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

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Why should a market researcher be interested in a book, and a big book at that, on "forecasting"? And *Principles of Forecasting is* a large book, weighing in at 738 pages prior to the Reviewer List, Author profiles, the Forecasting Dictionary (64 pages), and an Author and (7 page) Subject Index.

An initial "sampling" of the book, choosing pages more or less at random, reveals topics like "measurement of purchase intentions," "trial sales of new consumer packaged goods," "forecasting with conjoint analysis," perhaps not what most researchers think forecasting is all about.

But the book uses the term "forecasting" in a much more all-embracing fashion than do time-series analysts, embracing both time-series forecasting, and "qualitative" or "expert judgment" forecasting/estimation.
The introduction (p. 2) states

> *"Forecasting is important in many aspects of our lives. As individuals, we try to predict success in our marriages. occupations, and investments. Organizations invest enormous amounts based on forecasts for new products, factories, retail outlets and contracts with executives. Government agencies need forecasts of the economy, environmental impacts, new sports stadiums, and effects of proposed social programs"* going on to mention political polling (*"... errors in political polls have decreased since the 1936 ... debacle ..."),* long term forecasts of airline travel, and weather forecasting.

Now that is a broad definition.

Turning to the Forecasting Dictionary at the rear of the book, I find (p. 784) "forecasting" defined as

> *"Estimating in unknown situations. Predicting is a more general term and connotes estimating for any time period before, during, or after the current one. Forecasting is commonly used when discussing time series"*

"Prediction" is defined (p. 802) as

> *"A statement regarding future events or events that are unknown to the forecaster. Generally used as synonymous with forecast. Often, but not always used when the task involves forecasting with cross-sectional data (e.g. personnel predictions) "*

So, does it make sense to have one book with a scope as wide as this, one that attempts to meld quantitative and qualitative/judgmental prediction methods? After some initial doubts, I would have to answer "yes." *Principles of Forecasting* – with its statement of principles within each of the 11 identified forecasting areas (based on a methodology tree) and an overall summary and checklist – succeeds admirably.

The meaning of "Principles" is outlined on p. 3 under the heading "What do we mean by principles?"

> *"The purpose of this book is to summarize knowledge of forecasting as a set of principles. These 'principles' represent advice, guidelines, prescriptions, condition-action statements, and rules."*

It goes on to explain that the principles should be supported by empirical evidence, the authors describe and summarize the evidence where possible and identify "speculative principles" and those "based on expert judgment" as such.

Some idea of the scope of the book may be gained by a perusal of the titles of the 30 papers included (full author details and abstracts are available at the website): 9 of the papers are authored or co-authored by J. Scott Armstrong, with 39 researchers contributing and over 120 external reviewers.

The papers are:.

- *"Role Playing: A Method to Forecast Decisions"*
- *"Methods for Forecasting from Intentions Data"*
- *"Improving Judgmental Forecasts"*
- *"Improving Reliability of Judgmental Forecasts"*
- *"Decomposition for Judgmental Forecasting and Estimation"*
- *"Expert Opinions in Forecasting: Role of the Delphi Technique"*
- *"Forecasting with Conjoint Analysis"*
- *'Judgmental Bootstrapping: Inferring Experts' Rules for Forecasting"*
- *"Forecasting Analogous Time Series"*
- *"Extrapolation of Time Series and Cross-Sectional Data"*
- *"Neural Networks for Time Series Forecasting"*
- *"Rule-based Forecasting: Using Judgment in Time-Series Extrapolation"*
- *"Expert Systems for Forecasting"*
- *"Econometric Forecasting"*
- *"Selecting Forecasting Methods"*
- *"Judgmental Time Series Forecasting Using Domain Knowledge"*
- *"Judgmental Adjustments of Statistical Forecasts"*
- *"Combining Forecasts"*
- *"Evaluating Forecasting Methods"*
- *"Prediction Intervals far- Time Series"*
- *"Overconfidence in Judgmental Forecasting"*
- *"Scenarios and Acceptance of Forecasts"*
- *"Learning from Experience: Coping with Hindsight Bias and Ambiguity"*
- *"Population Forecasting"*
- *"Forecasting the Diffusion of Innovations: Implications for Time Series Extrapolation"*
- *"Econometric Models for Forecasting Market Share"*
- *"Forecasting Trial Sales of New Consumer Packaged Goods"*
- *"Diffusion of Forecasting Principles through Books"*
- *Diffusion of Forecasting Principles: An Assessment of Forecasting Software Programs"*
- *"Standards and Practices for Forecasting"*

Something there for everyone – population forecasting, time series, new product trial and adoption, group and expert judgment modeling, the measurement of intentions. At least part of the value of this handbook lies in its comprehensiveness and remarkable cohesiveness across such diverse fields. At the same time its "handbook" structure makes it possible to dive immediately into a chapter on an unfamiliar area without having to read all the preceding material.

