

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.

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Hald, A., A History of Probability and Statistics and Their Applications Before 1750. John Wiley & Sons, New York, 1990. ISBN 0-471-50230-8. xiii + 586 pp., £54.65.

The history of statistics is a topic that has long suffered from the lack of a modern and comprehensive textbook. Recently, this situation was changed radically by the publication of two books. The book by Hald, reviewed here, deals with the history of probability theory and statistics and their applications to games of chance, astronomy, demography, and life insurance before 1750. It provides an excellent complement to Stigler (1986), which covers the history of statistics from roughly 1700 to 1900, emphasizing two themes: the combination of observations and the uses of probability models in inference.

The bulk of Hald's book covers the period from the foundation of probability as laid down in the correspondence between Fermat and Pascal in 1654 to de Moivre's

works on probability and life insurance shortly after 1750. It encompasses a very important period, when probability theory evolved from pure reckoning on games of chance to its first use in solving important social problems. It also contains background material on the early works on games of chance, including a chapter on Cardano and the Liber de Ludo Alea, and some comments on developments that occurred later than 1750.

The book's general approach is problem-oriented; the content is ordered according to problems and methods rather than persons. This is very appealing, since it mirrors the evolution of probability theory itself. Thus, for instance, the Gambler's Ruin Problem occupied many of the great minds of the 17th and 18th centuries. Originally formulated as a special case by Pascal in a letter to Fermat, it is developed as Huygens's fifth problem and generalized by James Bernoulli and de Moivre. It was then modified as the Problem of Duration of Play by Montmort and further elaborated on by Nicholas Bernoulli and others. This development is easily followed in Hald's book, mainly in

two chapters, also including the solutions based on difference equations, given by Lagrange and Laplace, although they appeared after 1750. In a similar way, other problems are treated, for instance: the problem of points, i.e., the problem of dividing the stakes of an interrupted game, and the problem of coincidence.

The development of demography and life insurance is described through the works of Graunt on mortality figures with contributions by the Huygens brothers, de Witt, and Halley. This development led to the first tests of significance by 'sGravesande and others and to the theory of insurance mathematics by de Moivre and Simpson.

The classical proofs are rewritten in modern notation by using subscripts and a single letter to denote a probability. Although this approach may tempt the reader to underestimate the difficulties involved in the original derivations and also may remove some of the flavor of the classics, the advantages of a uniform and simplified notation are obvious.

The problem-oriented approach of the book has the advantage of putting the contributions of the different authors into a general and comprehensive framework. Nevertheless, due attention is given to the persons involved and their contributions in other fields as well as their social backgrounds.

It is to be expected that research of the magnitude that lies behind Hald's book leads to a reevaluation of the importance of the various contributions. Especially, it seems that Hald puts more value on the works by Montmort, Nicholas Bernoulli and Graunt than do other authors writing on the history of statistics.

Such reevaluation is, however, difficult to establish, since it depends upon the previous status of the works. According to Hald, it is a common misunderstanding that de Moivre gave the normal approximation only for the symmetrical binomial. This statement might be somewhat exaggerated. For instance, Cramér (1945), the standard textbook on mathematical statistics of the time and many years thereafter, pays due tribute to de Moivre's result.

One can read this book in two ways. First, one can read it through without bothering too much about derivations, in order to pick up the principal ideas. With some advance knowledge of probability, this way of reading the book is a sheer pleasure, and it is recommended to every professional statistician. Second, and in order to achieve a deeper insight into the problems treated, one can reread it, this time following the derivations in detail and solving at least a sample of the well considered problems listed in the end of many of the chapters.

The latter approach is, of course, more laborious, but is still recommended to teachers and students of probability and everyone else who wants to brush up her or his probability calculus.

Hald's book is the result of vast historical research, undertaken by one of this century's most distinguished statisticians. The pleasure that professor Hald has found in his research is clearly reflected in the text, which is eminently pedagogical and, at the same time, most entertaining. The only flaws are some typographical errors, which I hope will be corrected in the next edition.

