Journal of Official Statistics
Vol. 8. No. 4, 1992, pp. 521–531

Book Reviews

Books for review are to be sent to the Book Review Editor Gösta Forsman, Department of Mathematics, University of Linköping, S-581 83 Linköping, Sweden.

Biemer, P.P., Groves, R.M., Lyberg, L.E., Mathiowetz, N.A., and Sudman, S. (Eds.), Measurement Errors in Surveys. John Wiley & Sons, New York, 1991. ISBN 0–471–53405–6, xxxiii + 760pp., $75.

This book, dedicated to the memory of Morris Hansen – a pioneer in the development of statistical research on nonsampling error – is a collection of 32 invited papers initially presented at the International Conference on Measurement Errors in Surveys held November 11–14, 1990 in Tucson, Arizona, U.S.A., for which the editors served as organizers and a steering committee, along with their roles as authors and editors for key sections of this volume. However, this volume is both more than a summary of that conference, or a conference proceedings volume, and a bit less. It is less because the conference consisted of 60 invited papers (including the 32 included in the volume) and 70 contributed papers, thereby providing a somewhat broader coverage of this general topic than the current volume. Although adding even a selected set of these other papers to the current volume would clearly have made it unwieldy, a brief listing of titles and authors for each of the other papers presented might have served as a useful appendix to this book.

Nevertheless, the book was explicitly intended to be more than a conference proceedings volume, and indeed has largely achieved that objective. The organizing committee sought "to collectively write a book dealing with the most important issues in the field of survey measurement error, attempting whenever possible to integrate diverse perspectives" (p. xix). As noted on the front flap of its jacket: *Measurement Errors in Surveys* documents the current state of the field, reports new research findings, and promotes interdisciplinary exchanges in modeling, assessing, and reducing measurement errors in surveys." And, indeed, it does each of these quite well. In contrast with a conventional proceedings volume, the chapters have undergone extensive editing and review – by section editors, secondary editors, authors of other chapters, and outside reviewers – and revision, and extensive use is made of cross references to other chapters, both within and across the five major sections of the book.

Essentially, this book emerged from a common and pervasive concern expressed across a number of diverse disciplines – statistics, sociology, psychometrics, psychology, market research, and others – about errors inherent in the survey method. Although the languages used to express this concern may differ, as do the particular types of error

selected for study and the objectives or focus of these investigations (e.g., prevention of errors versus assessment of their effects), "all of them share a preoccupation with weaknesses in the survey method" (cf. Groves, Chapter 1, p. 1). As the guiding concept for this book, *survey measurement error* "refers to error in survey responses arising from the method of data collection (including the interviewer), the respondent, or the questionnaire (or other instrument)," factors that, at the time of survey data collection, "may intervene and interact in such a way as to degrade response accuracy" (p. xvii). Excluded from this definition, and largely from discussions in the book, are errors of "nonobservation" (i.e., those arising from coverage, nonresponse, and sampling) and processing or other errors occurring after data collection (i.e., those arising from editing and coding, imputation, and other changes in data resulting from post-processing). Reflecting this basic definition of survey measurement errors as fundamentally "observational errors," the book is organized into five basic sections (each edited by one of the committee members) – the questionnaire (Sudman), respondents and responses (Mathiowetz), interviewers and other means of data collection (Lyberg), measurement errors in the interview process (Groves), and modeling measurement errors and their effects on estimation and data analysis (Biemer). Thus, in theory, the chapters are organized by four sources of measurement error – the questionnaire, respondents, interviewers, and the interaction of these three – and statistical models for estimating measurement errors. In practice, however, reflecting the complex and interdependent nature of survey data collection, the contents of these sections are hardly mutually exclusive. Hence, several chapters in the first four sections of the book address multiple sources of error simultaneously, and a number of these – although focusing predominantly on sources or causes of measurement error or efforts to reduce such errors – also employ statistical models to estimate such errors.

