UCLA School of Education & Information Studies
Department of Education

EDUC 231D
Advanced Quantitative Methods: Multilevel Analysis
Winter 2025

Organizational and Contextual Effects

Lecture 8 Presentation Slides

January 30, 2025

Today’s Topics

- Group assignment #1 presentations
- Estimating the effect of individual organizations
- Reading discussion

Group Assignment #1 Presentations

Estimating the Effect of Individual Organizations

Why try to estimate the effect of individual organizations?

- Monitor the performance of individual organizations to hold organizational leaders accountable

- Rank organizational units to evaluate performance

- Identify unusually effective or ineffective organizations for further study (what about these organizations make them effective or ineffective)
  - "Which school districts do the best job of teaching math?"

Critical issues when estimating effects of individual organizations

- Causal attribution of observed differences between two organizations is probably tainted by bias

- Effects of individual organizations are often measured with a lot of uncertainty

- Results can be sensitive to model specification
  - What factors should one adjust for in the model?
  - What factors should one not adjust for in the model?

Use of multilevel models and empirical Bayes estimates

- Multilevel models and the resulting empirical Bayes random effect estimates are a common way to estimate the effects of individual organizations
  - We want to estimate level-2 residuals that are adjusted for factors outside the control of the organization (e.g., student background characteristics)
  - Grand-mean centering is appropriate

Level 1: $$Y_{ij} = \beta_{0j} + \beta_{1j}(X_{ij} - \bar{X}_{..}) + r_{ij},\ \ r_{ij} \sim N(0, \sigma^2)$$

Level 2: $$\beta_{0j} = \gamma_{00} + u_{0j},\ \ u_{0j} \sim N(0, \tau_{00})$$
$$\beta_{1j} = \gamma_{10}$$

Use of multilevel models and empirical Bayes estimates

- The OLS estimator for the effect of organization *j*:

$$\hat{u}_{0j} = \bar{Y}_{.j} - \hat{\gamma}_{00} - \hat{\gamma}_{10}\left(X_{ij} - \bar{X}_{..}\right)$$

- The empirical Bayes (EB) estimator "shrinks" the OLS estimate toward the mean to account for unreliability of the OLS estimate:

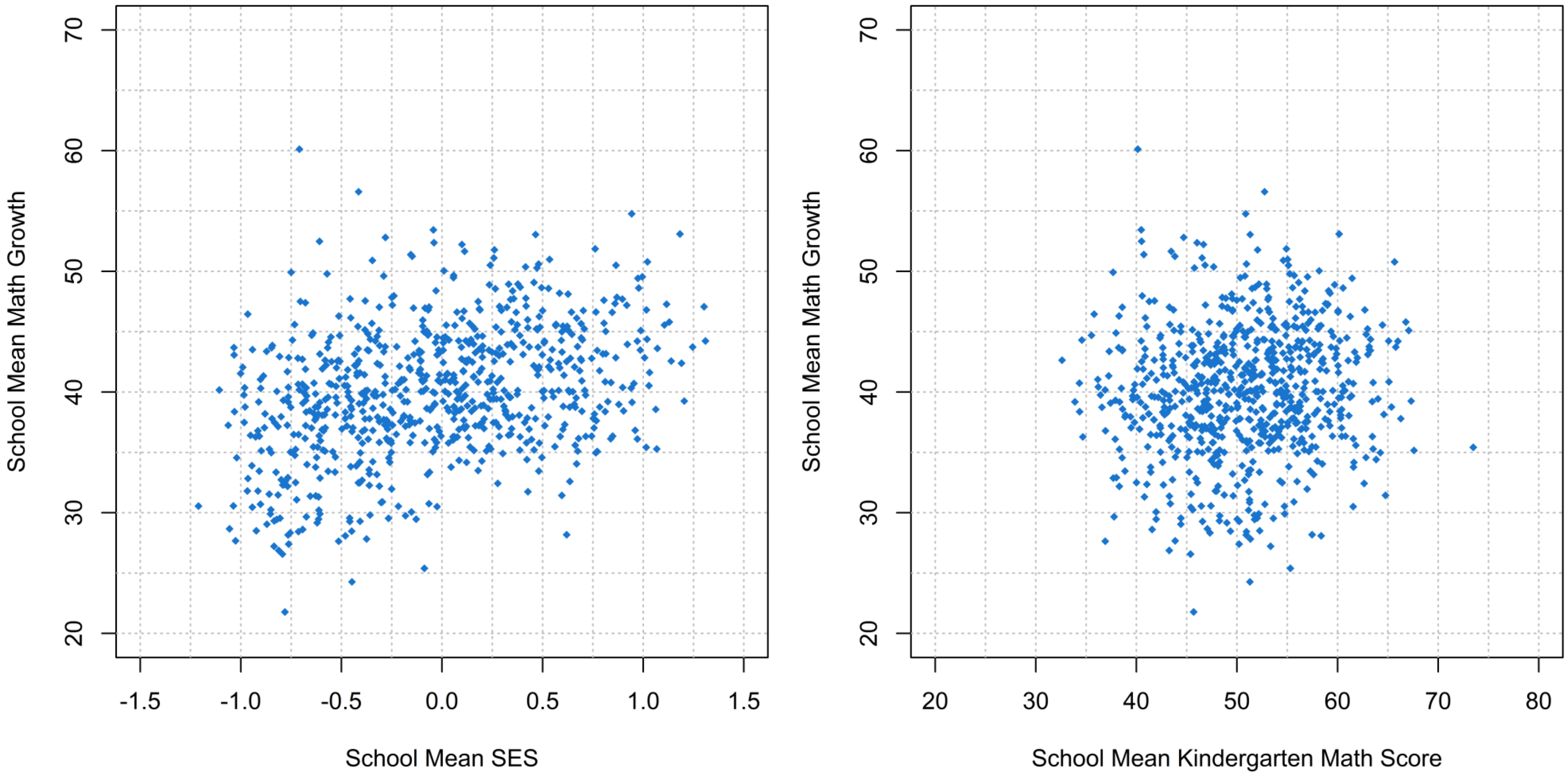
$$u_{0j}^{*} = \lambda_j \hat{u}_{0j}, \qquad \lambda_j = \frac{\hat{\tau}_{00}}{\hat{\tau}_{00} + \frac{\hat{\sigma}^2}{n_j}}$$

Organizational effects illustration

- Back to the ECLS-K data
- Which elementary schools are the "best" at teaching early elementary math? Which are the "worst"?
- Look at change in math scores from kindergarten to grade 2
- Control for match score in kindergarten, family SES, child age, school mean SES, and school mean kindergarten math score

variable	mean	sd	p0	p25	p50	p75	p100
g0mscore	50.78	13.52	11.85	41.16	50.71	59.19	112.54
g2mscore	90.81	18.08	18.24	76.16	91.49	104.99	139.10
mathgrowth	40.03	11.29	-33.80	32.48	39.86	47.67	87.88
famses	-0.03	0.82	-2.33	-0.65	-0.11	0.57	2.60
childage	85.45	4.35	73.08	82.06	85.32	88.50	109.40
schses	-0.03	0.54	-1.21	-0.45	-0.03	0.39	1.31
schmscore0	50.78	6.85	32.61	46.04	51.04	55.66	73.49

Organizational effects illustration



Organizational effects illustration

- Estimate multilevel model

```
m1 <- lmer(mathgrowth ~ g0mscore.gdc + famses.gdc + childage.gdc
              + schmscore0 + schses + (1 | schid), data = ex2)

print(as_flextable(m1), preview = "pptx")
```

