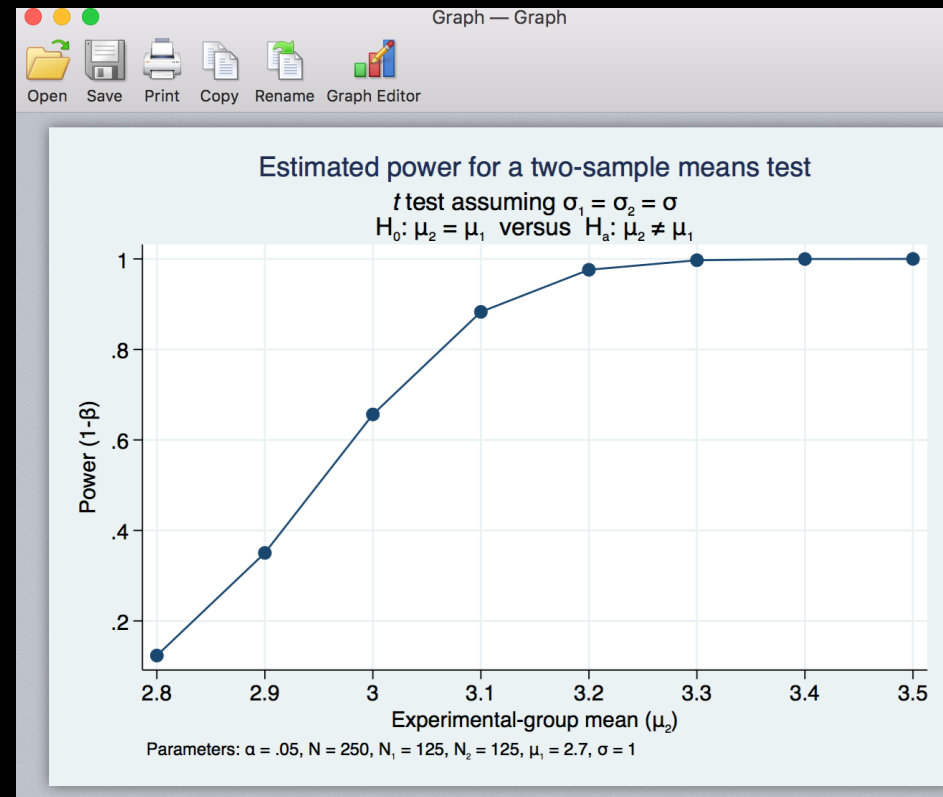


Biostatistics 212

Power and Sample Size Calculations

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Lecture Goals:

- * Review basic approach to determining sample size for a given study
- * Discuss basic concepts (alpha, beta, power)
- * Learn how STATA can calculate these numbers for different study types

Sample Size Calculation:

- * Critical to the success of a given study
- *Decide how many subjects to include in your study to achieve 'statistical significance'*
- Calculate too few subjects-may fail to answer the research question
- Calculate too many subjects-makes study more difficult and potentially costly
- *Calculate correct sample size-first step to optimally planning your study (although ballpark estimate-dropouts?)*

Hurley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research. 2013; 4th Edition. Walters, Kluwer, Lippincott.

Null vs Alternative Hypothesis:

- * State your research question as a hypothesis that summarizes main elements of your study
- * Restate your study hypothesis to one that proposes no difference between the study groups
- *This null hypothesis will become the formal basis for statistical testing on data analysis*
- *Statistical tests will then help to estimate the probability that an observed association in your study is due to chance*
- *As opposed to the alternative hypothesis-that an association in your study is actually present*

Hurley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research. 2013; 4th Edition. Walters, Kluwer, Lippincott.

Underlying Statistical Principles:

* Type 1 Error:

- *Rejection error*-failure to reject the null hypothesis when it is actually true (conclude that an association is present when one truly does not exist)
- Convict an innocent man, conclude there is an association between CT scans and cancer-when there truly is not one (*false positive error*)

* Type 2 Error:

- *Acceptance error*-failure to reject the null hypothesis when actually false (conclude that there is no association when one truly exists)
- Acquit a murderer, conclude that there is no association between CT scans and cancer-when there is truly one present (*false negative error*)

Hurley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research. 2013; 4th Edition. Walters, Kluwer, Lippincott.

Underlying Statistical Principles:

* Alpha:

- *Level of statistical significance*
- Maximum probability of committing a type I error, or level of reasonable doubt to accept result, using statistical tests
- *Typically set at 0.05 (5% chance of incorrectly rejecting the null hypothesis when it is true)*

* Beta:

- *Level at which one is willing to accept the chance of missing an association when actually present*
- *Typically set at 0.20 (20% chance of failure to recognize an association)*

Hurley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research. 2013; 4th Edition. Walters, Kluwer, Lippincott.

