

What is everything you always wanted to know about contrasts in Stata, but were afraid to ask?

Authored by
stats writer

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Contrasts in Stata refer to the comparison of different groups or categories within a dataset. They allow researchers to test for differences between these groups and determine which ones are significantly different from each other. Some common questions that researchers may have about contrasts in Stata include how to set them up, interpret the results, and choose the appropriate type of contrast for their data. Despite their importance in statistical analysis, many individuals may be hesitant to ask for clarification on these topics. This short formal description aims to provide a comprehensive overview of contrasts in Stata, addressing any potential doubts and concerns that individuals may have, and encouraging them to confidently incorporate this technique into their research.

Everything you always wanted to know about contrasts* (*But were afraid to ask) | Stata FAQ

Everything? No, that's a gross exaggeration. If you want to know everything about contrasts you will need read several other sources in addition to this page. Here are our suggestions:

Mitchell, M.N. 2012. Interpreting and Visualizing Regression Models Using Stata. College Station, TX: Stata Press.

StataCorp. 2009. Stata 11 Base Reference Manual. College Station, TX: Stata Press. Topics: contrast, margins, margins, comtrast, margins, pwcompare, marginsplot and pwcompare.

This page will cover a lot of examples without a lot of verbiage. But first, one more thing.

What is a contrast?

A contrast is a one degree of freedom test comparing means. One degree of freedom? You mean I can only compare two means? No, you can compare more than two means if you do it correctly. For example, you can compare the average of the means of groups 1 and 2 versus the mean of group 3. This contrast involves three means but uses only one degree of freedom.

Let's begin.

One-factor Model

We will begin with a one-factor model with four levels. First, we will load the data run the model, get the cell means and plot them. We can run the model using either anova or regress. Either way we will get the same results. We will use the anova command this time.

use <https://stats.idre.ucla.edu/stat/data/hsbanova>, clear

anova write grp

Number of obs = 200 R-squared = 0.1939

Root MSE = 8.5752 Adj R-squared = 0.1815

Source | Partial SS df MS F Prob > F

```
-----+-----
Model | 3466.19389 3 1155.39796 15.71 0.0000
|
grp | 3466.19389 3 1155.39796 15.71 0.0000
|
Residual | 14412.6811 196 73.5340873
-----+-----
Total | 17878.875 199 89.843593
```

margins grp // get cell means

Adjusted predictions Number of obs = 200

Expression : Linear prediction, predict()

