Investigating the effects of factor variables

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Outline

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2. Computing effects
3. Higher order effects
4. Pairwise comparisons
5. Summary

What are effects?

Effects

The effect of a factor variable is the change in a measurement between two or more levels of the factor.

Example:

- Difference in average cholesterol measurement between two age groups in a population.

Cholesterol data

```
. webuse cholesterol
(Artificial cholesterol data)
. describe chol agegrp
              storage  display     value
variable name   type   format      label      variable label
------------------------------------------------------------------------------
chol            float  %9.0g                  cholesterol level (mg/dL)
agegrp          float  %9.0g       ages
. label list ages
ages:
           1 10-19
           2 20-29
           3 30-39
           4 40-59
           5 60-79
```

One-way linear regression

```
. regress chol i.agegrp
```

Source	SS	df	MS
Model	14943.3997	4	3735.84993
Residual	7468.21971	70	106.688853
Total	22411.6194	74	302.859722

Number of obs	= 75
F(4, 70)	= 35.02
Prob > F	= 0.0000
R-squared	= 0.6668
Adj R-squared	= 0.6477
Root MSE	= 10.329

chol	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
agegrp						
2	8.203575	3.771628	2.18	0.033	.6812991	15.72585
3	21.54105	3.771628	5.71	0.000	14.01878	29.06333
4	30.15067	3.771628	7.99	0.000	22.6284	37.67295
5	38.76221	3.771628	10.28	0.000	31.23993	46.28448
_cons	180.5198	2.666944	67.69	0.000	175.2007	185.8388

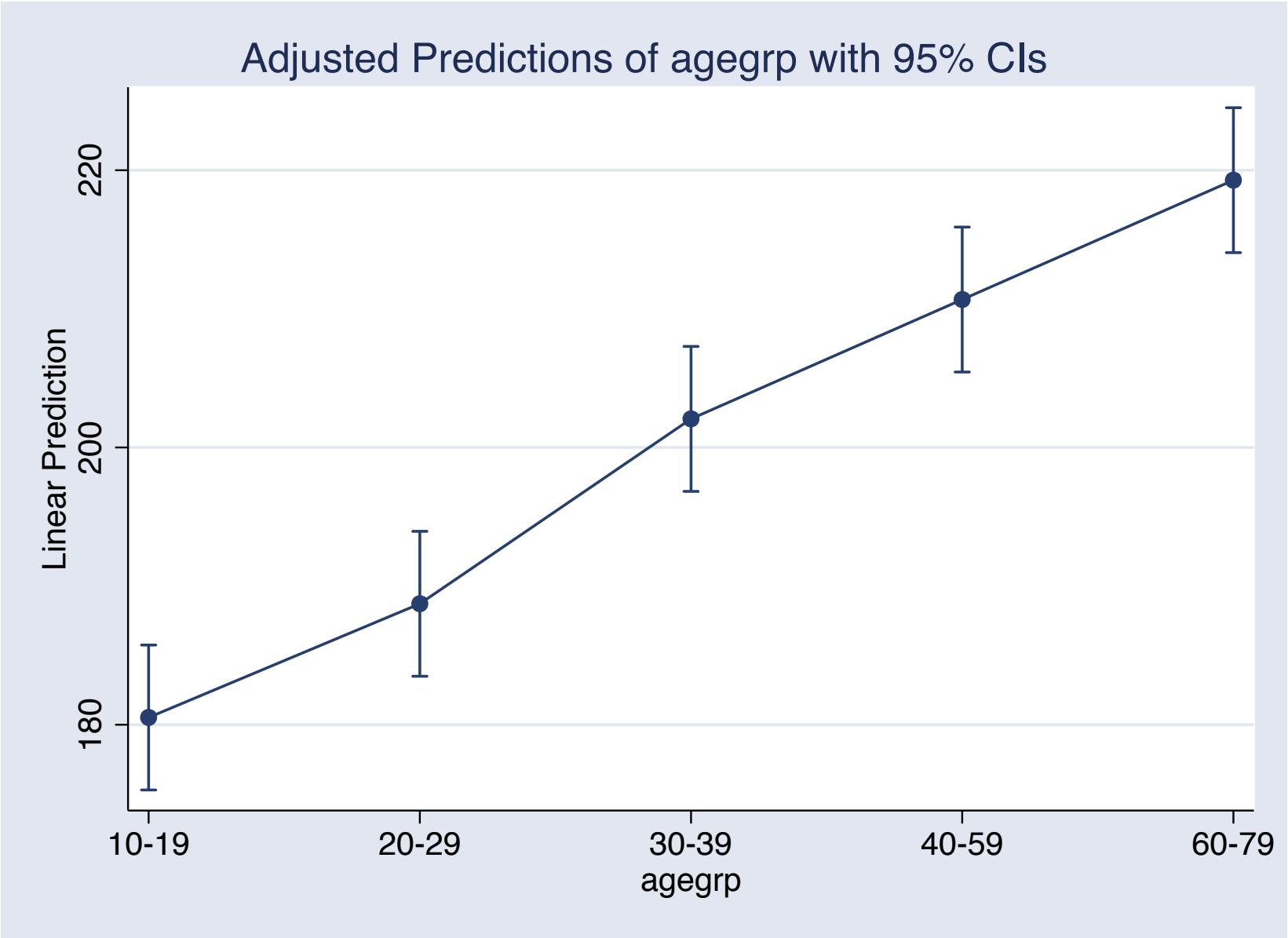
Margins

```
. margins agegrp
Adjusted predictions                            Number of obs   =         75
Model VCE    : OLS
Expression   : Linear prediction, predict()
```