Underlying Statistical Principles:

* Power:

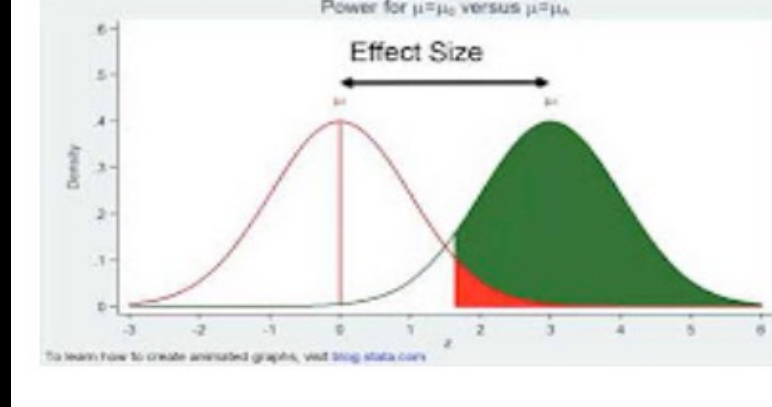
- *Calculated as 1-beta (beta 0.2 = power 0.8)*
- * *80% chance of finding an association between study groups of that size, or greater*
- Optimally alpha and beta would be 0.00, and power would be 100%
- However, that requires increasing the sample size (making the study potentially more difficult)

* Power Analysis:

- *Evaluates statistical power at a given effect size for a fixed sample size and level of significance*

Hurley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research. 2013; 4th Edition. Walters, Kluwer, Lippincott.

Underlying Statistical Principles:



* Calculate effect size

- Estimation of the size of the association in the study sample that one looks to detect
- *Difference in mean value of continuous outcome between 2 study groups*
- *Difference in proportion of subjects with dichotomous outcome between 2 study groups*

* Calculate study variability:

- *Standard deviation of outcome variable*

* Calculate standardized effect size (effect size / SD of outcome)

- *Increasing standardized effect size —> decreased sample size*

Hurley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research. 2013; 4th Edition. Walters, Kluwer, Lippincott.

Sample Size Calculators

SAMPLE SIZE CALCULATORS FOR DESIGNING CLINICAL RESEARCH

[HOME](#)
[ABOUT CALCULATING SAMPLE SIZE](#)
[GLOSSARY OF TERMS](#)
[ABOUT US](#)

TWO-GROUP ANALYTIC STUDY

COMPARING

[Means – Sample Size](#)
[Means – Effect Size](#)
[Means – Sample Size/Clustered](#)
[Means – Effect Size/Clustered](#)
[Proportions – Sample Size](#)
[Proportions – Effect Size](#)

ONE-GROUP ANALYTIC STUDY

COMPARING

[Correlation – Sample size](#)
[Correlation – Effect Size \[COMING\]](#)

ONE-GROUP DESCRIPTIVE STUDY

[CI for Mean – Sample Size](#)
[CI for Mean](#)
[CI for Proportion – Sample Size](#)
[CI for Proportion](#)

ONE-GROUP BEFORE-AFTER STUDY

[Paired t-test – Sample Size](#)
[Paired t-test – Effect Size](#)

TWO-GROUP SURVIVAL ANALYSIS

[Survival Analysis – Sample Size](#)
[Survival Analysis – Effect Size \[COMING\]](#)

STUDY OF DIAGNOSTIC TEST ACCURACY

[CI – Likelihood Ratio](#)

Sample Size Calculators

If you are a clinical researcher trying to determine how many subjects to include in your study or you have another question related to sample size or power calculations, we developed this website for you. Our approach is based on Chapters 5 and 6 in the 4th edition of [Designing Clinical Research](#) (DCR-4), but the material and calculators provided here go well beyond an introductory textbook on clinical research methods.

DCR-4 Chapter 6 “Estimating Sample Size and Power” Appendixes A-F provide instructions and tables for calculating sample sizes. However, the tables provided for two-group studies assume that the groups are of equal size. If you have unequal group sizes (as occurs in most observational studies) or a study parameter that does not correspond to one of the table headings, then you may have to use one of these online calculators.

Online Calculators Corresponding to Tables in DCR-4 Chapter 6

Two-group analytic study comparing

(A) Means

(A1) [sample size given effect size](#)

(A2) [effect size given sample size](#)

(A') Means with clustered sampling

(A'1) [sample size given effect size \(clustered sampling\)](#)

(A'2) [effect size given sample size \(clustered sampling\)](#)

(B) Proportions

(B1) [sample size given both proportions or baseline proportion and relative risk or odds ratio](#)

(B2) [second proportion \(and relative risk and odds ratio\) given baseline proportion and sample sizes](#)

One-group analytic study comparing



Study Example:



- * Let's think of a study looking at the effects of smoking on the lung function of subjects
- We will use a *two-sided alternative hypothesis* that specifies that there may be an association between smoking and FEV that could be either smaller or larger (smoking—> either decreased or increased FEV)
- Typically avoid a *one-side alternative hypothesis* that captures only one direction of a potential association between variable and outcome



Study Example:



- * Mean FEV non-smokers 3.0 liters, smokers 2.7 liters
- What test should we use?
- T-test to determine if the mean value of a continuous outcome in the non-smoker group (3.0 L) significantly differs from that in the smoker group (2.7 L)
- *T-test traditionally used in analysis of continuous variables and outcomes*
- Will use a standard deviation of 1



Review

Results

Command _rc

```

-----
/ _ _ / _ _ /
_ _ / _ _ / _ _ /

```

Statistics/Data

Special Edit

Single-user Stata
Serial number
Licensed

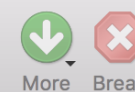
Notes:

