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The Stata® News

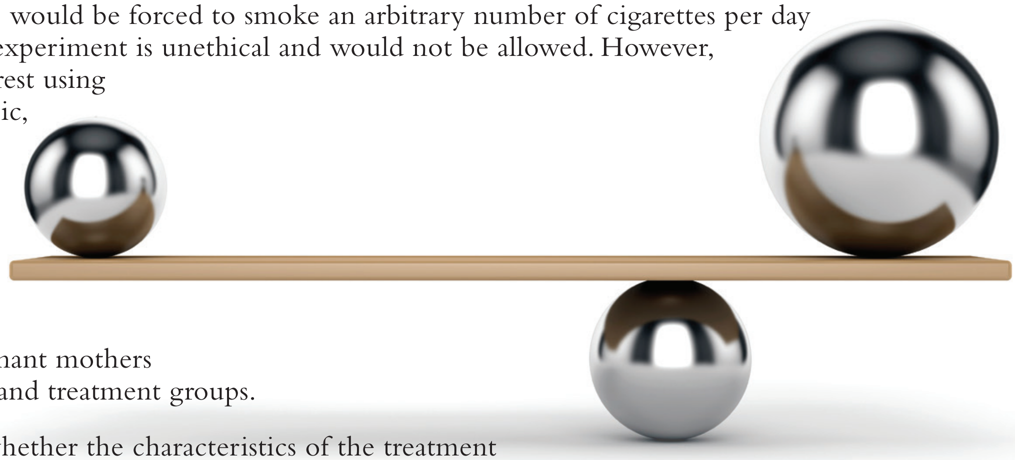
Statistics Graphics Data Management & Analysis

In the spotlight: Treatment effects

A delicate balancing act

Treatment-effects modeling is a fundamental tool to obtain experimental-style causal effects from observational data. Ideally, we would conduct an experiment, but for ethical or financial reasons, an experiment sometimes is not feasible.

A good example is the effect of cigarette smoking (the treatment) on the birthweight of infants (the outcome). In an experiment, we would first obtain a representative sample of pregnant women. Then, some would be told not to smoke (the control group), while others would be forced to smoke an arbitrary number of cigarettes per day (the treatment group). Clearly, such an experiment is unethical and would not be allowed. However, we can still answer our question of interest using Stata's suite of parametric, semiparametric, and nonparametric treatment-effects estimators.



Suppose we want to tackle this question using **teffects**. For our estimates to be trustworthy, we have to guarantee that once we control for observable characteristics, it is as if pregnant mothers had been randomly assigned to control and treatment groups.

In an experiment, it is easy to inspect whether the characteristics of the treatment and control groups are equivalent. We simply need to look at the data as observed. For instance, the mothers in both groups should have the same age and level of education on average, and if we plotted the density of both groups, they should look the same.

However, this is not the case with observational data. Instead, we inspect whether our treatment-effects model reweights the data in such a way that the model-adjusted distribution of the mothers' characteristics is equivalent across groups.

The balancing act in action

We model the birthweight (**bweight**) as a function of the number of prenatal visits (**nprenatal**), whether the mother is married (**mmarried**), and whether this baby is her first pregnancy (**fbaby**). The treatment, smoking during pregnancy (**mbsmoke**), is modeled as a function of the same variables and with regard to whether the mother consumed alcohol during her pregnancy. We type

```
. webuse cattaneo2, clear
(Excerpt from Cattaneo (2010) Journal of Econometrics 155: 138-154)

. teffects ipwra (bweight nprenatal i.mmarried i.fbaby)
                 (mbsmoke i.mmarried i.alcohol i.fbaby nprenatal)
```

We do not show the output, but suffice it to say that the effect of smoking is large and decidedly significant.

