Workshop on Multilevel Modeling 2 (Cross Classified Models)

Andy Grogan-Kaylor

11 Sep 2023 10:31:31

# 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  
 ────────────────┬────────────────────────────────────────────  
 │ No. of Observations per group  
 Group variable │ 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  
 ────────────────┬────────────────────────────────────────────  
 │ No. of Observations per group  
 Group variable │ 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???