Workshop on Multilevel Modeling

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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.

# Cross Sectional Model

## Get Data

. use "../multilevel-thinking/simulate-and-analyze-multilevel-data/simulated\_multilevel\_da  
> ta.dta", clear

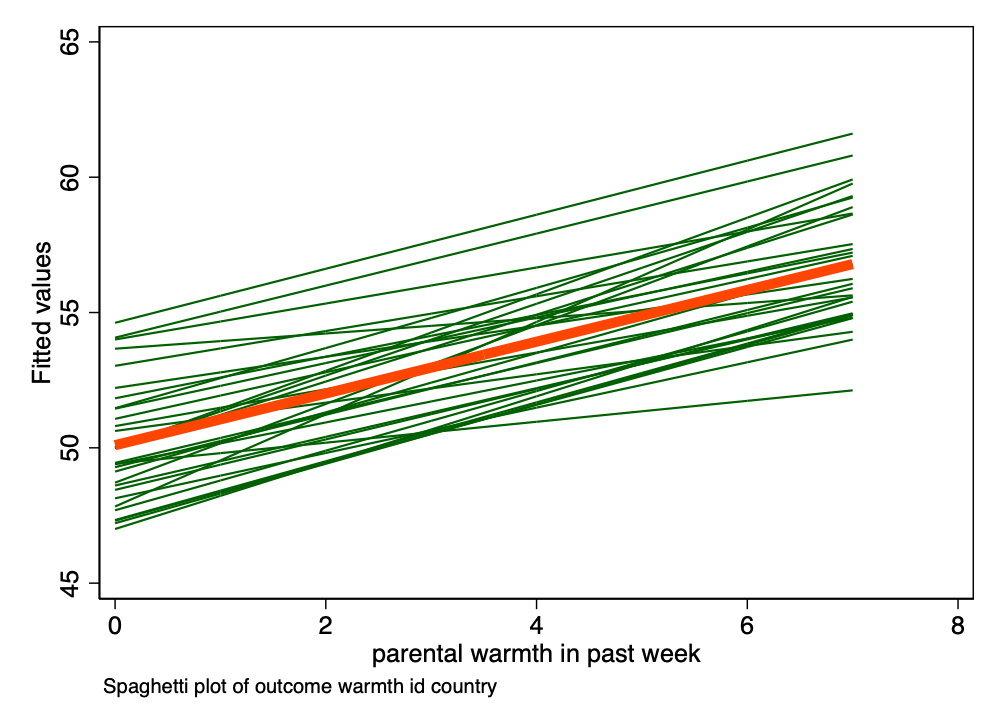
## The Equation

## Descriptive Statistics

. summarize // descriptive statistics  
  
 Variable │ Obs Mean Std. dev. Min Max  
─────────────┼─────────────────────────────────────────────────────────  
 country │ 3,000 15.5 8.656884 1 30  
 HDI │ 3,000 64.76667 17.24562 33 87  
 family │ 3,000 50.5 28.87088 1 100  
 id │ 0  
 group │ 3,000 1.497667 .5000779 1 2  
─────────────┼─────────────────────────────────────────────────────────  
physical\_p~t │ 3,000 2.494667 1.380075 0 5  
 warmth │ 3,000 3.524333 1.889956 0 7  
 outcome │ 3,000 53.46757 6.65179 33.39014 76.75101

## Spaghetti Plot

. spagplot outcome warmth, id(country) scheme(s1color)  
  
.   
. graph export spagplot1.png, width(1000) replace  
file /Users/agrogan/Desktop/GitHub/multilevel-workshop/spagplot1.png saved as PNG format



Spaghetti Plot of Outcome by Warmth by Country

## Unconditional Model

### Model

. mixed outcome || country: // unconditional model  
  
Performing EM optimization ...  
  
Performing gradient-based optimization:   
Iteration 0: log likelihood = -9856.1548   
Iteration 1: log likelihood = -9856.1548   
  
Computing standard errors ...  
  
Mixed-effects ML regression Number of obs = 3,000  
Group variable: country Number of groups = 30  
 Obs per group:  
 min = 100  
 avg = 100.0  
 max = 100  
 Wald chi2(0) = .  
Log likelihood = -9856.1548 Prob > chi2 = .  
  
─────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
─────────────┼────────────────────────────────────────────────────────────────  
 \_cons │ 53.46757 .3539097 151.08 0.000 52.77392 54.16122  
─────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Identity │  
 var(\_cons) │ 3.348734 .9702594 1.897816 5.908906  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 40.88284 1.060908 38.8555 43.01597  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chibar2(01) = 169.64 Prob >= chibar2 = 0.0000

### ICC

. estat icc  
  
Intraclass correlation  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Level │ ICC Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
 country │ .0757091 .0203761 .0442419 .1265931  
─────────────────────────────┴────────────────────────────────────────────────

## Full Model

. mixed outcome warmth physical\_punishment i.group HDI || country: warmth // multilevel mo  
> del  
  
Performing EM optimization ...  
  
