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

$$\text{outcome}_{ij} = \beta_0 + \beta_1 \text{parental warmth} + \beta_2 \text{physical punishment} + \beta_3 \text{time} +$$

$$\beta_4 \text{group}_2 + \beta_5 HDI +$$

$$u_{0j} + u_{1j} \times \text{parental warmth} + e_{ij}$$

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
```

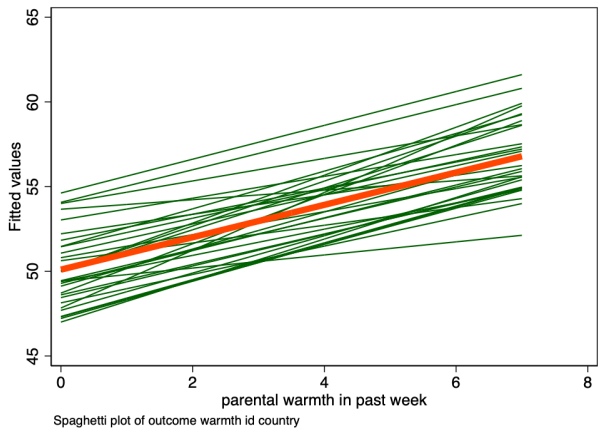

Figure 1: Spaghetti Plot of Outcome by Warmth by Country

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

$$\text{outcome}_{ij} = \beta_0 + \beta_1 \text{parental warmth} + \beta_2 \text{physical punishment} + \beta_3 \text{time} +$$

$$\beta_4 \text{group}_2 + \beta_5 HDI +$$

$$u_{0j} + u_{1j} \times \text{parental warmth} +$$

$$v_{0i} + v_{1i} \times t + e_{ij}$$

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
```

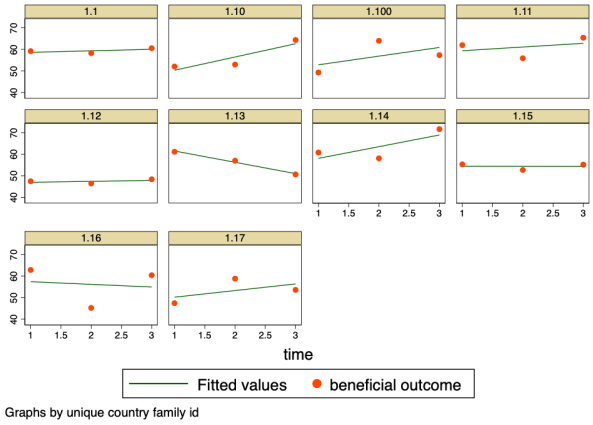

Figure 2: Alternate Plot of Outcome by Time by Individual; First 10 Observations

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

Group variable	No. of groups	Observations per group 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???