		Estimate	Standard Error	df	statistic	p-value	
			Fixed effects				
	(Intercept)	51.063	1.865	744	27.374	0.0000	***
	g0mscore.gdc	0.023	0.009	10,076	2.627	0.0086	**
	famses.gdc	1.739	0.167	10,043	10.418	0.0000	***
	childage.gdc	-0.236	0.025	10,748	-9.630	0.0000	***
	schmscore0	-0.215	0.036	745	-5.902	0.0000	***
	schses	3.743	0.486	946	7.701	0.0000	***
			Random effects				
schid	sd__(Intercept)	4.016					
Residual	sd__Observation	10.203					

Signif. codes: 0 <= '***' < 0.001 < '**' < 0.01 < '*' < 0.05

Organizational effects illustration

- Extract EB random effect estimates and standard errors

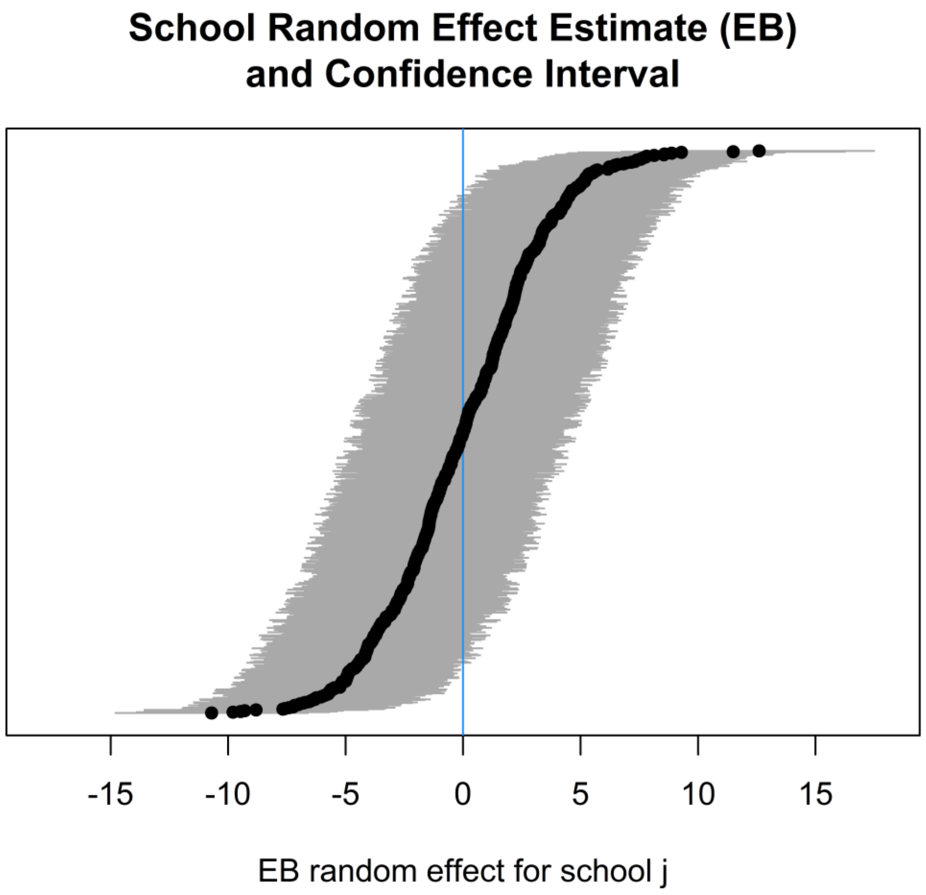
```
# extract predicted values
ex2$y_hat <- predict(m1, re.form=~0)

# extract random effects
re <- as.data.frame(ranef(m1,
        condVar=TRUE, whichel = "schid"))
```

