Principles of Forecasting: A Handbook for Researchers and Practitioners, J. Scott Armstrong, Ed. (2001), Boston: Kluwer Academic Publishers, 849 pages.

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Principles of Forecasting is a handbook on 139 guidelines or rules that are supported by accumulated knowledge, empirical evidence, and judgmental expertise in forecasting. It is the laborious work of the main author and his 39 co-authors, who are known experts with an impressive track record in forecasting research. They summarized the up-to-date knowledge on specific topics and inferred the principles. Not surprisingly, together with its support website, http://forecastingprinciples.com, this book is becoming a reference on recent work in forecasting. In the next paragraphs, I will report on some aspects of this book, which I consider to be of interest to readers of the *Journal of Forecasting*.

As pointed out by Armstrong in his introduction, the book is organized according to the "forecasters' major tasks": formulating the problem, gathering relevant information, selecting, implementing and evaluating methods, and finally using the forecasts. Most of the book focuses on the description of methods and conditions under which they are more likely to be useful according to practical or research evidence. Hence, the book is aimed at providing clear-cut guidelines on how to proceed in specific forecasting contexts.

Forecasting methods are described in a very general form and for more details the reader needs to consult the references which are given, or refer to a forecasting textbook. Overall., mathematical details are kept to a minimum and thus this handbook targets a wide readership – forecasting practitioners in business plus graduate or undergraduate students, who may use some chapters in the book as supplementary reading in a general forecasting course. The text is clearly written and is suitable for non-specialists and those who are not familiar with the specialized literature and would like to gain insights into a forecasting topic. However, the value of the handbook for active research in forecasting may be limited to being a reminder of open research issues and some of the controversies in the area. Similarly, practitioners in the more technical aspects of forecasting, as for example electricity demand or volatility forecasters, may find the text rather patronizing. In fact. the basic idea of developing clear-cut principles can be questioned due to the absence of consistent empirical evidence in many areas of forecasting.

A relatively small fraction of the book addresses what the author calls “extrapolation methods,” namely the more traditional methods to handle time series or cross-sectional data and neural networks. That is, most methods are dealt with in a bundle, perhaps because they are the subject of many textbooks and software packages in forecasting. The aim here is to devise principles which are based on. received wisdom and empirical studies, for selecting, extrapolating, assessing uncertainty and identifying when to use methods based on past data patterns. Neural networks are presented as potentially better performers than traditional models for monthly, quarterly and discontinuous time series, as well as for forecasts that are :several periods out on the forecast horizon.” According to this presentation, the key is that sufficient data need to be available. Nevertheless, by simply browsing the principles that are derived, we conclude that we should be more careful in our optimism. Forecasting using neural networks can become quite complex and concerned practitioners are advised by the authors to keep up with the growing literature on neural networks in a careful fashion. Unfortunately for the practitioner, the key issue of when to use a non-linear rather than a more traditional (possibly linear) method is not covered, the proposed evaluation criteria emphasize model comparisons and little attention is given to monitoring, forecast error diagnostics, and assessing model uncertainty. Furthermore, the number of steps ahead for which the authors advocate the use of neural networks is not fully clear, perhaps because the answer is not yet available.

Following a number of textbooks and reports in the specialized literature, developing econometric models may be perceived as of limited interest to practitioners in forecasting, because of the costs involved and many unfavorable or underperforming results. Furthermore, breaking an area such as econometrics down into a list of principles can become quite dangerous because of the risk of trivializing a century of research, and thus may be perceived as either naive or insulting to many in the area. However, in consulting this handbook, the reader should not skip Chapter 11. After reporting on past problems in modeling the dynamic structure and more recent empirical evidence, a strategy based on the work of the “new wave of time series econometricians” is drawn and clearly presented. Misspecification tests are then briefly but comprehensively summarized and practical advice concerning their usage is given. Each step in the strategy is further developed into general principles, some of which, I believe, may be useful to those developing forecasting models within other frameworks, like neural networks. Finally, general recommendations for developing econometric models for both practitioners and researchers are provided. In both cases, there is still much to be learned and evidence to be gathered. It may be that these principles are still premature, but most seem to be robust; some evidence is given by one of the applications in Chapter 18 on using

econometric models to forecast market share, We should look forward to the application of these principles in other forecasting contexts.

Selecting an appropriate method is crucial to forecasting. Armstrong describes “six ways”: convenience, market popularity, expert advice, statistical criteria, past record., guidelines supported by prior research. Based on the latter, a selection tree is developed that is aimed at guiding forecasters in selecting among a set of 10 forecasting methods. This may not be as specific as the reader would have liked, as for example a wide range of methods would be under the heading “extrapolation.” The guidelines that are presented depend on a number of factors, such as: sample size, type of data, knowledge of the relationships, cost of expert advice, availability of similar data, likelihood of changes. Accordingly principles are developed that favor quantitative methods and, not surprisingly, following the results of the M-competitions, simplicity. Finally, if different methods are available and selection is difficult, a combination is then recommended.

Evaluating results and. addressing their uncertainty are important tasks, which until recently were often neglected by many researchers and practitioners. Evaluation is described as a four-step procedure: testing assumptions, data and methods, replicating and assessing outputs. Some principles regarding standard statistical measures, like “do not use RMSE,” may seem surprising. given their wide use. Nevertheless, they are supported by the availability of alternative, more robust measures or the avoidance of misinterpretations. A checklist of 32 principles, of which most have been ignored in routine forecasting, is provided. Two papers address uncertainty in forecasts. The first focuses on prediction intervals for time-series forecasts. By discussing the problems involved in computation and possible approaches, it derives some very general principles to help the practitioner decide which approach to use and how. Limitations are also discussed, which point out some research issues like methods for finding the *h*-step-ahead forecast errors’ standard errors and their distribution. The second deals with overconfidence in judgmental forecasting and proposes six principles to counteract this effect.

Throughout this book, the role of judgment in forecasting is discussed in detail from predicting behavior (intentions, decisions and interactions among players) to situations where judgment integrates with domain knowledge (expert systems, causal models, model selection). There is a consistent effort to integrate judgment and statistical procedures. According to this perspective: econometric models are presented as an ideal form of modeling; domain (theory-based) knowledge integrates with statistical (quantitative methods); statistical-based forecasts provide means to avoid biases and aid revisions in judgmental forecasting: and combining (averaging)

forecasts becomes a practical approach of integrating the various methods. All in all, this handbook is also a comprehensive source of references on judgment in forecasting and the related chapters form a good starting point for those who intend to carry out research in this area.

According to the authors, innovations in forecasting diffuse slowly. Hence, there is motivation to investigate the diffusion of forecasting principles through books and software. Two studies are presented. The first shows that books tend to focus on time-series extrapolation and econometric methods, by describing procedures and giving advice that may contradict some of the proposed principles in this handbook. The second. suggests that, although software providers incorporate many principles, especially in the case of "business dedicated programs," if a practitioner relied on software to apply these principles then she would be restricted to econometric methods, extrapolation, expert systems, and conjoint analysis – in short, little attention seems to be devoted to judgmental forecasting. Could this be due to a shortcut based on the principles, which state that given enough data one should favor quantitative methods and simplicity? As yet, we do not know the answer, but we can follow up the outcome in the discussion forum that is provided at the Forecasting Principles Site.

To sum up, this book represents an intensive collective effort from a respected set of researchers in forecasting and provides an overview of the present state of the art in the forecasting area. It is not a collection of literature reviews, which a researcher may consider to have on her bookshelf. However, it is a reference book, which I would. find useful to have in my university library.