Journal of Official Statistics
Vol. 7. No. 4, 1991, pp. 521–530

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.

Durrett, R., Probability: Theory and Examples. Brooks/Cole Publishing Company, Pacific Grove, CA, 1991. x + 453 pp. $49.95.

As the author tells us, this text was developed from notes compiled over a four-year period of teaching introductory probability at the graduate level. Although the book's main purpose is to serve as a textbook, another potential audience is those who use probability in their work. They will find results, well emphasized and analyzed in prose, that can be used in actual problem solving. This book is also useful for those who want to complement their background in probability with contemporary results on classical problems or knowledge on special topics.

The presentation is highly mathematical and the reader should be familiar with measure theory. In case he or she is not, there is an Appendix that provides the required theoretical background.

The book consists of seven chapters: 1. Laws of Large Numbers; 2. Central Limit Theorems; 3. Random Walks; 4. Martingales; 5. Markov Chains; 6. Ergodic Theorems; and 7. Brownian Motion. The traditional topics are enriched with various extensions and complements. Nontraditional topics include: large deviations, local limit theorems, renewal theory, Markov chains on general state space, subadditive ergodic theory, and central limit theorems for stationary sequences and martingales. The bibliography is up-to-date and extensive. A great deal of material is covered and is very well organized and developed. Exercises are integrated throughout the text (540 altogether) and the examples are interesting and well-focused (amounting to 168).

Some exercises are steps in developing the theory or introduce extensions and theoretical complements. Other exercises provide practice of the techniques introduced in the proofs or check the reader's grasp of the general gist. Many exercises are supplied with some hint or clue of the solution. Nevertheless, some readers will find the exercises highly demanding.

The wealth of excellent examples serves successfully the aim of explaining definitions or commenting on the results. In addition, many examples make the book

fun to read: namely, the counter examples; the "comic relief" examples; and the examples which on the surface have nothing to do with randomness.

From a pedagogical point of view, the book is excellent. Proofs are structured so that they are easily grasped. Furthermore, some proofs are more simple and elegant than is usually the case in similar books. Most of the results are accompanied by succinct and at times surprising comments. The text does a lot to develop the reader's intuition in stochastics, but reminds that "education is needed in applying the intuitive definitions."

In summary, the book very well fulfills the author's goal "to treat the subject as simply and as completely as possible." It is a clearly written and sufficiently complete, up-to-date book on probability that should be of interest for students, teachers, and even researchers in the field.

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von Eye, A., Statistical Methods in Longitudinal Research. Volumes I and II. Academic Press, San Diego, CA, 1990. Vol. I ISBN 0-12-724960-5, 256 pp.; Vol. II 0-12-724961-3, 259–570 pp., $74.95.

This edited book consists of two volumes which together provide a broad overview of statistical methods in longitudinal research. The first volume deals with general problems and issues and with methods for structuring change for continuous variables, mainly within the structural equation tradition. The second volume discusses methods for the analysis of time series and event histories and for the analysis of categorical longitudinal data. There is also a companion book by Rovine and von Eye (1991) which provides examples of program applications (also published by Academic Press).

Volume I begins with a chapter about change measurement by Burr and Nesselroade. Some detailed problems in measuring change are discussed and an overview of different methods and conceptualization is given. I especially liked their balanced discussion of the pros and cons of change scores. This chapter serves as a good introduction to the book and is followed by a comprehensive chapter by Rovine and Delaney on missing data estimation in developmental research which also contains a computer program for cross-sectional maximum likelihood missing data estimation. Their conclusion is in favor of using such a procedure rather than an imputation approach. This conclusion is, in my opinion, not unreasonable but too categorical. Of course, mean imputation is normally not defensible, but there are more sophisticated methods available based on regression analysis or pattern analysis (some of which were mentioned by the authors). Such methods can be highly useful, especially for editing data that are to be used for many different kinds of analyses. A final chapter by Games in Section 1 deals with alternative analyses of repeated-measure designs by ANOVA and MANOVA. A nice feature of the chapter is the information on how to run the analysis (in SAS) and the efforts made to clarify the correspondence between different kinds of analyses.