The initial chapters in each of the first four sections of the book provide a brief review or overview of the major source(s) of measurement area represented by the chapters that follow. Simply by reading these chapters, a reader with some training in survey research, but relatively little grounding in survey measurement error research, would receive a valuable orientation and introduction to most of the key issues currently addressed by research in this area. Moreover, most of the specific chapters in these sections should be quite accessible and of interest to researchers and graduate students in sociology, psychology, or market research, as well as survey statisticians. In contrast, chapters in the fifth and final section of the book, which focus on the more theoretical statistical side of measurement error research and statistical models of measurement error, "require a fairly thorough grounding in survey sampling and mathematical statistics, at the level of *Introduction to Mathematical Statistics*, 3rd. ed., by R.V. Hogg and A. Craig, 1970" (p. xx).

Given the diversity of disciplines and orientations represented in these chapters, the imposition and use of a common terminology and notation across the chapters in this book was virtually impossible. Nevertheless, two of the chapters – one by Robert Groves (Chapter 1) and the other by Paul Biemer and Lynne Stokes (Chapter 24) – make an explicit attempt to link the terminological and notational conventions of the various disciplines and approaches represented in the book. While not entirely successful in meeting this lofty goal, these chapters do an excellent job of describing and explicating: (a) the "two major languages of error that are (commonly) applied to survey data," derived from the academic disciplines of "statistics (especially statistical sampling theory) and psychology (especially psychometric and measurement theory)" (Groves, Chapter 1, p. 1): and (b) the two distinct (and parallel) theoretical perspectives in the literature on measurement error modeling – the "sampling perspective," which views measurement error in a survey response as a random variable arising from the sampling of a hypothetical error population," and the "psychometric perspective," which seeks to describe the "variance-covariance structure of the

population" as a whole, "to understand the relationship among multiple responses from a sample of units and to evaluate the correctness of individual responses" (Biemer and Stokes, Chapter 24, pp. 487–488). Together, these two chapters constitute one of the few concise combined summaries of these alternative disciplinary approaches to survey measurement error, other than in Groves's (1989) recent book on *Survey Error and Survey Costs.*

Overall, the volume gives greater emphasis to population and household surveys than to business or establishment surveys, although three chapters are devoted to the latter, and a similar volume and international conference devoted exclusively to establishment surveys is currently under development. Among the issues or themes addressed especially well in this volume across both chapters and major sections are: (1) the use of cognitive, information-processing, and communication theory and methods to examine each of the major sources of measurement error and the interview process as a whole; (2) a viewpoint that takes both seriously and judiciously recent criticisms of the standardized survey research interview process from a sociolinguistic and other perspectives by Suchman and Jordan (1990) and others; (3) a surprisingly diverse and insightful set of papers addressing the ongoing question of the relative nature and levels of measurement error in self versus proxy responses to survey questions; and (4) an equally diverse and informative series of theoretical and statistical approaches to interviewer variance and interviewer effects on survey data, including some innovative new ways of modeling and understanding such effects on survey results.

In sum, this volume should be of great interest to students and practitioners of survey research and survey methodologists (along with others actively engaged in measurement error research) across a broad range of disciplines who seek "to learn more about the causes, consequences, and cures of survey error in order to improve the quality of surveys through better design, data collection, and analytical techniques" (p. xx). Its widespread dissemination and use would serve to: (a) greatly increase our level of knowledge of the causes and consequences of measurement error in surveys; (b) stimulate further research on several important topics in this area; and, especially; (c) foster a blending of conceptual strategies and methods across a number of different disciplines with interests in this area, which currently pursue their research with little knowledge of the activities of those in other disciplines seeking to understand a common set of phenomena.

References

Groves, R.M. (1989). Survey Error and Survey Costs. New York: John Wiley.

Suchman, L. and Jordan, B. (1990). Interactional Troubles in Face-to-Face Survey Interviews. Journal of the American Statistical Association, 85, 232–241.

Richard A. Kulka
National Opinion Research Center
University of Chicago
Chicago, IL, U.S.A.

Biemer, P.P., Groves, R.M., Lyberg, L.E., Mathiowetz, N.A., and Sudman, S. (Eds.), Measurement Errors in Surveys. John Wiley & Sons, New York, 1991. ISBN 0-471-53405-6, xxxiii + 760pp., $75.

The book is a set of 32 invited papers presented at the International Conference on Measurement Errors in Surveys held in Tucson in November 1990. The invited authors and the topics for their papers were especially chosen with this monograph in mind.

