——— (1997), "Graphics for Assessing the Adequacy of Regression Models," *Journal of the American Statistical Association*, 92, 490–499.
——— (1999), "Graphics in Statistical Analysis: Is the Medium the Message?" *The American Statistician*, 53, 29–37.
Tierney, L. (1990), *Lisp-Stat: An Object-Oriented Environment for Statistical Computing and Dynamic Graphics*, New York: Wiley.
Weisberg, S. (1985), *Applied Linear Regression* (2nd ed.), New York: Wiley.

Statistical Regression With Measurement Error, by Chi-Lun CHENG and John W. VAN NESS, London: Arnold (New York: Oxford University Press), 1999, ISBN 0-340-61461-7, xiv + 262 pp., $55.

Regression analysis is extensively used in applied research. As the title indicates, this book deals with an important class of regression models, called measurement error models, in which both the response and the explanatory variables are measured with error.

The basics of linear measurement models for one explanatory variable are provided in Chapter 1. I found the discussion on model identifiability and the additional assumptions required for identifying the model and for obtaining consistent estimates of the parameters to be concise and clear. This is very helpful in a quick understanding of one of the most important characteristics of measurement error models that distinguishes them from usual regression models. The authors point out that it is common to have replications of the explanatory variable, which is a bit confusing because they also mention that the book concentrates on the unreplicated model. Maximum likelihood estimation of the parameters for each of the three models—functional, structural, and ultrastructural models—is also given succinctly and clearly. Some more discussion on the nuisance parameters in functional and ultrastructural models would have been helpful. Starting with the early works, an overview of the developments in measurement-error models is provided in the last section. A summary of the main problems that are faced in using these models in practice is also given here; practitioners will find these details especially helpful. Overall, the presentation is inviting and the reader can expect to gain a good working knowledge of the subject without much tedious effort.

Asymptotic properties and consistency of parameter estimates under the additional assumptions of the model are covered in Chapter 2. Again, major results are presented succinctly. The reader is rightly forewarned that, unlike ordinary regression, the measurement-error-model parameters have unusual properties. Much material is covered in the first few pages; however, the authors do not detract from clarity. It is helpful to see all the estimators summarized in one place in a table. There is a good discussion on finite-sample properties of the estimators, and it is made clear that the estimators do not have good finite-sample properties. Alternative estimators exist, but the authors point out that either such estimators have very complicated distributions or their finite-sample properties are yet to be studied in the literature. For small sample sizes, the discussions clearly point to ordinary least squares estimators, which have a smaller expected mean square for finite samples. The rest of the chapter mainly deals with confidence intervals for the regression coefficient.

Further discussion on the model assumptions in Chapter 3 is mainly aimed at looking at the functional, structural, ultrastructural, and equation-error models in a unified way and at interrelationships among them. Generalized least squares and modified least squares are also discussed in this chapter. Although generalized least squares estimators retain their optimal properties only when the error covariance matrix is known, in practice an estimate of the error covariance matrix is frequently substituted for the true error covariance matrix. Essentially a similar approach leads to modified least squares in the case of measurement error models.

Alternative methods for estimating the model parameters are presented in Chapter 4. Instrument variables, the method of grouping variables, and ranking methods are discussed here. Methods of higher-order moments and product cumulants are also presented. The method of grouping variables, a special case of instrument variables, is discussed in detail. The case of several explanatory variables is treated in Chapter 5. In the authors' words, "The ideas and methodologies are analogous to those in the univariate model so we have only stated the basic results" (p. 148). Discussion on instrument variables for the case of several explanatory variables is also brief and the reader is referred to the econometrics literature for further details. Chapter 6 is concerned with polynomial measurement error models, and the important topic of robust estimation is considered in Chapter 7. Most of the developments in robust estimation are fairly recent, and these developments are presented well in this chapter. The final chapter is titled "Additional Topics" (Chap. 8), and it mainly discusses estimation of true response and explanatory variables and some ways of obtaining additional information for model identifiability.

Although measurement error models are appropriate for many practical situations, their widespread use is hindered by the additional assumptions for model identifiability and consistency of estimates. These concepts are presented clearly in the book. The presentation is also kept simple by avoiding the use of tedious mathematical notation. The authors have succeeded well in their goal of "providing a comprehensive coverage of the subject that emphasizes the ideas and the practical implementation of the theory without too great an emphasis on the theorem-proof format." This book is on the top of my list for anyone interested in linear and polynomial measurement error models. The book by Fuller (1987) gives more mathematical details and discusses several interesting examples. For a thorough treatment of nonlinear measurement error models; see Carroll, Ruppert, and Stefanski (1995).

Sudhir GUPTA
Northern Illinois University

REFERENCES

Carroll, R. J., Ruppert, D., and Stefanski, L. A. (1995), *Measurement Error in Nonlinear Models*, London: Chapman and Hall.
Fuller, W. A. (1987), *Measurement Error Models*, New York: Wiley.

Modelling and Estimation of Measurement Errors, by Michèle NEUILLY and CETAMA, Andover, U.K.: Intercep, 1999, ISBN 1-898298-59-9, x + 694 pp., $109.50.

This is a reference book (525 pages plus 169 pages of appendixes, tables, etc.) for physical scientists who must apply statistical methods to characterize measurement performance. It is written in recipe style with technical appendixes to explain the basis for some of the recipes. There are many examples, and the book should be useful for the intended audience. My opinion, however, is that scientists who frequently use statistical methods such as the standard ones covered in this book should not rely solely on such recipe-style books. It is better to learn the fundamentals from any of the classic textbooks on these standard topics (including parameter estimation, outlier detection, estimation of error components using analysis of variance (ANOVA) and factorial experiments including nested designs, error propagation to assign overall error to final assay result, regression/calibration, and sequential testing).

Somewhat coincidentally, the author's experience in characterizing measurement performance overlaps my own in the area of nuclear safeguards. In nuclear safeguards, we often measure special nuclear material (SNM) as it enters a controlled area in one physical form and we remeasure the SNM as it exits the area in another physical form after processing. The resulting material balance (MB) should vary randomly around 0 if there is no true loss of SNM. Because many assay methods are typically involved, the statistician who evaluates MB's must characterize both individual and combined assay methods. Jaech (1973), Bowen and Bennett (1988), Goldman, Picard, and Shipley (1982), and Speed and Culpin (1986) are four references that deal with the statistical issues in MB evaluation. Ms. Neuilly's new book largely overlaps the Jaech and Bowen and Bennett references. She mentions the MB application in Chapter II on page 138 without defining an MB. Although there is very little (if any) new material in the book, neither the Jaech nor the Bowen and Bennett references are available from a commercial publisher, and this book has an effective organization with all later chapters directly or indirectly tied to the simple error model given in Chapter I. Therefore, I believe this book can serve its intended audience, but as I will explain, I think it would greatly benefit from a careful revision.

There are five chapters, each with many subsections:

I. Modelling the Error for Directly Measured Observations
II. Estimation of Parameters of Probability Distributions