standardized math test. They want to compare the average math score with the previous year's average of 25 points using a one-sample *t* test. Assuming a standard deviation of 6.5 points, the officials want to determine the sample size necessary to detect a hypothesized average score of 30 points with 90% power using a 5%-level two-sided test.

- Compute sample size given a power of 0.9:

```
. power onemean 25 30, power(0.9) sd(6.5)
Performing iteration ...
Estimated sample size for a one-sample mean test
t test
Ho: m = m0  versus  Ha: m != m0
Study parameters:
        alpha =    0.0500
        power =    0.9000
        delta =    0.7692
           m0 =   25.0000
           ma =   30.0000
           sd =    6.5000
Estimated sample size:
            N =        20
```

- Compute power given a sample size of 15:

```
. power onemean 25 30, n(15) sd(6.5)

Estimated power for a one-sample mean test
t test
Ho: m = m0  versus  Ha: m != m0

Study parameters:

        alpha =    0.0500
            N =        15
        delta =    0.7692
           m0 =   25.0000
           ma =   30.0000
           sd =    6.5000

Estimated power:

        power =    0.7911
```

- Compute effect size and a hypothesized mean given a sample size of 15 and a power of 0.9:

```
. power onemean 25, power(0.9) n(15) sd(6.5)

Performing iteration ...

Estimated target mean for a one-sample mean test
t test
Ho: m = m0  versus  Ha: m != m0; ma > m0

Study parameters:

        alpha =    0.0500
        power =    0.9000
            N =        15
           m0 =   25.0000
           sd =    6.5000

Estimated effect size and target mean:

        delta =    0.9009
           ma =   30.8557
```

- Compute power for multiple sample sizes:

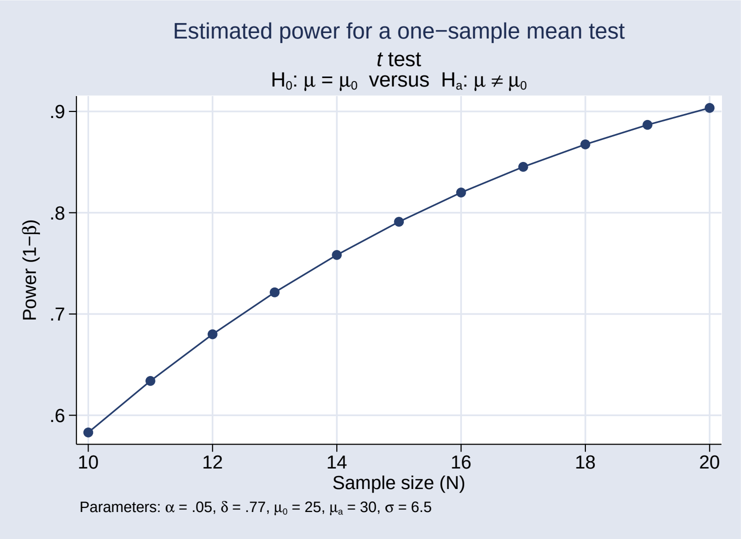
```
. power onemean 25 30, n(10 15 20) sd(6.5)
Estimated power for a one-sample mean test
t test
Ho: m = m0  versus  Ha: m != m0

   alpha   power      N  delta      m0      ma      sd

     .05    .583     10  .7692      25      30     6.5
     .05   .7911     15  .7692      25      30     6.5
     .05   .9035     20  .7692      25      30     6.5
```

- Customize the table:

```
. power onemean 25 30, n(10 15 20) sd(6.5) table(alpha:"Significance level"
> N:" Sample size" power:" Power" delta:" Effect size", formats(power "%6.2f"
>  delta "%6.2f"))

Estimated power for a one-sample mean test
t test
Ho: m = m0  versus  Ha: m != m0

  Significance level  Sample size  Power  Effect size

                 .05           10   0.58         0.77
                 .05           15   0.79         0.77
                 .05           20   0.90         0.77
```