Continued on p. 2

The Stata News
Executive Editor..............Karen Strope
Production Supervisor .....Annette Fett

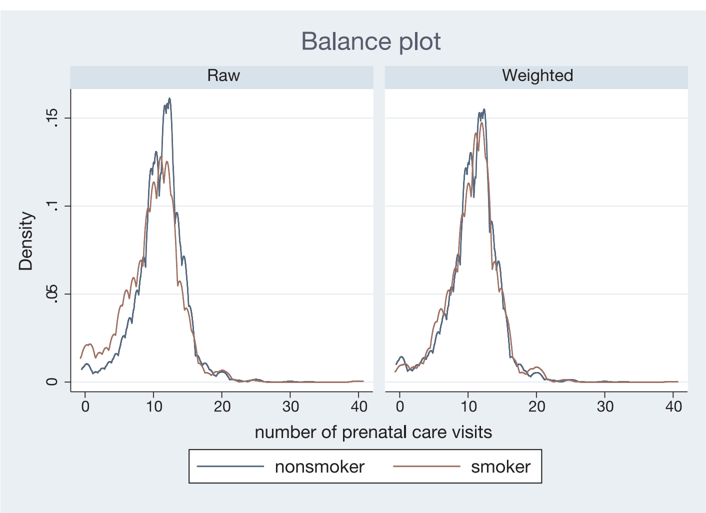
To obtain balancing diagnostics of the averages and variances of the mothers' characteristics across groups, we type

```
. tebalance summarize
  Covariate balance summary
                                          Raw      Weighted

                  Number of obs =        4,642      4,642.0
                  Treated obs   =          864      2,318.7
                  Control obs   =        3,778      2,323.3


                 Standardized differences          Variance ratio
                        Raw     Weighted           Raw   Weighted

        mmarried
         married   -.5953009   -.0002835      1.335944   1.000247

         alcohol
               1    .3222725   -.0031106      4.509207   .9838918

           fbaby
             Yes   -.1663271    .0131381      .9430944   1.003143

       nprenatal   -.2837987   -.0154989      1.430129   1.044148
```

The values in the Raw columns show that without controlling for covariates, the groups are very different. The values in the Weighted columns show the differences in means and the ratio of the variances of the control and treatment groups after reweighting for the covariates. The mean differences are all near zero, and the variance ratios are all close to one. These diagnostics suggest that after we control for the covariates, it is as if we had randomly assigned the mothers to either the control group or the treatment group.

We can also inspect this graphically by plotting the distribution before fitting our model and the distribution after weighting. We do this for the number of prenatal visits.

```
. tebalance density nprenatal
```



The density graphs confirm what we observe from our diagnostics.

Can we do a test?

What we have described so far is qualitative: we have diagnostics but not a formal test. We can, however, do a test. Intuitively, the score equations for the treatment and control groups should be the same. We can test whether this is the case by using the score equations as moments in an overidentification test. The null hypothesis is that our covariates are balanced. We type

```
. tebalance overid
Overidentification test for covariate balance
         H0: Covariates are balanced:

         chi2(5)       =    4.0425
         Prob > chi2   =    0.5433
```

We cannot reject the null hypothesis. This implies that there is no evidence that our covariates remain imbalanced after reweighting.

Parting words

Sometimes, we cannot conduct experiments, but we can obtain experimental-style causal effects from observational data. For this to happen, we need to be able to say that our treatment-effects model reweights the data in such a way that the model-adjusted distribution of the covariates is equivalent across treatment groups. We can verify this with the postestimation diagnostic tests provided in **teffects**.

—Enrique Pinzon
Senior Econometrician, StataCorp

In the spotlight: irt

New to Stata 14 is a suite of commands to fit item response theory (IRT) models. IRT models are used to analyze the relationship between the latent trait of interest and the items intended to measure the trait. Stata's **irt** commands provide easy access to some of the commonly used IRT models for binary and polytomous responses, and **irtgraph** commands can be used to plot characteristic functions and information functions.

To learn more about Stata's IRT features, refer to the [IRT] *Item Response Theory Reference Manual*; here I want to go beyond the manual and show you some examples of what you can do with a little bit of Stata code.

The dataset used in the examples contains answers to nine binary items, **q1–q9**. I do not show much Stata code here; see the accompanying blog entry at **blog.stata.com** for details, including replication code.

Example 1

To get started, I want to show you how simple IRT analysis is in Stata.