Other selected papers from the Conference has appeared in a special edition of the Journal of Official Statistics. This provides a useful complement to the monograph.

The contents of the book are adequately described by the section titles. It is divided into five sections with each of the editors responsible for a section. The five sections are:

- The Questionnaire (Sudman)
- Respondents and Responses (Mathiowetz)
- Interviewers and Other Means of Data Collection (Lyberg)
- Measurement Errors in the Interview Process (Groves)
- Modeling Measurement Errors and Their Effects on Estimation and Data Analysis (Biemer)

Many of the chapters are of a review style, summarising and relating past research. The remaining chapters discuss more contemporary research on specific topics.

I found the review chapters particularly useful, especially having so many on different "measurement error" topics in a single volume. It is not possible to list all "review" topics but among those I found more interesting were a chapter by Eisenhower et al. on recall errors, Lyberg and Kasprzyk's chapter on collection mode effects, Forsyth and Lessler's review of cognitive laboratory methods and Biemer and Stokes's survey of measurement error models.

Most of the research papers are of the "interesting" rather than "cutting edge" category. Perhaps I am too demanding. Nevertheless, they do hang together well and complement the other chapters in the sections.

A comprehensive and very useful bibliography is included. This alone may justify the purchase of the book. The range of literature containing papers on measurement errors is vast covering statistical, psychological and social sciences. It is an incredibly valuable resource to have all these papers in a single bibliography.

The conference from which the papers were derived was an international conference with participants from 15 countries. In this light it is surprising to find the volume dominated by researchers from USA and the Netherlands. Possibly, it reflects the research effort but it would have been preferable to have a greater international contribution.

The book is aimed at both survey practitioners and researchers in the field of household surveys. (All but three of the chapters deal with household surveys.) It would be an extremely useful reference for both state of the art measurement error research; for both designing surveys or new research. It does not require detailed knowledge of mathematical statistics, except for Section 5 on measurement error models. However, some exposure to the design and conduct of household surveys would be essential. The book will also serve as a very useful text for a course on measurement errors. In fact, the manuscript has already served that purpose for some short courses.

In summary, I believe the book provides an extremely valuable contribution to the literature on measurement errors. It is highly recommended to all who are interested in this topic.

Dennis Trewin
Department of Statistics
Wellington, New Zealand

Biemer, P.P., Groves, R.M., Lyberg, L.E., Mathiowetz, N.A., and Sudman, S. (Eds.), Measurement Errors in Surveys. John Wiley & Sons, New York, 1991. ISBN 0–471–53405–6, xxxiii + 760pp., $75.

This volume represents a collective, international effort to address a range of measurement error topics in survey research. The editors assembled the monograph to illustrate the multi-disciplinary approaches in conceptualizing and modelling observational errors, as well as measuring, analyzing and reducing them. The editors' stated goal is to "stimulate a blending of methods and conceptual strategies" to further understand and reduce errors of measurement in collecting survey data.

The chapters in this volume comprise a carefully selected subset of invited papers presented at the International Conference on Measurement Errors in Surveys. The conference was held in November 1990 in Tucson, Arizona, U.S.A. It included the delivery of 60 invited and 70 contributed papers, and was attended by over 400 participants from 15 countries. The conference was initiated by the Survey Research

Methods Section of the American Statistical Association (ASA), and sponsored by ASA, the American Association of Public Opinion Research, the American Marketing Association, and the International Association of Survey Statisticians.

The monograph begins with a preface, introductory remarks, and an introductory chapter on measurement error in surveys. The balance of the book is organized around five (admittedly overlapping) themes or sections:

Section A: The Questionnaire
Section B: Respondents and Responses
Section C: Interviewers and Other Means of Data Collection
Section D: Measurement Errors in the Interview Process
Section E: Modeling Measurement Errors and Their Effects on Estimation and Data Analysis.

Each section was assigned to a different editor and contains five or six chapters (articles), except for Section E which has nine.

The structure of the sections is worthy of note. Each begins with a chapter devoted to a review or overview of the content area suggested by the section title. Moreover, apart from Section D, each overview chapter is co-authored by the section editor. The remainder of each section contains chapters which illustrate research projects and analytic approaches to problems related to the section content area.

