

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_data.d
> ta", clear
```

The Equation

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

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

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	1.496	.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
```

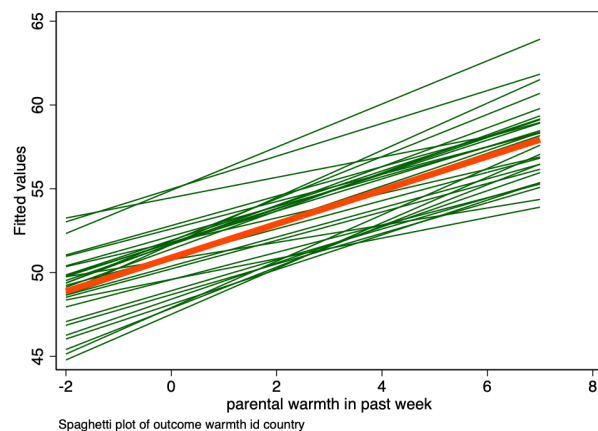


Figure 1: Spaghetti Plot of Outcome by Warmth by Country

Unconditional Model

Model

```
. mixed outcome || country: // unconditional model
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log likelihood = -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)      =        .
                                           Prob > chi2       =        .

Log likelihood = -9956.6096
```

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 || country: warmth // multilevel model
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log likelihood = -9622.5983
Iteration 1:   log likelihood = -9622.076
Iteration 2:   log likelihood = -9622.0697
Iteration 3:   log likelihood = -9622.0697
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(2)       =       749.92
                                         Prob > chi2        =       0.0000

Log likelihood = -9622.0697
```

outcome	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
warmth	.9822454	.0445447	22.05	0.000	.8949394	1.069551
physical_punishment	-.9259144	.0574361	-16.12	0.000	-1.038487	-.8133417
_cons	52.35557	.3833106	136.59	0.000	51.6043	53.10685

Random-effects parameters	Estimate	Std. err.	[95% conf. interval]	
country: Independent				
var(warmth)	4.83e-15	4.20e-14	1.95e-22	1.20e-07
var(_cons)	3.442879	.9792352	1.971606	6.01206
var(Residual)	34.91739	.9061059	33.18587	36.73927

LR test vs. linear model: chi2(2) = 210.33 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

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

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

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

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	1.496	.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(sicolor)
.
. twoway (lfit outcome t) (scatter outcome t) if idNUMERIC <= 10, by(idNUMERIC) scheme(sicolor
> )
.
. graph export spagplot2.png, width(1000) replace
file /Users/agrogan/Desktop/GitHub/multilevel-workshop/spagplot2.png saved as PNG format
```

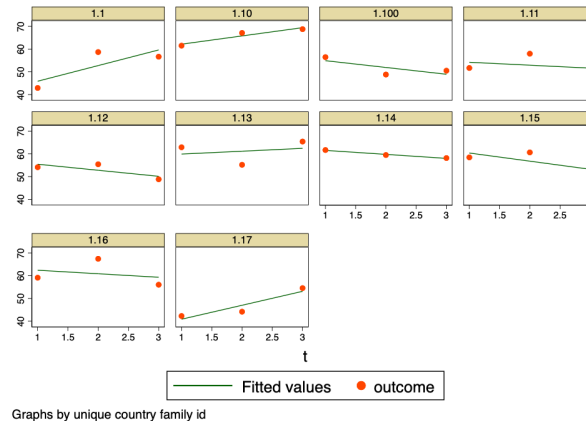


Figure 2: Alternate Plot of Outcome by Time by Individual; First 10 Observations

Unconditional Model

Model

```
. mixed outcome || country: || id: // unconditional model
```

Performing EM optimization:

Performing gradient-based optimization:

Iteration 0: log likelihood = -29398.984

Iteration 1: log likelihood = -29398.984

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

Log likelihood = -29398.984 Wald chi2(0) = .
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 || country: warmth || id: t // multilevel model
```

Performing EM optimization:

Performing gradient-based optimization:

```
Iteration 0: log likelihood = -28560.856
Iteration 1: log likelihood = -28539.271
Iteration 2: log likelihood = -28539.01
Iteration 3: log likelihood = -28538.97
Iteration 4: log likelihood = -28538.966
Iteration 5: log likelihood = -28538.966
```

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

Log likelihood = -28538.966 Wald chi2(3) = 1796.70
Prob > chi2 = 0.0000

outcome	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
t	.9929284	.0658203	15.09	0.000	.863923	1.121934
warmth	1.047035	.0336035	31.16	0.000	.9811738	1.112897
physical_punishment	-.9405095	.0383163	-24.55	0.000	-1.015608	-.8654109
_cons	51.22522	.3885182	131.85	0.000	50.46373	51.9867

Random-effects parameters		Estimate	Std. err.	[95% conf. interval]	
---------------------------	--	----------	-----------	----------------------	--

```

country: Independent
      var(warmth)      .0064869      .0085229      .0004939      .0851915
      var(_cons)      3.557187      .9801715      2.072816      6.104534

id: Independent
      var(t)      2.16e-07      1.79e-07      4.26e-08      1.09e-06
      var(_cons)      8.894507      .4833934      7.995788      9.894241

      var(Residual)      25.99026      .4745961      25.07652      26.9373

LR test vs. linear model: chi2(4) = 1340.10      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	0.982***	1.047***
physical_punishment	-0.926***	-0.941***
t		0.993***
_cons	52.356***	51.225***
lns1_1_1		
_cons	-16.482***	-2.519***
lns1_1_2		
_cons	0.618***	0.634***
lnsig_e		
_cons	1.776***	1.629***
lns2_1_1		
_cons		-7.674***
lns2_1_2		
_cons		1.093***
Statistics		
N	3000	9000
ll	-9622.070	-2.85e+04
chi2	749.924	1796.701

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

QUESTIONS???