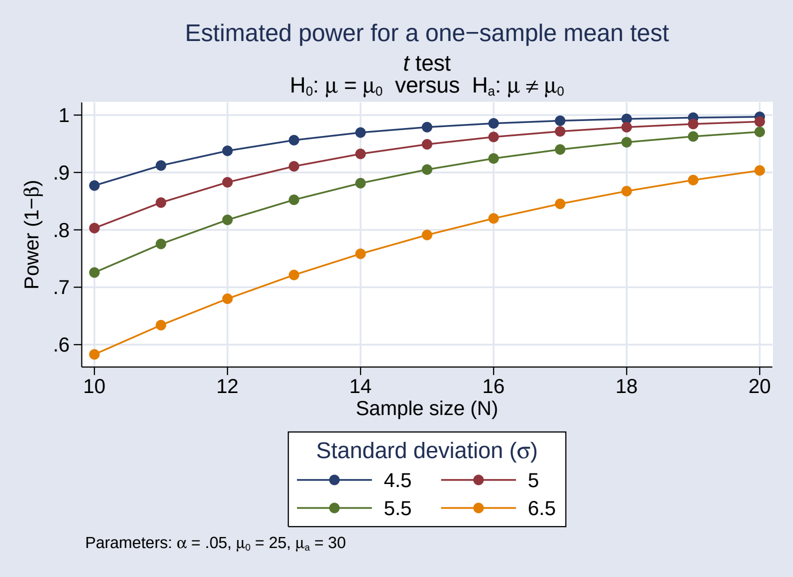
- Plot power for a range of sample sizes:

```
. power onemean 25 30, n(10(1)20) sd(6.5) graph
```



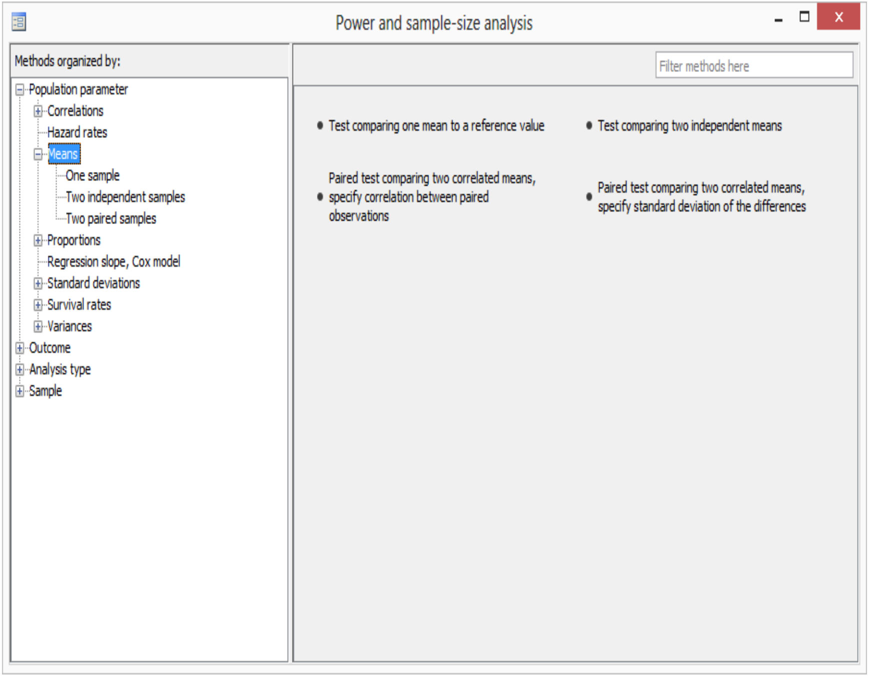
- Plot power for a range of sample sizes and standard deviations:

```
. power onemean 25 30, n(10(1)20) sd(4.5 5 5.5 6.5) graph
```



Go to the **Statistics** > **Power and sample size** menu to launch the PSS Control Panel for point-and-click analysis:

(NEXT SLIDE)



Power and sample-size analysis

Methods organized by:

- Population parameter
  - Correlations
  - Hazard rates
  - Means
    - One sample
    - Two independent samples
    - Two paired samples
  - Proportions
  - Regression slope, Cox model
  - Standard deviations
  - Survival rates
  - Variances
- Outcome
- Analysis type
- Sample

Filter methods here

- Test comparing one mean to a reference value
- Test comparing two independent means
- Paired test comparing two correlated means, specify correlation between paired observations
- Paired test comparing two correlated means, specify standard deviation of the differences

Suppose you want to add the mymethod method to power. Here is an outline of the steps to follow:

- create an rclass program defined by power_cmd_mymethod.ado that performs PSS computations and follows power's conventions for naming options and storing results;
- optionally, create the initializer, an sclass program defined by power_cmd_mymethod_init.ado, that specifies the information about table columns, options which may allow a *numlist*, etc.;
- optionally, create a program defined by power_cmd_mymethod_parse.ado that checks the syntax of method-specific options.