1. Unicode
2. Maximum

Command

/Users/phillipsperera/Des

- Summaries, tables, and tests ▶
- Linear models and related ▶
- Binary outcomes ▶
- Ordinal outcomes ▶
- Categorical outcomes ▶
- Count outcomes ▶
- Fractional outcomes ▶
- Generalized linear models ▶
- Time series ▶
- Multivariate time series ▶
- Spatial autoregressive models ▶
- Longitudinal/panel data ▶
- Multilevel mixed-effects models ▶
- Survival analysis ▶
- Epidemiology and related ▶
- Endogenous covariates ▶
- Sample-selection models ▶
- Treatment effects ▶
- SEM (structural equation modeling) ▶
- LCA (latent class analysis) ▶
- FMM (finite mixture models) ▶
- IRT (item response theory) ▶
- Survey data analysis ▶
- Multiple imputation ▶
- Nonparametric analysis ▶
- Multivariate analysis ▶
- Exact statistics ▶
- Resampling ▶
- Power and sample size**
- Bayesian analysis ▶
- Postestimation
- Other ▶



Search

Search Help



Variables

Name Label

7 StataCorp LLC

exas 77845 USA

<http://www.stata.com>

stata@stata.com

e [help set_maxvar.](#)



Properties

Variables

Name	
Label	
Type	
Format	
Value label	
Notes	

Data

Filename	
Label	
Notes	
Variables	0



118% ▾



Power and sample-size analysis

Methods organized by:

▼ Population parameter

▶ Correlations

Hazard rates

▼ Means

▶ ANOVA (multiple means)

One sample

Two independent samples

Two paired samples

▶ Odds ratio

▶ Proportions

R-squared

▶ Regression slopes

▶ Standard deviations

▶ Survival rates

▶ Variances

▼ Outcome

▼ Continuous

▶ Correlations

▶ Means

R-squared

▶ Regression slopes

▶ Standard deviations

▶ Variances

▼ Binary

Linear trend in proportions in Jx2 table

Matched case-control data

One proportion

Stratified 2x2 tables

Two independent proportions

Two paired proportions

▶ Survival

▶ Analysis type

▶ Sample

- Test comparing two independent means

- Test comparing two independent means in a cluster randomized design



Review

Command

Methods organized by:

- Population parameter
 - Correlations
 - Hazard rates
- Means
 - ANOVA (multiple means)
 - One sample
 - Two independent samples
 - Two paired samples
- Odds ratio
- Proportions
- R-squared
- Regression slopes
- Standard deviations
- Survival rates
- Variances
- Outcome
- Analysis type
- Sample

power twomeans - Power analysis for a two-sample means test

Main Table Graph Iteration

Compute: * Accepts numlist [\(Examples\)](#)

Total sample size

Error probabilities

0.05 * Significance level 0.8 * Power

Sample size

1 * Allocation ratio, N2/N1

☐ Allow fractional sample size

Effect size

Means

3.0 * Control

2.7 * Experimental

Standard deviations

☒ Common standard deviation

1 * Common value

☐ Group standard deviations

* Control

* Experimental

☐ Assume a known standard deviations

Sides:

Two-sided test

☐ Treat number lists in starred(*) options as parallel

? R

Submit Cancel OK

**Review**

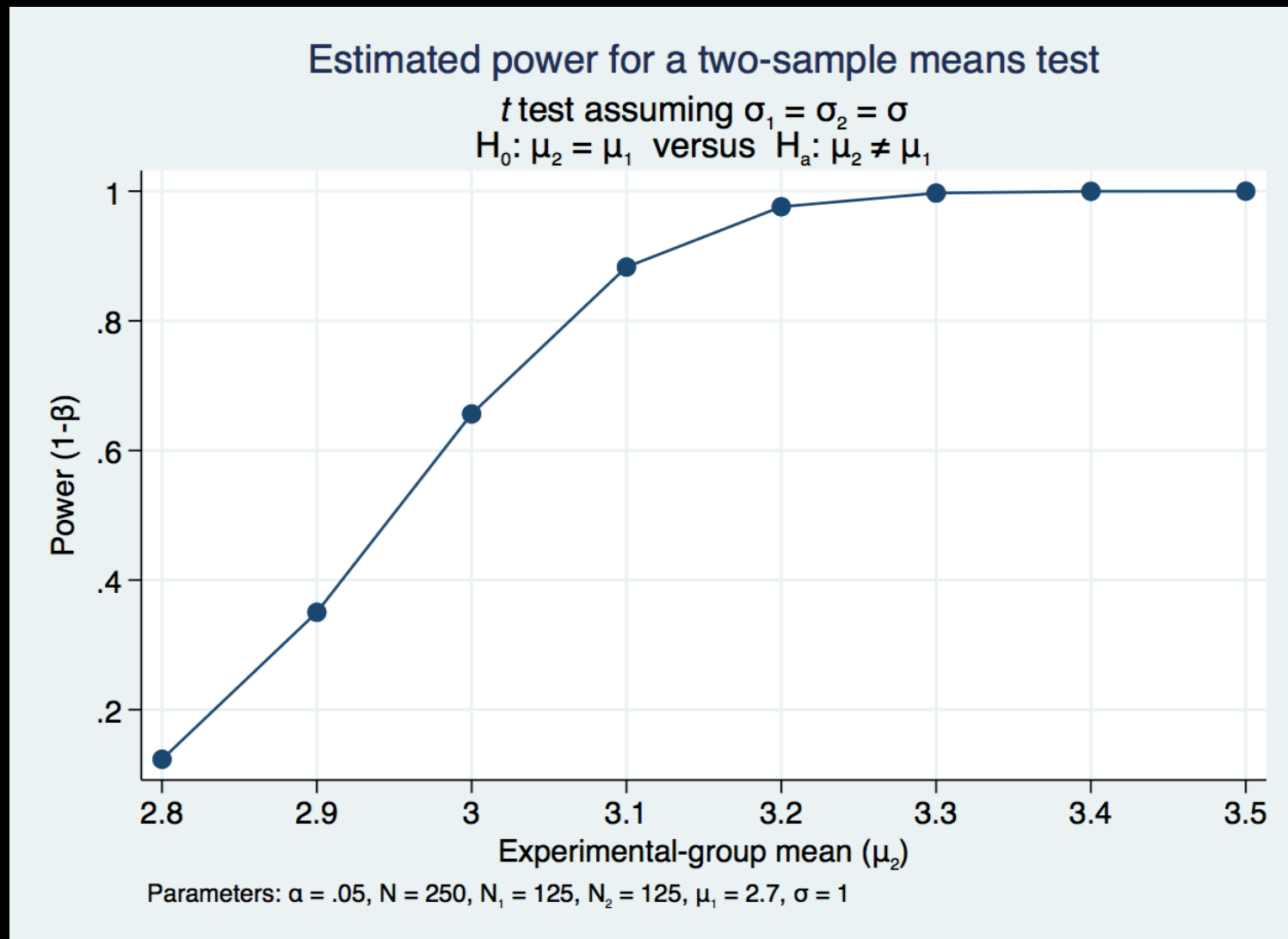
^ Command _rc
1 power twomeans 3.0 2.7

Results

```
.  
. power twomeans 3.0 2.7  
  
Performing iteration ...  
  
Estimated sample sizes for a two-sample means test  
t test assuming sd1 = sd2 = sd  
Ho: m2 = m1 versus Ha: m2 != m1  
  
Study parameters:  
  
alpha = 0.0500  
power = 0.8000  
delta = -0.3000  
m1 = 3.0000  
m2 = 2.7000  
sd = 1.0000  
  
Estimated sample sizes:  
  
N = 352  
N per group = 176
```

. power twomeans 2.7 (2.8(0.1)3.5), n(250) graph

Power Curve:



* Increasing mean difference between study groups increases power

```
. power twomeans 3 2.7, sd(0.5(0.1)1.5) n(250)
```

