



Forecasting Principles and Applications



Stephen A. DeLurgio

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FORECASTING PRINCIPLES AND APPLICATIONS

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FORECASTING PRINCIPLES AND APPLICATIONS

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PREFACE

"I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a very meagre and unsatisfactory kind."

William Thomson, Lord Kelvin, 1824-1907

"If we could first know where we are, then whither we are tending, we could then decide what to do and how to do it."

Abraham Lincoln, 1809-1865

Today's computer-based analytical tools and systems provide users with effective forecasting technology. The challenges of the continuing revolutions in technology and information provide exciting opportunities for analysts and managers to make extraordinary contributions to their organizations. We can seize these opportunities by generating better plans based on better forecasts. This book is about better forecasting methods and processes. It is about modeling as much information as possible about the past, present, and future so that more effective plans can be made. This objective applies to all organizations whether public or private, profit or nonprofit, product or service oriented. It is especially relevant to emerging market economies and globally competitive firms. This forecasting challenge is not easily met, but nonetheless it is a necessary endeavor if we are to thrive—individually and collectively.

Purpose

The purpose of this book is to present forecasting principles and applications in an accessible way for students and researchers alike. The forecasting methods presented here are used by analysts and managers at successful retailers, wholesalers, manufacturers, and many service organizations such as health care, utilities, government offices, universities, financial institutions, research institutions, and others. As this book illustrates, the principles and applications of forecasting vary considerably whether short, intermediate, or long term forecasts are being made. Short-run methods are easier to understand and apply than other long-term methods such as multiple regression, econometric, and multivariate Box-Jenkins. However, our purpose is to make even these more sophisticated methods accessible to all while highlighting their strengths and limitations.

We have tried to make this book as comprehensive and theoretically valid as possible while still being accessible and understandable for all willing to study it. A clear, concise, and motivating writing style and layout are used to stimulate reader involvement and understanding. This style provides the substance of forecasting in a form that

makes the topics interesting to the reader. To accomplish this task, this text has several important characteristics:

1. Comprehensiveness More statistical forecasting methods are presented in this text than in other textbooks. Forecasting methods that are viewed by many as being difficult to understand are presented in this text including **Multivariate ARIMA, ARIMA Intervention, econometric methods, and neural networks**. It has been our experience that these methods are as easily learned as others when students have the correct study materials. This book includes pedagogically effective materials such as many more graphical illustrations, solved examples, exercises, and minicases.

2. Motivational Material Special interest and motivating information is provided through short examples of successful and unsuccessful forecasts of the past as well as forecasting trivia, history, and applications. We hope these added bits of information and folklore will stimulate the readers' intellectual curiosity.

3. Evolving Statistical Sophistication The level of mathematical and statistical rigor in this book progresses from the elementary to intermediate level. The mathematics of the earlier sections of the book (Parts I and II) is introductory, assuming that the reader needs to be eased into the material carefully. It is assumed that the students of the more advanced chapters either have studied the earlier chapters or had similar prerequisite courses.

4. Time Series Database Approximately 250 actual time series are included on the enclosed diskette, and many are analyzed within the text. This database includes ASCII files of all series used in the text and problem sets. In addition, almost all of the homework problems use data from the diskette. For a large portion of the problems we recommend that the students have either a spreadsheet or statistical software package as a solution tool.

5. Continuing Minicases Each chapter has 10 minicases which illustrate actual time series applications in an "integrative" format. These minicases continue throughout the book and by having a common thread of knowledge from chapter to chapter and method to method, we hope students will gain a better, more integrative understanding of alternative forecasting methods. In addition, these minicases and the other major exercises are tied together using a Master Forecasting Summary Table introduced at the end of Chapter 4.

6. Forecasting Process Throughout the text, the process of forecasting is emphasized. This begins in Chapter 1 and continues throughout the book by way of reference to the **Master Forecasting Summary Table**. This table provides an overall perspective on the forecasting process by highlighting the effectiveness, advantages, and disadvantages of different methods. Completion of this table provides insights that are very much like those of past forecasting studies (e.g., the M-competition) of Makridakis et al. The table forces the forecaster to measure in and out-of-sample forecasting accuracy in a realistic setting and by doing so, he or she gains further insights to the principles and applications of forecasting.

7. Theoretical Underpinnings Some chapters have appendices where the most technical derivations and theories are presented. These chapters can be used by students with varying statistical background and are intended to make the text useful for elementary through advanced forecasting courses. The serious student (i.e. manager or analyst) who earns a living using statistical forecasting methods will want to be familiar with the material in these appendices, while they may be skipped in some introductory classes.

8. Computer Software Support We have not tied this book to specific computer software because to do so would diminish its value as a source of generic fore-

casting concepts and models. There are many “best” software packages available, more than can be integrated into a single textbook.

9. Spreadsheet Support Modern spreadsheets provide an extraordinary opportunity for students to learn and apply forecasting methods. To support such activities we have developed about 35 templates containing some of the techniques and tables of the text. Some of the more sophisticated methods do not lend themselves to easy spreadsheet implementation, consequently not all tables are included. Templates on the enclosed diskette use a generic wk1 format.

