Workshop on Multilevel Modeling

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15 Feb 2023 13:17:02

# 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\_data.d  
> ta", clear

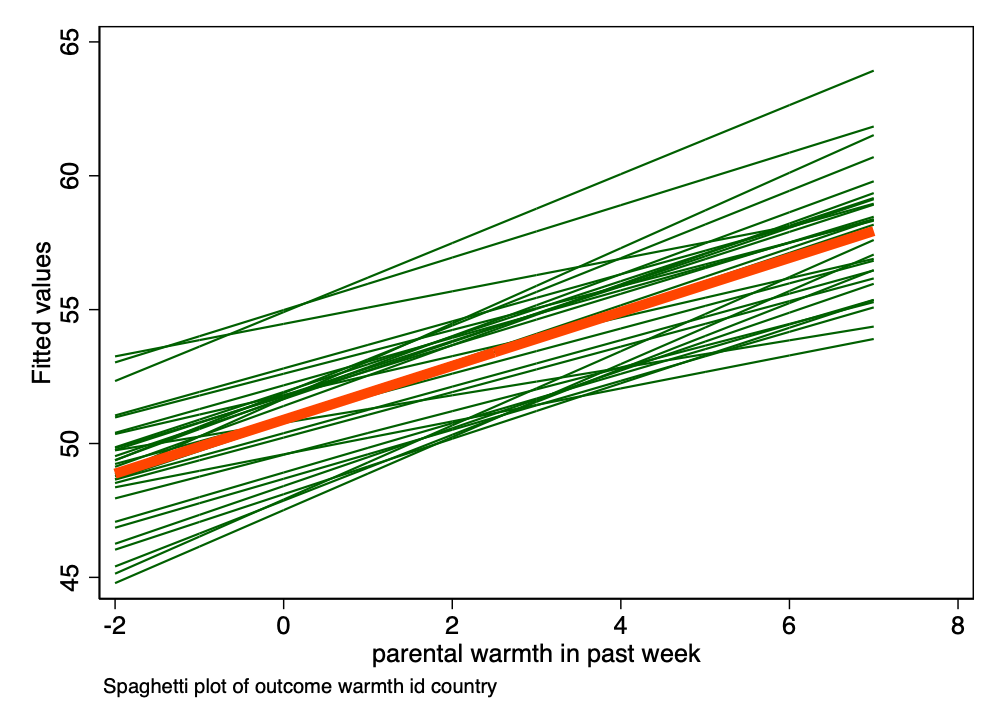
## The Equation

## 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 1.496 .5000674 1 2  
─────────────┼─────────────────────────────────────────────────────────  
physical\_p~t │ 3,000 1.516 1.884744 -2 5  
 warmth │ 3,000 2.543667 2.431336 -2 7  
 outcome │ 3,000 53.45039 6.884502 25.02363 81.63657

## 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 = -9956.6096   
Iteration 1: log likelihood = -9956.6096   
  
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 = -9956.6096 Prob > chi2 = .  
  
─────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
─────────────┼────────────────────────────────────────────────────────────────  
 \_cons │ 53.45039 .3702932 144.35 0.000 52.72463 54.17615  
─────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Identity │  
 var(\_cons) │ 3.676471 1.062168 2.086944 6.476667  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 43.70413 1.134121 41.53688 45.98446  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chibar2(01) = 175.05 Prob >= chibar2 = 0.0000

### ICC

. estat icc  
  
Intraclass correlation  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Level │ ICC Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
 country │ .0775944 .0207813 .0454528 .129384  
─────────────────────────────┴────────────────────────────────────────────────

## Full Model

. mixed outcome warmth physical\_punishment i.group HDI || country: warmth // multilevel model  
  
Performing EM optimization:   
  
Performing gradient-based optimization:   
  
Iteration 0: log likelihood = -9616.8876   
Iteration 1: log likelihood = -9616.3536   
Iteration 2: log likelihood = -9616.3475   
Iteration 3: log likelihood = -9616.3475   
  
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) = 764.27  
Log likelihood = -9616.3475 Prob > chi2 = 0.0000  
  