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Bollen, K., *Structural Equations with Latent Variables*. John Wiley & Sons, New York, 1989. ISBN 0-471-01171-1. xiv + 514 pp., £39.30

and

Byrne, B.M., *A Primer of LISREL: Basic Applications and Programming for Confirmatory Factor Analytic Models*. Springer-Verlag, New York, 1989. ISBN 0-387-96972-1 (Springer-Verlag, New York), ISBN 3-540-96972-1 (Springer-Verlag, Berlin). xii + 184 pp., DM98.

There are already several texts on structural equation models: elementary introductions have been written by Duncan (1975), Heise (1975), and Saris and Stronkhorst (1984). Latent variable models have been introduced by Kenny (1979), Long (1983a, b), and Hayduk (1987). Given the abundance of texts, do we really need the new introductory texts by Bollen and Byrne? In my opinion, Bollen's book makes a fine contribution to the existing literature, whereas Byrne's book is filled with so much erroneous material that it is not interesting. Bollen's book differs from the others by giving a complete overview of the linear structural equation modelling approach. The book "fills the gap existing in the treatment of this topic between introductory texts and specialized papers" as the cover text correctly announces. A lot of statistical research has been done in this field but little information about this research has reached those who can benefit by it: the social science researchers. The reason for this state of affairs is the technical character of the papers generally published.

However, this book is not an easy introduction for the average researcher. The author starts with the use of matrix algebra which is unavoidable in such a text. An efficient introduction giving the necessary information is provided in an appendix. In another appendix, a brief introduction to the asymptotic distribution theory is given and Chapter 2 contains a few useful rules of covariance algebra. Relatively sophisticated

mathematical skills are required to understand this book which is more complex than the elementary introductions of Duncan or Saris and Stronkhorst where these skills are not needed. On the other hand, this does not mean that the book is very difficult. It is extremely clear in its presentation and comprehension is facilitated by a number of strategic examples. The book also delivers a nearly complete overview of the developments in the field. Some discussions are relatively brief, e.g., the discussion of the robustness of the estimation procedures under nonmultivariate normal distribution and the artificial intelligence approach to causal modelling. These developments are, however, so recent that it is commendable that Bollen was able to include the basic ideas and references.

In summary, I think that Bollen's book will be very useful for social science researchers who care about the correctness of the approaches they use. In it they will find the necessary information about the state of the art. The book will also be very useful for graduate courses on this topic.

The purpose of Byrne's book is to provide a "nonmathematical introduction to the LISREL computer program." She says that she writes for those who "have been frightened off LISREL's seemingly complex notation, mathematical concepts and statistical headiness." She thinks that she is the proper person to help these readers because she is also "a victim of mathematical anxiety and symbol shock." Although the idea of helping the less sophisticated readers with their understanding of the LISREL approach is commendable, the realization of such an effort requires another author and a different approach to the problem. Let me explain my point. The book contains a very brief introduction of the LISREL model and notation but no explanation of why these equations are used. Matrix algebra is used without introduction, some of the formulas are systematically wrong (Figure 1.6 and 1.10), the assumptions which are an essential part of the model are not specified, the residuals are said to represent the difference between the hypothesized model and the observed data, there

is hardly any explanation of the statistics behind the procedures, and as early as the first part there were so many misunderstandings about LISREL that I was inclined to stop reading.

For the sake of the review I finished the book but the other two parts did not change my opinion. From page 37 to page 177, the book contains different examples of path models, inputs and outputs. Why the examples are chosen is unclear. In each part, the examples are so similar that one example would have been adequate. The explanations of the models, inputs, and outputs are so minimal that they do not merit publication. It would have been useful to explain clearly several points which students always ask, for instance:

- why do we need to restrict one loading per factor to 1?
- what estimation procedure should be used?
- what should we do in case of categorical variables?
- should we analyze a correlation matrix or a covariance matrix?
- what should be done if the assumptions are not satisfied?
- what sample size should we use if pairwise deletion is used?
- when can we be sure that a model is identified?
- when is a model rejected?
- what is the relation between explained variance and goodness of fit?
- how should we correct a rejected model?