Estimated power for a two-sample means test

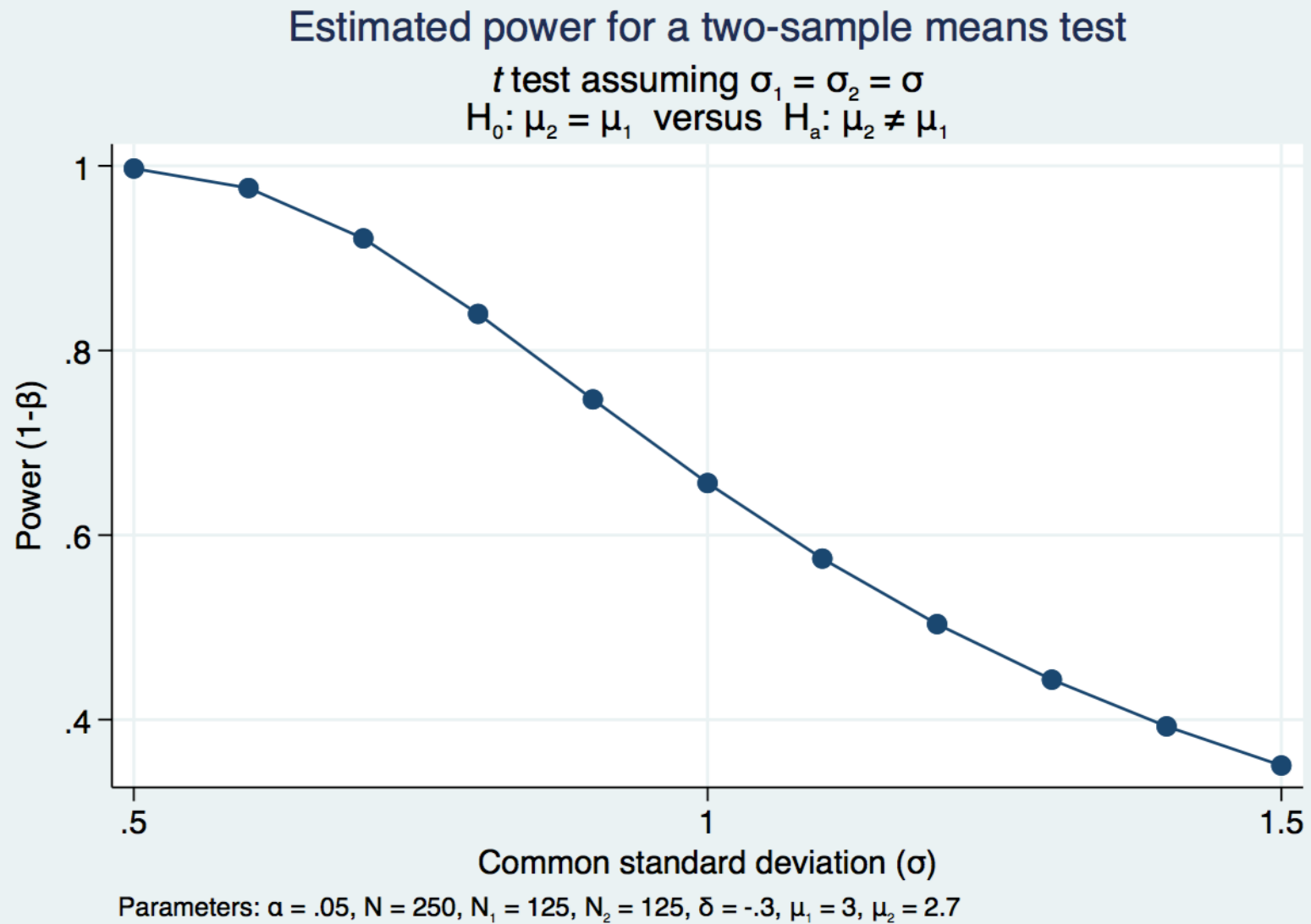
t test assuming $sd1 = sd2 = sd$

$H_0: m2 = m1$ versus $H_a: m2 \neq m1$

alpha	power	N	N1	N2	delta	m1	m2	sd
.05	.9972	250	125	125	-.3	3	2.7	.5
.05	.976	250	125	125	-.3	3	2.7	.6
.05	.9215	250	125	125	-.3	3	2.7	.7
.05	.8397	250	125	125	-.3	3	2.7	.8
.05	.747	250	125	125	-.3	3	2.7	.9
.05	.6564	250	125	125	-.3	3	2.7	1
.05	.5745	250	125	125	-.3	3	2.7	1.1
.05	.5036	250	125	125	-.3	3	2.7	1.2
.05	.4434	250	125	125	-.3	3	2.7	1.3
.05	.3928	250	125	125	-.3	3	2.7	1.4
.05	.3503	250	125	125	-.3	3	2.7	1.5

 Increasing standard deviation of measurements between study groups decreases power by increasing overlap between groups

```
. power twomeans 3 2.7, sd(0.5(0.1)1.5) n(250) graph
```



Power Calculation:

```
. power twomeans 3.0 2.7, n(250)
```

Estimated power for a two-sample means test
t test assuming $sd1 = sd2 = sd$
 $H_0: m2 = m1$ versus $H_a: m2 \neq m1$

Study parameters:

alpha =	0.0500
N =	250
N per group =	125
delta =	-0.3000
m1 =	3.0000
m2 =	2.7000
sd =	1.0000

Estimated power:

power =	0.6564
---------	--------

Power Calculation:

```
. power twomeans 3.0 2.7, n(1000)
```

Estimated power for a two-sample means test

t test assuming $sd1 = sd2 = sd$

$H_0: m2 = m1$ versus $H_a: m2 \neq m1$

Study parameters:

alpha =	0.0500
N =	1,000
N per group =	500
delta =	-0.3000
m1 =	3.0000
m2 =	2.7000
sd =	1.0000

Estimated power:

power =	0.9973
---------	--------

```
. power twomeans 3.0 2.7, n(250(50)1000)
```

