
Robert B. Smith

Multilevel Modeling of Social Problems

A Causal Perspective

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Please note that additional material for this book (i.e., companion data sets and syntaxes for the analyses) can be downloaded from <http://extras.springer.com>

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*To grandchildren Adam, Jay, Eli,
Isaac, and Dev*

Preface

Contemporary societal problems are complex, intractable, and costly. Aiming to ameliorate them, social scientists formulate policies and programs; then, to test the efficacy of the planned interventions, they develop study designs and conduct policy research. All too often the results are disappointing because the theories guiding the policies and programs are inappropriate and the study designs are flawed; moreover the empirical databases for answering the research questions are often sparse. This book confronts these difficulties by defining the following five-step process: Analyze the roots of the social problem both theoretically and empirically; formulate a study design that captures the nuances of the problem; gather empirical data providing valid and repeatable measures; model the multilevel data using appropriate multilevel statistical methods to uncover potential causes and any biases to their implied effects; and, finally, use the results to refine theory and to formulate evidence-based policy recommendations for implementation and further testing.

The core chapters apply this process to analyze the following societal problems I have studied: political extremism; global human development; violence against religious minorities; computerizations of work; reform of urban schools; health care utilization and costs; and parental reluctance to vaccinate children. These chapters address the multilevel data structures of the social problems by grouping observations on microunit (level-1) by more macrounits (level-2) (e.g., professors are grouped by their university), and by presenting multilevel statistical modeling in contextual, longitudinal, and meta-analyses. These chapters apply qualitative typologies that may explain the differences between the macrounits, thereby crafting a “mixed-methods” approach that combines qualitative attributes with quantitative measures.

Rather than beginning with a novel statistical model bearing on statistical theory and searching for illustrative data, each core chapter begins with a pressing societal problem. Exemplifying the usefulness of multilevel modeling for the quantifications of effects and for causal inference, the chapters serve as vivid exemplars for teaching students. This use of examples reverses the usual procedure for introducing statistical methods. The specific substantive problem motivates theoretical

analysis, gathering of relevant data, and application of appropriate statistical procedures. Readers can use the supplementary data sets and syntaxes to replicate, critique, and advance the analyses, thereby developing their independent ability to produce applications of multilevel modeling. These data sets and syntaxes are available for downloading from <http://extras.springer.com/>

Multilevel models can capture the contextual and longitudinal aspects of social problems and provide evidence for causal inferences. But researchers working on social problems seldom develop multilevel models, even though the problems and the empirical data require such analyses. Facilitating the use of these statistical methods, this book provides examples of hierarchical data structures for which multilevel models are appropriate; namely, colleges and their professors, global regions and their constituent countries, countries and their citizens, organizations and their employees, schools and their students, and hospitals and their patients.

Software such as SAS's Proc Mixed and Proc Glimmix, MLwiN, M+, HLM, GLLAMM, SPSS Mixed Models, Stata, and BUGS have enabled researchers to conduct analyses of multilevel data sets after having mastered the logic of the method and the syntax of the computer programs. But students and researchers who desire to learn and apply these techniques are confronted with technical books that stress the statistical theory that may be too abstract for the general reader. Furthermore, these texts present examples mostly drawn from fields other than the social and behavioral sciences. Recent developments in the assessment of causal relationships in observational studies have stimulated discussions and research studies that differentiate the analysis of correlations from the analysis of causes. This literature can be technical and difficult for the uninitiated to grasp.

Through its substantive and incremental approach, this book meets the need for a basic introduction to the logic of multilevel modeling of social problems, and the assessment of causal relationships produced by such models. Each core chapter tackles a problem bearing directly or indirectly on aspects of social and economic development; each example is drawn from research practice and illustrates new theoretical or methodological principles. The four parts of the book and their component chapters can be read in any order but they are best read in sequence. Each advances the knowledge gained from mastery of the material that earlier chapters present; a reading of this book from chapter to chapter will develop the reader's knowledge and intuition. By replicating the analyses of each chapter using the available data sets and syntax, the learner will be able to solve similar problems and then tackle advanced methods and applications.