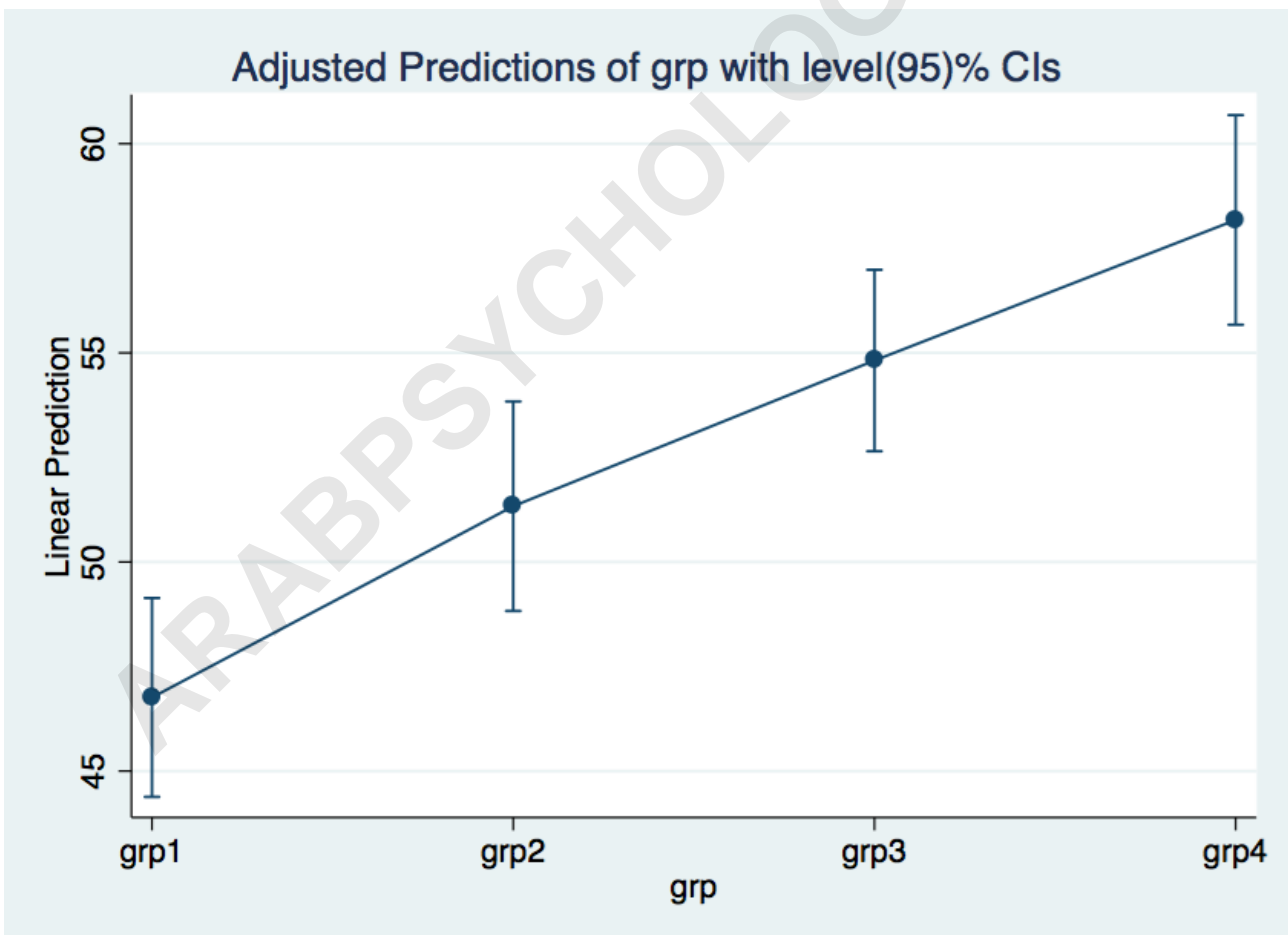
| Delta-method

| Margin Std. Err. z P>|z|

grp |

1		46.76	1.212717	38.56	0.000	44.38312	49.13688
2		51.33333	1.278316	40.16	0.000	48.82788	53.83879
3		54.81667	1.107054	49.52	0.000	52.64688	56.98645
4		58.17778	1.278316	45.51	0.000	55.67233	60.68323

marginsplot



* Reference group contrast

contrast r.grp, effects

Contrasts of marginal linear predictions

Margins : asbalanced

```
-----
| df F P>F
```

```
-----+-----
grp |
(2 vs 1) | 1 6.74 0.0102
(3 vs 1) | 1 24.07 0.0000
(4 vs 1) | 1 41.99 0.0000
Joint | 3 15.71 0.0000
```

```
|
Residual | 196
```

```
-----
| Contrast Std. Err. t P>|t|
```

```
-----+-----
grp |
(2 vs 1) | 4.573333 1.762036 2.60 0.010 1.098349
8.048318
(3 vs 1) | 8.056667 1.642026 4.91 0.000 4.818359
```

11.29497

**(4 vs 1) | 11.41778 1.762036 6.48 0.000 7.942793
14.89276**

*** Change the reference group to grp3.**

**contrast rb3.grp, effects // change reference group to
grp3**

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp |
(1 vs 3) | 1 24.07 0.0000
(2 vs 3) | 1 4.24 0.0407
(4 vs 3) | 1 3.95 0.0482
Joint | 3 15.71 0.0000

|
Residual | 196

| Contrast Std. Err. t P>|t|
 -----+

grp |

**(1 vs 3) | -8.056667 1.642026 -4.91 0.000 -11.29497
 -4.818359**

**(2 vs 3) | -3.483333 1.691053 -2.06 0.041 -6.818328 -
 .1483388**

**(4 vs 3) | 3.361111 1.691053 1.99 0.048 .0261165
 6.696106**

*** Adjacent group contrast**

contrast a.grp, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F
 -----+

grp |

(1 vs 2) | 1 6.74 0.0102

(2 vs 3) | 1 4.24 0.0407

(3 vs 4) | 1 3.95 0.0482

Joint | 3 15.71 0.0000

|

Residual | 196

| Contrast Std. Err. t P>|t|

grp |

**(1 vs 2) | -4.573333 1.762036 -2.60 0.010 -8.048318
-1.098349**

**(2 vs 3) | -3.483333 1.691053 -2.06 0.041 -6.818328 -
.1483388**

**(3 vs 4) | -3.361111 1.691053 -1.99 0.048 -6.696106 -
.0261165**

*** Grand mean contrast**

contrast g.grp, effects

Contrasts of marginal linear predictions

Margins : asbalanced

```

-----
| df F P>F
-----+-----
grp |
(1 vs mean) | 1 32.62 0.0000
(2 vs mean) | 1 1.74 0.1888
(3 vs mean) | 1 4.24 0.0408
(4 vs mean) | 1 24.56 0.0000
Joint | 3 15.71 0.0000
|
Residual | 196
-----

-----
| Contrast Std. Err. t P>|t|
-----+-----
grp |
(1 vs mean) | -6.011944 1.052672 -5.71 0.000 -8.087962
-3.935927
(2 vs mean) | -1.438611 1.09079 -1.32 0.189 -3.589803
.7125804
(3 vs mean) | 2.044722 .9927543 2.06 0.041 .0868706

```

4.002574

**(4 vs mean) | 5.405833 1.09079 4.96 0.000 3.254642
7.557025**

*** Helmert contrast**

contrast h.grp, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp |

(1 vs >1) | 1 32.62 0.0000

(2 vs >2) | 1 11.35 0.0009

(3 vs 4) | 1 3.95 0.0482

Joint | 3 15.71 0.0000

|

Residual | 196

| Contrast Std. Err. t P>|t|

grp	Contrast	Std. Err.	t	P>	t
(1 vs >1)	-8.015926	1.403562	-5.71	0.000	-10.78395
(2 vs >2)	-5.163889	1.532647	-3.37	0.001	-8.186484
(3 vs 4)	-3.361111	1.691053	-1.99	0.048	-6.696106

*** Polynomial contrast**

contrast p.grp, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

(linear)	1	46.23	0.0000
(quadratic)	1	0.25	0.6202

(cubic) | 1 0.03 0.8572

Joint | 3 15.71 0.0000

|

Residual | 196

| **Contrast Std. Err. t P>|t**

-----+-----
grp |

(linear) | 4.219088 .62051 6.80 0.000 2.995354 5.442821

**(quadratic) | -.3030556 .6105546 -0.50 0.620 -1.507156
.9010444**

(cubic) | .1082008 .6004343 0.18 0.857 -1.07594 1.292342

*** User defined contrast grp1 vs grp4**

contrast {grp 1 0 0 -1}, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| **df F P>F**