Section 2 in Volume I deals with methods for structuring change. A chapter by Tisak and Meredith deals with longitudinal factor analysis and both exploratory and confirmatory methods are covered. Another chapter by McArdle and Aber deals with patterns of change within latent variable structural equation models. Both chapters concentrate on multivariate continuous data which fulfill standard assumptions of normality, etc. Also, an illuminating discussion is given of problems in structural equation modelling. Applications of nonmetric multidimensional scaling techniques for developmental research are discussed by Wood in the final chapter of Volume I and he concludes that

such methods are underused by developmental psychologists.

The first section of Volume II deals with the analysis of time series. There are chapters on the analysis of event histories (Petersen), linear and nonlinear curve fitting (Thissen and Bock), spectral analysis of psychological data (Larsen), univariate and multivariate time series (Schmitz), and descriptive and associative developmental models (Tisak and Meredith). Here the reader can find up to date presentations of many methods in the area.

The second section of Volume II concerns the analysis of categorical longitudinal data. Clogg, Eliason, and Grego present models for analyzing change in discrete variables based on sophisticated analyses of multivariate contingency table data and Rindskopf discusses testing developmental models using latent class analysis and also gives a computer program. The following chapter is by Erdfelder and discusses "deterministic developmental hypotheses, probabilistic rules of manifestation, and the analysis of finite mixture distributions." Prediction analysis as a method for analyzing cross-classified data is presented by Szabat. The author shows how the method can be used for predicting empirical events based on theoretical expectations of specific relationships between different categorical variables. It is an interesting approach but the inferential and the probability aspects of the approach may need clarification and further work. A final chapter by the editor himself deals with configural frequency analysis (CFA) as a method for analyzing longitudinal multivariate responses. CFA is a heuristic method for analyzing single cells in multivariate contingency tables first developed by Lienert. von Eye shows the potential of this method in longitudinal settings and elaborates on some different techniques within this framework. CFA is a technically simple method not so well known outside Germany which, in my opinion, can be very useful and allows the researcher to stay very close to the data. For presentations of the method the researcher is referred to von Eye (1990) and Krauth and Lienert (1973).

It should be evident from this review that these two volumes constitute a rich book. It covers a great variety of statistical methods in the longitudinal field and the chapters are written by highly competent researchers. The material is well-organized and often the writing is clear and comprehensible. A further good feature is that program descriptions and instructions are included on how to decide upon and run the analyses. The book contains some printing errors including the prefaces of Volumes I and II being switched.

The book squarely focuses on statistical methods and may therefore be complemented by the two volumes about longitudinal research methodology in the European Science Foundation series where one volume concentrates on data quality issues (Magnusson and Bergman 1990) and the other on the matching of problems and methods in longitudinal research (Magnusson, Bergman, Rudinger, and Törestad 1991).

To sum up, this is a scholarly and well-written book about statistical methods in longitudinal research which not only contains theoretical presentations but also discusses the implementation of the methods and provides guidance about software, etc. It is recommended for any researcher seriously interested in statistical methods in longitudinal research. Since many of the empirical examples are taken from the behavioral sciences, it is possible that researchers from other fields may not feel as comfortable with the book as behavioral scientists do.

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Rovine, M.J. and von Eye, A. (1991). Applied Computational Statistics in Longitudinal Research. San Diego: Academic Press.

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Finkelstein, M. and Levin, B., Statistics for Lawyers. Springer–Verlag, New York, 1990. ISBN 0-387-97140-8, xxii + 608 pp., DM78.00.

During the last two decades, there has been a remarkable increase in the use of statistical methods of proof in the American legal system. This is an interesting development for, prior to the 1960s, the courts in the United States tended to be suspicious of many forms of statistical evidence, even rejecting in some cases the use of properly drawn random samples in financial audits (see, e.g., Sprowls 1957). In contrast today, the legal use of statistics is far from uncommon in the courtroom or classroom, and textbooks and monographs on the subject have now begun to appear in profusion (Baldus and Cole 1980; Barnes 1983; Barnes and Conley 1986; DeGroot, Fienberg, and Kadane 1987; Fienberg 1989; Gastwirth 1988).