The first chapter, entitled "Measurement Error Across the Disciplines," discusses how substantive disciplines, principally psychology and statistics, approach the problem of measurement error using different terminology for similar concepts. It briefly overviews approaches to modelling response error, mentioning validity, reliability, levels of effects (e.g., interviewer effects, instrument effects), etc.

Section A is devoted to measurement error issues related to the structure and content of the survey instrument. The section first offers a review article, and continues with chapters on specific investigations of measurement error due to order and selection of response categories, question context effects, telephone versus mail mode effects, and question wording effects. The section closes with an overview of instrument related measurement errors in business surveys.

Section B treats another measurement error source: recall error. The opening paper focuses on response error stemming from the recollection of autobiographical material. Thereafter, chapters appear on an investigation comparing self and proxy reporting, an experiment comparing two methods of obtaining personal history information (regarding smoking behaviors), and a study contrasting two methods of asking sensitive questions: direct questioning and an item count technique. The section's final chapter discusses issues regarding the development of a response error model in establishment surveys.

Section C contains chapters covering data collection methods and related sources of error. The review chapter covers virtually all manner of data capture and associated error. It is followed by chapters on techniques for reducing interviewer error, the use of reinterviews for error detection and analysis, errors related to diary surveys, observation errors associated with crop yield surveys, and errors in electronic data collection (optical scanners) for retail trade surveys.

In Section D, measurement errors which arise in the interview process are discussed. The opening chapter focuses on the respondent-interviewer interaction and how it affects observational errors, especially in the context of the standardized interview. This is followed by chapters which discuss cognitive laboratory methods, a respondent-interviewer interaction study, an empirical study which models interviewer effects, and a response variance model which is used to study response error and overall measurement error (combining response and procedural errors).

The final section of the monograph is the lengthiest. Section E deals with modelling measurement error and the effect of such error on statistical inference. The section opens with an overview of statistical measurement error models. The next chapter proposes a measurement error model for

dichotomous variables and includes an illustration. Thereafter, chapters are devoted to measurement error models for memory effects, models for simple response variance (with empirical applications), and evaluation of measurement errors using a structural models approach. The section closes with chapters which discuss statistical inference in the presence of measurement error, including the treatment of path analysis, regression analysis, chi-squared tests (with complex survey data), and event history analysis.

The book concludes with 83 pages of references.

Overall, the reviewers found this book to be well organized. The selection of papers provides a nice mix of theory and applications. Like all "compilation" books, there are the inevitable problems of inconsistent terminology and mathematical presentation, as well as the lack of consistency in the organization and presentation of material from chapter to chapter. However, it is clear that considerable effort went into reducing the magnitude of these problems, and the editors should be commended for this.

The sections' opening review chapters form a fine collection of papers for those who wish to learn about measurement error in surveys. Unfortunately, no two opening section review chapters are organized alike. This is a bit curious, since these were mostly co-authored by the editors. The collection could have been strengthened with more coordination.

The overall content of the book is exceptional. Currently we are not aware of any similar work which has such breadth in its treatment of measurement errors from theoretical, empirical, and methodological (e.g., methods for reducing error) perspectives. In this sense, the editors have achieved their professed goals for this book.

This book is most appropriate for survey statisticians and methodologists who have some familiarity with basic concepts of measurement error but wish to learn more about specific error sources and models. The interdisciplinary flavor of the book makes it particularly attractive to researchers outside the survey research world, too. Carefully selected subsets of the book could be used as a basis for a graduate level course on measurement errors in surveys (e.g., the opening section chapters and additional "applications" chapters). The inconsistent use of terminology across chapters could occasionally prove troublesome to the novice student, however.

As a final point, this monograph would make a good addition to those of us who have its companion volume, *Telephone Survey Methodology*.

Robert L. Santos and
Karin M. Clissold
Survey Research Center
University of Michigan
Ann Arbor, MI
U.S.A.

Jambu, M., Exploratory and Multivariate Data Analysis. Academic Press, Inc., San Diego, 1991. ISBN 0–12–380090–0. xiii + 474 pp., $79.