-----+-----

grp | 1 41.99 0.0000

|

Residual | 196

| **Contrast Std. Err. t P>|t|**

-----+-----

grp |

(1) | -11.41778 1.762036 -6.48 0.000 -14.89276 -7.942793

*** Nonpairwise user defined contrast, grp2 vs average of grp3 & grp4**

contrast {grp 0 1 -.5 -.5}, effects // nonpairwise contrast

Contrasts of marginal linear predictions

Margins : asbalanced

| **df F P>F**

-----+-----

grp | 1 11.35 0.0009

|

Residual | 196

| **Contrast Std. Err. t P>|t|**

-----+

grp |

(1) | -5.163889 1.532647 -3.37 0.001 -8.186484 -2.141293

*** All pairwise comparisons with Tukey adjustment**

pwcompare grp, mcompare(tukey) effects group

Pairwise comparisons of marginal linear predictions

Margins : asbalanced

| **Number of**

| **Comparisons**

-----+

grp | 6

| Tukey

| Margin Std. Err. Groups

grp |

1 | 46.76 1.212717

2 | 51.33333 1.278316 A

3 | 54.81667 1.107054 AB

4 | 58.17778 1.278316 B

Note: Margins sharing a letter in the group label are not significantly different at the 5% level.

Note: The tukey method requires balanced data for proper level coverage. A factor was found to be unbalanced.

| Number of

| Comparisons

grp | 6

| Tukey Tukey

| Contrast Std. Err. t P>|t|

grp |

2 vs 1	4.573333	1.762036	2.60	0.049	.0075312	9.139136
3 vs 1	8.056667	1.642026	4.91	0.000	3.801836	12.3115
4 vs 1	11.41778	1.762036	6.48	0.000	6.851976	15.98358
3 vs 2	3.483333	1.691053	2.06	0.170	-.8985349	7.865202
4 vs 2	6.844444	1.807811	3.79	0.001	2.16003	11.52886
4 vs 3	3.361111	1.691053	1.99	0.196	-1.020757	7.742979

Note: The tukey method requires balanced data for proper level coverage. A factor was found to be unbalanced.

Two-factor Model

We again load the data and run the regression model this time.

use <https://stats.idre.ucla.edu/stat/data/hsbanova>, clear

regress write grp##female

Source | SS df MS Number of obs = 200

-----+----- F(7, 192) = 11.05

Model | 5135.17494 7 733.59642 Prob > F = 0.0000

Residual | 12743.7001 192 66.3734378 R-squared = 0.2872

-----+----- **Adj R-squared = 0.2612**

Total | 17878.875 199 89.843593 Root MSE = 8.147

-----+-----
write | Coef. Std. Err. t P>|t|

grp |

2 | 7.31677 2.458951 2.98 0.003 2.466743 12.1668

3 | 10.10248 2.292658 4.41 0.000 5.580454 14.62452

4 | 16.75286 2.525696 6.63 0.000 11.77119 21.73453

1.female | 9.136876 2.311726 3.95 0.000 4.577236 13.69652

grp#female |

2 1 | -5.029733 3.357123 -1.50 0.136 -11.65131 1.591845

3 1 | -3.721697 3.128694 -1.19 0.236 -9.892723 2.449328

4 1 | -9.831208 3.374943 -2.91 0.004 -16.48793 -3.174482

**_cons | 41.82609 1.698765 24.62 0.000 38.47545
45.17672**

*** Test interaction and main effects**

contrast grp##female

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp	 3	18.29	0.0000
female	 1	14.83	0.0002
grp#female	 3	2.89	0.0367
Residual	 192		

*** Cell means for all 8 cells**

margins grp#female

Adjusted predictions Number of obs = 200

Expression : Linear prediction, predict()

