Multilevel Analysis for Applied Research

It's Just Regression!

Robert Bickel

SERIES EDITOR'S NOTE by David A. Kenny



THE GUILFORD PRESS New York London

Contents

Broo	Broadening the Scope of Regression Analysis	
1.1	Chapter Introduction	1
1.2	Why Use Multilevel Regression Analysis?	2
1.3	Limitations of Available Instructional Material	3
1.4	Multilevel Regression Analysis in Suggestive Historical Context	4
1.5	It's Just Regression under Specific Circumstances	8
1.6	Jumping the Gun to a Multilevel Illustration	9
1.7	Summing Up	1.2
1.8	Useful Resources	14
The	Meaning of Nesting	1 <i>7</i>
2.1	Chapter Introduction	17
2.2	Nesting Illustrated: School Achievement and Neighborhood Quality	20
2.3	Nesting Illustrated: Comparing Public and Private Schools	25
2.4	Cautionary Comment on Residuals in Multilevel Analysis	31
2.5	Nesting and Correlated Residuals	33
2.6	Nesting and Effective Sample Size	41
2.7	Summing Up	47
2.8	Useful Resources	49
Cont	extual Variables	52
3.1	Chapter Introduction	52
3.2	Contextual Variables and Analytical Opportunities	55
3.3	Contextual Variables and Independent Observations	61
3.4	Contextual Variables and Independent Observations: A Nine-Category Dummy Variable	68
3.5	Contextual Variables, Intraclass Correlation, and Misspecification	74
3.6	Contextual Variables and Varying Parameter Estimates	81

xxiv	Cont	ents	
	3.7	Contextual Variables and Covariance Structure	86
	3.8	Contextual Variables and Degrees of Freedom	98
		Summing Up	101
	3.10	Useful Resources	102
4 •	From	OLS to Random Coefficient to Multilevel Regression	105
	4.1	Chapter Introduction	105
	4.2	Simple Regression Equation	107
	4.3	Simple Regression with an Individual-Level Variable	107
	4.4	Multiple Regression: Adding a Contextual Variable	108
	4.5	Nesting (Again!) with a Contextual Variable	109
	4.6	Is There a Problem with Degrees of Freedom?	110
	4.7	Is There a Problem with Dependent Observations?	111
	4.8	Alternatives to OLS Estimators	112
	4.9	The Conceptual Basis of ML Estimators	114
	4.10	Desirable Properties of REML Estimators	117
	4.11	Applying REML Estimators with Random Coefficient Regression Models	119
	4.12	Fixed Components and Random Components	125
	4.13	Interpreting Random Coefficients: Developing a Cautionary Comment	128
	4.14	Subscript Conventions	130
	4.15	Percentage of Variance Explained for Random Coefficient and Multilevel Models	131
	4.16	Grand-Mean Centering	134
	4.17	Grand-Mean Centering, Group-Mean Centering, and Raw Scores Compared	137
	4.18	Summing Up	144
	4.19	Useful Resources	148
5	• Deve	loping the Multilevel Regression Model	150
	5.1	Chapter Introduction	150
	5.2	From Random Coefficient Regression to Multilevel Regression	152
	5.3	Equations for a Random Intercept and Random Slope	153
	5.4	Subscript Conventions for Two-Level Models: Gamma Coefficients	154
	5.5	The Full Equation	155
	5.6	An Implied Cross-Level Interaction Term	156
	5.7	Estimating a Multilevel Model: The Full Equation	156
	5.8	A Multilevel Model with a Random Slope and Fixed Slopes at Level One	161
	5.9	Complexity and Confusion: Too Many Random Components	163
	5.10	Interpreting Multilevel Regression Equations	167
	5.11	Comparing Interpretations of Alternative Specifications	174
		What Happened to the Error Term?	177