This book strikes a working balance among vital substantive problems, statistical theory, and statistical practice. Although it places a heavier emphasis on research practice than on statistical theory, each chapter explicates the theory bearing on its statistical modeling. It complements other books that present the formal, mathematical, or theoretical aspects of these methods. These texts are geared more toward mathematical statisticians, applied statisticians, and students of statistics, whereas this book is directed toward the social sciences (sociology, econometrics, education, government, history) as well as public health (health promotion, policy, and management) for advanced undergraduates, graduate

students, and teachers of research methods; professional researchers; and managers of policy research. This book will also interest statisticians because the chapters present substantive analyses using statistical methods, and data sets and computer syntaxes are available for use in replications and reanalyses. The motivated learner will master this material by reading the chapters, thinking about their content, and replicating and advancing the analyses.

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All of the chapters in this book are timely and contemporary: my access to Harvard University's Widener and Cabot libraries enabled me to advance my sociological and statistical knowledge; teaching a short course at the Massachusetts Institute of Technology helped me clarify the exposition. The chapters in their present form have not been published previously. However, I did derive aspects of some chapters from my prior published work: Chapter 2 is drawn from my explication of *The Academic Mind* that appeared in *Applications of Mathematics in Models, Artificial Neural Networks and Arts*, edited by V. Capecchi et al. (© Springer 2010, 163–193). Portions of Chapter 3, on James Coleman's causal model, appeared in my article on inferential causal models (*Quality & Quantity*, vol. 37, issue 4, 337–361; © Kluwer 2003) and in my Introduction to Coleman's

Mathematics of Collective Action (©Aldine Transaction 2006, vii-li). Some of the modeling of electoral voting in Chapter 4 was published online in *Case Studies in Business, Industry, and Government Statistics: An Internet Journal* (vol. 2, no. 2, 127–146; © Robert B. Smith 2009). Key parts of Chapter 7, on global human development, appeared in *Quality & Quantity* (vol. 43, issue 1, 1–34, © Springer 2009), as did key parts of Chapter 8 on contemporary violence against European Jewish people (vol. 42, issue 2, 135–180; 2008, © Springer 2006). Major portions of Chapter 9, on how an automated fraud detector influenced employee moral, appeared in the *Evaluation Review* (vol. 26, no. 1, 3–39; © Sage Publications 2002), as did major portions of Chapter 14, on meta-analytic consolidations of findings about health care utilization and costs (vol. 25, no. 3, 288–330; © Sage Publications 2001). I thank these journals for allowing me to reuse my writings in these new chapters.

Cambridge, Massachusetts

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Acronyms

ADL	Anti-Defamation League, a Jewish defense organization
AIC	Akaike Information Criteria
AMOS	Analysis of Moment Structures, a computer program.
ANOVA	Analysis of Variance
AR(1)	Auto Regressive covariance structure
ASD	Autism-spectrum disorders
BIC	Bayesian Information Criterion
BIC	Bayesian Information Criteria
BUGS	Bayesian inference Under Gibbs Sampling, a computer program
CATE	Average causal effect conditional on the covariates in the sample
CCT	controlled clinical trial
CDC	Centers for Disease Control and Prevention
CDSR	Cochrane Database of Systematic Reviews
CFRD	Computerized Fraud Detector
CS	compound symmetry covariance structure
DARE	Database of Abstracts of Reviews of Effects
DF or <i>df</i>	Degrees of Freedom
DID	Difference-in-Differences
DTaP	Diphtheria and tetanus toxoids and acellular pertussis (a vaccine)
DTP	diphtheria-tetanus and pertussis vaccine (a vaccine)
DTwP	diphtheria-tetanus and whole-cell pertussis (a vaccine) vaccine
EEs	Enrollees in an insurance plan
EMBASE	A biomedical and pharmacological bibliographic database
G20	Group of Twenty, see OECD.