- As an illustration, we will compute power for a one-sample z test.
- We want to add a method called `myztest` that performs this computation to the `power` command.
- We first create an `rclass` program which computes power for a z test, and store the program in a file named `power_cmd_myztest.ado`.

```
*! version 1.0.0  18jul2013
*! Power computation for a one-sample z test
program power_cmd_myztest, rclass
        version 13
                                                /* parse options */
        syntax ,        n(integer)              /// sample size
                        STDDiff(real)           /// standardized difference
                [                               ///
                        Alpha(string)           /// significance level
                        ONESIDed                /// one-sided test
                ]
                                                /* compute power */
        tempname power za
        if ("`onesided´"=="") scalar `za´ = invnormal(1-`alpha´/2)
        else scalar `za´ = invnormal(1-`alpha´)
        scalar `power´ = normal(`stddiff´*sqrt(`n´)-`za´)
                                                /* return results */
        return scalar N         = `n´
        return scalar power     = `power´
        return scalar alpha     = `alpha´
        return scalar stddiff   = `stddiff´
        return scalar onesided  = ("`onesided´"!="")
end
```

- Compute power given a sample size of 20 and a standardized difference of 1:

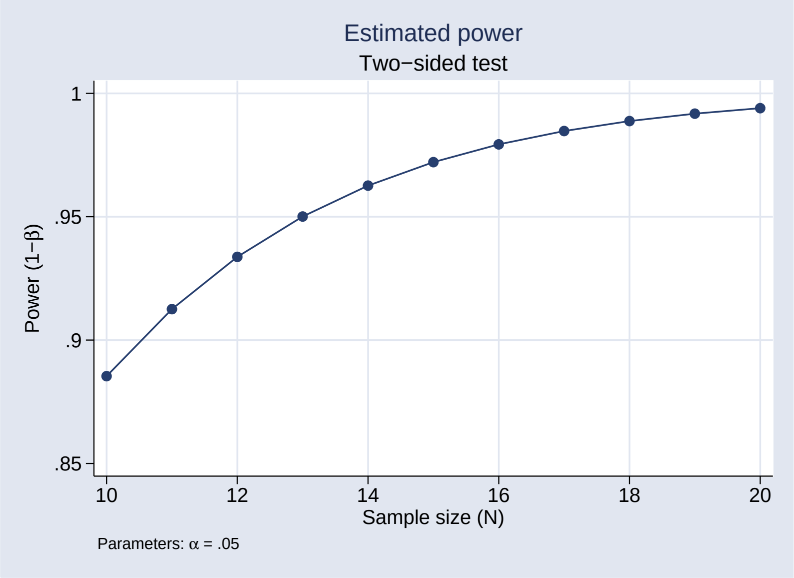
```
. power myztest, n(20) stddiff(1)
Estimated power
Two-sided test

    alpha   power       N

      .05    .994      20
```

- Compute power for a range of sample sizes:

```
. power myztest, n(10 15 20) stddiff(1)
Estimated power
Two-sided test

    alpha   power       N

      .05   .8854      10
      .05   .9721      15
      .05    .994      20
```

- Plot power for a range of sample sizes:

```
. power myztest, n(10(1)20) stddiff(1) graph
```



- We would like to add a column containing standardized differences to our table.
- We need to somehow get this information to the power command. This is done with the initializer.
- To add a column to the displayed table, we store the name of the return scalar containing the values of that column in the s(pss_columns) macro in the initializer program
- power_cmd_myztest stores the differences in a scalar r(stddiff).
- We create an sclass program power_cmd_myztest_init and store “stddiff” in s(pss_colnames).

```
*! version 1.0.0  18jul2013
program power_cmd_myztest_init, sclass
        sreturn local pss_colnames "stddiff"
end
```