| Delta-method

| Margin Std. Err. z P>|z|

-----+-----

grp#female |

1 0 | 41.82609 1.698765 24.62 0.000 38.49657 45.1556

1 1 | 50.96296 1.567889 32.50 0.000 47.88996 54.03597

2 0 | 49.14286 1.777819 27.64 0.000 45.6584 52.62732

2 1 | 53.25 1.662997 32.02 0.000 49.99059 56.50941

3 0 | 51.92857 1.539636 33.73 0.000 48.91094 54.9462

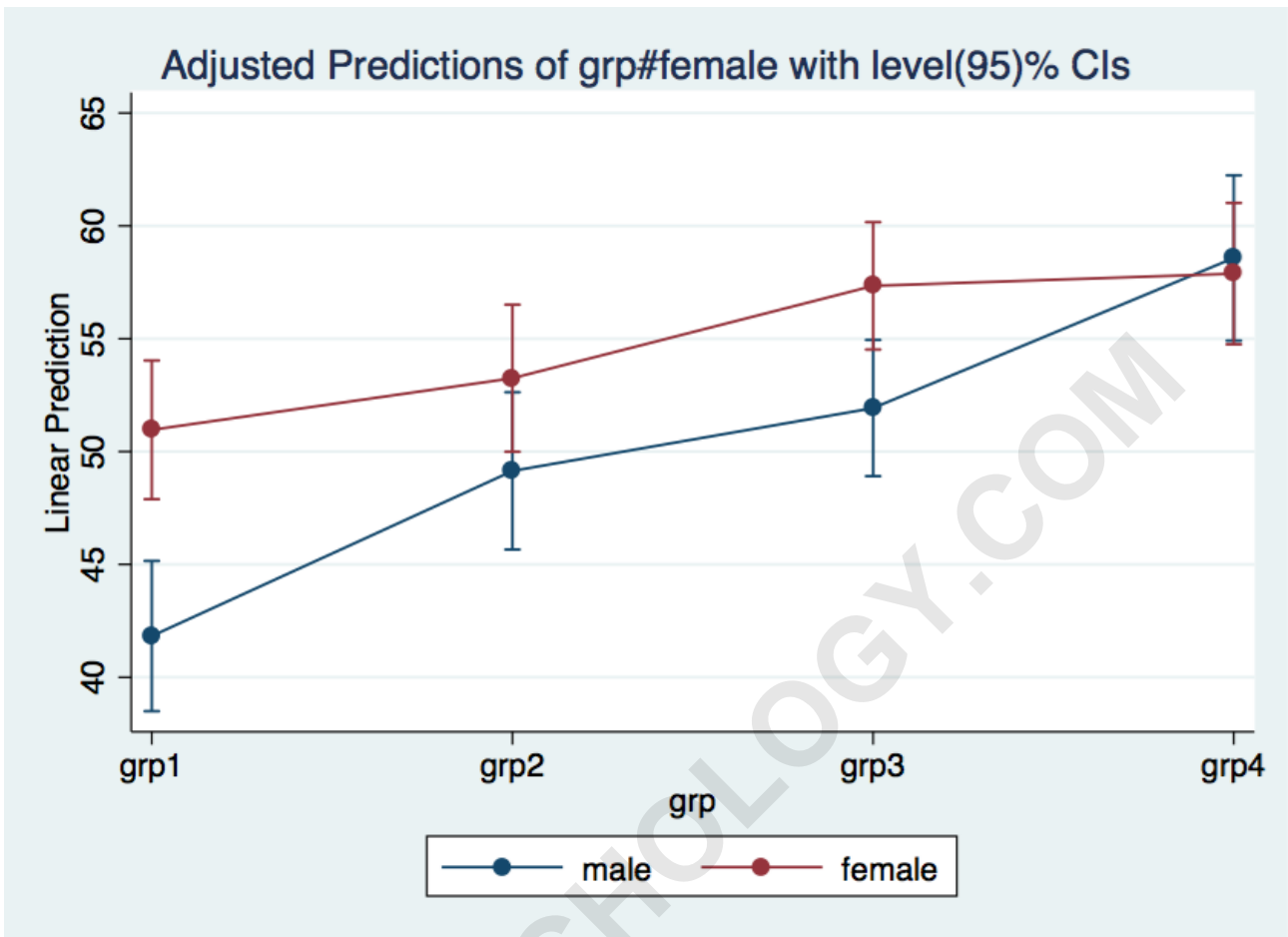
3 1 | 57.34375 1.440198 39.82 0.000 54.52101 60.16649

4 0 | 58.57895 1.869048 31.34 0.000 54.91568 62.24221

4 1 | 57.88462 1.597756 36.23 0.000 54.75307 61.01616

* Plot cell means

marginsplot



*** Simple contrasts & simple effects* Simple contrasts**

contrast r.grp@female, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+-----
grp@female |

(2 vs 1) 0 | 1 8.85 0.0033

(2 vs 1) 1 | 1 1.00 0.3183

(3 vs 1) 0 | 1 19.42 0.0000

(3 vs 1) 1 | 1 8.98 0.0031

(4 vs 1) 0 | 1 44.00 0.0000

(4 vs 1) 1 | 1 9.56 0.0023

Joint | 6 9.94 0.0000

|

Residual | 192

| Contrast Std. Err. t P>|t|
 -----+

grp@female |

(2 vs 1) 0 | 7.31677 2.458951 2.98 0.003 2.466743 12.1668

**(2 vs 1) 1 | 2.287037 2.285571 1.00 0.318 -2.221015
 6.79509**

**(3 vs 1) 0 | 10.10248 2.292658 4.41 0.000 5.580454
 14.62452**

**(3 vs 1) 1 | 6.380787 2.128954 3.00 0.003 2.181646
 10.57993**

**(4 vs 1) 0 | 16.75286 2.525696 6.63 0.000 11.77119
 21.73453**

**(4 vs 1) 1 | 6.921652 2.238549 3.09 0.002 2.506347
11.33696**

*** Simple effects**

contrast grp@female

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp@female |

0 | 3 15.33 0.0000

1 | 3 4.55 0.0042

Joint | 6 9.94 0.0000

|

Residual | 192

*** Partial interactions**

contrast female#a.grp

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+-----
female#grp |

(joint) (1 vs 2) | 1 2.24 0.1357

(joint) (2 vs 3) | 1 0.16 0.6851

(joint) (3 vs 4) | 1 3.56 0.0608

Joint | 3 2.89 0.0367

|

Residual | 192

* User defined contrast, female by grp1 vs grp4

contrast female#{grp 1 0 0 -1}

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+-----

female#grp | 1 8.49 0.0040

|

Residual | 192

*** Treatment contrast interaction**

contrast r.female#r.grp, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+-----

female#grp |

(1 vs 0) (2 vs 1) | 1 2.24 0.1357

(1 vs 0) (3 vs 1) | 1 1.41 0.2357

(1 vs 0) (4 vs 1) | 1 8.49 0.0040

Joint | 3 2.89 0.0367

|

Residual | 192

| Contrast Std. Err. t P>|t|
 -----+

female#grp |

(1 vs 0) |

**(2 vs 1) | -5.029733 3.357123 -1.50 0.136 -11.65131
 1.591845**

(1 vs 0) |

**(3 vs 1) | -3.721697 3.128694 -1.19 0.236 -9.892723
 2.449328**

(1 vs 0) |

**(4 vs 1) | -9.831208 3.374943 -2.91 0.004 -16.48793
 -3.174482**

*** Polynomial interaction**

contrast p.grp#r.female, effects

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+-----

grp#female |
(linear) (1 vs 0) | 1 7.04 0.0086
(quadratic) (1 vs 0) | 1 0.05 0.8172
(cubic) (1 vs 0) | 1 1.81 0.1805
Joint | 3 2.89 0.0367

|
Residual | 192

| Contrast Std. Err. t P>|t|

-----+-----

grp#female |
(linear) |
(1 vs 0) | -3.151245 1.187871 -2.65 0.009 -5.494197 -
.8082918
(quadratic) |
(1 vs 0) | -.2699444 1.16622 -0.23 0.817 -2.570192
2.030303
(cubic) |
(1 vs 0) | -1.537891 1.144158 -1.34 0.180 -3.794625
.7188432