	Margin	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
agegrp						
1	180.5198	2.666944	67.69	0.000	175.2926	185.7469
2	188.7233	2.666944	70.76	0.000	183.4962	193.9504
3	202.0608	2.666944	75.76	0.000	196.8337	207.2879
4	210.6704	2.666944	78.99	0.000	205.4433	215.8975
5	219.282	2.666944	82.22	0.000	214.0548	224.5091

```
. marginsplot
```

Margins plot



Changing the base level

Coefficient table

`regress` reports some simple tests on the effects of **`agegrp`** on **`chol`**.

How can we change the base level?

- Refit the model using the **`b.`** operator.
- Use **`test`** or **`lincom`** to perform the comparison.

Change the base level with “lincom”

```
. lincom 1.agegrp - 5.agegrp
 ( 1)  1b.agegrp - 5.agegrp = 0
```

chol	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	-38.76221	3.771628	-10.28	0.000	-46.28448	-31.23993

```
. lincom 2.agegrp - 5.agegrp
 ( 1)  2.agegrp - 5.agegrp = 0
```

chol	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	-30.55863	3.771628	-8.10	0.000	-38.08091	-23.03636

Contrast

- New in Stata 12
- ANOVA-style tests of linear hypotheses involving factor variables and their interactions from the most recently fit model.
  - main effects
  - simple effects
  - interaction effects
  - nested effects
- Decompose tests into individual components/effects/constrasts.
  - built-in contrast operators
  - user defined contrasts

Contrast operators

Syntax

contrast *op*.*varname* [, *options*]

op.	Description
r.	diff from a reference (base) level; the default
a.	diff from the next level (adjacent)
ar.	diff from the previous level (reverse adjacent)

Change the base level with “contrast”

```
. contrast rb5.agegrp, effects
Contrasts of marginal linear predictions
Margins      : asbalanced
```

	df	F	P>F
agegrp			
(1 vs 5)	1	105.62	0.0000
(2 vs 5)	1	65.65	0.0000
(3 vs 5)	1	20.85	0.0000
(4 vs 5)	1	5.21	0.0255
Joint	4	35.02	0.0000
Residual	70		

	Contrast	Std. Err.	t	P>|t|	[95% Conf.	Interval]
agegrp						
(1 vs 5)	-38.76221	3.771628	-10.28	0.000	-46.28448	-31.23993
(2 vs 5)	-30.55863	3.771628	-8.10	0.000	-38.08091	-23.03636
(3 vs 5)	-17.22115	3.771628	-4.57	0.000	-24.74343	-9.698877
(4 vs 5)	-8.611533	3.771628	-2.28	0.025	-16.13381	-1.089257

Adjacent contrasts

```
. contrast a.agegrp, effects
Contrasts of marginal linear predictions
Margins      : asbalanced
```

	df	F	P>F
agegrp			
(1 vs 2)	1	4.73	0.0330
(2 vs 3)	1	12.51	0.0007
(3 vs 4)	1	5.21	0.0255
(4 vs 5)	1	5.21	0.0255
Joint	4	35.02	0.0000
Residual	70		

	Contrast	Std. Err.	t	P>|t|	[95% Conf.	Interval]
agegrp						
(1 vs 2)	-8.203575	3.771628	-2.18	0.033	-15.72585	-.6812991
(2 vs 3)	-13.33748	3.771628	-3.54	0.001	-20.85976	-5.815204
(3 vs 4)	-8.60962	3.771628	-2.28	0.025	-16.1319	-1.087345
(4 vs 5)	-8.611533	3.771628	-2.28	0.025	-16.13381	-1.089257

As-balanced operators

As-balanced effects

Compute effects using linear combinations that weight each margin equally.

op.	Description
`g.`	diff from the balanced grand mean
`h.`	diff from the balanced mean of subsequent levels (Helmert)
`j.`	diff from the balanced mean of previous levels (reverse Helmert)
`p.`	orthogonal polynomial in the level values
`q.`	orthogonal polynomial in the level squence

Helmert contrasts

```
. contrast h.agegrp, effects
Contrasts of marginal linear predictions
Margins      : asbalanced
```

	df	F	P>F
agegrp			
(1 vs >1)	1	68.42	0.0000
(2 vs >2)	1	50.79	0.0000
(3 vs >3)	1	15.63	0.0002
(4 vs 5)	1	5.21	0.0255
Joint	4	35.02	0.0000
Residual	70		