Of all these questions only the test of models receives attention and only in a very superficial way. The ratio of the chi-square statistic and the degree of freedom seems to be the most important criterion. If this ratio is smaller than 2 the model is, in general, accepted and otherwise it is rejected. This decision rule is completely arbitrary and has been criticized in literature which has not been cited. All other questions are mostly ignored. The author concentrates on the translation of the models in inputs and the presentation of outputs. Furthermore, suggestions are made which are incorrect: for example, to look at the t -values in order to improve a rejected model (page 56); models are changed without any argument but

improvement of fit (example page 59), after an analysis of a four-factor model which did not fit, a two-factor and a one-factor model are tested; results which are very implausible are presented without any comment.

My conclusion is that I hope that my students will never find this book because it does more harm than good.

Given this criticism I will concentrate from now on Bollen's book which is very good. This author knows what he is writing about and he gives a complete overview of the literature. I have used his book in a class with success even though the nonmathematical students had some problems. However, it is better that the less qualified students have problems with a good book than that good students have problems with a bad book.

Some detailed comments

Chapter 1 of Bollen's book is a brief introduction to the approach. This is useful if you are familiar with the approach but those new to it will find that very little explanation is given. The explanation is more complete in Chapter 2 where covariance algebra is used.

The second chapter introduces the LISREL notation in matrix algebra which might be very frightening in the beginning. Here the covariance algebra, which is important, and the sample covariance matrix are introduced. Considerable attention is rightly given to the problem of outliers. Finally, the path analysis is introduced.

Chapter 3 gives a brief introduction to the causal modelling approach and a more philosophical discussion of the definition of "cause". This is, of course, a difficult subject. Although the presentation is clear and relevant, I would recommend that this chapter be read later in a course when students are more familiar with the approach.

Chapter 4 is a reformulation of path analysis, regression, and simultaneous equation modelling in the covariance structure approach. A lot of attention is given to identification and estimation, but not to testing. In Chapter 7 fit indices are discussed, in Chapter 8 the power of the test and in Chapter 9 estimation is again discussed by now

taking into account nonnormal distribution of the variables and crude measurement. This decision to present parts of these technical matters in different chapters is a bit unfortunate because these topics should really be discussed together, perhaps in a more technical, separate chapter. It should be clear that the given results apply to all the models presented. With this text, teachers will need to stress that fit indices are not only important in factor analysis and testing not only for the full model.

Chapter 5 is a very nice introduction to measurement error problems and I recommend it to any researcher who is wondering why one should work with such complex models as LISREL in research.

Chapter 6 continues the discussion of measurement models, introducing concepts of operationalization, validity, and reliability. Bollen gives a very clear overview of the different approaches and their problems. The overview is the best part of the chapter. Given all the problems with the measures for validity, which are very well presented, he suggests a different definition: the explained variance coming only from the latent variable which is supposed to be measured by the observed variable. His definition excludes spurious relations between these variables. One should always allow for possible indirect effects. Later, where he uses the true scores in the models, there is no direct effect of the latent variable on the observed variable but I think that Bollen would agree that the validity of these second order factors is not zero because the effect goes via a third variable.

According to Bollen the reliability is the variance explained by all latent variables together. Even though his criticism of other measures is correct, his measure is also imperfect because the strength of the reliability depends on the completeness of the model. In general, this measure will underestimate the reliability, ignoring systematic components which are not explicitly included in the model. My point of view is that we have to live with the old measures while being aware of the problems which have correctly been pointed out by Bollen. For the moment I do not believe that his measures are better or less problematic.

Chapter 7 introduces the restricted factor analysis model. I would have liked to see a clearer distinction made between the measurement model and the factor analysis model (Saris 1982) but this is perhaps very much a personal opinion. However, the example given by Bollen clearly indicates the problems: If the variables are not measuring the same variable (required in a measurement model but not in a factor model) there is a risk of all kinds of correlated errors due to specific components and that is indeed what he finds in his example.