*** Difference in differences examined**

***We will begin by looking at the difference between grp3 and grp4 at each level of female.**

*** grp3 vs grp4 when female = 0**

contrast {grp 0 0 -1 1}@i0.female

Contrasts of marginal linear predictions

Margins : asbalanced

```
-----
| df F P>F
-----+-----
grp@female |
(1) 0 | 1 7.54 0.0066
|
Residual | 192
-----
```

```
-----
| Contrast Std. Err.
-----+-----
grp@female |
```

(1) 0 | 6.650376 2.421532 1.874154 11.4266

*** grp3 vs grp4 when female = 1**

contrast {grp 0 0 -1 1}@i1.female

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp@female |

(1) 1 | 1 0.06 0.8017

|

Residual | 192

| Contrast Std. Err.

grp@female |

(1) 1 | .5408654 2.151045 -3.701848 4.783579

*** The same as above using a single contrast command**

contrast {grp 0 0 -1 1}@female

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp@female |

(1) 0 | 1 7.54 0.0066

(1) 1 | 1 0.06 0.8017

Joint | 2 3.80 0.0240

|

Residual | 192

| Contrast Std. Err.

grp@female |

(1) 0 | 6.650376 2.421532 1.874154 11.4266

(1) 1 | .5408654 2.151045 -3.701848 4.783579

*** Now for the actual difference in differences.**

contrast {grp 0 0 -1 1}#{female -1 1}

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

grp#female | 1 3.56 0.0608

|
Residual | 192

| Contrast Std. Err.

grp#female |

(1) (1) | -6.109511 3.238952 -12.49801 .278988

*** Arbitrary contrast within interaction**

contrast {grp#female 1 0 0 0 0 0 -1}

Contrasts of marginal linear predictions

Margins : asbalanced

	df	F	P>F	
-----+				
grp#female	1	47.42	0.0000	
Residual	192			

	Contrast Std. Err.			
-----+				
grp#female				
(1) (1)	-16.05853	2.332086	-20.65833	-11.45873

*** Check out the L matrix**

matrix list r(L)

r(L)

1b. 2. 3. 4. 0b. 1.

grp grp grp grp female female

u1.grp#

u1.female 1 0 0 -1 1 -1

1b.grp# 1b.grp# 2o.grp# 2.grp# 3o.grp# 3.grp#

0b.female 1o.female 0b.female 1.female 0b.female

1.female

u1.grp#

u1.female 1 0 0 0 0 0

4o.grp# 4.grp#

0b.female 1.female _cons

u1.grp#

u1.female 0 -1 0

Three-factor Model

use <https://stats.idre.ucla.edu/stat/data/3way>, clear

anova y a##b##c

Number of obs = 24 R-squared = 0.9689

Root MSE = 1.1547 Adj R-squared = 0.9403

Source | Partial SS df MS F Prob > F

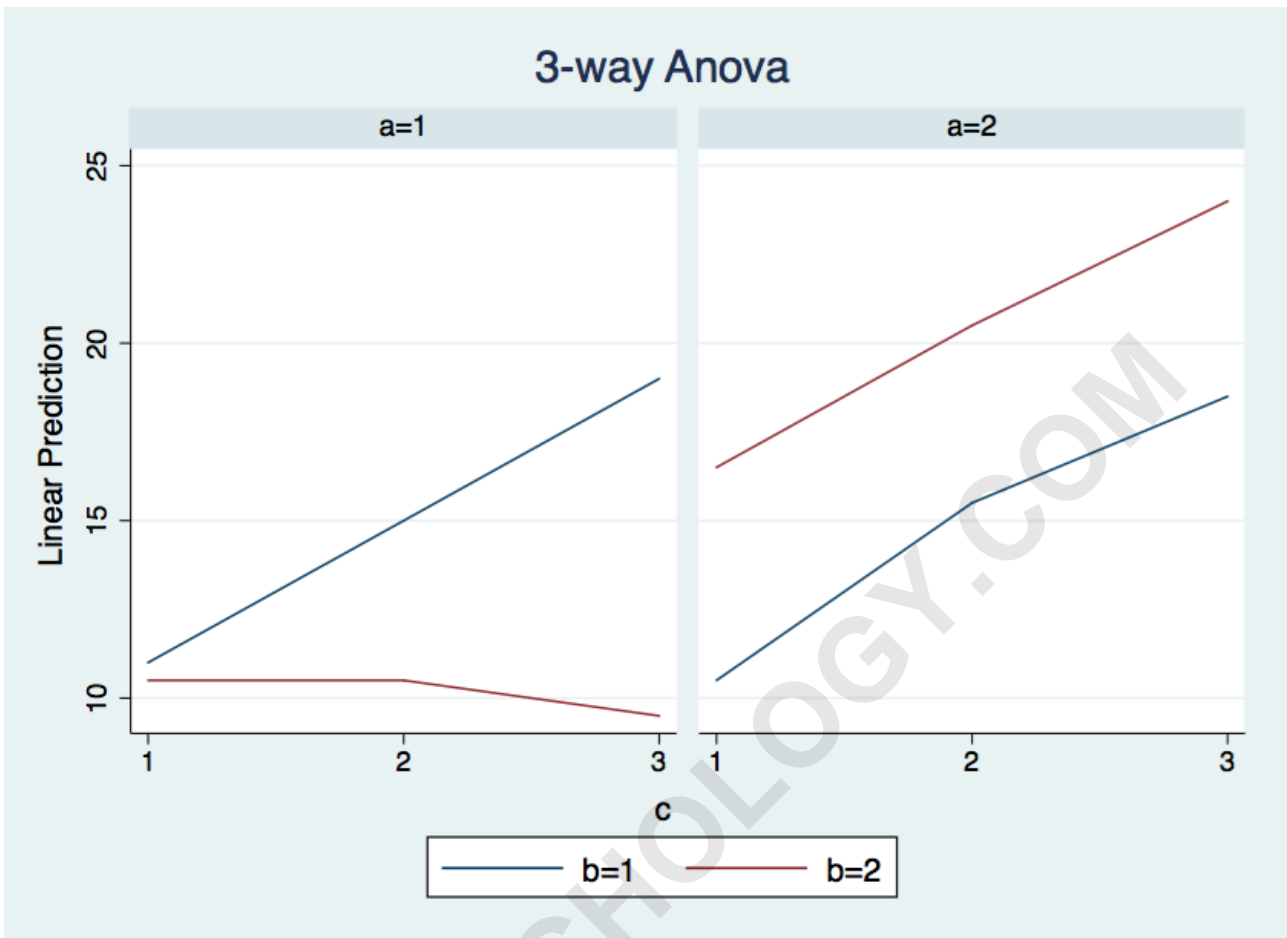
```
-----+-----
Model | 497.833333 11 45.2575758 33.94 0.0000
|
a | 150 1 150 112.50 0.0000
b | .666666667 1 .666666667 0.50 0.4930
a#b | 160.166667 1 160.166667 120.13 0.0000
c | 127.583333 2 63.7916667 47.84 0.0000
a#c | 18.25 2 9.125 6.84 0.0104
b#c | 22.5833333 2 11.2916667 8.47 0.0051
a#b#c | 18.5833333 2 9.29166667 6.97 0.0098
|
Residual | 16 12 1.33333333
-----+-----
Total | 513.833333 23 22.3405797
```