────────────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
────────────────────┼────────────────────────────────────────────────────────────────  
 warmth │ .9826773 .0444598 22.10 0.000 .8955377 1.069817  
physical\_punishment │ -.9239791 .0573291 -16.12 0.000 -1.036342 -.8116161  
 2.group │ .7280691 .2163084 3.37 0.001 .3041125 1.152026  
 HDI │ .0075692 .0206019 0.37 0.713 -.0328098 .0479482  
 \_cons │ 51.50019 1.392584 36.98 0.000 48.77077 54.2296  
────────────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Independent │  
 var(warmth) │ 5.38e-17 4.71e-16 1.90e-24 1.53e-09  
 var(\_cons) │ 3.43782 .9775981 1.968931 6.002548  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 34.7837 .9026366 33.0588 36.5986  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chi2(2) = 210.87 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\_longit  
> udinal\_data.dta", clear

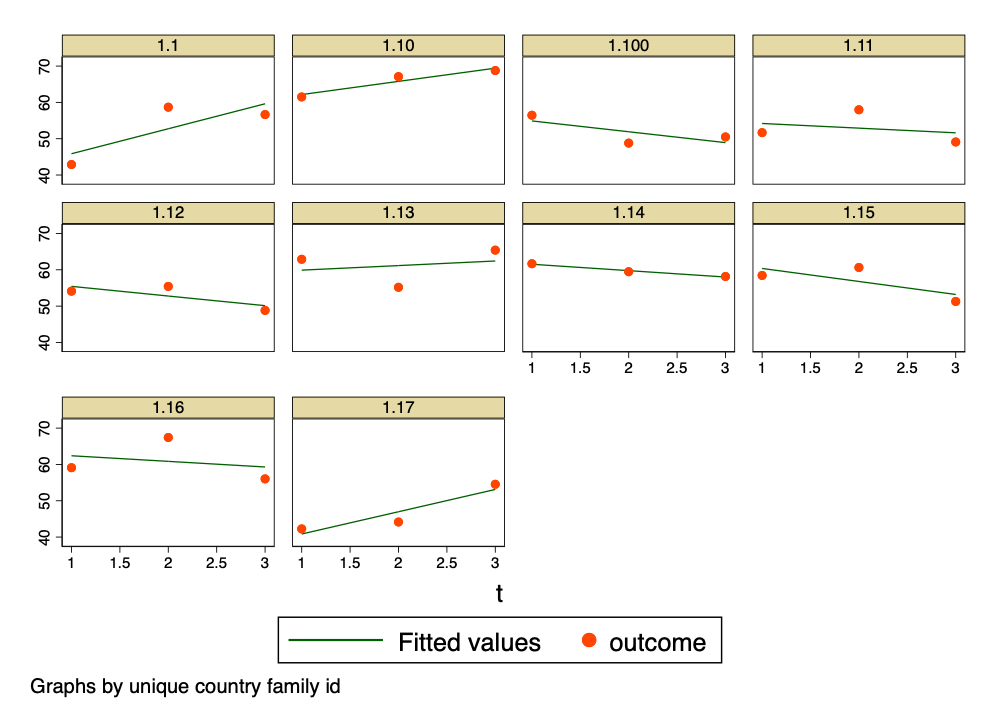
## The Equation

## 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 1.496 .5000118 1 2  
─────────────┼─────────────────────────────────────────────────────────  
 t │ 9,000 2 .8165419 1 3  
physical\_p~t │ 9,000 1.517111 1.884289 -2 5  
 warmth │ 9,000 2.533778 2.449075 -2 7  
 outcome │ 9,000 54.43846 7.019933 25.02363 81.63657

## 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(s1color  
> )  
  
.   
. 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 = -29398.984   
Iteration 1: log likelihood = -29398.984   
  
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 = -29398.984 Prob > chi2 = .  
  