When I use the nine binary items **q1–q9**, all I need to type to fit a 1PL model is

```
. irt 1pl q*
```

Equivalently, I can use a dash notation or explicitly spell out the variable names:

```
. irt 1pl q1-q9
. irt 1pl q1 q2 q3 q4 q5 q6 q7 q8 q9
```

I can also use parenthetical notation:

```
. irt (1pl q1-q9)
```

Parenthetical notation is not very useful for a simple IRT model, but it comes in handy when you want to fit a single IRT model to combinations of binary, ordinal, and nominal items:

```
. irt (1pl q1-q5) (1pl q6-q9) (pcm x1-x10) ...
```

IRT graphs are equally simple to create in Stata. For example, to plot item characteristic curves (ICCs) for all the items in a model, I type

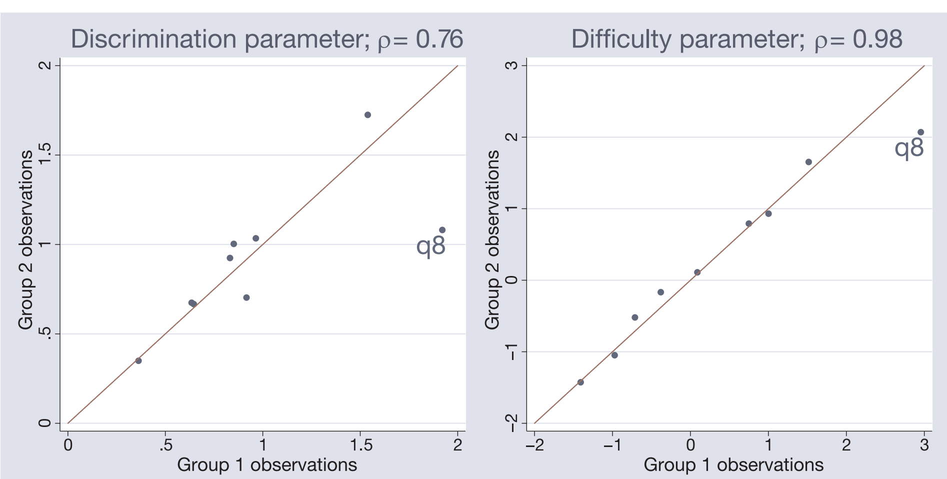
```
. irtgraph icc
```

Yes, that's it!

Example 2

Sometimes, I want to fit the same IRT model on two different groups and see how the estimated parameters differ between the groups. This exercise can be part of investigating differential item functioning (DIF) or parameter invariance.

I split the data into two groups, fit two separate 2PL models, and create two scatterplots to see how close the parameter estimates for discrimination and difficulty are for the two groups. For simplicity, my group variable is 1 for odd-numbered observations and 0 for even-numbered observations.



We see that the estimated parameters for item **q8** appear to differ between the two groups.

Example 3

Continuing with the example above, I want to show you how to use a likelihood-ratio test to test for item-parameter differences between groups.

Using item **q8** as an example, I want to fit one model that constrains item **q8** parameters to be the same between the two groups and fit another model that allows these parameters to vary.

The first model is easy. I can fit a 2PL model for the entire dataset, which implicitly constrains the parameters to be equal for both groups. I store the estimates under the name **equal**.

```
. quietly irt 2pl q*
. estimates store equal
```

To estimate the second model, I need the following:

```
. irt (2pl q1-q7 q9) (2pl q8 if odd) (2pl q8 if !odd)
```

Unfortunately, this is illegal syntax. I can, however, split the item into two new variables where each variable is restricted to the required subsample:

```
. generate q8_1 = q8 if odd
. generate q8_2 = q8 if !odd
```

I estimate the second IRT model, this time with items **q8_1** and **q8_2** taking the place of the original **q8**:

```
. quietly irt 2pl q1-q7 q8_1 q8_2 q9
. estat report q8_1 q8_2

Two-parameter logistic model                    Number of obs     =        800
Log likelihood = -4116.2064
```