10. Classroom Tested The material in this book has been classroom tested by the author to achieve a teachable text, one that will free the instructor and student from many elementary questions. We hope the text will stimulate students to ask more thoughtful and advanced questions.

11. The Internet Connection In today’s nearly instantaneous distribution of information, the Internet represents an important source of information. The publisher and author both maintain Internet websites in support of this book. The publisher’s website (<http://www.mhhe.com>) is the primary locus of support materials for this textbook. A secondary source of information is the author’s website; the address for this site is maintained on the publisher’s website. These websites make the use of this book a dynamic process that motivates excitement and excellence in student learning.

Using this Book

This book is divided into six major sections.

I. Foundations of Forecasting (Chaps. 1 to 3) Introduction, Statistics, and Regression Analysis.

II. Univariate Methods (Chaps. 4 to 6) Simple Smoothing, Exponential Smoothing, Decomposition, Holt-Winters, and Fourier Series Analysis.

III. Univariate ARIMA Methods (Chaps. 7 to 9) ARIMA Basics, Applications, and ARIMA Forecasting/Estimation.

IV. Multivariate Forecasting Methods (Chaps. 10 to 13) Multiple Regression, Econometrics, MARIMA I (intervention analysis), and MARIMA II (transfer functions).

V. Cyclical, Qualitative, and Artificial Intelligence Methods (Chaps. 14 to 16) including Cyclical, Technological, and Neural Network forecasting methods.

VI. Validation, Qualitative, Managerial Issues (Chaps. 17 and 18) Combining, Validation and Control, Comparing and Selecting Methods.

Part I (Chapters 1 to 3) introduces the basic concepts and principles of forecasting including statistics and simple linear regression. This section is the foundation of the remainder of the book and is an essential part of bringing students “up to speed” in statistical modeling. It introduces the concepts of autocorrelations and cross correlations so that students can use them throughout the remainder of the text.

Part II (Chapters 4 to 6) introduces the simpler univariate forecasting methods including simple smoothing, exponential smoothing, decomposition, and Fourier Series analysis. Normally, at least some of these are covered before moving into Part III.

Part III (Chapters 7 to 9) develops an accessible presentation of ARIMA methods, including appendices of derivations for those desiring a more statistical presentation. These derivations should be accessible to all students completing Part I.

Part IV (Chapters 10 to 13) presents multivariate forecasting methods including advanced regression/econometric methods, intervention methods and multivariate ARIMA methods. As is true for all parts of this book, these methods are accessible to everyone completing part I and in the case of MARIMA methods, part III. If one wants a more statistically rigorous presentation of forecasting methods, then the appendices of these chapters should be included.

Part V (Chapters 14 to 16) presents a variety of important concepts and methods. Chapter 14 presents several methods of cyclical forecasting including leading indicators, cyclical indexes, and pressure cycles. Chapter 15 presents Qualitative and Technological forecasting methods. These methods continue to take on more importance as globally competitive markets require greater use of longer term forecast when little objective data exists. Chapter 16 presents important contemporary topics from the area of artificial intelligence, particularly neural networks.

Part VI (Chapters 17 and 18 and Appendices A and B) present important forecasting methods and managerial concepts. These can be introduced at any time, early within the course or as capstone summaries. Chapter 17 develops control, combining, and validation techniques that are applicable to all the forecasting methods and Chapter 18 presents a review of forecasting characteristic and accuracy studies. Appendix A presents an extensive listing of sources of forecasting data including sources on the Internet. Appendix B presents an elementary introduction to outlier detection and adjustment procedures. These Appendices are designed to be presentable at anytime in the term, or for independent study by the student.

The six sections of this book are intended to provide flexibility and some variety of levels for undergraduate to intermediate graduate level courses. If you are only interested in a good understanding of univariate forecasting methods without delving into the more technical multivariate methods, then parts I, II, III, and sections of parts V and VI yield a course of approximately 15 chapters. Those desiring a basic univariate/multivariate presentation might use parts I, II, and sections of parts IV, V and VI. If a more theoretical study is desired, then selected chapters and their appendices could be included. These basic combinations suggest the following:

Univariate Course (11 Chapters and Appendices A and B): Chapters 1 to 6, 14 to 18.

Univariate and Multivariate Course (13 Chapters and Appendices A and B): Chapters 1 to 6, 10, 11, 14, 15, 16, 17 and 18.

Intermediate Univariate Course (14 Chapters): Chapters 1 to 9, 14 to 18 with all appendices.

Intermediate Univariate/Multivariate Course (18 Chapters): Chapters 1 to 18 and their appendices, where some elementary chapters are skipped.

This book can also be used for self-study and reference by persons engaged in forecasting including those in marketing, finance, operations, management, engineering, and the social, health, and biological sciences.

Instructors Manual and Internet Support. An Instructor's Solutions Manual containing detailed solutions to all discussion questions, numerical problems, and minicases is available from the publisher for use by instructors. In addition, this manual has many programs and examples from the book written in RATS and SAS

formats. This ancillary material will be updated on the Author's website. In addition, this website will be available to other instructors who want to electronically publish programs they have developed for use with this text. The author's website is available through the Irwin/McGraw-Hill website <http://www.mhhe.com>.

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Steve DeLurgio, Sr.

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