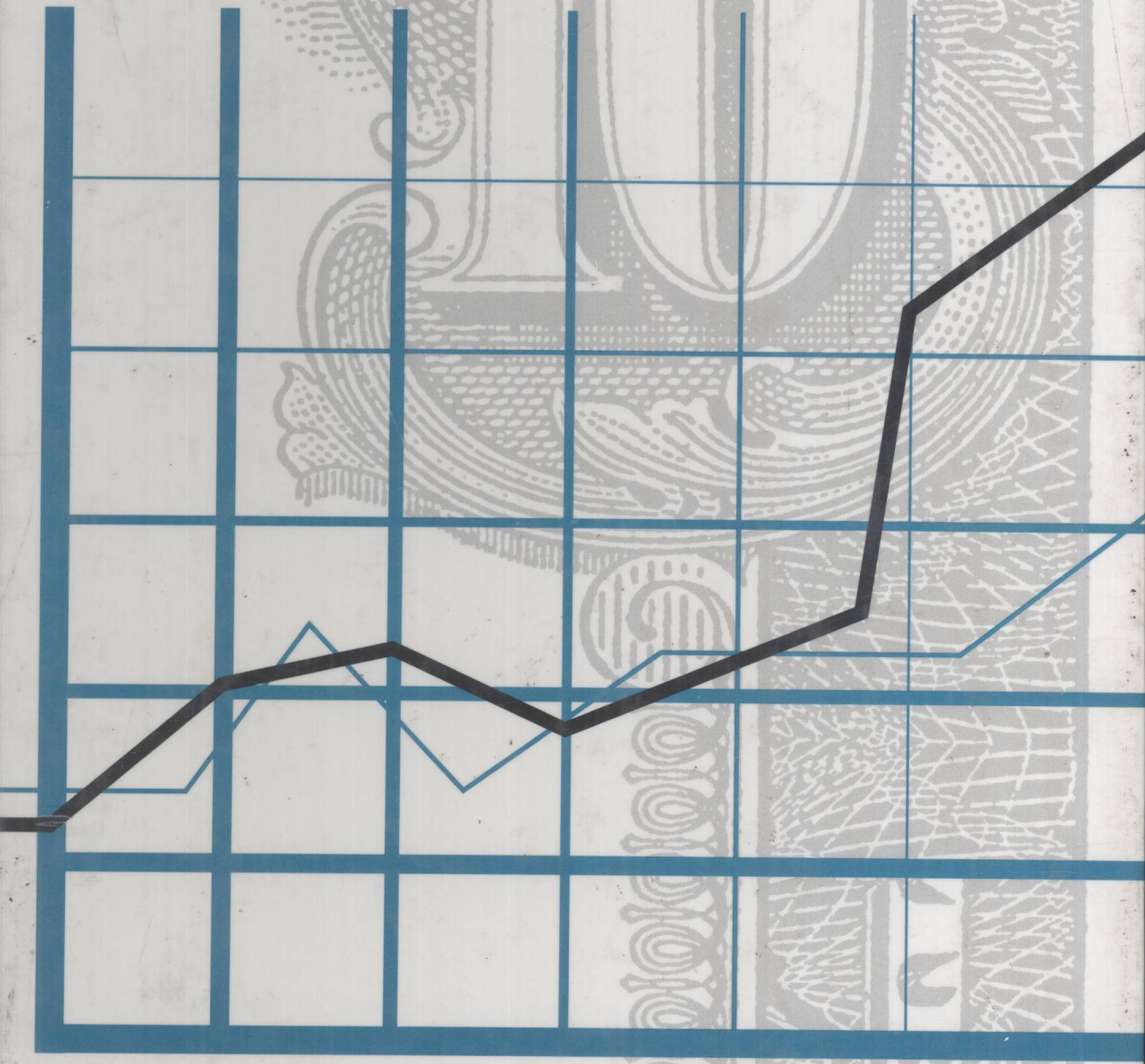
Business Forecasting

FOURTH EDITION

John E. Hanke — Arthur G. Reitsch



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FOURTH EDITION

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BUSINESS FORECASTING

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Boston London Sydney Toronto Tokyo Singapore

Dedicated to Harry, Gerry, Jack, and Irene (who don't need to read it);
Judy and Judy (who will and probably won't, respectively);
Jill, Amy, Julie, Katrina, and Kevin (who might);
and all of our students (who better).