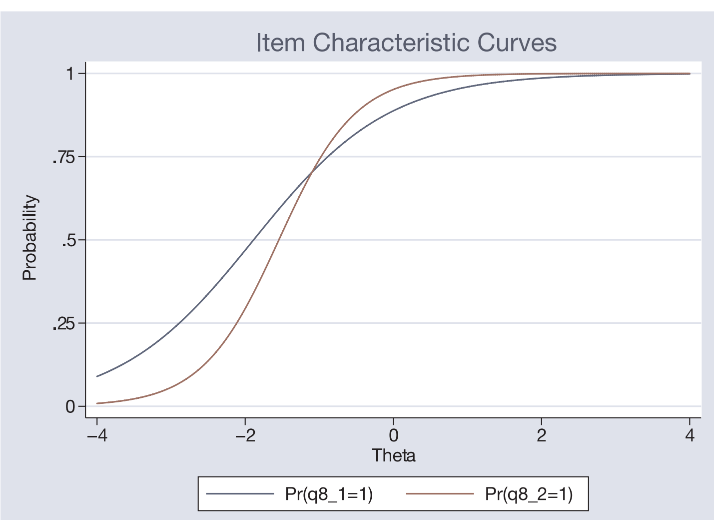
	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
q8_1						
Discrim	1.095867	.2647727	4.14	0.000	.5769218	1.614812
Diff	-1.886126	.3491548	-5.40	0.000	-2.570457	-1.201795
q8_2						
Discrim	1.93005	.4731355	4.08	0.000	1.002721	2.857378
Diff	-1.544908	.2011934	-7.68	0.000	-1.93924	-1.150577

Now, I can perform the likelihood-ratio test:

```
. lrtest equal ., force

Likelihood-ratio test       LR chi2(2)   = 4.53
(Assumption: equal nested in .)   Prob > chi2 = 0.1040
```

The test suggests the first model is preferable even though the two ICCs clearly differ:

```
. irtgraph icc q8_1 q8_2, ylabel(0(.25)1)
```



Summary

IRT models are used to analyze the relationship between the latent trait of interest and the items intended to measure the trait. Stata's **irt** commands provide easy access to some of the commonly used IRT models, and **irtgraph** commands implement the most commonly used IRT plots. With just a few extra steps, you can easily create customized graphs, such as the ones demonstrated above, which incorporate information from separate IRT models. Don't forget to see the accompanying blog entry at **blog.stata.com** that shows the Stata code used in this article.

—Rafal Raciborski
Senior Statistical Developer, StataCorp

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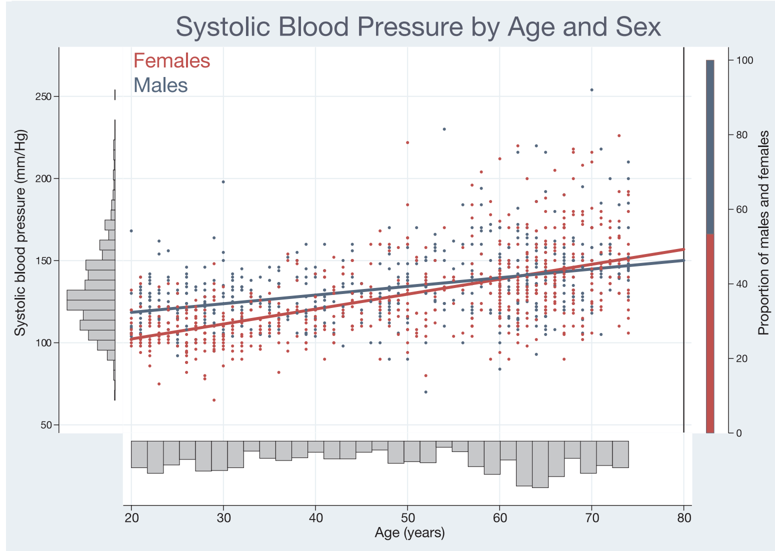

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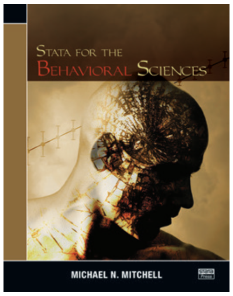
New from Stata Press

Stata for the Behavioral Sciences



Author: Michael N. Mitchell
Copyright: 2015
Price: $62.00

Estimated ship date: September 7

Stata for the Behavioral Sciences, by Michael Mitchell, is the ideal reference for researchers using Stata to fit ANOVA models and other models commonly applied to behavioral science data. Drawing on his education in psychology and his experience in consulting, Mitchell uses terminology and examples familiar to the reader as he demonstrates how to fit a variety of models, how to interpret results, how to understand simple and interaction effects, and how to explore results graphically.