Some papers of special interest to market researchers include

'Methods for Forecasting from Intentions Data, "Vicki G. Morwitz, Stern School, New York University.

> "Forecasting from Intentions Data" presents a useful summary of various methods of measuring intentions and a list of 9 principles with empirical support for each of those.

1. Use probability scales, instead of other types of intentions scales, to measure individuals' predictions of what they will do in the future

2. Instruct respondents to focus on their own individual characteristics when responding to intentions questions

3. Do not accept intentions data at face value; rather, adjust intentions to remove biases

4. Use data about past participation in a behavior to adjust intentions data

5. Segment respondents prior to adjusting intentions

6. For best- and worst-case situations, use intentions to determine the bounds of probability forecasts

7. Place more reliance on predictions from intentions for behaviors in which respondents have previously participated

8. Be aware that measuring intentions can change behavior

9. Be aware that respondents who recall the time of their last purchase inaccurately may make biased predictions for future purchases

The principles are eminently sensible and the supporting evidence compelling. Of particular interest is the discussion of the Juster purchase probability scale and its limitations, and a subsequent discussion of various heuristic adjustment schemes to forecast sales from 5-point likelihood of purchase scales.

There is an interesting discussion of Manski's approach to using intentions to determine bounds of probability forecasts (rather than just point estimates) and its extension by Bemmoar which was later tested across 93 purchase intention studies.

A careful review of this chapter by market researchers or anyone engaged in forecasting from intentions data is strongly, recommended.

"Expert Opinions in Forecasting: Role of the Delphi Technique" Gene Rowe, Institute of Food Research, and George Wright, University of Strathclyde

Expert opinion is obviously one way of getting a "forecast" … but there is a great deal more to it than getting a bunch of people to sit around in a meeting.

The Delphi technique, a structured group process for eliciting and combining expert judgments has been widely used and widely criticized. This paper examines the proper application of Delphi, contrasts it with traditional group meetings and the Nominal Group Technique, and arrives at 11 principles for the design and application of structured group forecasting techniques.

The contributing authors to *Principles of Forecasting* have done us a great service in their synthesis of theory and evidence and their dedication to "getting it right," and I highly recommend a close study of this chapter to anyone in the situation of having to use structured group elicitation of forecasts from experts.

"Forecasting with Conjoint Analysis," Dick R. Wittink. Yale University and Trond Bergestuen, Johnson Graduate School of Management, Cornell University

Conjoint analysis is widely known in the market research community but perhaps not thought of as a "forecasting" procedure. The chapter by Wittink and Bergestuen provides an overview of the conjoint procedure and conditions under which conjoint should work well.

The chapter is undoubtedly useful, but we would like to have seen perhaps a greater level of exposition on recent developments in discrete choice modeling.

"Judgmental Bootstrapping (exjoint analysis) "J. Scott Armstrong

Judgmental bootstrapping is a novel procedure proposed by J. Scott Armstrong to "predict what an expert would predict." He also suggests the somewhat more appropriate name "exjoint analysis" drawing on its conceptual relationship to conjoint analysis. Another name for the area is "policy capturing" – a type of expert system based on an expert's opinions and cues. Models are typically estimated by ordinary least squares.

This is an intriguing approach and while the applications to date have been limited, Professor Armstrong provides guidance as to situations in which such an approach might profitably be applied. He concludes that exjoint analysis can provide more accurate forecasts than unaided judgments especially when the prediction problem is complex, the model can be reliably estimated and the experts have valid knowledge about relationships.

"Overconfidence in Judgmental Forecasting," Hal R. Arkes, Department of Psychology, Ohio State University

The paper by Arkes contains some valuable suggestions about counteracting the typical optimistic bias by seeking potentially disconfirmatory information, the value of feedback in reducing bias and the types of "belief system defenses" typically encountered.

Belief system defenses include the "close counter-factual" ("I was nearly correct, so why should I change my thinking?"), "fundamental forces have changed," "the forecast was sabotaged," the prediction was incorrect "but would eventually become correct after a longer period of time," and finally the denigration by unsuccessful forecasters of the forecasting task in which they participated.

Time-Series Based Methods

"Forecasting Analogous Time Series," George T. Duncan. Wilpen L. Gorr, and Januz Szczypula, School of Public Policy, Carnegie Mellon University

The chapter on "analogies" concentrates on pooling analogous time-series (those that co-vary).

It is not thus about analogies in the broader sense and for a brief discussion of some of the uses of analogies we recommend *Forecasting Methods and Applications* (Makridakis, Wheelwright and Hyndman, Chapter 9, p. 466), in which an analogy between five important inventions of the Industrial Revolution and corresponding ones of the Information Revolution is explored.