schid	n_j	$\bar{Y}_{.j}$	$\hat{Y}_{.j}$	$\hat{u}_{0j}$	u^*_{0j}
1002	14	39.05	39.18	-0.13	-0.09
1003	13	39.57	41.35	-1.78	-1.19
1006	15	30.85	37.96	-7.12	-4.97
1014	16	37.47	40.75	-3.27	-2.33
1015	14	52.23	42.25	9.97	6.83
1016	15	37.82	44.95	-7.14	-4.99
1017	21	41.34	42.22	-0.87	-0.67
1019	17	39.51	41.56	-2.05	-1.49
1020	15	50.04	38.93	11.11	7.77
1021	11	36.08	39.39	-3.31	-2.09
1022	16	41.95	39.38	2.57	1.83
1023	17	42.66	42.85	-0.19	-0.14
1025	11	45.23	40.84	4.39	2.77
1028	10	40.18	37.05	3.14	1.91
1031	16	45.58	41.44	4.13	2.94
1032	12	39.56	39.65	-0.09	-0.06
1033	20	48.69	43.14	5.54	4.19
1034	13	43.26	40.73	2.53	1.69
1035	15	31.44	40.70	-9.26	-6.48
1036	17	37.96	40.08	-2.11	-1.53

Organizational effects illustration

- Compare school EB effect estimates with confidence intervals



Reading Discussion (in small groups)

Using hierarchical linear modeling to study social contexts: The case of school effects

- “Only when the ICC is more than trivial … would the analyst need to consider multilevel methods.” (Lee, 2000, p. 128)
    - What does this mean conceptually? What does this mean statistically?

- Equations for the multilevel models were not included in the paper. Can you write out the model for Study 1 and Study 2, focusing on the main components, not all the variables used?

- In your version of the models, what are the main parameters of interest for testing the social context effect(s)?

Using hierarchical linear modeling to study social contexts: The case of school effects

- Equations for the multilevel models were not included in the paper. Can you write out the model for Study 1 and Study 2, focusing on the main components, not all the variables used?
- Study 1

Level 1: $Y_{ij} = \beta_{0j} + \beta_{1j}\left(SES_{ij} - \overline{SES}_{.j}\right) + \beta_{2j}\left(X_{ij} - \bar{X}_{..}\right) + r_{ij},\ r_{ij} \sim N(0, \sigma^2)$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}SIZE_j + \gamma_{02}\overline{SES}_{.j} + \gamma_{03}W_j + u_{0j}\ ,\ u_{0j} \sim N(0, \tau_{00})$

$\beta_{1j} = \gamma_{10} + \gamma_{11}SIZE_j + \gamma_{12}\overline{SES}_{.j} + \gamma_{13}W_j + u_{1j}\ ,\ u_{1j} \sim N(0, \tau_{11})$

$\beta_{2j} = \gamma_{20}$

Using hierarchical linear modeling to study social contexts: The case of school effects

- Equations for the multilevel models were not included in the paper. Can you write out the model for Study 1 and Study 2, focusing on the main components, not all the variables used?
- Study 2

Level 1: $Y_{ij} = \beta_{0j} + \beta_{1j}\left(SES_{ij} - \overline{SES}_{.j}\right) + \beta_{2j}\left(X_{ij} - \bar{X}_{..}\right) + r_{ij},\ r_{ij} \sim N(0, \sigma^2)$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}CRL_j + \gamma_{02}\overline{SES}_{.j} + \gamma_{03}W_j + u_{0j}\ ,\ u_{0j} \sim N(0, \tau_{00})$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}CRL_j + \gamma_{12}\overline{SES}_{.j} + \gamma_{13}W_j + u_{1j}\ ,\ u_{1j} \sim N(0, \tau_{11})$$

$$\beta_{2j} = \gamma_{20}$$

Using hierarchical linear modeling to study social contexts: The case of school effects

- What do you think are the main strengths of the analysis for Study 1 and Study 2?
- What do you think are the main limitations of the analysis for Study 1 and Study 2?
- What other types of social context measures do you think would be interesting/important to examine? (Does not have to be limited to schooling/education.)