		Conten	ts xxv
	5.13	Summing Up	180
	5.14	Useful Resources	181
6	• Givin	g OLS Regression Its Due	183
	6.1	Chapter Introduction	183
	6.2	An Extended Exercise with County-Level Data	184
	6.3	Tentative Specification of an OLS Regression Model	184
	6.4	Preliminary Regression Results	189
	6.5	Surprise Results and Possible Violation of OLS Assumptions	190
	6.6	Curvilinear Relationships: Y_{BUSH} by X_{BLACK} , $X_{HISPANIC}$, and X_{NATIVE}	191
	6.7	Quadratic Functional Form	191
	6.8	A Respecified OLS Regression Model	192
	6.9	Interpreting Quadratic Relationships	192
		,	193
		Further Respecification of the Regression Model	196
	6.12	Clarifying OLS Interaction Effects	196
	6.13	Interpreting Results for the Respecified OLS Regression Equation for County-Level Data	198
		Summing Up	199
	6.15	Useful Resources	200
7	• Does	Multilevel Regression Have Anything to Contribute?	201
	7.1	Chapter Introduction	201
	7.2	Contextual Effects in OLS Regression	202
	7.3	Respecification and Changing Functional Form	204
	7.4	Addressing the Limitations of OLS	206
	7.5	Counties Nested within States: Intraclass Correlation	207
	7.6	Multilevel Regression Model Specification: Learning from OLS	208
	7.7	Interpreting the Multilevel Regression Equation for County-Level Data	211
	7.8	Knowing When to Stop	213
	7.9	Summing Up	215
	7.10	Useful Resources	217
8	• Multi	level Regression Models with Three Levels	218
	8.1	Chapter Introduction	218
	8.2	Students Nested within Schools and within Districts	219
	8.3	Level One: Students	220
	8.4	Level Two: Schools	221
	8.5	Level Three: Districts	222
	8.6	Notation and Subscript Conventions for Specifying a Three-Level Model	224
	8.7	Estimating a Three-Level Random Coefficient Model	226

xxvi	Con	tents	
	8.8	Adding a Second Level-One Predictor	228
	8.9	Adding a Level-Two Predictor	232
	8.10	Adding a Second Predictor at Level Two and a Predictor at Level Three	235
		Discretionary Use of Same-Level Interaction Terms	237
		Ongoing Respecification of a Three-Level Model	239
		A Level-Two Random Slope at Level Three	242
		Summing Up	246
		Useful Resources	246
9 •	Fami	liar Measures Applied to Three-Level Models	248
	9.1	Chapter Introduction	248
	9.2	The Intraclass Correlation Coefficient Revisited	249
	9.3	Percentage of Variance Explained in a Level-One Dependent Variable	252
	9.4	Other Summary Measures Used with Multilevel Regression	257
	9.5	Summing Up	264
	9.6	Useful Resources	264
10	Dete	rmining Sample Sizes for Multilevel Regression	26 6
	10.1	Chapter Introduction	266
	10.2	Interest in Sample Size in OLS and Multilevel Regression	268
	10.3	Sample Size: Rules of Thumb and Data Constraints	272
	10.4	Estimation and Inference for Unstandardized Regression Coefficients	275
	10.5	More Than One Level of Analysis Means More Than One Sample Size	276
	10.6	An Individual-Level OLS Analysis with a Large Sample	277
	10.7	A Group-Level OLS Analysis with a Small Sample	278
	10.8	Standard Errors: Corrected and Uncorrected, Individual and Group Levels	279
	10.9	When Output Is Not Forthcoming!	280
		Sample Sizes and OLS-Based Commonsense in Multilevel Regression	281
		Sample Size Generalizations Peculiar to Multilevel Regression	282
		Level-One Sample Size and Level-Two Statistical Power	282
		The Importance of Sample Size at Higher Levels	282
		Summing Up	283
		Useful Resources	283
11	• Mult	ilevel Regression Growth Models	285
	11.1	Chapter Introduction	285
	11.2	Analyzing Longitudinal Data: Pretest–Posttest	286
	11.3	Nested Measures: Growth in Student Vocabulary Achievement	287
	11.4	Nested Measures: Growth in NCLEX Pass Rates	290
	11.5	Developing Multilevel Regression Growth Models	292
	11.6	Summary Statistics with Growth Models	297

Content	s xxvii
11.7 Sample Sizes	300
11.8 The Multilevel Regression Growth Model Respecified	302
11.9 The Multilevel Regression Growth Model: Further Respecification	303
11.10 Residual Covariance Structures	306
11.11 Multilevel Regression Growth Models with Three Levels	311
11.12 Nonlinear Growth Curves	316
11.13 NCLEX Pass Rates with a Time-Dependent Predictor	325
11.14 Summing Up	328
11.15 Useful Resources	329
References	331
Author Index	343
Subject Index	347