* Compute cell means for plotting

quietly margins a#b#c

* Plot the cell means

marginsplot, recast(line) noci x(c) by(a) byopts(title(3-
way Anova))



* Start by looking at the simple effects of the **b#c** interaction at each level of **a**

contrast b#c@a

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+

b#c@a |

1 | 2 15.25 0.0005

2 | 2 0.19 0.8314

Joint | 4 7.72 0.0026

|

Residual | 12

*** Follow up with the simple effects of b at each level of c holding a at at 1**

contrast b@c@1.a

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+

b@c#a |

1 1 | 1 0.19 0.6727

2 1 | 1 15.19 0.0021

3 1 | 1 67.69 0.0000

Joint | 3 27.69 0.0000

|

Residual | 12

*** Difference in differences**

*** b = 1 vs b = 2 when c = 2 and a = 1**

contrast {b -1 1}@2.c@1.a

Contrasts of marginal linear predictions

Margins : asbalanced

| **df F P>F**

-----+

b@c#a |

(1) 2 1 | 1 15.19 0.0021

|

Residual | 12

| **Contrast Std. Err.**

-----+-----

b@c#a |

(1) 2 1 | -4.5 1.154701 -7.015876 -1.984124

*** since b has only two levels this is the same as**

contrast b@2.c@1.a, effect

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

-----+-----

b@c#a |

2 1 | 1 15.19 0.0021

|

Residual | 12

| Contrast Std. Err. t P>|t|

-----+-----

b@c#a |

(2 vs base) |

2 1 | -4.5 1.154701 -3.90 0.002 -7.015876 -1.984124

*** Inspect L matrix**

matrix list r(L)

r(L)

1b. 2. 1b. 2. 1b.a# 1b.a# 2o.a# 2.a# 1b.

a a b b 1b.b 2o.b 1b.b 2.b c

2.b@2.c@1.a 0 0 -1 1 -1 1 0 0 0

2. 3. 1b.a# 1b.a# 1b.a# 2o.a# 2.a# 2.a# 1b.b#

c c 1b.c 2o.c 3o.c 1b.c 2.c 3.c 1b.c

2.b@2.c@1.a 0 0 0 0 0 0 0 0

1b.a# 1b.a# 1b.a# 1b.a#

1b.b# 1b.b# 2o.b# 2.b# 2.b# 1b.b# 1b.b# 1b.b# 2o.b#

2o.c 3o.c 1b.c 2.c 3.c 1b.c 2o.c 3o.c 1b.c

2.b@2.c@1.a -1 0 0 1 0 0 -1 0 0

1b.a# 1b.a# 2o.a# 2o.a# 2o.a# 2o.a# 2.a# 2.a#

2o.b# 2o.b# 1b.b# 1b.b# 1b.b# 2o.b# 2.b# 2.b#

2o.c 3o.c 1b.c 2o.c 3o.c 1b.c 2.c 3.c _cons

2.b@2.c@1.a 1 0 0 0 0 0 0 0

*** difference in levels of b between c = 2 and c = 3, when a = 1**

contrast b#{c 0 -1 1}@1.a, effect

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F
 -----+

b#c@a |
(joint) (1) 1 | 1 9.37 0.0099

|
Residual | 12

| Contrast Std. Err. t P>|t|
 -----+

b#c@a |
(2 vs base) |
(1) 1 | -5 1.632993 -3.06 0.010 -8.557986 -1.442014

* difference in levels of b between c = 2 and c = 3, when a = 2

contrast b#{c 0 -1 1}@2.a, effect

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

b#c@a |

(joint) (1) 2 | 1 0.09 0.7647

|

Residual | 12

| Contrast Std. Err. t P>|t|

b#c@a |

(2 vs base) |

(1) 2 | .5 1.632993 0.31 0.765 -3.057986 4.057986

*** difference in differences in differences**

*** difference in levels of b between c = 2 and c = 3, when a = 1 vs a = 2**

contrast b#{c 0 -1 1}#{a 1 -1}, effect

Contrasts of marginal linear predictions

Margins : asbalanced

| df F P>F

b#c#a | 1 5.67 0.0347

Residual | 12

| Contrast Std. Err. t P>|t|

b#c#a |

(2 vs base) |

(1) (1) | -5.5 2.309401 -2.38 0.035 -10.53175 -.4682473

*** Inspect L matrix again (nasty isn't it?)**

matrix list r(L)

r(L)