Some comments on the technical aspects of this chapter are also in order. The discussion of identification, estimation, and testing is essentially correct but it should be mentioned that the results of the simulations with respect to distributions of statistics always depend on the model chosen and the parameter values. From the best known simulation studies, a rule has been derived: The ML estimates and test statistic are well behaved if the sample size is larger than 100 or 200 depending on the source. However, Satorra and Saris (1982) have done simulations which show that with high explained variances even samples as small as 25 cases can provide well behaved statistics.

A second critical point concerns the discussion of the fit measures. Bollen does not connect the fit measures with the power of the test. The power of the test gives an indication of the sensitivity of the test statistic for deviations from their true values for different parameters. This point has been elaborated by Saris et al. (1987) for the chi-square statistic. They have also shown that in one and the same model the test statistic can be sensitive to one but not to another misspecification in the model. It is therefore possible that the test will not detect certain types of misspecifications for which it is not sensitive. But given that the fit indices are based on the same statistic, they will be affected in the same way and a good fit will therefore not give the assurance that there are no misspecifications in the model. Extreme sensitivity to a specific misspecification may also lead to a bad fit even when the misspecification is only very small.

Finally, with respect to the factor scores, Bollen remarks that the procedure used to

calculate them does not matter very much. Although this statement is correct, it is desirable to use the best scores for your own purposes if that is possible. In this section I missed a discussion of the calculation of the relationship between the latent factor and the estimated factor score. These correlations could be substituted in the LISREL model in order to correct for measurement error, without necessarily using very large models. This is often a second best approach to the specification of a full LISREL model.

Chapter 8 presents the full LISREL model, identification, estimation, and testing. In this chapter the power of the test is discussed. Although the presentation is clear, in my opinion it should have been presented in a technical chapter along with the other technical aspects. This chapter could have concentrated on the model and the results derived from it, such as the covariance matrix, the direct, indirect, and total effects.

Chapter 9 is an extension of the previous chapter where more recent developments are brought together. First of all, different notations and tricks are discussed. This is a very good presentation that puts some exaggerated discussions into perspective. The rest of the chapter deals with different kinds of violations of the basic assumptions of the approach: linearity and additivity, multinormality, and interval scale variables.

For each of these assumptions the author indicates what can be done if a specific assumption does not hold in a study. Research in this field is ongoing and therefore one cannot expect the discussion to be completely up to date. Although the ADF estimator has been given a lot of attention recently because of the lack of distributional assumptions, this approach also has serious problems if the sample sizes are not very large. Given this situation, it is fortunate that robustness studies show that the ML estimation is robust under very mild conditions. For an elaborate but elementary discussion of this topic, see Satorra (1990).

On the whole, I believe that this is a very useful book and I hope that it will be used extensively, especially for teaching graduate courses. The book is also a valuable source of

information about the structural equation modelling approach. Bollen's experience in teaching courses on these topics and in doing research using this approach has led to a very clear presentation of a great deal of information useful in practice. I recommend this book to all those interested in the Structural Equations approach.

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Kasprzyk, D., Duncan, G., Kalton, G., and Singh, M.P., *Panel Surveys*. John Wiley & Sons, New York, 1989. ISBN 0-471-62592-2. xiv + 592 pp., £47.00.

This book is a compilation of 22 invited papers and 9 discussants' papers presented at the 1986 International Symposium on Panel Surveys. Initiated by the Survey Research Methods Section of the American Statistical Association, the symposium was an experiment to determine the feasibility of a continuing series of conferences on research in survey sampling. As this book attests, the experiment was successful, leading to subsequent conferences on telephone survey methodology and measurement errors in sample surveys.

Also referred to as longitudinal surveys, panel surveys collect data from the same units over time. The National Crime Survey (NCS), for instance, uses a longitudinal dwelling unit design where the current occupants of a rotating panel of dwellings are interviewed every six months. The 1977 National Medical Care Expenditure Survey (NMCES), the 1980 National Medical Care Utilization and Expenditure Survey (NMCUES), and the continuing Survey of Income and Program Participation (SIPP) all use a longitudinal household design where interviews are repeated for sample persons and the families they spawn over time.

Articles in the book are based upon research that the authors conducted with the above mentioned surveys and other panel surveys. Readers unfamiliar with the

sample designs and data collection plans for these surveys may have difficulty in interpreting some papers. In spite of this, the book is an excellent source of information for designing panel studies or analyzing their data.