In situations in which organizations have to forecast hundreds or thousands of time series, it might be expected that these series include several sets of "analogous time series," e.g., sales of the same products in different geographic areas might be expected to co-vary positively over time. That covariation can be put to work in increasing the precision of estimates and adapting readily to pattern changes, while being somewhat robust to outliers.

In spite of the lack of a wide literature on pooling as an area of forecasting, there are some attractive ideas in this chapter and I particularly recommend it to those dealing with large numbers of time series.

At the other end of the scale the author suggests that pooling might be applicable to micro-scale time-series models, those in which intermittent demand leads to a series with many zeros and where Croston's smoothing might usually be applied.

"Neural Networks for Time Series Forecasting" William Remus, College of Business Administration, U. of Hawaii and Marcus O'Connor, Univ. of New South Wales

Remus and O'Connor contribute a short but highly readable chapter on the use of Neural Networks in time-series forecasting including comparisons between neural nets and traditional models.

Neural networks are attractive to many practitioners because of their flexibility and inherent non-linearity, but there has been significant controversy about their application to the time-series domain. The authors remain optimistic about the potential for neural networks for situations with discontinuities in the data or for forecasting longer time horizons. A set of principles is supplied for a sensible application of neural net techniques.

"Extrapolation of Time Series and Cross-Sectional Data," J. Scott Armstrong

The chapter on "Extrapolation" is a gentle introduction to time-series and contains a lot of common sense and useful guidelines. It emphasizes the principle of simplicity and recommends a simple representation of trend, unless there is evidence to the contrary: the chapter contains a discussion of the empirical evidence to support this and refers to the results of the M-competition. (The M forecasting competitions are well known to time-series analysts, but perhaps not so well known outside that sphere, and this chapter gives pointers to the key results of the competition, in which one technique is pitted against another.)

"Econometric Forecasting," P. Geoffrey Allen, Department of Resource Economics, University of Massachusetts and Robert Fildes, The Management School, Lancaster University

This chapter is highly readable and accessible to non-econometricians: there is a refreshing level of understated humor throughout.

It starts *"Econo-magic and economic tricks are two of the pejorative terms its detractors use to describe the art and science of econometrics. No doubt, these terms are well deserved in many instances,"* but then goes on to discuss the source of the problems, and gives a brief but illuminating history of econometric forecasting and the 1925 work of Charles Sarle in forecasting the price of hogs. And thence to *"Unfortunately for forecasters, research by econometricians has not focused on what works best with real-world data but on which particular method would be optimal if a standard assumption is violated in some well-defined way."*

They go on to explain *"The principal tool of the econometrician is regression analysis, using several causal variables .... compared with univariate modeling, multivariate analysis opens up many more choices for the investigator ...."*

They identify the fundamental principle as being to *"aim for a relatively simple model for specification,"* relative being a keyword in this context.

An 8-step strategy for econometric forecasters is proposed, starting from the eminently sensible "define the objectives of the modeling effort."

Each of these 8 steps is loosely discussed in compact but sufficient detail and there are sub-sections within each of the 8 steps. For example, there is much discussion about the use of disaggregated data and aggregating forecasts and the evidence to support the bottom-up approach.

Econometricians and noneconometricians alike will find the discussion of co-integration and ECM (Error Correction Models) and the range of possibilities illuminating. There is even a reference to the classic "A Drunk and Her Dog" article (Murray 1994) which describes co-integration thus *"As they wander home, the dog and its owner may make their own little detours but will never be far apart. But a drunk and someone els"s dog will wander their separate ways."*

The conclusion of the chapter presents 23 principles of econometric forecasting and for each the conditions under which it applies and the evidence to support the recommendation. A review of this material is highly recommended.

"Prediction Intervals for Time Series," Chris Chatfield, Department of Mathematical Sciences, University of Bath

This addresses the important issue of estimating prediction intervals and thus providing interval forecasts as well as the more usual point forecasts. Time-series specialists will undoubtedly be aware of Dr Chatfield's most recent book *Time-Series Forecasting* which addresses many of the issues touched upon here.

For those not familiar with a prediction interval it is *"an interval estimate for an unknown future value"* and the terminology is preferred to the term "confidence interval." Density forecasting, the problem of the complete probability distribution of some future value is a related topic.

Chatfield draws a clear distinction between forecasting method and the model, a method being a rule or formula for computing a point forecast, which may or may not be based on a model. For example, exponential smoothing is a method based on a model. Models, of course, permit one to compute theoretical prediction intervals which may not be the case with methods.

