BUSINESS FORECASTING

John E. Hanke
Eastern Washington, University, Emeritus

Dean W. Wichern
Texas A&M University
Brief Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td></td>
<td>xv</td>
</tr>
<tr>
<td>CHAPTER 1</td>
<td>Introduction to Forecasting</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER 2</td>
<td>A Review of Basic Statistical Concepts</td>
<td>15</td>
</tr>
<tr>
<td>CHAPTER 3</td>
<td>Exploring Data Patterns and an Introduction to Forecasting</td>
<td>61</td>
</tr>
<tr>
<td>CHAPTER 4</td>
<td>Moving Averages and Smoothing Methods</td>
<td>107</td>
</tr>
<tr>
<td>CHAPTER 5</td>
<td>Time Series and Their Components</td>
<td>165</td>
</tr>
<tr>
<td>CHAPTER 6</td>
<td>Simple Linear Regression</td>
<td>221</td>
</tr>
<tr>
<td>CHAPTER 7</td>
<td>Multiple Regression Analysis</td>
<td>281</td>
</tr>
<tr>
<td>CHAPTER 8</td>
<td>Regression with Time Series Data</td>
<td>339</td>
</tr>
<tr>
<td>CHAPTER 9</td>
<td>The Box-Jenkins (ARIMA) Methodology</td>
<td>399</td>
</tr>
<tr>
<td>CHAPTER 10</td>
<td>Judgmental Forecasting and Forecast Adjustments</td>
<td>481</td>
</tr>
<tr>
<td>CHAPTER 11</td>
<td>Managing the Forecasting Process</td>
<td>503</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>Data for Case 7-1</td>
<td>521</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>Tables</td>
<td>523</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>Data Sets and Databases</td>
<td>533</td>
</tr>
</tbody>
</table>

Index 547
Contents

Preface xv

CHAPTER 1 Introduction to Forecasting 1
The History of Forecasting 1
Is Forecasting Necessary? 2
Types of Forecasts 2
Maeroeconomic Forecasting Considerations 3
Choosing a Forecasting Method 4
Forecasting Steps 4
Managing the Forecasting Process 6
Forecasting Software 6
Online Information 7
Forecasting Examples 7
Summary 9
Case 1-1: Mr. Tux 10
Case 1-2: Consumer Credit Counseling 10
Minitab Applications 11
Excel Applications 12
References 12

CHAPTER 2 A Review of Basic Statistical Concepts 15
Describing Data with Numerical Summaries 15
Displays of Numerical Information 19
Probability Distributions 22
Sampling Distributions 26
Inference from a Sample 29
Estimation 29
Hypothesis Testing 30
'. p-Value 32
CHAPTER 3 Exploring Data Patterns and an Introduction to Forecasting Techniques 61

Exploring Time Series Data Patterns 62
Exploring Data Patterns with Autocorrelation Analysis 64

Are the Data Random? 69
Do the Data Have a Trend? 72
Are the Data Seasonal? 76

Choosing a Forecasting Technique 76
Forecasting Techniques for Stationary Data 78
Forecasting Techniques for Data with a Trend 78
Forecasting Techniques for Seasonal Data 79
Forecasting Techniques for Cyclical Series 79

Other Factors to Consider When Choosing a Forecasting Technique 79

Empirical Evaluation of Forecasting Methods 81

Measuring Forecast Error 81
Determining the Adequacy of a Forecasting Technique 84
Application to Management 86
Glossary 87
Key Formulas 87
Problems 88

Case 3-1A: Murphy Brothers Furniture 94
Case 3-1B: Murphy Brothers Furniture 96
Case 3-2: Mr. Tux 97
Case 3-3: Consumer Credit Counseling 98
Case 3-4: Alomega Food Stores 99
Forecasting a Seasonal Time Series 185
The Census II Decomposition Method 187
Application to Management 189
- Appendix: Price Index 190
Glossary 192
Key Formulas 192
Problems 193
Case 5-1: The Small Engine Doctor 201
Case 5-2: Mr. Tux 202
Case 5-3: Consumer Credit Counseling 206
Case 5-4: Murphy Brothers Furniture 207
Case 5-5: AAA Washington 210
Case 5-6: Alomega Food Stores 212
Case 5-7: Surtido Cookies 213
Case 5-8: Southwest Medical Center 214
Minitab Applications 214
Excel Applications 217
References 219