Although this book is not designed as an introduction to Stata, it is appealing even to Stata novices. Throughout the text, Mitchell thoughtfully addresses any features of Stata that are important to understand for the analysis at hand. He also is careful to point out additional resources such as related videos from Stata's YouTube channel.

The book is divided into five sections. The first section contains a chapter that introduces Stata commands for descriptive statistics and another that covers basic inferential statistics such as one- and two-sample *t* tests.

The second section focuses on between-subjects ANOVA modeling. The discussion moves from one-way ANOVA models to ANCOVA models to two-way and three-way ANOVA models. In each case, special attention is given to the use of commands such as **contrast** and **margins** for testing specific hypotheses of interest. Mitchell also emphasizes the understanding of interactions through contrasts and graphs. Underscoring the importance of planning any experiment, he discusses power analysis for *t* tests, for one- and two-way ANOVA models, and for ANCOVA models.

Section three of the book extends the discussion in the previous section to models for repeated-measures data and for longitudinal data.

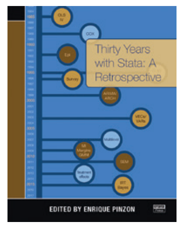
The fourth section of the book illustrates the use of the **regress** command for fitting multiple regression models. Mitchell then turns his attention to tools for formatting regression output, for testing assumptions, and for model building. This section ends with a discussion of power analysis for simple, multiple, and nested regression models.

The final section has a tone that differs from the first four. Rather than focusing on a particular type of analysis, Mitchell describes elements of Stata. He first discusses estimation commands and similarities in syntax from command to command. Then, he details a set of postestimation commands that are available after most estimation commands. Another chapter provides an overview of data management commands. This section ends with a chapter that will be of particular interest to anyone who has used IBM® SPSS®; it lists commonly used SPSS® commands and provides equivalent Stata syntax.

This book is an easy-to-follow guide to analyzing data using Stata for researchers in the behavioral sciences and a valuable addition to the bookshelf of anyone interested in applying ANOVA methods to a variety of experimental designs.

Read the table of contents and order online at **stata-press.com/books/stata-for-the-behavioral-sciences**.

Thirty Years with Stata: A Retrospective



Editor: Enrique Pinzon
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Price: $25.00

This volume is a sometimes serious and sometimes whimsical retrospective of Stata, its development, and its use over the last 30 years.

We simply wanted to celebrate the relationship between Stata users and Stata software. This volume holds something interesting for everyone.

Read the table of contents and order online at **stata-press.com/books/thirty-years-with-stata**.

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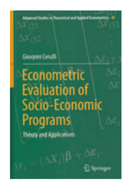

Author: Giovanni Cerulli
Publisher: Springer
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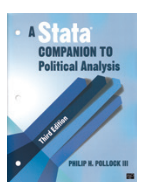

Author: Philip H. Pollock III
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July 28–29, 2016, at the Gleacher Center

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stata.com/meeting/nordic-and-baltic15

Canberra, Australia September 24–25, 2015
stata.com/meeting/australia15

London, UK September 10–11, 2015
stata.com/meeting/uk15

Madrid, Spain October 22, 2015
stata.com/meeting/spain15

Lisbon, Portugal September 18, 2015
stata.com/meeting/portugal15

Florence, Italy November 12–13, 2015
stata.com/meeting/italy15

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Public training schedule

Using Stata Effectively: Data Management, Analysis, and Graphics Fundamentals

September 22–23, 2015, Washington, DC
October 13–14, 2015, Washington, DC

Aimed at both new Stata users and those who wish to learn techniques for efficient day-to-day use of Stata, this course enables you to use Stata in a reproducible manner, making collaborative changes and follow-up analyses much simpler. Exercises and Stata examples supplement the lessons.

Survey Data Analysis Using Stata

October 15–16, 2015, Washington, DC

Set up and analyze data from complex survey designs. The course covers the sampling methods used to collect survey data and how they affect the estimation of totals, ratios, and regression coefficients. The course also covers Stata's support for many survey variance estimators, including linearization, balanced and repeated replications (BRR), and jackknife.

Multilevel/Mixed Models Using Stata

October 19–20, 2015, Washington, DC

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