Estimated power for a two-sample means test

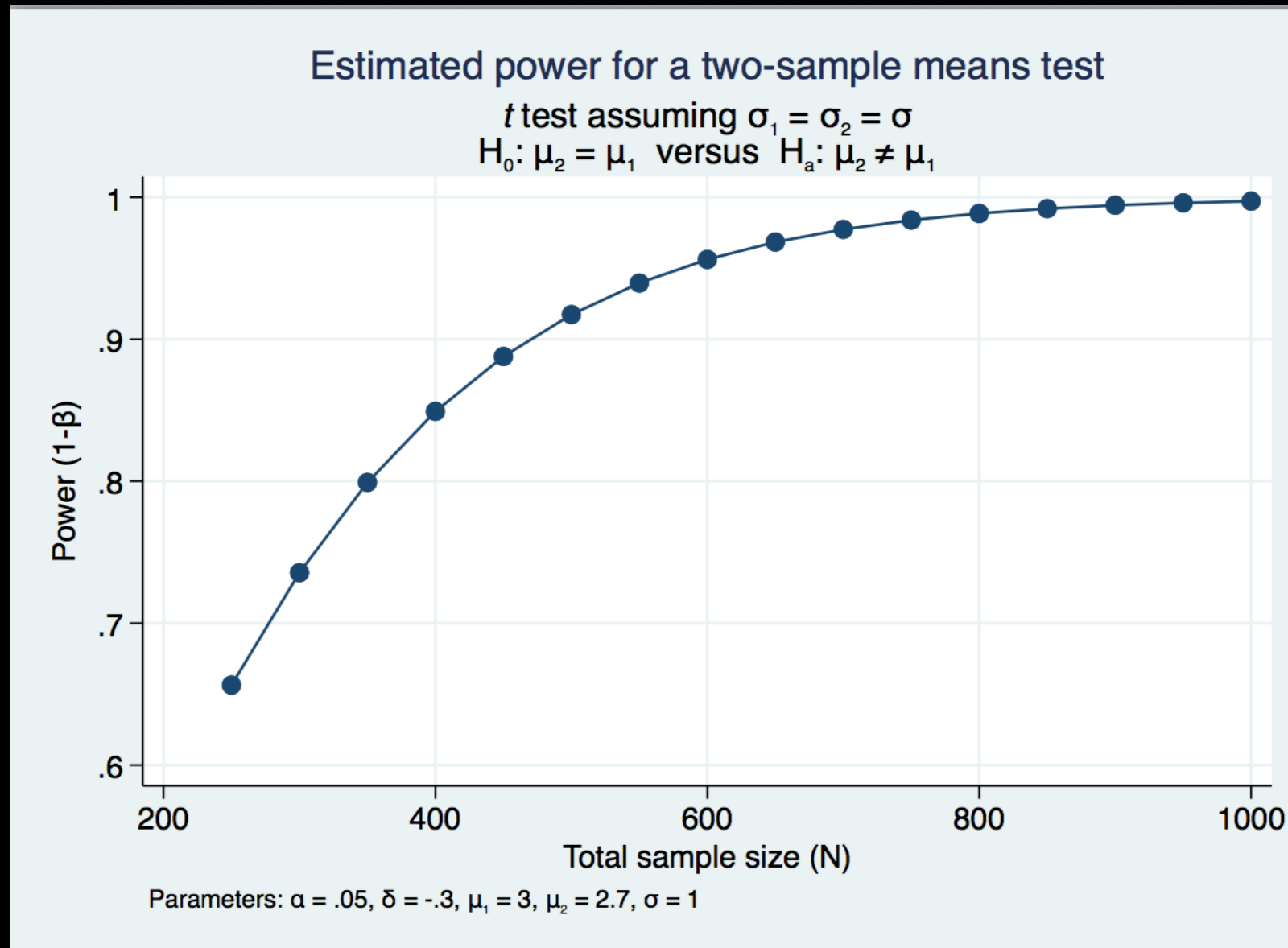
t test assuming $sd1 = sd2 = sd$

$H_0: m2 = m1$ versus $H_a: m2 \neq m1$

alpha	power	N	N1	N2	delta	m1	m2	sd
.05	.6564	250	125	125	-.3	3	2.7	1
.05	.7356	300	150	150	-.3	3	2.7	1
.05	.7991	350	175	175	-.3	3	2.7	1
.05	.8491	400	200	200	-.3	3	2.7	1
.05	.8879	450	225	225	-.3	3	2.7	1
.05	.9174	500	250	250	-.3	3	2.7	1
.05	.9396	550	275	275	-.3	3	2.7	1
.05	.9562	600	300	300	-.3	3	2.7	1
.05	.9685	650	325	325	-.3	3	2.7	1
.05	.9774	700	350	350	-.3	3	2.7	1
.05	.9839	750	375	375	-.3	3	2.7	1
.05	.9886	800	400	400	-.3	3	2.7	1
.05	.992	850	425	425	-.3	3	2.7	1
.05	.9944	900	450	450	-.3	3	2.7	1
.05	.9961	950	475	475	-.3	3	2.7	1
.05	.9973	1,000	500	500	-.3	3	2.7	1

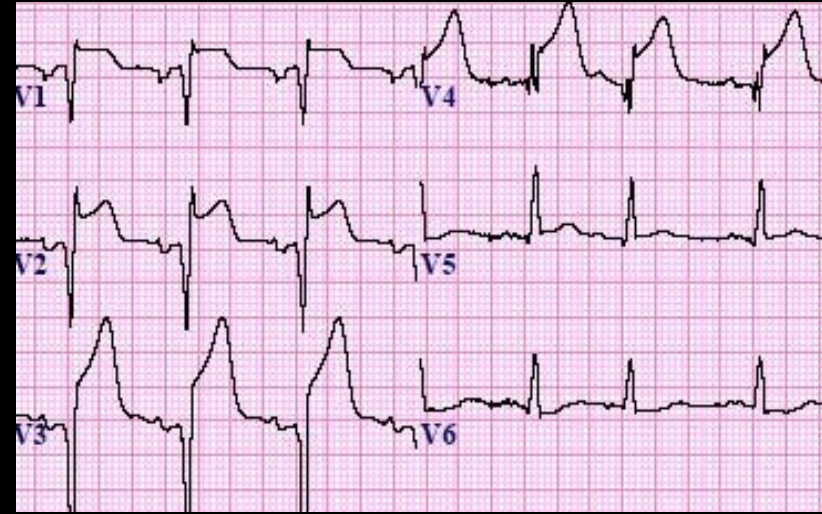
. power twomeans 3.0 2.7, n(250(50)1000) graph

Sample Size Curve:





Next Example:



- * Let's think of a study looking at the effects of aspirin on the rate of myocardial infarction (MI)
- Estimated proportion of MI in non-users of aspirin (control group)
 $189/11034 = 0.0171$ vs the users of aspirin (experimental group)
 $104/11037 = 0.0094$
- * What test should we use?
- Chi-squared test
- *Used to compare the proportion of subjects in each study group who have a dichotomous outcome (categorical variable)*

```
. power twoproportions 0.0171 .0094
```

Performing iteration ...

Estimated sample sizes for a two-sample proportions test

Pearson's chi-squared test

Ho: $p_2 = p_1$ versus Ha: $p_2 \neq p_1$

Study parameters:

alpha = 0.0500

power = 0.8000

delta = -0.0077 (difference)

p1 = 0.0171

p2 = 0.0094

Estimated sample sizes:

N = 6,922

N per group = 3,461

.