CHAPTER 6 Simple Linear Regression 221
Regression Line 222
Standard Error of the Estimate 226
Forecasting \( Y \) 227
Decomposition of Variance 230
Coefficient of Determination 234
Hypothesis Testing 236
Analysis of Residuals 239
Computer Output 241
Variable Transformations 243
Growth Curves 246
Application to Management 250
Glossary 252
Key Formulas 253
Problems 254
Case 6-1: Tiger Transport 266
Case 6-2: Butcher Products, Inc. 268
Case 6-3: Ace Manufacturing 269
Case 6-4: Mr. Tux 270
Case 6-5: Consumer Credit Counseling 270
Case 6-6: AAA Washington 271
Minitab Applications 274
Model Specification Error (Omitting a Variable) 348
Regression with Differences 350
Autocorrelated. Errors and Generalized Differences 354
Autoregressive Models 357
Summary 358
Time Series Data and the Problem of Heteroscedasticity 358
Using Regression to Forecast Seasonal Data 361
Econometric Forecasting 364
Cointegrated Time Series 365
Application to Management 367
Glossary 367
Key Formulas 367
Problems 369
Case 8-1: Company of Your Choice 378
Case 8-2: Business Activity Index for Spokane County 379
Case 8-3: Restaurant Sales 383
Case 8-4: Mr. Tux 385
Case 8-5: Consumer Credit Counseling 388
Case 8-6: AAA Washington 389
Case 8-7: Alomega Food Stores 392
Case 8-8: Surtido Cookies 393
Case 8-9: Southwest Medical Center 394
Minitab Applications 395
Excel Applications 396
References 398

CHAPTER 9  The Box-Jenkins (ARIMA) Methodology 399
Box-Jenkins Methodology 399
  Autoregressive Models 404
  Moving Average Models 405
  Autoregressive Moving Average Models 407
Summary 407
Implementing the Model-Building Strategy 407
  Step 1: Model Identification 407
  Step 2: Model Estimation 409
  Step 3: Model Checking 410
  Step 4: Forecasting with the Model 411
  Model-Building Caveats 430
  Model Selection Criteria 431
  A RIMA Models for Seasonal Data 432
CHAPTER 10  Judgmental Forecasting and Forecast Adjustments  481

Judgmental Forecasting  483
  The Delphi Method  483
  Scenario Writing  485
  Combining Forecasts  486
  Forecasting and Neural Networks  488
  Summary of Judgmental Forecasting  490

Other Tools Useful in Making Judgments About the Future  491

Key Formulas  496

Problems  496

Case 10-1: Golden Gardens Restaurant  497
Case 10-2: Alomega Food Stores  497
Case 10-3: The Lydia E. Pinkham Medicine Company  498

References  501

CHAPTER 11  Managing the Forecasting Process  503

The Forecasting Process  503
Monitoring Forecasts  504
Forecasting Steps Reviewed  509
Forecasting Responsibility  510
Forecasting Costs  511
Forecasting and Management Information Systems  511
Selling Management on Forecasting  512
The Future of Forecasting  512
• Problems  513
  Case 11-1: Boundary Electronics  513
  Case 11-2: Busby Associates  514
  Case 11-3: Consumer Credit Counseling  517
  Case 11-4: Mr. Tux  518
  Case 11-5: Alomega Food Stores  519
  Case 11-6: Southwest Medical Center  520
References  520
APPENDIX A  Data for Case 7-1  521
APPENDIX B  Tables  523
  Table B-1  Individual Terms of the Binomial Distribution  523
  Table B-2  Areas for Standard Normal Probability Distribution  525
  Table B-3  Critical Values of t  526
  Table B-4  Critical Values of Chi-Square  527
  Table B-5  F Distribution  529
  Table B-6  Durbin-Watson Test Bounds  530
APPENDIX C  Data Sets and Databases  533
Index  547