There are several reasons for this fairly abrupt change. The use of statistics in the American courtroom of course mirrors the increasingly pervasive use of statistical methods throughout modern industry and society. But there are also other factors at work specific to the law itself. First, beginning in the 1960s, a number of American lawyers began to forcefully advocate the use of statistical methods of proof in a variety of contexts, most notably, Hans Zeisel and Michael Finkelstein. Zeisel's best-known piece from this period is perhaps his paper on the selection of jurors in the famous trial of Dr. Benjamin Spock and several codefendants for advocating resistance to the military draft during the Vietnam War (Zeisel 1969); Finkelstein's best-known piece is, a paper co-authored with Fairley which advocated the use of Bayes's theorem as an aid to jurors grappling with certain types of frequency evidence (Finkelstein and Fairley 1970).

But during the decade of the 1970s, statistical methods of proof came to have great practical importance because of their use in one particular area: employment discrimination. In 1971, in the case *Griggs v. Duke Power Company* (401 U.S. 424, 1971),[1] the United States Supreme Court ruled that a test used to determine eligibility for promotion violated Title 7 of the 1964 Civil Rights Act solely because it had a "disparate impact" on a protected class of individuals (in *Griggs*, black employees), even without a finding that those individuals had been subject to "disparate treatment" by the employer (that is, that the employer had intentionally discriminated against them). By divorcing outcome from intent, *Griggs* created a purely statistical species of discrimination, one for which in principle only statistical proof was necessary.[2]

Thus it was only a matter of time before the courts began to permit the use of the formal methods of statistical inference in the courtroom. Here too, the Supreme Court played a key role: in two later cases, *Castaneda v. Partida* (430 U.S. 482, 1977) and *Hazelwood School District v. U.S.* (433 U.S. 299, 1977), it actually included statistical calculations in its published opinions; and in the United States, when the Supreme Court speaks, the lower courts listen.

Today statistical methods such as the analysis of variance, multiple and logistic regression, and even survival analysis are usually accepted (even if not always understood) in the courtroom. They are employed in a wide variety of types of litigation including jury discrimination, antitrust suits, environmental protection and census adjustment. But in a case like *Cuomo v. Baldridge* (674 F. Supp. 1089; S.D.N.Y. 1987), when statisticians of the eminence of

David Freedman and Jay Kadane square off against each other in depositions and courtroom testimony (see Freedman and Navidi 1986), what is the "trier of fact" (i.e., the judge or jury) to think? Clearly, if the legal profession is to survive such uncompromising expert witnesses, it will have to upgrade its statistical defences; thus the recent number of textbooks that have entered the market deserve careful attention.

Statistics for Lawyers testifies to the diversity of uses to which statistics is now being put in the American courtroom. Michael Finkelstein (a partner in a prominent New York law firm and a lecturer at the Columbia University Law School), and Bruce Levin (a professor at the Columbia University School of Public Health) between them have contributed dozens of papers to the literature of legal statistics, and have had extensive experience in litigation and consulting. Drawing on this experience, they have put together a remarkably rich compendium of cases and examples.

The book consists of twelve chapters, organized by statistical topic: descriptive statistics, methods of counting, elements of probability, probability distributions, statistical inference for two proportions, comparing multiple proportions, comparing means, combining evidence across independent strata, sampling issues, survival analysis, nonparametric methods, and regression models. But this is in no sense a statistics textbook, whose illustrative examples just happen to be legal in nature. Quite the contrary: the examples are the heart and soul of the book. The supporting theoretical material serves more to review basic concepts and cover topics usually omitted from a first course (for example, the Clopper–Pearson exact confidence intervals for a binomial proportion, the Mantel–Haenszel test, and the methods of survival analysis).

The purpose and methodology of the text is described by the authors in their preface:

> The aim of this book is to introduce lawyers and prospective lawyers to methods of statistical analysis used in legal disputes. The vehicle for this entertainment is a series of case studies interlaced with sections of mathematical exposition. The studies consist of summaries drawn primarily (but not exclusively) from actual cases, which are cast in the form of problems by questions posed to focus discussion.

The questions at the end of each case-study are in fact an integral part of the book: they often substantially extend the argument in the text, and detailed solutions to them are given in a 70-page appendix at the end.

There are a total of 104 such case studies. Although, given such a multitude of targets, it is certainly possible to raise questions of technical detail in the discussion of individual cases,[3] the overall quality of the discussion in most instances is very high. There are also relatively few typographical errors.