1b. 2. 1b. 2. 1b.a# 1b.a# 2o.a# 2.a# 1b. 2.

a a b b 1b.b 2o.b 1b.b 2.b c c

2.b#

u1.c#

u1.a 0 0 0 0 0 0 0 0 0 0

3. 1b.a# 1b.a# 1b.a# 2o.a# 2.a# 2.a# 1b.b# 1b.b# 1b.b#

c 1b.c 2o.c 3o.c 1b.c 2.c 3.c 1b.c 2o.c 3o.c

2.b#

u1.c#

u1.a 0 0 0 0 0 0 0 0 0 0

1b.a# 1b.a# 1b.a# 1b.a# 1b.a# 1b.a# 2o.a#

2o.b# 2.b# 2.b# 1b.b# 1b.b# 1b.b# 2o.b# 2o.b# 2o.b#

1b.b#

1b.c 2.c 3.c 1b.c 2o.c 3o.c 1b.c 2o.c 3o.c 1b.c

2.b#

u1.c#

u1.a 0 0 0 0 1 -1 0 -1 1 0

2o.a# 2o.a# 2o.a# 2.a# 2.a#

1b.b# 1b.b# 2o.b# 2.b# 2.b#

2o.c 3o.c 1b.c 2.c 3.c _cons

2.b#

u1.c#

u1.a -1 1 0 1 -1 0

Model with categorical by continuous interaction

We will change to the hsbdemo dataset.

**use <https://stats.idre.ucla.edu/stat/data/hsbdemo>, clear
anova math prog##c.read**

Number of obs = 200 R-squared = 0.5051

Root MSE = 6.67488 Adj R-squared = 0.4924

Source | Partial SS df MS F Prob > F

-----+-----

Model | 8822.31169 5 1764.46234 39.60 0.0000

|

prog | 166.100182 2 83.050091 1.86 0.1578

read | 2926.41146 1 2926.41146 65.68 0.0000

prog#read | 315.914185 2 157.957093 3.55 0.0307

|

Residual | 8643.48331 194 44.5540377

-----+-----

Total | 17465.795 199 87.7678141

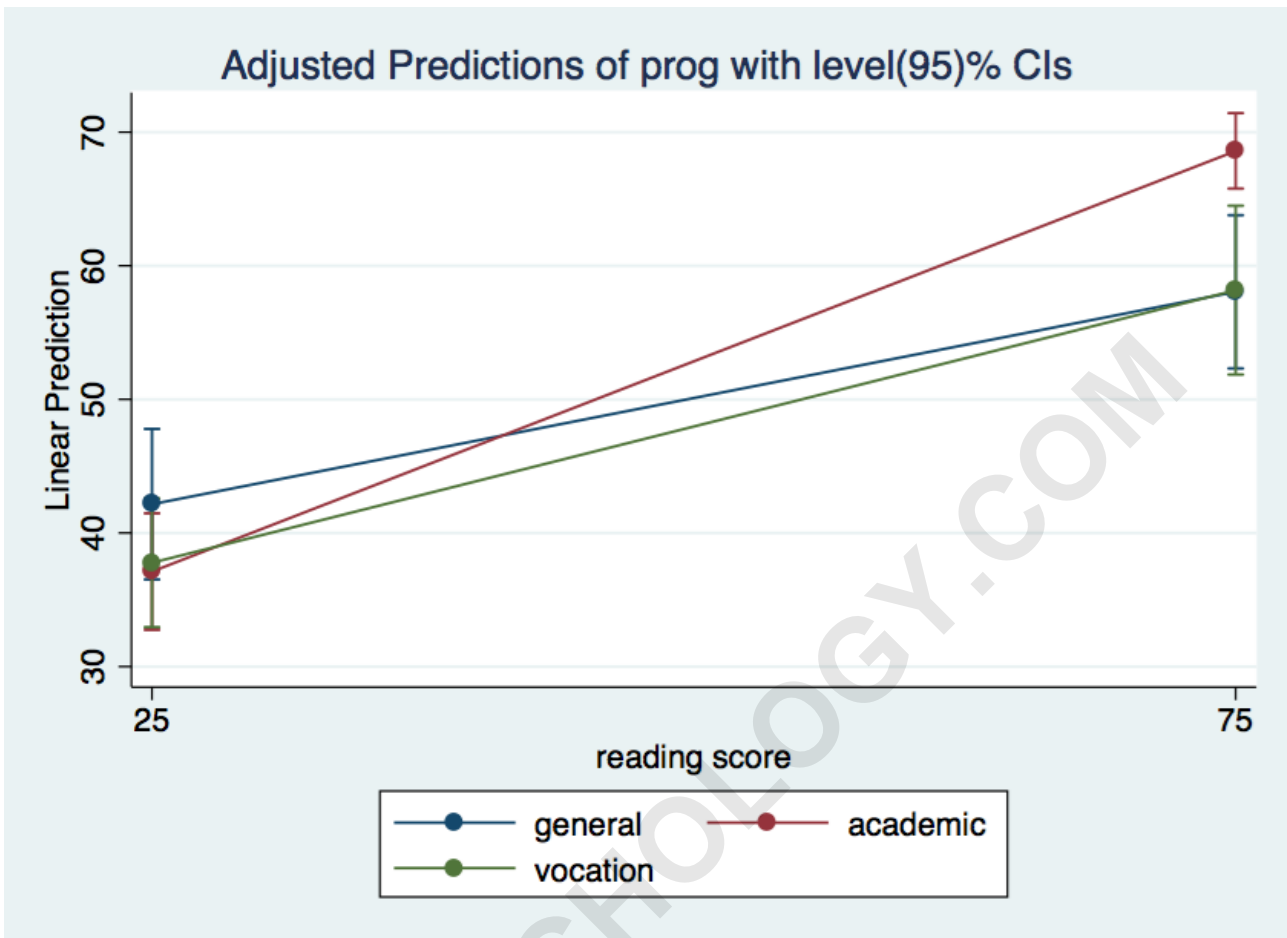
*** Used for plotting with two values, 25 & 75, for the continuous variable**