Much of the balance of the chapter focuses on the computation of PIs, the reasons for their not being computed routinely or computed incorrectly, the effects of model uncertainty on PIs, and the reasons underlying the common observation that computed PIs are too narrow.

Applications

The chapter contains a diverse set of "applications" – for each of which we will give a brief sketch.

"Population Forecasting," Dennis A. Ahlburg, University of Minnesota, and Department of Social Statistics, University of Southampton

This presents an .interesting summary of recent advances in the application of econometric models and time-series models rather than just the traditional cohort component method. It is possible with these newer methods to provide better subcomponent forecasts such as for the elderly widowed population, and estimates of uncertainty are increasingly being provided.

"Forecasting the Diffusion of Innovations: Implications for Time Series Extrapolation," Nigel Meade and Towhidul Islam, The Management School, Imperial College, London

This provides a comprehensive review of the so-called "growth curve" models including the popular Bass Model based on a population of "innovators" and "imitators.+"

Forecasting in this context poses some unique problems not the least of which is the fact that there are typically only a few observations available. Diffusion modeling also sets itself the difficult tasks of estimating the saturation level and the timing and magnitude of peak penetration.

"Econometric Models for Forecasting Market Share, "Roderick J. Brodie and Peter Danaher, Department of Marketing, University of Auckland, V. Kumar, University of Houston, and Peter Leeflang, Gröningen University

This is a review paper specifically examining the application of econometric methods to estimation and to forecasting market share from, for example, disaggregated store level data.

The conclusion is that econometric market share models work better than extrapolation models when there are strong effects of current market activity and sufficient disaggregate store level data. Competitive activity can be embedded into such models and scenario evaluation can take place based on reasonable expectations of the actions of one's competitors.

"Forecasting Trial Sales of New Consumer Packaged Goods." Peter S. Fader, The Wharton School, University of Pennsylvania and Bruce Hardie, London Business School

The subject matter of this paper is that of forecasting initial sales of new products, prior to their introduction but late in the development stage. Thus this differs from a situation in which a product is yet to be developed (in which case in measuring intentions or using conjoint analysis may be the tools of choice), and from the situation in which the product has been on the market for some time. It does however include the use of test market forecasting models and the paper provides an overview of those. Controlled test markets allow the collection of data from stores and from consumer panels, and measurement of the trial and repeat purchase rates. Given this data, various structural models, some of which have their genesis in the hazard-rate model literature, can be employed: the authors provide some guidelines.

Software

"Diffusion of Forecasting Principles: An Assessment of Forecasting Software Programs," Leonard J. Tashman, University of Vermont, and Jim Hoover, U.S. Navy.

The focus of the paper by Tashman and Hoover is the degree to which forecasting software programs facilitate "best practice." This is probably of most interest to decision makers attempting to standardize on a forecasting software package or to those who need to audit some forecasting practices.

Although it is difficult to come up with a summary score it would appear that forecasting software is about "halfway there" – that is, about 50% of forecasting principles are implemented across all software evaluated. However the area of prediction interval forecasting, not surprisingly, remains an area of weakness. The authors conclude that best forecasting practices cannot readily be achieved within the spreadsheet medium, and that in general the dedicated business forecasting programs for forecasting time-series data are more likely to provide forecasting best practice implementation than general statistical packages.

Standards of Practice

"Standards and Practices for Forecasting," J. Scott Armstrong

The last chapter of the book presents a somewhat daunting list of some 139 forecasting principles in 16 categories.

The authors themselves recognize their 139 principles might be too many, but point out that only some of them would be applicable in any given situation.

As well as the 139 principles the chapter contains a brief discussion on auditing forecasts, and re-presents the 139 principles as a checklist (which is also available from the website).

It seems reasonable that this be used, given its extensive peer review, as the benchmark for auditing procedures.

Conclusion

Is this a book for the bookshelf? Certainly it is not cheap but given its scope and depth, the international effort that has gone into its production, the extensive peer review ..and finally the fact that it is a `handbook' into which one can dip at will rather than read from cover to cover ..1 would say yes.

The Forecasting Principles website http://forecasting.com contains much useful information about *Principles of Forecasting.*

A detailed table of contents, with links to abstracts of each of the 30 papers (this is a particularly nice touch), is available at and the methodology tree at http://forecasting.com/insidecover.pdf.

A copy of the subject index is at http://forecasting.com/subject.pdf.

A number of Professor Armstrong's papers, including those that contributed to Principles of Forecasting may be found at http://forecasting.com/papers.html, including one which older researchers and analysts may remember with some fondness:

> Armstrong, J. (1967), "Derivation of Theory by Means of Factor Analysis, or Tom Swift and His Electric Factor Analysis Machine," *The American Statistician* (December), 17-21.

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