The number of cases discussed or cited is extensive. In addition to the by-now classic examples to be found in most books touching on this subject, many others have been included which are of equal interest but far less known, some as recent as 1988. One of the nicest features of the book is that the authors usually include sufficient data from a case to permit the reader to check statements made in the text or to perform their own independent analyses. (One of the few exceptions to this is Case Study 12.33: "Death penalty: does it deter murder?" (pp. 444–446), which discusses Isaac Ehrlich's 1975 analysis of the possible deterrent effect of capital punishment. The reason for the omission? Despite the importance of the subject, Ehrlich did not include his data in his original article, has not published it since, and has declined to make it generally available.)

Thus the book should be useful to many. Statisticians interested in finding examples for the classroom, or desiring to explore the literature of legal statistics, will find *Statistics for Lawyers* a veritable treasure-trove; while statistically experienced lawyers and judges involved in litigation will find the book helpful because of its discussion of issues concerning the appropriate use of statistical methodologies.

The book is less suitable, however, as a classroom text for law students or graduate students in cognate fields (e.g., finance, pub-

lic policy, or environmental protection). Although, as noted above, introductory material is included covering such basic topics as probability, random variables, statistical distributions, and methods of inference, it is for the most part at a level substantially beyond that of most nonstatisticians. (I used *Statistics for Lawyers* as the primary text for a small seminar at the Northwestern Law School in the Spring of 1991; the students, including one who had had previous statistical training, found it very rough going.)

This, it must be frankly said, is the major defect of the book. The examples are wonderful: rich, extensive, provocative, stimulating. But insufficient thought appears to have been given to the strategy and tactics of presenting the statistical superstructure. Two examples drawn from the first chapter of the book, "Descriptive Statistics," may suffice to illustrate the problem. The first section of the chapter is entitled "Measuring the disparity between two proportions"; it discusses the distinctions between and properties of the difference, ratio, and odds ratio of two binomial proportions. Quite apart from being a rather dry way to begin a book, the section as written will immediately lose the statistically uninitiated. It is hard to understand why the authors did not begin by introducing a concrete example first, and then use it as a touchstone to illustrate the various methods of quantifying a disparity. Similarly, the authors introduce the concepts of random variable, expectation, and variance in this first chapter on descriptive statistics, using notation such as $P[X = x]$ and $\Sigma x P[X = x]$, *before* developing the material on probability and probability spaces in the second and third chapters. The result is an unsatisfactory compromise: the theoretical material discussed is cast at a level not really understandable to the novice, and unnecessary for those to whom it makes sense.

This pedagogical problem occurs throughout the book: the examples it contains are outstanding, but the basic statistical material appears to have been added almost as an afterthought, with little thought given to level of audience, order of placement, or engaging the interest of the reader. Curiously, the authors acknowledge this themselves. In their introduction they state:

> For the uninitiated, the statistical notes supply the technical tools. Since these sometimes follow the first case in which the material is needed, the baffled reader should read on; there may yet be light.

Good advice you or I might give to each other, but from the authors??? The obvious question arises: why not introduce material when it is first needed, or if there is compelling reason to do otherwise, at least include a forward reference?

Thus the bottom line: *Statistics for Lawyers* cannot be recommended as a primary textbook for a class unless the students in it have already had very considerable exposure to statistical methods. On the other hand, as a supplementary text or a source of examples for the instructor, it is a truly outstanding book: rich, varied, and comprehensive. It sets a new standard for excellence in the field, and convincingly illustrates just how pervasive statistical methods have become in the American legal system.

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[1] For those unacquainted with American legal citations, the "U.S." indicates a Supreme Court decision; "401," the number of the volume in which the decision appears, "424," the first page of the decision; "1971," the year of the decision.

[2] Ironically, the decision was written by the conservative Chief Justice of the Court, Warren Burger. Robert Woodward reports in his book *The Brethren* that although Burger could have written a much narrower decision, he was irritated at his reputation as a political Neanderthal, and therefore penned a much more sweeping opinion in order to rectify what he viewed as an unjust misperception. He could scarcely have foreseen the consequences.

[3] For example, in the discussion of Fisher's method of combining levels of significance by using the transformation $-2\log_e P$ (pp. 246–248), the requirement that the distribution of the test statistics being combined be continuous is not clearly stated. In a footnote on p. 247, it is noted that if X is a random variable with a continuous distribution function F, then $F(X)$ has a uniform distribution; but in the text itself this restriction on F is not stated and the method is applied in an example where the variates are in fact discrete. In such cases Fisher's method can be very conservative and often substantially understates the combined level of significance (this appears to be the case in the example the book discusses).