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PREFACE

The goal of the fourth edition of *Business Forecasting* remains the same as that of the previous editions: to present the basic statistical techniques that are useful for preparing individual business forecasts and long-range plans. This book is written in a simple straightforward style and makes extensive use of practical business examples. Twenty-five cases appear at the end of the chapters to provide the students with the necessary link between theoretical concepts presented in the text and their real-world applications. The emphasis is on the application of techniques by management for decision making. Students are assumed to have taken an introductory course in both statistics and computer usage.

ORGANIZATION

All chapters have been revised to enhance the clarity of the writing and to increase teaching and learning effectiveness. The content has been organized into six sections.

The first section (Chapters 1 and 2) serves as background and lays the groundwork. The nature of forecasting and a quick review of basic statistical concepts set the stage for the coverage of techniques that begin in the second section.

The second section (Chapters 3 and 4) emphasizes data collection methods, the exploration of data patterns, and the choosing of a forecasting technique.

The third section (Chapter 5) covers averaging and smoothing techniques. The fourth section (Chapters 6 and 7) emphasizes causal forecasting techniques, such as correlation, regression, and multiple regression analysis. The fifth section (Chapters 8 through 10) looks at techniques involving time series analysis. The book concludes with a final chapter (Chapter 11) on technological and judgemental forecasting techniques, along with a discussion of managing and monitoring the forecasting process.

CHANGES IN THE FOURTH EDITION

The following changes are new in this edition:

- A new chapter (four) on exploring data patterns and choosing a forecasting technique.
- Several examples of how to use Minitab have been added throughout all chapters.
- Most of the exercises are new in Chapters 4 through 9.
- Seven new data sets have been added to Appendix E.
- New discussions of double moving averages and double exponential smoothing have been added to old Chapter 4, which is now new Chapter 5.
- A comprehensive case has been added to Chapter 11.
- A new discussion on tracking and monitoring forecasts has been added to Chapter 11.
- A new discussion of macroeconomic forecasting has been added to Chapter 1.

FEATURES OF THIS TEXT

The following features have proven to be effective, and are included in this edition:

- A wealth of real world cases—both solved and unsolved—included in every chapter.
- Helpful learning aids—included in each chapter are applications to management, glossary, key formulas, problems, and case studies.
- Computer output from different computer packages are provided at the end of each chapter. They familiarize students with a range of software packages used in the business world and teach them how to read the output.
- A unique chapter (9) on econometric topics, including coverage of the regression of time series data that makes these difficult concepts understandable to students.
- A unique chapter (10) that explains autocorrelation analysis and the use of Box-Jenkins techniques in understandable terms.
- A chapter (11) emphasizing judgmental forecasting techniques, an important but often overlooked set of techniques.

THE ROLE OF THE COMPUTER

In the first three editions, the computer was recognized as a powerful tool in forecasting. The computer is even more important now, with modern

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managers taking advantage of the ease and availability of sophisticated forecasting afforded by desk-top microcomputers.

The authors have spent several sleepless nights deciding what to do about the computer. Two nationwide research studies conducted by the authors to determine what faculty do about using computers for teaching forecasting showed that (1) most forecasting faculty attempt to provide students with hands-on experience in using the computer, and (2) several mainframe statistical packages and specific personal computer forecasting packages were mentioned in the survey. The packages mentioned most frequently were Minitab, SAS, SPSS^X, SPSSpc, Sibyl/Runner, TSP, and Lotus 1-2-3.

The authors decided to use the following approaches to help faculty and students use the computer for forecasting:

1. Minitab instructions are presented throughout all chapters of the book.
2. A brief look at computer forecasting packages in general has been placed at the end of Chapter 1.
3. Examples of different computer outputs are placed throughout the text.
4. Examples of four computer packages are provided at the end of various chapters: packages include Minitab, SAS, SPSS^X, and TSP.

SUPPLEMENTS

The Instructor's Manual includes answers to chapter-end problems, comments on the case studies that appear at the end of most chapters, and multiple choice questions.