Next Example:



- * Let's imagine a study looking at the effects of concussion in those who try a new 'super-thin and comfortable' bicycle helmet and fall with blunt head trauma
- Proportion of subjects with concussion in control group (no helmet) 47%
- Proportion of subjects with concussion in experimental group (wearing helmet) 59%
- 32 patient enrolled in control group
- 27 patients enrolled in experimental group
- What is estimated power of study?

```
. power twoproportions 0.47 0.59, n1(32) n2(27)
```

Estimated power for a two-sample proportions test

Pearson's chi-squared test

Ho: $p_2 = p_1$ versus Ha: $p_2 \neq p_1$

Study parameters:

alpha = 0.0500

N = 59

N1 = 32

N2 = 27

N2/N1 = 0.8438

delta = 0.1200 (difference)

p1 = 0.4700

p2 = 0.5900

Estimated power:

power = 0.1489

Sample Size Calculation:

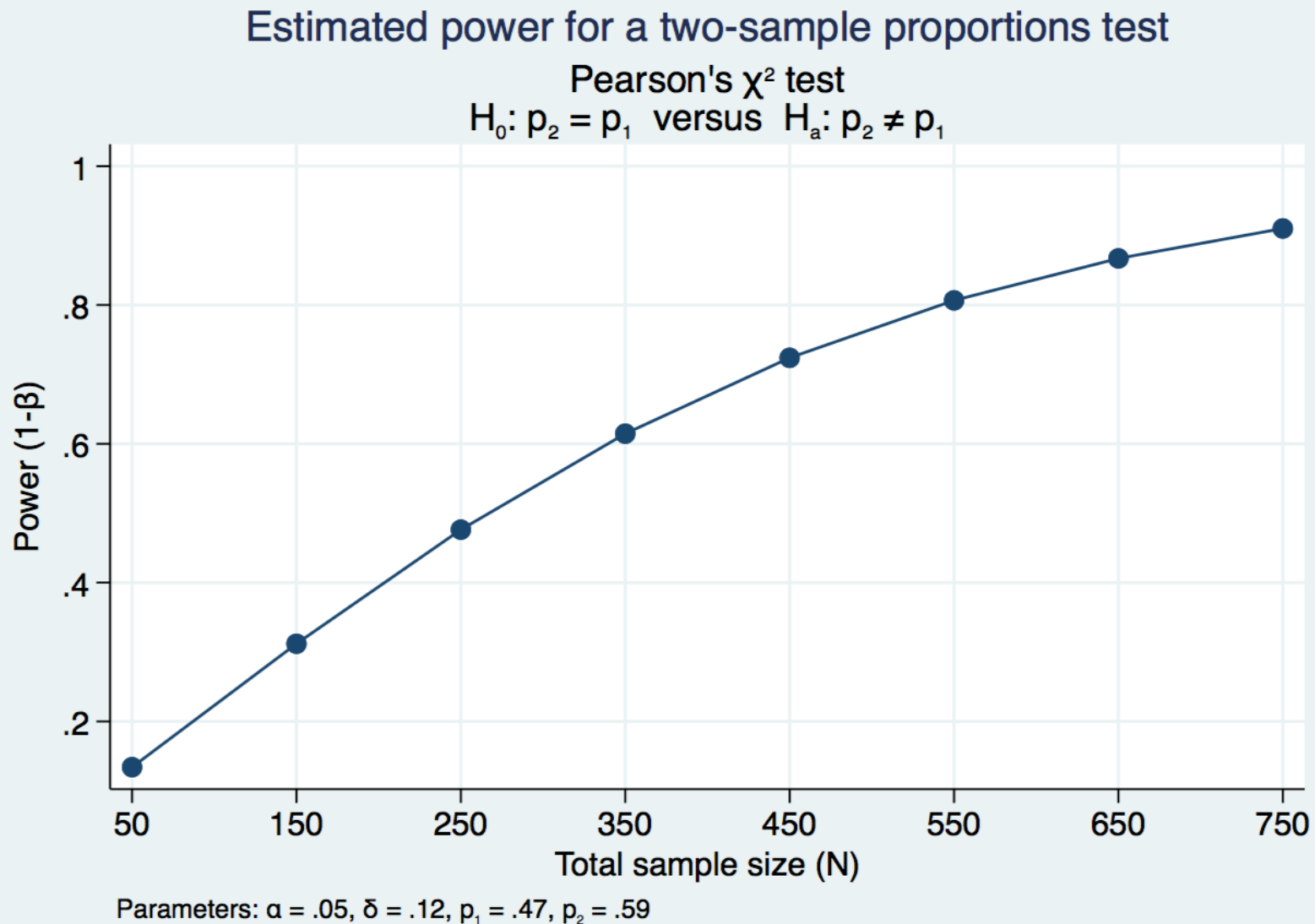
```
. power twoproportions 0.47 0.59, n (50(100)750)
```

Estimated power for a two-sample proportions test
Pearson's chi-squared test

Ho: $p_2 = p_1$ versus Ha: $p_2 \neq p_1$

alpha	power	N	N1	N2	delta	p1	p2
.05	.1341	50	25	25	.12	.47	.59
.05	.3119	150	75	75	.12	.47	.59
.05	.4763	250	125	125	.12	.47	.59
.05	.6146	350	175	175	.12	.47	.59
.05	.7239	450	225	225	.12	.47	.59
.05	.8067	550	275	275	.12	.47	.59
.05	.8672	650	325	325	.12	.47	.59
.05	.9102	750	375	375	.12	.47	.59