Gifi, A., Nonlinear Multivariate Analysis. John Wiley & Sons, Chichester, 1990. ISBN 0-471-92620-5, xx + 579 pp. £39.95.

There has long been a dichotomy in multivariate statistics between the classical model-oriented techniques (usually based on assumptions of multivariate normality) and descriptive techniques such as principal components and correspondence analysis. This book, although firmly based in the descriptive tradition, goes someway towards building a bridge between the two camps.

Albert Gifi is actually a nom de plume for the members of the Department of Data Theory at the University of Leiden and this text is the result of work undertaken in the department in the 1970s. It is unfortunate that, in some respects, the book is already outdated since it is based on a 1981 draft. Although an attempt has been made to bring the material up to date by the inclusion at the end of each chapter of an "epilogue" describing recent developments, the epilogue is often very brief and does not integrate the new material into the main body of the text.

The book describes a system of multivariate analysis techniques for the exploratory analysis of statistical data. The techniques described are non-linear versions of standard techniques, primarily principal components and canonical variates analysis but also including multiple regression, discriminant analysis and multivariate analysis of variance. A heavy emphasis is placed on plotting observations and variables in low dimensional spaces, while the change from linear to non-linear methodology is accompanied by a change in emphasis away from distributional assumptions about populations and samples. Each technique is now considered a tool for data analysis not requiring justification in terms of a particular parametric distributional model. Furthermore, such models are considered to be merely gauges by which to judge the effectiveness of specific techniques in a variety of situations. Significance testing is replaced by estimates of stability obtained from methods such as the Jacknife and the Bootstrap.

The book contains thirteen chapters: 1. Conventions and Controversies in Multivariate Analysis; 2. Coding of Categorical Data; 3. Homogeneity Analysis; 4. Nonlinear Principal Components Analysis; 5. Nonlinear Generalized Canonical Analysis; 6. Nonlinear Canonical Correlation

Analysis; 7. Asymmetric Treatment of Sets: Some Special Cases, Some Future Programs; 8. Multidimensional Scaling and Correspondence Analysis; 9. Models as Gauges for the Analysis of Binary Data; 10. Reflections on Restrictions; 11. Nonlinear Multivariate Analysis: Principles and Possibilities; 12. The Study of Stability; and 13. The Proof of the Pudding.

The first chapter is an entertaining and original description of standard multivariate techniques and texts, including a correspondence analysis of the contents of a variety of textbooks. Chapters 3 to 6 contain the main descriptions and examples of the proposed techniques based on nonlinear principal components and canonical variates analysis while Chapter 7 discusses the proposed future implementation of further techniques. The problems of stability are addressed in Chapter 12 and Chapter 13 contains a series of examples of analyses.

Many of the properties of the proposed methodology appear very attractive in theory, for example, the visual presentation and the avoidance of distributional and linear assumptions. In practice, however, the techniques are not as all-encompassing as they first appear. Several are not yet implemented and descriptions of these are relatively brief. Those that are fully described give the impression of being less versatile than the standard methods they replace. One is faced by a long sequence of two-dimensional plots with very little to choose between them.

The three alternate treatments used for missing data are all also unsatisfactory in some respects. Although this is essentially an unresolvable aspect of the chosen methodology, in that the lack of distributional assumptions does not allow a more satisfactory treatment, the text gives the impression that this is a minor problem. By concentrating on the question "what can we do with missing data" it largely avoids the more important question "what consequences and implications do these ways of coping with missing data have." No reference is made to recent advances in missing data methodology.

Although very readable, the presentation of the material also has some drawbacks. The text is strongly mathematical in places requiring a prior knowledge of matrix and linear algebra. Furthermore on first reading one is left somewhat with an impression more often produced by computer manuals – all the information is there and readily understandable provided only that the user is already familiar with the subject. For the uninitiated, however, the text may appear rather obtuse.

For these reasons I would hesitate to recommend this book to the potential *user* of multivariate methods. Its non-standard approach to the subject and the lack of readily available commercial software would, I feel, limit its usefulness. However to those interested in a broader understanding of multivariate methodology the book makes a very interesting and thought-provoking accompaniment to the more traditional textbook.