The topics covered in this book are diverse, spanning the gamut of sample design, data collection, data base management, nonsampling errors, nonresponse adjustments, and estimation and modeling. State of the art methodologies are presented in the book that are not readily available elsewhere.

Much of the research was associated with extensions of existing methodology needed to establish the NCS, NMCES, NMCUES, and SIPP sample design and estimation procedures. For instance, NCS made substantial contributions to the literature on nonsampling errors such as recall loss, telescoping, seam effects, panel conditioning, and time in sample effects. NMCES and NMCUES solved estimation problems caused by the dynamic changes associated with panel surveys by applying time-at-risk ideas to person-level analyses and formulating a multiplicity-based strategy for family-level analyses. SIPP sponsored extensive research to classify the various types of panel nonresponse and to develop efficient imputation and weighting procedures to reduce nonresponse bias.

The papers are generally well-written although a few are only tangentially related to panel surveys. Of course, some papers are more interesting than others while other papers are controversial. When I disagreed with what a particular author was suggesting, however, I usually found the discussant's comments right on target with my reservations. Reflecting the orientation of the conference organizers perhaps, SIPP issues were emphasized for most topics.

Clearly a lot of effort was spent to make the papers more general purpose than case studies usually are. Each paper contains a review of the relevant literature including unpublished papers and reports known only to insiders. The references alone are an invaluable resource for researchers. (I did find the index not as complete as desirable

with not all topics listed that were addressed in the text.)

I highly recommend this book for all those interested in panel surveys. This will be the first book I consult the next time I design a panel survey or analyze panel data.

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Turvey, R. (Ed.), *Developments in International Labour Statistics*. Geneva, International Labour Organization, Pinter Publishers, London, 1990, ISBN 0-86187-818-3. xvii + 446 pp., £37.50

Ralph Turvey, formerly Chief Statistician of the International Labour Office (ILO) in Geneva, presents a useful collection of papers in the volume *Developments in International Labour Statistics*. Although only four of the papers in the collection are not previously published, this book makes the important work of the ILO accessible and widely available. Even those who have already read the previously published work in issues of the ILO's *Bulletin of Labour Statistics* will appreciate the convenience of having these articles compiled in one volume.

Comparisons among countries are increasingly relevant in our interdependent world. When such comparisons are made, uniformity of concepts and conceptual relevance to the issue being investigated are essential if the comparisons are to be valid. As Ralph Turvey points out in his introduction to this compendium, international comparability in the field of labor statistics has been a major pursuit of the ILO's Bureau of Statistics. For many years, the ILO has provided guidance to national statisticians and promoted the international comparability of labor statistics by the promulgation of international recommendations. Those working in the field of international labor comparisons owe a large debt to the ILO for its efforts in making comparisons more viable.

Developments in International Labour Statistics is divided into six parts, covering: (1) The two most recent International Conferences of Labour Statisticians; (2) Labour Accounting; (3) Measuring the Labour Force; (4) Standard Classifications; (5) Labour Cost, Earnings, and Productivity; and (6) Other Topics. Although the articles do not cover the entire work of the ILO in the field of international labor statistics, the papers selected cover a wide array of topics. Some of them deal with conceptual and methodological issues in such areas as the labor force, employment, and unemployment; labor costs; labor productivity; and earnings indexes for the computation of real employment trends. The only major labor-related topic not covered is price statistics, but Turvey points out that papers on this subject have already been reprinted in ILO (1989).

Turvey has selected a fine blend of general papers and papers specific to statistical developments in a single country which illustrate the ways in which certain problems have been addressed. For instance, in Chapter 10 Richard Anker of the ILO critiques current definitions and data collection methods relating to female labor force participation in developing countries; in Chapter 11, J.N. Tewari, formerly of the Department of Statistics of India, describes an experiment in his country which compared the direct observation method with the more conventional household interview method of obtaining data on women's participation in economic activities. On the basis of the results, the author makes suggestions on the ways in which the method of data collection on women's activities could be improved for developing countries.