Performing gradient-based optimization:   
Iteration 0: log likelihood = -9668.198   
Iteration 1: log likelihood = -9667.9551   
Iteration 2: log likelihood = -9667.9534   
Iteration 3: log likelihood = -9667.9533   
Iteration 4: log likelihood = -9667.9532   
  
Computing standard errors ...  
  
Mixed-effects ML regression Number of obs = 3,000  
Group variable: country Number of groups = 30  
 Obs per group:  
 min = 100  
 avg = 100.0  
 max = 100  
 Wald chi2(4) = 401.26  
Log likelihood = -9667.9532 Prob > chi2 = 0.0000  
  
────────────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
────────────────────┼────────────────────────────────────────────────────────────────  
 warmth │ .9616447 .0581825 16.53 0.000 .8476091 1.07568  
physical\_punishment │ -.8453802 .0798155 -10.59 0.000 -1.001816 -.6889448  
 2.group │ 1.084344 .2200539 4.93 0.000 .6530461 1.515642  
 HDI │ .010557 .0204522 0.52 0.606 -.0295286 .0506426  
 \_cons │ 50.96398 1.403621 36.31 0.000 48.21293 53.71502  
────────────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Independent │  
 var(warmth) │ 1.83e-06 .0000178 1.02e-14 329.3069  
 var(\_cons) │ 3.370262 .9633726 1.92465 5.901676  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 36.01906 .9346936 34.23291 37.89842  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chi2(2) = 198.01 Prob > chi2 = 0.0000  
  
Note: LR test is conservative and provided only for reference.  
  
.   
. est store crosssectional // store estimates

# Longitudinal Model

## Setup

. use "../multilevel-thinking/simulate-and-analyze-multilevel-data/simulated\_multilevel\_lo  
> ngitudinal\_data.dta", clear

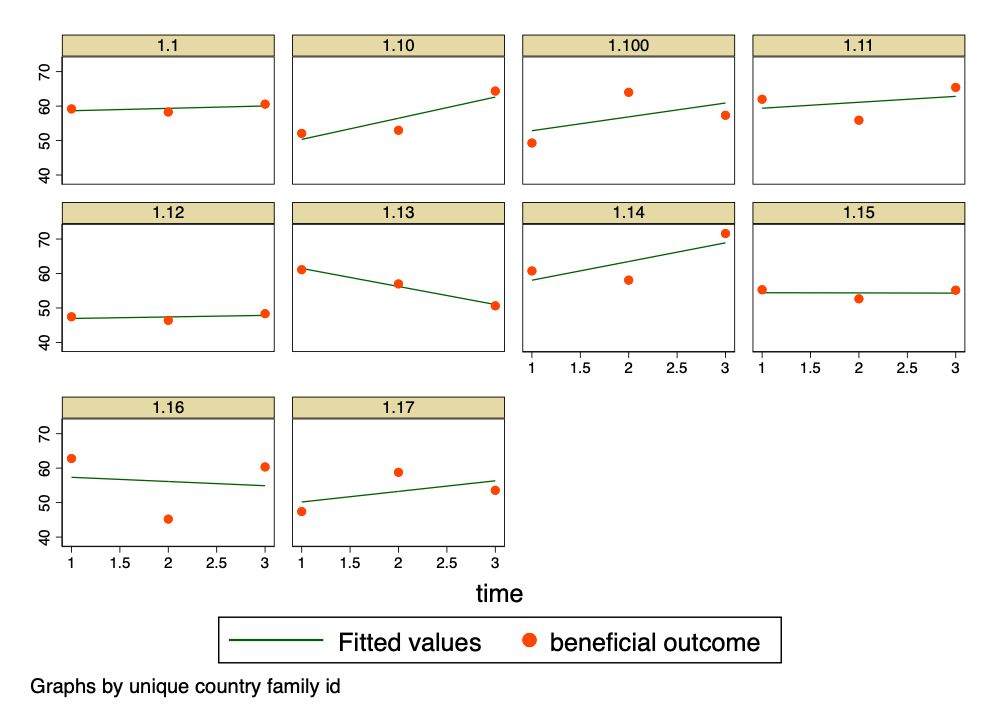
## The Equation

## Descriptive Statistics

. summarize // descriptive statistics  
  
 Variable │ Obs Mean Std. dev. Min Max  
─────────────┼─────────────────────────────────────────────────────────  
 country │ 9,000 15.5 8.655922 1 30  
 HDI │ 9,000 64.76667 17.2437 33 87  
 family │ 9,000 50.5 28.86767 1 100  
 id │ 0  
 group │ 9,000 1.497667 .5000223 1 2  
─────────────┼─────────────────────────────────────────────────────────  
 t │ 9,000 2 .8165419 1 3  
physical\_p~t │ 9,000 2.489778 1.378847 0 5  
 warmth │ 9,000 3.516 1.888893 0 7  
 outcome │ 9,000 54.45497 6.630079 28.72382 79.86467

## Alternate Plot

. encode id, generate(idNUMERIC) // numeric version of id  
  
.   
. \* spagplot outcome t if idNUMERIC <= 10, id(idNUMERIC) scheme(s1color)  
.   
. twoway (lfit outcome t) (scatter outcome t) if idNUMERIC <= 10, by(idNUMERIC) scheme(s1c  
> olor)  
  
.   
. graph export spagplot2.png, width(1000) replace  
file /Users/agrogan/Desktop/GitHub/multilevel-workshop/spagplot2.png saved as PNG format



Alternate Plot of Outcome by Time by Individual; First 10 Observations

## Unconditional Model

### Model

. mixed outcome || country: || id: // unconditional model  
  
Performing EM optimization ...  
  
