Workshop on Multilevel Modeling 2 (Cross Classified Models)

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Navigation

When this document is presented in slide show format, some slides may be long, and you may need to scroll down to see the full slide. In slide show format `b` makes text bigger, and `s` makes text smaller.

Introduction

A two level multilevel model imagines that *Level 1* units are nested in *Level 2* units. A three level multilevel model imagines that *Level 1* units are nested in *Level 2* units, which are in turn nested in *Level 3*.

A cross-classified model imagines that the nesting is not hierarchical, but rather that there are two sets of clusters or nestings in which individuals may be nested.

Setup

```
. use "../multilevel-thinking/simulate-and-analyze-multilevel-data/simulated_multilevel_long
> itudinal_data.dta", clear
```

Cross Classified Model

We can treat these random effects as being *cross classified*.

This might be useful if we had data where individuals lived in different countries at different times.

However, because `id` is in fact nested inside `country`, in this case, estimating the random effects as cross classified will be more time consuming, but will give us equivalent results to a three level model.

Standard (Less Computationally Efficient) Syntax

The below syntax will take a very long time to run with the full sample, and thus we have commented it out.

```
. * mixed outcome t warmth physical_punishment || _all: R.country || _all: R.id
.
. * est store crossed1
```

The documentation notes that we can use a *much* more computationally efficient version of the above command, which is what we do in these notes. The user can verify that both versions of the command will produce equivalent results.

In fact, at the end of handout we verify the similarity of both sets of syntax using a random sample.

Cross Classified With Computationally Efficient Syntax

```
. mixed outcome t warmth physical_punishment || _all: R.country || id:
Performing EM optimization ...
Performing gradient-based optimization:
Iteration 0:  Log likelihood = -28554.574
Iteration 1:  Log likelihood = -28554.549
Iteration 2:  Log likelihood = -28554.549
Computing standard errors ...
Mixed-effects ML regression                           Number of obs =   9,000
        Grouping information
------------------------------------------------------------------------------
 Group variable |     No. of       Observations per group
                |     groups    Minimum    Average    Maximum
----------------+-------------------------------------------------------------
           _all |          1      9,000    9,000.0      9,000
            id |      3,000          3        3.0          3
------------------------------------------------------------------------------
                                                      Wald chi2(3)  = 1156.04
Log likelihood = -28554.549                           Prob > chi2   =  0.0000
------------------------------------------------------------------------------
             outcome | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
---------------------+--------------------------------------------------------
                   t |   .9880161   .0658318    15.01   0.000     .8589881    1.117044
              warmth |   .9494521   .0383876    24.73   0.000     .8742138     1.02469
physical_punishment |  -.9247961   .0501648   -18.44   0.000    -1.023117   -.8264749
               _cons |    51.4432   .4233657   121.51   0.000     50.61342    52.27299
------------------------------------------------------------------------------

------------------------------------------------------------------------------
  Random-effects parameters |   Estimate   Std. err.      [95% conf. interval]
----------------------------+-------------------------------------------------
_all: Identity              |
                var(R.country) |   3.672826   .9942325       2.16063    6.243387
----------------------------+-------------------------------------------------
id: Identity                |
                     var(_cons) |     9.0953   .4874893      8.188312    10.10275
----------------------------+-------------------------------------------------
                  var(Residual) |   26.00112   .4747689      25.08704     26.9485
------------------------------------------------------------------------------
LR test vs. linear model: chi2(2) = 1348.94                   Prob > chi2 = 0.0000
Note: LR test is conservative and provided only for reference.
.
. est store crossed2 // store crossed effects result
```

Three Level Model

```
. mixed outcome t warmth physical_punishment || country: || id:  // 3 level w/ random interc
> epts only
Performing EM optimization ...
Performing gradient-based optimization:
Iteration 0:  Log likelihood = -28554.574
Iteration 1:  Log likelihood = -28554.549
Iteration 2:  Log likelihood = -28554.549
Computing standard errors ...
Mixed-effects ML regression                           Number of obs =   9,000
        Grouping information
------------------------------------------------------------------------------
 Group variable |     No. of       Observations per group
                |     groups    Minimum    Average    Maximum
----------------+-------------------------------------------------------------
        country |         30        300      300.0        300
             id |      3,000          3        3.0          3
------------------------------------------------------------------------------
                                                      Wald chi2(3)  = 1156.04
```

```
Log likelihood = -28554.549                              Prob > chi2   =  0.0000
```

outcome	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
t	.9880161	.0658318	15.01	0.000	.8589881	1.117044
warmth	.9494521	.0383876	24.73	0.000	.8742138	1.02469
physical_punishment	-.9247961	.0501648	-18.44	0.000	-1.023117	-.8264749
_cons	51.4432	.4233657	121.51	0.000	50.61342	52.27299

Random-effects parameters	Estimate	Std. err.	[95% conf.	interval]
country: Identity				
var(_cons)	3.672826	.9942325	2.16063	6.243387
id: Identity				
var(_cons)	9.0953	.4874893	8.188312	10.10275
var(Residual)	26.00112	.4747689	25.08704	26.9485

```
LR test vs. linear model: chi2(2) = 1348.94                   Prob > chi2 = 0.0000
Note: LR test is conservative and provided only for reference.
.
. est store threelevel // store random intercept model
```

Nice Table of Results of Three Level and Cross Classified Model

```
. est table threelevel crossed2, ///
> b(%9.3f) star stats(N ll chi2) ///
> varwidth(20) modelwidth(15)
```

Variable	threelevel	crossed2
outcome		
t	0.988***	0.988***
warmth	0.949***	0.949***
physical_punishment	-0.925***	-0.925***
_cons	51.443***	51.443***
lns1_1_1		
_cons	0.650***	0.650***
lns2_1_1		
_cons	1.104***	1.104***
lnsig_e		
_cons	1.629***	1.629***
Statistics		
N	9000	9000
ll	-2.86e+04	-2.86e+04
chi2	1156.045	1156.045

Legend: * p<0.05; ** p<0.01; *** p<0.001

Verification of Syntax Equivalence for Cross Classified Model

```
.
. keep if family <= 5 // random sample of families
(8,550 observations deleted)
.
. quietly mixed outcome t warmth physical_punishment || _all: R.country || _all: R.id
.
. est store crossed1A // less efficient syntax
.
```

```
. quietly mixed outcome t warmth physical_punishment || _all: R.country || id:
.
. est store crossed2A // more efficient syntax
.
. est table crossed1A crossed2A, ///
> b(%9.3f) star stats(N ll chi2) ///
> varwidth(20) modelwidth(15)
```

Variable	crossed1A	crossed2A
outcome		
t	1.222***	1.222***
warmth	0.854***	0.854***
physical_punishment	-1.214***	-1.214***
_cons	51.616***	51.616***
lns1_1_1		
_cons	0.649*	0.649*
lns1_2_1		
_cons	1.132***	
lnsig_e		
_cons	1.716***	1.716***
lns2_1_1		
_cons		1.132***
Statistics		
N	450	450
ll	-1469.923	-1469.923
chi2	58.301	58.301

Legend: * p<0.05; ** p<0.01; *** p<0.001

```
.
```

QUESTIONS???