18. *Writing about Hierarchical Linear Models*

SUGGESTED COURSE EXTENSIONS

A. Reviewing

1. Find a journal article in your field that presents results of a two-level hierarchical linear model (OLS). Use the criteria in chapter 18 of *Writing about Multivariate Analysis, 2nd Edition* to evaluate the following aspects of the article:

    a. The authors' rationale for using a hierarchical linear model to address the research question at hand;
    b. Their definition of the units of analysis at each level, and the hierarchical structure by which they relate to one another;
    c. The sample size at each level. Discuss whether sizes meet minimum sample size requirements within levels.
    d. The description of the variables and the levels to which they pertain;
    e. The description of the model specifications, including
        i. the series of models estimated and what substantive question each model or comparison of models is intended to address;
        ii. which parameters are specified with fixed effects and which with random effects.
    f. The table of multivariate HLM results, including whether the authors provided information on
        i. the statistical significance of individual coefficients;
        ii. the overall fit of models across different HLM specifications;
        iii. the variance components.
    g. The prose description of within- and between-group variation, and the intraclass correlation coefficient.
    h. The prose interpretation of key level-1 and level-2 coefficients for their research question, including what they show about the associations among the variables at each level, for each model alone and in conjunction with the other models;
    i. Presentation of cross-level interactions, if included. Consider whether a chart would facilitate presentation of that pattern. If so, sketch the design of the chart to show what goes on each axis and in the legend, and include a complete title, labels, and footnotes.
    j. Their discussion of the strengths and limitations of HLM for their topic and data;

k. Rewrite the description of the cross-level interaction to correct any shortcomings you identified in parts i and j.

2. Repeat question A.1 for a journal article that presents results of a growth trajectory HLM.

B. Applying Statistics and Writing

Use a data set with a hierarchical structure to perform the following tasks for a two-level HLM, using the guidelines in chapter 18 of *Writing about Multivariate Analysis, 2nd Edition*:

1. Address sample size issues for your HLM:

   a. Assess whether the minimum number of level-1 cases within level-2 units meets the standard for HLM, following the guidelines under "Sample Size" on pp. 389–91;
   b. Evaluate the extent and distribution of missing values at levels 1 and 2;
   c. Write a paragraph for the methods section describing the sample sizes at level 1 and level 2, and your conclusions from parts a and b of this question.

2. Create a table of descriptive statistics for all variables in your analysis, including the following elements:

   a. Organize the variables to convey the level at which each variable is measured, and to identify the dependent variable.
   b. Report the sample size at each level.
   c. Label each variable to convey its meaning, units, and categories, following the conventions in chapters 5 and 18.
   d. Report the pertinent descriptive statistics for that type of variable (level of measurement).

3. Conduct the following steps for an HLM with your data:

   a. Estimate the following three types of models:
      i. an unconditional (null) model;
      ii. a random intercept model;
      iii. a random intercept-and-slope model in which you permit the intercept and the slope of *one* key independent variable to vary randomly across the level-2 units.
   b. Write a series of equations to convey the statistical specifications for your HLM.
   c. Write a paragraph for the methods section describing the series of models you estimated, using the guidelines in chapter 18, including the following elements:
      i. what substantive questions each model or comparison of models is intended to address;

ii. which parameters are specified with fixed effects and which with random effects;
iii. the covariance structure and error terms you used;
iv. your assumptions about distributions of residuals at each level of analysis;
v. the type of software, estimation method, and algorithm used to estimate your models.

4. Create a table of multivariate HLM results for the series of models you estimated for the preceding question, including the following elements and following the guidelines in chapters 5 and 18:

   a. Label each model to convey the pertinent type of HLM specification (e.g., unconditional means, fixed effects, random effects, etc.);
   b. Organize the variables to convey the level at which they were measured, and to identify cross-level interactions;
   c. Report estimated coefficients and inferential statistical test information for each variable;
   d. Report variance components for each model;
   e. Report goodness-of-fit statistics for each model.

5. If your specification includes a cross-level interaction, create a chart to present that pattern, following the guidelines in chapters 6, 16, and 18 of *Writing about Multivariate Analysis, 2nd Edition*.

6. Write paragraphs to report and interpret the results of your multivariate HLM models, working from the table you created in question B.4. Be sure to address each of the following topics and to follow the guidelines in chapters 15 and 18:

   a. the direction, magnitude, and statistical significance of your key individual level-1 and level-2 coefficients;
   b. how the coefficient on a key level-1 variable compares when treated as fixed (in the random intercept model) and when treated as random (in the random intercept-and-slope model), and what you can learn about the variation in that key level-1 variable across level-2 units from comparing that coefficient from those two different HLM specifications;
   c. description of any cross-level interaction patterns included in your specification, referring to the chart created in the preceding question;
   d. how the overall fit of the model compares between the unconditional model, the random intercept model, and the random intercept-and-slope model, and what you can learn about the pattern of variation within and across levels from the comparison of model goodness of fit;
   e. the variance components results for the different specifications;
   f. within- and between-group variation, and the intraclass correlation coefficient for different models;

g. what your results show about the associations among the key independent variables at each level, for each model alone and in conjunction with the other models.

C. Revising

1. Repeat question A.1 for a paper you have written previously about an application of an HLM. Revise it to rectify any shortcomings you identified.

2. Evaluate a table of multivariate HLM results you created previously, using the guidelines in chapters 5 and 18 of *Writing about Multivariate Analysis, 2nd Edition*.

3. Repeat questions B.5 and B.6c for a paper you have written previously about an HLM involving a cross-level interaction. Revise those descriptions to rectify any shortcomings you identified.

4. Exchange drafts of your materials from questions C.1 through C.3 with someone who conducted an HLM analysis of a different research question or data. Peer-edit each other's work and revise according to the feedback you receive.