The author works at the National Centre for Telecommunications Studies in Paris, and is a self-described student of Professor J.P. Benzecri of the Universite Pierre et Marie Curie in Orleans. So the book grows very much out of the French schools of data analysis. Indeed, the book is translated from an earlier French edition. The heart of the book is a discussion of the French approach called correspondence analysis. Since Benzecri has recently written "the very spirit of correspondence analysis, as we understand it, did not cross over (the Atlantic) yet," a chance to learn more of this approach was indeed welcome.

The author has set impressive goals. "The heart of this book contains methods of exploring data from a statistical data analysis point of view, from the most elementary, associated with univariate and bivariate statistical description, to the most advanced, associated with multivariate statistical description, factor analysis, correspondence analysis and clustering. The book is written for anyone who analyzes data or

expects to do so in the future, including students, statisticians, scientists, engineers, managers and teachers." In this reviewer's opinion, the author has failed to meet his goals.

Chapter 1 (17 pages) gives general introductory remarks about data exploration. It presents, for example, a ten step approach to data exploration beginning with "Data decision," i.e., defining the aim and scope of the study. Then comes data elaboration, that is, defining the variables to be studied. This is followed by data input, data management, 1–D analysis, 2–D analysis, and then N–D analysis. Step 8 is factor analysis, followed by clustering and finally data communication and presentation. The structure of the book follows this outline.

Chapter 2 (7 pages) discusses variables and data sets. For example, the author distinguishes between "Discrete or Categorical Variables" and "Continuous or Quantitative Variables." According to the author "the number of children of a family is not a quantitative variable as it cannot take all possible values; a family can have 2, 3, or 4 children but not 2.4."

Chapter 3 presents techniques of one dimensional data analysis. It discusses numeric summaries including the median, the arithmetic mean, the quadratic mean, the harmonic mean, the geometric mean, the mode, quantiles, deciles, quartiles, the range, interquartile range, the mean difference, the mean deviation, the standard deviation, the median deviation, the geometric deviation, skewness (Yule's, Kelley's, and Pearson's coefficients), and Kurtosis (both Kelley's and Pearson's coefficients). Histograms, Ogives, frequency curves, boxplots, barcharts, pie charts, line graphs, and statistical maps are also covered. This is all done in 36 pages.

The author turns to two-dimensional data analysis in Chapter 4 (32 pages). The topics include independence testing, marginal and conditional variables, the method of least squares (both in general and linear least squares fit), scatter diagrams and sunray plots. Chapter 5 (18 pages) introduces various methods (mainly graphical) of multidimensional data analysis. These include multiple boxplots, multiple sunray plots, draftsman diagrams, triangular diagrams, and maps.

The author discusses factor analysis in Chapter 6 (12 pages). The technique is described using both matrix algebra and geometry. This is followed in Chapter 7 by a discussion of principal components analysis (43 pages). Much of this chapter is devoted to the interpretation of the results. An interesting aspect of this presentation is a series of graphs displaying jointly the points associated with the individuals (rows) and the variables (columns). Further points associated with supplementary individuals and supplementary rows can be mapped on to the same graph. This provides a rich tableau for interpretation.

The author's real interest is correspondence analysis. The discussion begins with "2–D Correspondence Analysis" in Chapter 8 (71 pages). The *Encyclopedia of Statistical Sciences* describes correspondence analysis as "an algebraic technique analogous to principal components analysis, but appropriate to categorical rather than to continuous variates." The chapter gives a mathematical description of correspondence analysis. It discusses the interpretation of the results. It describes factor graphics, classifying supplementary points, and rules for selecting significant axes and elements. The illustrative example used in this chapter is the number of patents registered in telecommunications in each of nine industrial countries each year from 1980 to 1986. Although only 9×7, the data set is sufficiently complex to demonstrate exploratory techniques. Multidimensional correspondence analysis is discussed in Chapter 9 (63 pages). The topics covered are similar to those of Chapter 8, but of course, related to multiple dimensions.

Chapter 10 (101 pages) deals with classification methods applied to individuals–variables data sets. These are data sets "that involve several variables observed on different statistical units," i.e., individuals. This is in contrast to proximities data sets which are "sets of numerical values corresponding to a distance matrix between two sets of variables or two sets of individuals." The chapter discusses both partitioning methods and hierarchical classifications. Several interesting examples are given. Proximities

data sets are discussed briefly in Chapter 11 (12 pages).