Problems relevant to developed countries are also covered in this book. In Chapter 29, Thomas Plewes of the U.S. Bureau of Labor Statistics describes the redesign of a major establishment survey in the United States. Although this survey has characteristics unique to its own history and to the highly developed U.S. statistical system, the process of redesign described by Plewes undoubtedly contains some important insights and lessons for other countries conducting establishment surveys. As Plewes

points out, "A statistical agency that embarks on a programme to redesign an ongoing, well-established survey is hoisting its sails in relatively uncharted waters." Plewes' chapter as well as the several other "national experience" chapters, provide a compass for uncharted waters.

Several chapters take an international comparisons perspective. Chapter 6 by I. Chernyshev of the ILO's Bureau of Statistics describes the ILO's program which aims to publish comparable annual data on employment and unemployment for as many countries as possible, including regional totals. This program, launched in 1987, is still in its developmental stages. Pilot tables have been published in ILO (1990) and this work will become a separate chapter of the *Year Book of Labour Statistics*.

Chernyshev first discusses the work already done in this comparative field by the Organisation for Economic Cooperation and Development, the Statistical Office of the European Communities, the U.S. Bureau of Labor Statistics, and the Council for Mutual Economic Assistance. He notes that the ILO will build upon rather than duplicate this work. All of these organizations cover a limited number of countries, whereas the ILO program seeks to encompass a much wider range. The ILO's initial research focused on developing internationally comparable labor force data for the centrally planned economies of Eastern Europe and for five newly industrializing Asian countries or territories. Chapter 6 proceeds to describe the work done on Eastern Europe, with detailed descriptions of the data and adjustments made for Czechoslovakia and Poland. With the recent movement of Eastern European countries toward more market-oriented economies, the ILO work on these countries might be considered obsolete. Yet, it is of considerable value in that the descriptions point out the great efforts which will be required as these countries attempt to reorient their statistics to match their economies. For instance, very few of these countries have any experience in the measurement of unemployment, a phenomenon which is quickly becoming evident in their restructured economies and will have to be measured. Furthermore,

labor statistics are obtained from compulsory reports from all economic units rather than from the establishment or household sample surveys commonly used in market economies. The ILO's work on Eastern European labor statistics has already been useful to the U.S. Department of Labor in planning statistical assistance to Poland. Statisticians in Eastern Europe could benefit from the conceptual and methodological articles in this book as they move toward Westernizing their statistics.

The ILO's work on the newly industrializing countries or territories, which is not described in Chapter 6, is also welcome to those interested in international labor comparisons. As these countries have become more important in international trade, the need for more information to assess international competitiveness has grown. One of the best by-products of the ILO project to obtain comparable data is that it invariably points out deficiencies in national statistics which are then often remedied by the countries concerned. As the ILO comparable measures program extends to more and more countries, international data users can expect that their jobs will become easier.

Other chapters review the statistics available by country and their differences in coverage and methodology by selected labor series. Chapter 15 by K.M. Bashir, formerly of the ILO's Bureau of Statistics, describes statistics on the urban informal sector developed from the work of the ILO employment missions to developing countries; Chapter 20 by K. Taswell of the ILO's Bureau of Statistics describes the alternative concepts, coverage, and data sources for the labor cost statistics introduced in the 1983 *Year Book of Labour Statistics*; Chapter 21 by R. Turvey, one of the four papers not previously published, describes the many pitfalls to developing labor productivity measures, an area for which the ILO has not developed any formal recommendations; and Chapter 24 by R. Turvey includes examples of alternative measures of net earnings for selected countries.

Although written by numerous experts in their fields, the papers in this compendium are consistent in their succinctness of pres-

entation. The works are well illustrated with helpful charts and tables, and most contain a bibliography or list of references which guide the reader to other sources. Only a few of the chapters are so technical that they require that the reader have some mathematical background in order to understand them fully.

This book belongs on the desk of anyone who works in the field of international labor comparisons. It should also be very useful to national statisticians who can benefit greatly from the experience of different countries and from the guidance of the ILO in setting international standards.

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