	Contrast	Std. Err.	t	P>|t|	[95% Conf.	Interval]
agegrp						
(1 vs >1)	-24.66438	2.981734	-8.27	0.000	-30.61126	-18.7175
(2 vs >2)	-21.94774	3.079522	-7.13	0.000	-28.08965	-15.80583
(3 vs >3)	-12.91539	3.266326	-3.95	0.000	-19.42987	-6.400905
(4 vs 5)	-8.611533	3.771628	-2.28	0.025	-16.13381	-1.089257

As-observed operators

As-observed effects

Compute effects using linear combinations that weight each margin according to the sample frequencies of the levels.

op.	Description
gw.	diff from the weighted grand mean
hw.	diff from the weighted mean of subsequent levels (Helmert)
jw.	diff from the weighted mean of previous levels (reverse Helmert)
pw.	weighted orthogonal polynomial in the level values
qw.	weighted orthogonal polynomial in the level squence

Higher order effects

Interaction effect

When the effect of one factor depends on the level of other factors.

Example:

- Difference in average blood pressure measurement between two dosage levels for men and women.
- Factors: dosage and gender

Blood pressure data

```
. webuse bpchange
(Artificial blood pressure data)
. describe
Contains data from http://localpress.stata.com/data/r12/bpchange.dta
  obs:            30                          Artificial blood pressure data
 vars:             3                          21 Feb 2011 16:59
 size:           360
-------------------------------------------------------------------------------
              storage  display     value
variable name   type   format      label      variable label
-------------------------------------------------------------------------------
bpchange        float  %9.0g                  change in diastolic blood
                                                pressure
dose            float  %9.0g                  dosage in milligrams per day
gender          float  %9.0g       gender
-------------------------------------------------------------------------------
Sorted by:
```

Two-way model

```
. anova bpchange dose##gender
```

```
                   Number of obs =        30     R-squared     =  0.9647
                   Root MSE      =    1.4677     Adj R-squared =  0.9573
```

Source	Partial SS	df	MS	F	Prob > F
Model	1411.9087	5	282.381741	131.09	0.0000
dose	963.481795	2	481.740897	223.64	0.0000
gender	355.118817	1	355.118817	164.85	0.0000
dose#gender	93.3080926	2	46.6540463	21.66	0.0000
Residual	51.699253	24	2.15413554		
Total	1463.60796	29	50.4692399		

Test for an interaction effect

```
. contrast dose#gender
Contrasts of marginal linear predictions
Margins      : asbalanced
```

	df	F	P>F
dose#gender	2	21.66	0.0000
Residual	24		

Full ANOVA-style table

```
. contrast dose##gender
Contrasts of marginal linear predictions
Margins      : asbalanced
```

	df	F	P>F
dose	2	223.64	0.0000
gender	1	164.85	0.0000
dose#gender	2	21.66	0.0000
Residual	24		

Simple effects

```
. contrast a.dose@gender, effects
Contrasts of marginal linear predictions
Margins      : asbalanced
```

	df	F	P>F
dose@gender			
(250 vs 500) 1	1	47.24	0.0000
(250 vs 500) 2	1	122.90	0.0000
(500 vs 750) 1	1	11.06	0.0028
(500 vs 750) 2	1	70.68	0.0000
Joint	4	122.65	0.0000
Residual	24		

	Contrast	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dose@gender						
(250 vs 500) 1	6.380018	.9282533	6.87	0.000	4.464198	8.295839
(250 vs 500) 2	10.29073	.9282533	11.09	0.000	8.374914	12.20655
(500 vs 750) 1	3.087217	.9282533	3.33	0.003	1.171396	5.003038
(500 vs 750) 2	7.803784	.9282533	8.41	0.000	5.887963	9.719605

Other features

- Factor effects on slopes
  - **`contrast`** *fvar*`#c.`*xvar*
- Nonlinear models
  - **`clogit`**, **`glm`**, **`logit`**, **`heckman`**, **`ivregress`**, **`nbreg`**, **`poisson`**, ...
- Multiple equations
  - **`manova`**, **`mlogit`**, **`mprobit`**, **`mvreg`**
  - Special **`_eqns`** factor for effects between equations
- Adjusting for multiple comparisons
  - Bonferroni
  - Šidák
- [R] **contrast** — over 50 pages of informaton

Pairwise comparisons

Syntax

pwcompare *marginlist* [, *options*]

- Intercept and slope effects
- Nonlinear models
- Multiple equations
- Adjusting for multiple comparisons
  - Generally applicable
    - Bonferroni, Scheffe, Šidák
  - Linear models only
    - Tukey, Student-Newman-Keuls, Duncan, Dunnett
- [R] **pwcompare** — almost 30 pages of informaton

Summary

- **marginsplot** graphs results from **margins**
- **contrast** provides a short and simple syntax for testing all kinds of factor effects
- **pwcompare** performs pairwise comparisons of marginal linear predictions
- **margins** has new **contrast** and **pwcompare** features