A final chapter (8 pages) discusses some computer aspects of exploratory and multivariate data analysis, with emphasis on "Data Analysis and Classification Library–DACL," a program written in France to do correspondence analysis. Eighteen rather interesting data sets are given in Appendix 2, including data sets on skulls, confidence criteria concerning investments abroad, family timetables, and a semantic field associated with colors.

In reviewing the book, I kept wondering who the intended reader was. In one sense, it assumes no previous statistical knowledge. It covers topics as basic as mean and standard deviation. On the other hand, the topics are presented in the most terse mathematical manner imaginable. To choose but one example, least squares regression is given about three pages. This seems to me far too little for someone just learning, but of little value as well for those who already know the topic. The ideal reader would be an engineer, well trained in mathematics, who knew no statistics. Such a reader would come away with a very strange view of statistics and modern data analysis, however.

To make matters worse, the author has been betrayed by either his translator or his typesetter. The spelling of "Californie" and "Hawai" lends a light touch and does little harm. The occasional mistranslation is distracting, such as the use of "the rests" rather than "the residuals." However, there are more serious problems. For example the semi-quartile range is defined as

$$Q = Q_3 - Q_1/2$$

rather than

$$Q = (Q_3 - Q_1)/2$$

This is not a big error, but would be confusing to someone (a student?) trying to learn from this book. Unfortunately, this is not a unique or even rare example.

The notation of this book makes things even worse: Q_1 can mean either the first quantile of X, or the first quartile; and "Q" can mean the semi-quartile range, the quadratic mean of X, a set of q questions or categorical variables, or a partition of I. One encounters "equations" such as

$$X_{ij} = (X_{ij} - \bar{X})/\sigma_j \sqrt{n}.$$

Such "equations" may be perfectly acceptable in computer programming, but not in a statistical text. Besides being mathematically incorrect, they leave the reader confused about which "X_{ij}" is being referred to in the subsequent material.

In spite of these weaknesses, the chapters on correspondence analysis may still be about the best available in English. A statistician well versed in the analysis of cross classified data, including factor analysis and principal component analysis, might well benefit from a peak into the French approaches presented in the second half of this book. Students interested in exploratory data analysis would do better reading Hoaglin et al. (1986) and of course Tukey (1977). Those interested in learning about multivariate analysis have a wide selection of texts to choose among.

The views expressed here are those of the reviewer and do not necessarily reflect those of the U.S. Bureau of the Census.

References

Benzecri, J.P. (1991). Comments on Measures, Models, and Graphical Displays in the Analysis of Cross-Classified Data by Leo Goodman. Journal of the American Statistical Association, 86, 1112–1115.

Hoaglin, D.C., Mosteller, F. and Tukey, J.W. (1983). Understanding Robust and Exploratory Data Analysis. New York: John Wiley & Sons.

Hill, M.O. (1982). Correspondence Analysis. In Encyclopedia of Statistical Sciences, Kotz, S. and Johnson, N. (Eds.), New York: John Wiley & Sons.

Tukey, J.W. (1977). Exploratory Data Analysis. Reading, MA: Addison-Wesley.

Howard Hogan
Bureau of the Census
Washington, DC, U.S.A.

Luijben, T., Statistical Guidance for Model Modification in Covariance Structure Analysis. Sociometric Research Foundation, Amsterdam, 1989, ISBN 90–70974–11–0, iii + 191pp.

Covariance structure modeling methods have proven to be highly valuable techniques for testing theories with social science data. While Bollen (1989) has provided an overview of the basic issues and problems in this area, the current monograph (which is taken from the author's dissertation at the University of Groningen) addresses itself to a particular subarea within covariance structure modeling, model modification. Specifically, the author is concerned with providing a statistical foundation for guiding the model modification process.

A brief explanation of the problem the author seeks to investigate may be useful. Suppose that a researcher has hypothesized a model with a specific set of overidentifying restrictions on the parameter space. Let us refer to this, as Luijben does, as a baseline model. The fit of this model can be evaluated in a number of different ways, including the use of a chi-square goodness-of-fit statistic when particular distributional assumptions are made. In testing the baseline model in a given sample, evidence from the test statistic suggests that there are inconsistencies between the model and the data. A researcher may then wish to change the overidentifying restrictions in the parameter space to find a model that is more consistent with observed data. Changes might include either the addition of new parameters to improve model fit or the deletion of parameters to obtain a more parsimonious summarizing model. Such specification searches for models have been discussed in econometric models by Leamer (1978) and early work in the area of covariance structure modeling was reported by Sörbom (1975) and later elaborated by MacCallum (1986).

