BOOK REVIEWS
Editor: Niels Keiding


Statistics and Experimental Design for Toxicologists (3rd edition) by Shayne C. Gad is designed as a source book and textbook for both practising and student toxicologists, with the central objective of equipping them for the regular statistical analysis of experimental data.

Good laboratory practice and detailed protocols are well incorporated in the daily work practice of toxicologists. However, these practices and protocols mostly do not include detailed plans for the statistical analysis. Prior selection of statistical methodologies is, however, essential for an overall proper design. Moreover, as statistical packages become more powerful and easier to use, the probability of misuse of these powerful methods increases.

The book covers all steps in the cascade of statistical checks and analyses usually encountered in the analysis of experimental data. The steps are illustrated by examples and SAS command codes. Much attention is given to the description of methods that can be used. However, only limited statistical background information is provided for the presented methodologies. As a result the book becomes a kind of 'cookbook' for statistical analysis and experimental design for toxicologists. Therefore, it might be recommendable to check the statistical background in an appropriate handbook for biostatistics. Assumptions and limitations of the proposed methods are carefully enumerated, but are unfortunately not explained in detail.

The statistical analyses proposed for most presented examples are sound and have been used in toxicology for many decades. No attention is given to more novel statistical techniques such as the application of mixed models for the analysis of variance or the application of Monte Carlo simulations. The latter method is widely used for assessing uncertainty in the output function, based on the collective uncertainty of the model's input.

Some minor errors and mistakes are still present in this edition (for example, Table 1.1 has too many digits in the given significance levels: 0.005 and 0.001 instead of 0.05 and 0.01; Chapter 4 has a different name in the contents).

In conclusion, the book describes statistical methods that can be used in toxicology research. It enables students and practitioners in the field to select appropriate methodologies easily. However, students and practitioners interested in the background of the applied statistics will not gain very much from this book.

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This book is intended to replace and extend the treatment of functional and structural relationship models in the classical work Kendall’s Advanced Theory of Statistics. The relevant part, the earlier Chapter 29 of Kendall and Stuart [1] has been deleted from the fifth edition (by Stuart and Ord).

The basic setting given in the book is that the ordinary simple linear regression model is replaced by an assumed relation $\eta_i = \beta_0 + \beta_1 \xi_i$ in the 'true' unobservable variables $(\xi_i, \eta_i)$, and that one observes $x_i = \xi_i + \delta_i$ and $y_i = \eta_i + \epsilon_i$, where the errors are uncorrelated with finite variances. If the $\xi_i$’s are fixed unknown constants, this is called a functional model; if they are random variables with a constant expectation, it is called a structural model; a general set of assumptions covering both cases is called an ultrastructural model.

For many users of statistical methods, it may seem to be a very relevant supplement to their
methods are of interest, will the above points, that the measurement error aspects of these models and methods. The models themselves and the corresponding maximum likelihood estimation are introduced in Chapter 1. In Chapter 2 asymptotic properties of the estimators are discussed under various assumptions, with applications to confidence intervals and confidence regions. The joint confidence set for \((\beta_0, \beta_1)\) turns out to be unbounded quite generally.

In Chapter 3 we find more discussion of the identifiability conditions, and of the estimation methods generalized least squares and modified least squares. Chapter 4 contains a discussion of instrument variables, in particular grouping variables, of which the authors are rather sceptical. Chapter 5 gives the necessary generalization to the multiple regression case, while Chapter 6 treats polynomial regression, which turns out to be quite complicated for measurement error models. Robust estimation for measurement error models is treated in Chapter 7, starting with a general survey of robust estimation theory, and ending up with computational methods illustrated on a simulated example. Finally, Chapter 8 briefly treats some additional topics, most notably the relation to other latent variable settings like factor analysis models.

Each chapter is well organized; in most cases they conclude with a very informative discussion session together with a set of exercises. Of particular interest are the ‘exercises’ that are formulated as open research problems, a special feature that shows that the authors are in close touch with the research frontier attached to their subject. This should also be clear from the comprehensive bibliography included. One may miss a few of the central references on calibration, though, but here the book may be supplemented by the recent review paper by Sundberg [3].

In summary, this is a very thorough and well-written book on nearly all aspects of the use of measurement error models in regression. The serious user of these methods who consults this book will probably find an impartial discussion of most topics of interest. For somebody interested in doing methodological research on a subject related to measurement error models, the book is a must.

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REFERENCES