- The `power` command uses the convention that the name of the table column is the same as the name of the return scalar containing values of this column.
- The `stddiff` column is now displayed in the default table:

```
. power myztest, n(20) stddiff(1)

Estimated power
Two-sided test

┌─────────────────────────────────┐
│   alpha    power       N stddiff│
├─────────────────────────────────┤
│     .05     .994      20       1│
└─────────────────────────────────┘
```

- If desired, we can change the default column label:

```
. power myztest, n(20) stddif(1) table(, labels(stddiff "  Std. Difference"))

Estimated power
Two-sided test

┌───────────────────────────────────────────┐
│   alpha    power       N   Std. Difference│
├───────────────────────────────────────────┤
│     .05     .994      20                 1│
└───────────────────────────────────────────┘
```

- We would also like to be able to specify multiple values in the `stddiff()` option.

- If we try doing this now, we will receive an error:

```
. power myztest, n(20) stddiff(0.5 1)
option stddiff() invalid
r(198);
```

- We need to let power know that we want to allow stddiff() to accept multiple values.
- We need to include the name of each option (with abbreviation) for which we wish to allow multiple values in the s(pss_numopts) macro in the initializer:

```
. type power_cmd_myztest_init.ado
*! version 1.0.0  18jul2013
program power_cmd_myztest_init, sclass
        sreturn local pss_colnames "stddiff"
        sreturn local pss_numopts "STDDiff"
end
```

- The stddiff() option now accepts multiple values:

```
. power myztest, n(20) stddiff(0.5 1)
Estimated power
Two-sided test

    alpha   power        N stddiff

      .05   .6088       20      .5
      .05    .994       20       1
```

- For example, we can produce results for all possible combinations of specified sample sizes and standardized differences:

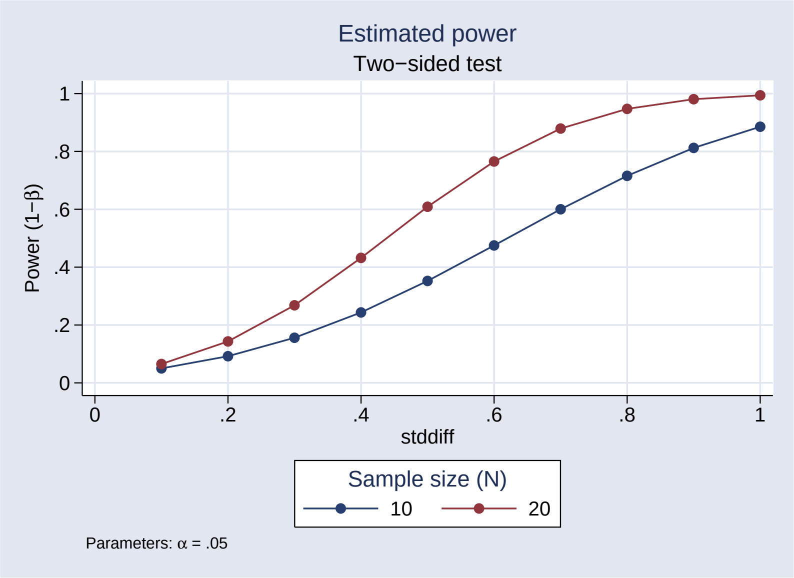
```
. power myztest, n(10 20) stddiff(0.5 1)

Estimated power
Two-sided test

  ┌──────────────────────────────────┐
  │  alpha   power        N stddiff  │
  ├──────────────────────────────────┤
  │    .05   .3524       10      .5  │
  │    .05   .8854       10       1  │
  │    .05   .6088       20      .5  │
  │    .05    .994       20       1  │
  └──────────────────────────────────┘
```

- or only for specific combinations:

```
. power myztest, n(10 20) stddiff(0.5 1) parallel

Estimated power
Two-sided test

  ┌──────────────────────────────────┐
  │  alpha   power        N stddiff  │
  ├──────────────────────────────────┤
  │    .05   .3524       10      .5  │
  │    .05    .994       20       1  │
  └──────────────────────────────────┘
```

- We can also plot powers for a range of standardized differences and sample sizes

```
. power myztest, n(10 20) stddiff(0.1(0.1)1) graph(xdimension(stddiff))
```



- More power and sample-size computations
- More control for customization of user-written methods; keep an eye out for a forthcoming FAQ for more details
- Possibly other additions based on your feedback