The work reported in this monograph focusses on model modification based on a sequence of parameter-nested models. Lagrange multiplier tests (also referred to as Score tests of MIs [for "modification indices" as they are referred to in the LISREL computer program; Jörekog and Sörbom 1988] in this monograph) are used to test hypotheses about overly restrictive models and evaluate the need to relax the overidentifying restrictions on the parameter space. Univariate Lagrange multiplier tests are compared with information from the first derivative of a discrepancy function (labelled FD in the monograph) and the expected parameter change statistic (labelled EPC). The EPC statistic estimates the change in the value of a parameter from a model where it is fixed to a subsequent model where it is freely estimated. These three statistics calibrate the univariate change in moving from the baseline model towards a less restrictive model that estimates one additional parameter.

The work reported in this monograph also considers the effects of simplifying models. In this case, parameters are deleted from a model to obtain a more parsimonious description of the data. Wald tests (or equivalently the "t-values" reported in LISREL) are used to evaluate whether additional overidentifying restrictions can be placed on a model. Such restrictions would reduce the parameter space of the baseline model. As was the case with the statistics that seek to add model parameters, removal of model parameters is considered primarily from a univariate perspective (i.e., the deletion of one parameter at a time), although there is some discussion in this monograph of multivariate expansion and deletion as well using multivariate versions of the Lagrange and Wald tests.

Luijben wishes to explore two specific problems that might be encountered in the model modification process. The first deals with the effects of statistical power on model modification. It may be the case that researchers investigating the same misspecified model with two different sample sizes might be directed to alter models in different ways. This would happen as a function of the statistical power of the associated tests of the overidentifying restrictions. The second major problem addressed in this monograph

is the effects of the model modification process on parameter estimates and their standard errors. Luijben frames this as a question about the equivalence of the sampling distributions of parameters conditional on a sequential model search versus the unconditional sampling distribution of the parameters.

The monograph is structured as follows. Chapter 1 provides an overview of the kinds of model modification problems to be considered. Chapter 2 provides a review of the relevant statistical literature on covariance structure models. Chapters 3 through 6 provide the heart of the original contributions of this work. Chapter 3 presents Monte Carlo studies of some common model modification statistics for model expansion and contraction. Chapter 4 considers the effects of model expansion and contraction on parameter sampling distributions. Chapter 5 considers the development of an alternative local test for relaxing overidentifying restrictions. Chapter 6 discusses the role of equivalent models in covariance structure analysis and provides a discussion of the effects of equivalent models on model modification statistics.

In many ways, the structure of this monograph closely parallels the classic work of Boomsma (1983) on sample size effects and non-normality in testing covariance structure models. The population models used in the Monte Carlo research are identical to those found in Boomsma and it is clear that the careful groundwork laid in the Boomsma simulations was closely followed in this study. As was the case with the Boomsma results, the current monograph extends results in covariance structure modeling in quite interesting ways.

There are several major points that are made by this monograph. First, the simulations make clear that the recent advances in developing statistics for model expansions are clearly worthwhile. The earlier recommendations of basing model expansions on large first derivatives (Sörbom 1975) underperform both the EPC and the MI in terms of identifying model improvements. The observation that low statistical power is associated with any particular univariate MI led to the discussion of an alternative test procedure elaborated in Chapter 5 of adding model parameters based either on the omnibus (lack of) fit of a particular model (the usual case in practice) or the existence of a large MI associated with any fixed parameter. The latter argument is developed in terms of a Bonferroni adjustment made on the number of sets of fixed parameters which, if freed, would lead to nonequivalent models.