Performing gradient-based optimization:   
Iteration 0: log likelihood = -29092.154   
Iteration 1: log likelihood = -29092.149   
Iteration 2: log likelihood = -29092.149   
  
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(0) = .  
Log likelihood = -29092.149 Prob > chi2 = .  
  
─────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
─────────────┼────────────────────────────────────────────────────────────────  
 \_cons │ 54.45497 .3545946 153.57 0.000 53.75998 55.14997  
─────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Identity │  
 var(\_cons) │ 3.556606 .9740016 2.079353 6.083357  
─────────────────────────────┼────────────────────────────────────────────────  
id: Identity │  
 var(\_cons) │ 12.12878 .5851203 11.03451 13.33156  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 28.26794 .5160995 27.27429 29.29779  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chi2(2) = 1404.70 Prob > chi2 = 0.0000  
  
Note: LR test is conservative and provided only for reference.

### ICC

. estat icc  
  
Intraclass correlation  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Level │ ICC Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
 country │ .0809178 .0204085 .0489023 .1310061  
 id|country │ .3568646 .0177124 .3229478 .3922796  
─────────────────────────────┴────────────────────────────────────────────────

## Full Model

. mixed outcome t warmth physical\_punishment i.group HDI || country: warmth || id: t // mu  
> ltilevel model  
  
Performing EM optimization ...  
  
Performing gradient-based optimization:   
Iteration 0: log likelihood = -28560.818   
Iteration 1: log likelihood = -28534.486   
Iteration 2: log likelihood = -28534.01   
Iteration 3: log likelihood = -28533.997   
Iteration 4: log likelihood = -28533.997   
  
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(5) = 1206.21  
Log likelihood = -28533.997 Prob > chi2 = 0.0000  
  
────────────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
────────────────────┼────────────────────────────────────────────────────────────────  
 t │ .9879647 .0658315 15.01 0.000 .8589373 1.116992  
 warmth │ .9462548 .0381869 24.78 0.000 .8714098 1.0211  
physical\_punishment │ -.926774 .0499549 -18.55 0.000 -1.024684 -.8288642  
 2.group │ .9858189 .1534866 6.42 0.000 .6849907 1.286647  
 HDI │ .0075436 .020712 0.36 0.716 -.0330512 .0481383  
 \_cons │ 50.48029 1.408094 35.85 0.000 47.72048 53.24011  
────────────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Independent │  
 var(warmth) │ 3.39e-10 2.87e-09 2.08e-17 .0055112  
 var(\_cons) │ 3.650996 .9880288 2.148128 6.205299  
─────────────────────────────┼────────────────────────────────────────────────  
id: Independent │  
 var(t) │ 3.17e-08 4.80e-06 5.1e-137 2.0e+121  
 var(\_cons) │ 8.852631 .4817168 7.957088 9.848965  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 26.00091 .474775 25.08683 26.94831  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chi2(4) = 1328.22 Prob > chi2 = 0.0000  
  
Note: LR test is conservative and provided only for reference.  
  
.   
. est store longitudinal // store estimates

# Nice Table of Results

. est table crosssectional longitudinal, ///  
> b(%9.3f) star stats(N ll chi2) ///  
> varwidth(20) modelwidth(15)  
  
─────────────────────┬──────────────────────────────────────────  
 Variable │ crosssectional longitudinal   
─────────────────────┼──────────────────────────────────────────  
outcome │  
 warmth │ 0.962\*\*\* 0.946\*\*\*   
 physical\_punishment │ -0.845\*\*\* -0.927\*\*\*   
 │  
 group │  
 2 │ 1.084\*\*\* 0.986\*\*\*   
 │  
 HDI │ 0.011 0.008   
 t │ 0.988\*\*\*   
 \_cons │ 50.964\*\*\* 50.480\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lns1\_1\_1 │  
 \_cons │ -6.605 -10.903\*   
─────────────────────┼──────────────────────────────────────────  
lns1\_1\_2 │  
 \_cons │ 0.607\*\*\* 0.648\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lnsig\_e │  
 \_cons │ 1.792\*\*\* 1.629\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lns2\_1\_1 │  
 \_cons │ -8.633   
─────────────────────┼──────────────────────────────────────────  
lns2\_1\_2 │  
 \_cons │ 1.090\*\*\*   
─────────────────────┼──────────────────────────────────────────  
Statistics │   
 N │ 3000 9000   
 ll │ -9667.953 -2.85e+04   
 chi2 │ 401.262 1206.210   
─────────────────────┴──────────────────────────────────────────  
 Legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

# QUESTIONS???