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van de Pol, F., Issues of Design and Analysis of Panels. Sociometric Research Foundation, Amsterdam, 1989. ISBN 90-70947-10-2, vii + 135 pp.

This monograph is a compilation of five of Frank van de Pol's published papers, several co-authored, supplemented by an introductory chapter outlining the monograph's content. (There is also a final summary chapter in Dutch.) The monograph attempts a difficult task. The wide diversity in purposes and designs of panel surveys makes a broad sweep of design and analysis issues an ambitious undertaking, and comprehensive coverage of these topics is a near-impossible task in a short monograph of 135 pages. The monograph touches on a number of issues relating to survey design and then focuses on one type of longitudinal analysis – Markov models. This makes for a manageable treatment of topics in a short

space but results in a certain degree of disjointedness in the presentation. The monograph would have benefitted from additional editing to improve the flow across the different papers, and it would also have been useful to collect the bibliography in one location. However, its separate pieces offer a number of useful insights.

The monograph's five papers roughly divide into two parts – general discussion of panel survey design and detailed presentation of discrete-time Markov models. The discussion of panel survey design notes a number of advantages of panels over cross-sectional studies. These include the ability to gather extensive data about respondents by spreading data collection over several waves with both a fixed and variable portion of the questionnaire, the possibility of training respondents to complete a difficult questionnaire, reducing recall biases by frequent recording of activities that change rapidly, having longitudinal checks to improve the quality of the data, and greater efficiency in measuring change and trends for most variables. van de Pol's discussion of missing data encompasses both post-stratification and imputation procedures in the special context of panel data.

Problems inherent to panel studies include following a changing population (with new persons born or moving in and initial persons leaving), selective attrition (persons leaving the study differing in important ways from those remaining in the study), and panel effects (contamination resulting from respondents being asked questions at a prior time). van de Pol describes these problems and several design elements and options that affect them – rotation, autorejuvenation, quota sampling, a split panel, and interview frequency. Woven throughout the discussion is the point that panel surveys often serve the dual, and sometimes conflicting, purposes of studying long-term micro-level dynamics and of providing descriptions of the population of interest at various points in time. Conflict can arise in the treatment of the problems inherent to panel studies. For example, rotation is a design element which introduces a new group of panel members periodically. This helps keep up with a changing population, improves representativeness if there is selective attrition, and reduces panel effects. However, it also interferes with the goal of analyzing long-term change.

Throughout the first three chapters van de Pol notes important points likely to be new to readers unfamiliar with panel studies and the perspective that time adds to data collection and analysis. Among these points is the need to base the sample on units that remain intact over time, such as individuals, even if the interest is in what happens to aggregates of those units, such as households. Changing composition of the aggregate units is more apparent in panel studies than in cross-sectional studies, and basing findings only on aggregates with unchanged composition between consecutive waves can be misleading. While the two chapters on survey design contain many useful insights, some of the generalities should be viewed with caution, as for instance statements about typical rates of nonresponse and attrition. There is likely to be considerable disagreement about what is "typical" for panels in this respect.

The discussion of Markov models is detailed, with substantial development of several Markov models, estimation methods, and illustrative empirical examples. The models include the Latent Markov (LM) model, the Mixed Markov (MM) model, and, more generally, Mixed Markov Latent Class (MMLC) models. The collection of models provides a broad perspective on ways to tackle, in a Markov framework, data problems ranging from measurement error, to latent variables, to identification, and subgroup differences in change processes. Of particular interest is a brief but comprehensive description of an iterative EM algorithm for estimating missing or latent data when a specific model is assumed. This description mentions a way to address the problem of the algorithm not producing standard errors for the parameters and notes a PC program (PANMARK) that contains the EM algorithm for Mixed Markov models. The examples – change in income satisfaction, labor market transitions, and change in contact with children for low versus high education parents – span

topics of interest across a variety of disciplines. Markov models, though, are not the only approach for analyzing panel data, and the monograph contains no discussion of the wider variety of techniques. Even a brief discussion, referring readers to other sources such as Duncan and Kalton (1987) and Kasprzyk, Duncan, Kalton, and Singh (1989), would have been a useful addition.

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