The Chapter 5 discussion leads directly to the consideration of equivalent models presented in Chapter 6. From the model modification perspective taken in this monograph, the problem of equivalent models is framed in terms of the choice of moving from a baseline model to two (or more) other models with different sets of free parameters that yield identical reproduced covariance matrices. Luijben shows that the equality of MIs provides a necessary condition for the equivalence of the expanded models and goes on to derive the necessary and sufficient conditions for model equivalence. This development is based on the following logic. Suppose that an investigator can choose to expand a baseline model by freeing two different parameters with the identical MI value leading to the models M_1 and M_2. If both parameters are freed to obtain the model M_{12} which has two additional parameters relative to the baseline model, the Jacobian matrix for the M_{12} model is rank deficient. Luijben summarizes this result by stating that, for two locally equivalent models M_1 and M_2, univariate MIs exist, but the multivariate MI for the M_{12} model for jointly freeing the parameters in the M_1 and M_2 models exists only when a generalized inverse of the information matrix of the M_{12} model is employed.

I have some concerns about the presentation of material in this monograph that undermine its clarity. One example of this is in the presentation of results from the simulation study in figures, particularly in Chapter 3. Figure 3.2 of the monograph provides a prototype of this problem. In this fugure, the FD, MI, and EPC are compared with respect to their relative utility in leading to an appropriate model modification. The shading employed for these three statistics makes it difficult to differentiate

among them and, in particular, between the FD and the EPC results as these appear in two apparently different shades of black that did not reproduce well. While the corresponding text makes it clear what findings are being referred to in the figure, a clearer presentation of the graphical material would have been helpful.

A second detail-oriented concern about this monograph is the labelling of equations. In particular, at the end of Chapter 4, there is a discussion of bias in incorrectly omitted parameters. A method for estimating the bias to compensate for this effect is suggested. The reader is referred to a formula presented earlier in the chapter which, unlike many of the other formulas presented in text, is not set off with its own parenthetical label. This makes it somewhat more difficult to track down where this formula exists in the text.

While this monograph makes important theoretical and empirical contributions to the literature on model modification in covariance structure models, a deficiency is its relative inattention to spelling out what the implications of this work are. Researchers with empirical data who are interested in the model modification process are less likely to benefit from the contents of this monograph as much as they would have if the author had written a concluding chapter summarizing study results and their implications for model fit. The perspective taken here can be contrasted with work by La Du and Tanaka (1989, 1992) that is interested in the same model modification phenomenon, but focusses to a greater extent on the substantive implications of these model respecifications. While the current monograph is a scholarly and important contribution to the literature on model modification in covariance structures, it is unclear that readers will be able to make conceptual links between this work and its implications for model fit and model testing as was accomplished, for example, in the Boomsma (1983) monograph.

Luijben is to be congratulated for his thorough treatment of the issue of model modification in covariance structure modeling. As he points out, much of the work that had previously been done in this area had been speculative. Luijben's empirical and theoretical work in this monograph clearly place some of these earlier speculations on a more solid statistical foundation. The ultimate effect of this work, however, may be limited to the extent to which it is left to the reader's interpretation about how Luijben's impressive results may influence on model fitting strategies in any particular empirical application.

References

Bollen, K.A. (1989). Structural Equation Models with Latent Variables. New York: John Wiley.

Boomsma,A. (1983). On the Robustness of LISREL (Maximum Likelihood Estimation) Against Small Sample Size and Nonnormality. Amsterdam: Sociometric Research Foundation.

Jöreskog, K.G. and Sörbom, D. (1988). LISREL 7: A Guide to the Program and Applications. Chicago: SPSS.

La Du, T.J. and Tanaka, J.S. (1989). Influence of Sample Size, Estimation Method, and Model Specification on Goodness-of-Fit Assessments in Structural Equation Models. Journal of Applied Psychology, 74, 625–635.

La Du, T.J. and Tanaka, J.S. (1992). Incremental Fit Index Changes for Nested Structural Equation Models. Manuscript under review for publication.

Leamer, E.E. (1978). Specification Searches. New York: John Wiley.

MacCallum, R. (1986). Specification Searches in Covariance Structure Modeling. Psychological Bulletin, 100, 107–120.

Sörbom,D. (1975). Detection of Correlated Errors in Longitudinal Data. British Journal of Mathematical and Statistical Psychology, 28, 138–151.

The reviewer wishes to acknowledge his support from the University of Illinois' University Scholars program.

Jeffrey S. Tanaka
University of Illinois
Champaign, IL, U.S.A.