. power twoproportions 0.47 0.59, n (50(100)750) graph
Sample Size Curve:



Other Commands to Know:

- Power onemeans
- Power twomeans
- Power pairedmeans
- Power oneproportion
- Power twoproportions
- Power oneway (ANOVA)
- Power mcc
- Power trend
- Power cox (proportional hazards)
- Power log rank

stata sample size calculation - x

Secure | <https://www.google.com/search?q=stata+sample+size+calculation&oq=stata&aqs=chrome.1.69i5>

stata sample size calculation

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Power and sample size | Stata
www.stata.com > Products > Features ▼
Browse Stata's features for power and sample size, including power, sample size, effect size, minimum detectable effect, and much more.

[doc] Using Stata to Calculate Sample Size and Power A. Required Sample ...
sda.berkeley.edu/dlab/sampling/stata-npow.doc ▼
Using Stata to Calculate Sample Size and Power. A. Required Sample Size (for a given alpha and power). 1. For a single measurement (a proportion) in one ...

STATA TIPS #1: POWER & SAMPLE SIZE | Timberlake Consultants
www.timberlake.co.uk/news/stata-tips-1-power-sample-size/ ▼
A crucial step in designing an experiment is determining the sample size, the statistical power and detectable effect size. ... Use PSS in Stata 14 for your experimental needs.

Tour of power and sample sizes in Stata® - YouTube
 <https://www.youtube.com/watch?v=szNkh8Z7Op8> ▼
Jun 9, 2013 - Uploaded by Stata
Explore the power and sample-size methods introduced in Stata 13, including solving for power, sample ...

Power and sample size calculations using Stata® - YouTube
www.youtube.com/playlist?list=PLN5lSkQdgXWmExGRjdy0s0VCdYnzGMZrT ▼
Mar 2, 2015 - Sample size calculation for comparing a sample mean to a reference value ... Calculating power for two independent proportions using Stata®.

Power Analysis for Two-group Independent sample t-test | Stata Data ...
<https://stats.idre.ucla.edu/stata/.../power-analysis-for-two-group-independent-sample-t-...> ▼
In Stata, it is fairly straightforward to perform power analysis for comparing means. For example, we can use Stata's sampsi command for our calculation as ...

Multiple Regression Power Analysis | Stata Data Analysis Examples ...
<https://stats.idre.ucla.edu/stata/dae/multiple-regression-power-analysis/> ▼
Introduction. Power analysis is the name given to the process for determining the sample size for a research study. The technical definition of power is that it is ...

← → ↻ StataCorp LP [US] | https://www.stata.com/features/power-and-sample-size/#

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Power and sample size

Before you conduct your experiment, determine the sample size needed to detect meaningful effects without wasting resources. Do you intend to perform tests of means, variances, proportions, or correlations? Do you plan to fit a one-way, two-way, or repeated-measures ANOVA model? Do you want to fit a Cox proportional-hazards model or compare survivor functions using a log-rank test or exponential regression? Use Stata's **power** commands or interactive Control Panel to compute power and sample size, create customized tables, and automatically graph the relationships between power, sample size, and effect size for your planned study. And much more.

Watch A tour of power and sample size.
Watch New power and sample-size features.

Classic comparisons

- Means (t-tests) Updated
- Proportions Updated
- Variances
- Correlations
- McNemar's test
- Clustered data New

ANOVA

- One-way models
- Two-way models
- Repeated-measures models

Linear regression New

- Slope test
- Coefficient-of-determination test
- Partial-correlation test

Watch Power analysis for cluster randomized designs and linear regression.

Contingency tables

- Cochran–Mantel–Haenszel test
- Matched case–control studies
- Cochran–Armitage trend test

Cluster randomized designs New

- One-sample mean
- Two-sample means
- One-sample proportion
- Two-sample proportions
- Log-rank test

Watch Power analysis for cluster randomized designs and linear regression.

Survival analysis

- Log-rank test of survival functions Updated
- Cox proportional hazards model
- Exponential regression
- Clustered data New

Solve for

- Power
- Sample size
- Number of clusters New
- Cluster size New
- Effect size (minimum detectable effect)

Specify lists of

- Alpha values
- Power levels
- Beta values
- Sample sizes
- Ratios of sample sizes
- And more

Multiple scenarios using

- All combinations of values
- Parallel lists of values

Control panel interface

- Select analysis type from descriptive summaries
- Specify list of power, sample size, or other levels
- Automated tables and graphs
- Customize tables and graphs
- Command interface too (of course)

Designs

- Matched case–control studies
- Cohort studies
- Cross-sectional studies
- Balanced
- Unbalanced
- Cluster randomized designs

Tables

- Automated
- Customized

Graphs

- Automated
- Customized
- Simple or comparative

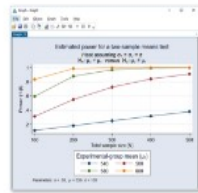
Save results to dataset

Add your own methods

Additional resources

- Power and Sample-Size Reference Manual

Watch Power and sample size tutorials

Resources:

- Older sampsi command no longer in version 15

Thank You!

* Kristen Aiemjoy, PHD in progress

- A truly awesome teacher!

* Biftu Mengesha, MD

- Gave excellent lecture last year