─────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
─────────────┼────────────────────────────────────────────────────────────────  
 \_cons │ 54.43846 .3767998 144.48 0.000 53.69995 55.17698  
─────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Identity │  
 var(\_cons) │ 3.995172 1.099853 2.329182 6.85279  
─────────────────────────────┼────────────────────────────────────────────────  
id: Identity │  
 var(\_cons) │ 16.98591 .7068169 15.65556 18.42931  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 28.29352 .5165663 27.29897 29.3243  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chi2(2) = 1819.49 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 │ .0810797 .0205569 .0488675 .1315879  
 id|country │ .4257992 .0163912 .3940284 .4581946  
─────────────────────────────┴────────────────────────────────────────────────

## Full Model

. mixed outcome t warmth physical\_punishment i.group HDI || country: warmth || id: t // multil  
> evel model  
  
Performing EM optimization:   
  
Performing gradient-based optimization:   
  
Iteration 0: log likelihood = -28546.535   
Iteration 1: log likelihood = -28524.928   
Iteration 2: log likelihood = -28524.635   
Iteration 3: log likelihood = -28524.601   
Iteration 4: log likelihood = -28524.598   
Iteration 5: log likelihood = -28524.598   
  
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) = 1818.96  
Log likelihood = -28524.598 Prob > chi2 = 0.0000  
  
────────────────────┬────────────────────────────────────────────────────────────────  
 outcome │ Coefficient Std. err. z P>|z| [95% conf. interval]  
────────────────────┼────────────────────────────────────────────────────────────────  
 t │ .9929535 .0658203 15.09 0.000 .8639481 1.121959  
 warmth │ 1.047045 .0338001 30.98 0.000 .9807983 1.113292  
physical\_punishment │ -.9377711 .0381761 -24.56 0.000 -1.012595 -.8629473  
 2.group │ .8219777 .1530957 5.37 0.000 .5219157 1.12204  
 HDI │ .0047772 .0205645 0.23 0.816 -.0355285 .0450829  
 \_cons │ 50.50391 1.389611 36.34 0.000 47.78032 53.2275  
────────────────────┴────────────────────────────────────────────────────────────────  
  
─────────────────────────────┬────────────────────────────────────────────────  
 Random-effects parameters │ Estimate Std. err. [95% conf. interval]  
─────────────────────────────┼────────────────────────────────────────────────  
country: Independent │  
 var(warmth) │ .0071126 .0086595 .0006542 .0773303  
 var(\_cons) │ 3.560166 .9807369 2.074844 6.108788  
─────────────────────────────┼────────────────────────────────────────────────  
id: Independent │  
 var(t) │ 3.01e-10 2.17e-10 7.29e-11 1.24e-09  
 var(\_cons) │ 8.722256 .4792014 7.831839 9.713906  
─────────────────────────────┼────────────────────────────────────────────────  
 var(Residual) │ 25.98996 .4745951 25.07622 26.93699  
─────────────────────────────┴────────────────────────────────────────────────  
LR test vs. linear model: chi2(4) = 1331.93 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 │ 0.983\*\*\* 1.047\*\*\*   
 physical\_punishment │ -0.924\*\*\* -0.938\*\*\*   
 │  
 group │  
 2 │ 0.728\*\*\* 0.822\*\*\*   
 │  
 HDI │ 0.008 0.005   
 t │ 0.993\*\*\*   
 \_cons │ 51.500\*\*\* 50.504\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lns1\_1\_1 │  
 \_cons │ -18.731\*\*\* -2.473\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lns1\_1\_2 │  
 \_cons │ 0.617\*\*\* 0.635\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lnsig\_e │  
 \_cons │ 1.775\*\*\* 1.629\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lns2\_1\_1 │  
 \_cons │ -10.963\*\*\*   
─────────────────────┼──────────────────────────────────────────  
lns2\_1\_2 │  
 \_cons │ 1.083\*\*\*   
─────────────────────┼──────────────────────────────────────────  
Statistics │   
 N │ 3000 9000   
 ll │ -9616.347 -2.85e+04   
 chi2 │ 764.268 1818.962   
─────────────────────┴──────────────────────────────────────────  
 Legend: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

# QUESTIONS???