quietly margins prog, at(read=(25 75))

*** Plot it**

marginsplot

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* get slopes for each level of prog

margins prog, dydx(read)

Average marginal effects Number of obs = 200

Expression : Linear prediction, predict()

dy/dx w.r.t. : read

| Delta-method

| dy/dx Std. Err. z P>|z|

```
-----+-----
read |
prog |
1 | .3180025 .1089668 2.92 0.004 .1044316 .5315735
2 | .629824 .0682596 9.23 0.000 .4960377 .7636103
3 | .4081276 .1070485 3.81 0.000 .1983165 .6179387
-----
```

*** Compare slopes using reference group contrast**

margins r.prog, dydx(read)

Contrasts of average marginal effects

Expression : Linear prediction, predict()

dy/dx w.r.t. : read

```
-----
| df chi2 P>chi2
-----+-----
```

```
read |
prog |
(2 vs 1) | 1 5.88 0.0153
(3 vs 1) | 1 0.35 0.5552
Joint | 2 7.09 0.0289
```


| Contrast Delta-method

| dy/dx Std. Err.

-----+-----
 read |
 prog |
 (2 vs 1) | .3118215 .1285812 .059807 .563836
 (3 vs 1) | .090125 .1527519 -.2092631 .3895132

*** Change reference group to prog3**

margins rb2.prog, dydx(read)

Contrasts of average marginal effects

Expression : Linear prediction, predict()

dy/dx w.r.t. : read

| df chi2 P>chi2

-----+-----
 read |
 prog |

(1 vs 2) | 1 5.88 0.0153

(3 vs 2) | 1 3.05 0.0808

Joint | 2 7.09 0.0289

| Contrast Delta-method

| dy/dx Std. Err.

-----+-----
read |

prog |

(1 vs 2) | -.3118215 .1285812 -.563836 -.059807

(3 vs 2) | -.2216965 .1269596 -.4705327 .0271398

*** All pairwise slopes**

margins prog, dydx(read) pwcompare(effects group)

Pairwise comparisons of average marginal effects

Expression : Linear prediction, predict()

dy/dx w.r.t. : read

| Delta-method Unadjusted

| Margin Std. Err. Groups

-----+-----

read |

prog |

1 | .3180025 .1089668 A

2 | .629824 .0682596 B

3 | .4081276 .1070485 AB

Note: Margins sharing a letter in the group label are not significantly different at the 5% level.

| Contrast Delta-method Unadjusted Unadjusted

| dy/dx Std. Err. z P>|z|

-----+-----

read |

prog |

2 vs 1 | .3118215 .1285812 2.43 0.015 .059807 .563836

3 vs 1 | .090125 .1527519 0.59 0.555 -.2092631 .3895132

3 vs 2 | -.2216965 .1269596 -1.75 0.081 -.4705327
.0271398

* User defined slope contrast

```
margins {prog -.5 1 -.5}, dydx(read)
```

Contrasts of average marginal effects

Expression : Linear prediction, predict()

dy/dx w.r.t. : read

```
-----+-----
| df chi2 P>chi2
-----+-----
read |
prog | 1 6.78 0.0092
-----+-----

| Contrast Delta-method
| dy/dx Std. Err.
-----+-----
read |
prog |
(1) | .266759 .1024336 .0659927 .4675252
-----+-----
```

* The same thing using contrast

```
contrast {prog -.5 1 -.5}#c.read
```

Contrasts of marginal linear predictions

Margins : asbalanced

```
-----
| df F P>F
```

```
-----+-----
prog#c.read | 1 6.78 0.0099
```

```
|
Residual | 194
```

```
-----
| Contrast Std. Err.
```

```
-----+-----
prog#c.read |
(1) | .266759 .1024336 .0647324 .4687855
```

For this last contrast we are not looking at differences in slopes but rather at differences in predicted values. In particular, we want to look at the differences

among the three predicted values when read = 25 and again when read = 75.

* Differences in predicted values

`margins r.prog, at(read=(25 75))`

Contrasts of adjusted predictions

Expression : Linear prediction, predict()

1._at : read = 25

2._at : read = 75

| df chi2 P>chi2
-----+

prog@_at |

(2 vs 1) 1 | 1 1.92 0.1654

(2 vs 1) 2 | 1 10.46 0.0012

(3 vs 1) 1 | 1 1.34 0.2467

(3 vs 1) 2 | 1 0.00 0.9773

Joint | 4 26.07 0.0000

| **Delta-method**

| **Contrast Std. Err.**

```
-----+-----  
prog@_at |  
(2 vs 1) 1 | -5.043076 3.635333 -12.1682 2.082046  
(2 vs 1) 2 | 10.548 3.261109 4.156342 16.93966  
(3 vs 1) 1 | -4.382197 3.782612 -11.79598 3.031587  
(3 vs 1) 2 | .1240545 4.3535 -8.408649 8.656758  
-----
```

That's all for now.