A Student Edition of Forecast Plus by Walonick Associates, a popular forecasting package for microcomputers, can be purchased at a special discount when packaged with the textbook.

A Data Disk is available to qualified adopters upon request. The disk contains numerous data sets to be used for student practice.

ACKNOWLEDGMENTS

The authors are indebted to the many instructors around the world who have used the first three editions and have provided invaluable suggestions for improving the book. Special thanks go to Professor Frank Forst (Marquette University), Professor William Darrow (Towson State University), Professor William C. Struning (Seton Hall University), Professor Mark Craze (Eastern Washington University), and Professor Shik Chun Young (Eastern Washington University); to Marilyn Love, Judy Johnson, Dorothy

Mercer, Vicki LaBlanc, and Paul Nosbisch (Decision Science Associates) for providing cases; and to Jennifer Dahl for constructing the index.

The authors sincerely appreciate the time taken by J. Scott Armstrong, Judy Johnson, and Essam Muhoud who provided useful materials. Also, portions of this text, particularly several data sets, are adapted from those that appeared in our *Understanding Business Statistics* text published by Richard D. Irwin, Inc., whom we here credit for this reuse.

We also thank reviewers Benito Flores, Texas A & M; Harriet Hinck, Trenton State College; Leo Mahoney, Bryant College; David R. McKenna, Boston College; Ahman Sorabian, Cal State Polytech; and Richard Withycombe, University of Montana, for their very constructive comments in the revision of the book. If we were talented enough to accomplish everything our reviewers suggested, this book would be improved 100 percent. As is, we did our best.

Finally, we thank our computers and wonder how we ever wrote a textbook without one. We, not the computers, are responsible for any errors. We also sincerely thank Ruth Kembel who recently retired. *Business Forecasting* would have never made the first edition without her.

J. E. H.
A. G. R.

CONTENTS

PREFACE ix

1 INTRODUCTION TO FORECASTING 1
History of Forecasting 1
Need for Forecasting 1
Types of Forecasts 3
Macroeconomic Forecasting 4
Choosing a Forecasting Method 5
Forecasting Steps 6
Managing the Forecasting Process 7
Computer Forecasting Packages 8
Selected Bibliography 11

2 A REVIEW OF BASIC STATISTICAL CONCEPTS 12
Descriptive Statistics 12
Probability Distributions 16
Sampling Distributions 20
Estimation 22
Hypothesis Testing 24
Goodness-of-Fit Test 30
Correlation Analysis 34
Scatter Diagrams 35
Correlation Coefficient 39
Application to Management 42
Glossary 44
Key Formulas 44
Problems 46
Case Study 2.1: Alcam Electronics 55
Case Study 2.2: Great City Bank 57
Case Study 2.3: Aluminum Products 58
Case Study 2.4: Bank Customers 59
Case Study 2.5: Unit Lifetimes 60
Minitab Example 61
Selected Bibliography 62

3 DATA SOURCES 63
Data Types 63
Data Sources 65
Secondary Data Sources 65
Primary Data Sources 69
Application to Management 75
Glossary 77
Problems 77
Case Study 3.1: Argyl Food Products 78
Case Study 3.2: Solomon's Jewelry 80
Case Study 3.3: Market Feasibility Study 81
Minitab Example 88
Selected Bibliography 89

4 EXPLORING DATA PATTERNS AND CHOOSING A FORECASTING TECHNIQUE 90
Time Series Components 91
Exploring Data Patterns with Autocorrelation Analysis 93
Choosing a Forecasting Technique 107
Forecasting Techniques for Stationary Data 108
Forecasting Techniques for Data with a Trend 109
Forecasting Techniques for Data with Seasonality 110
Forecasting Techniques for Cyclical Series 110
Other Factors to Consider When Choosing a Forecasting Technique 111
Measuring Forecasting Error 112
Determining the Adequacy of a Forecasting Technique 116
Application to Management 118
Glossary 119
Key Formulas 119
Problems 120
Case Study 4.1: Murphy Brothers Furniture 125

5 MOVING AVERAGES AND SMOOTHING METHODS 128
Naive Models 129
Averaging Methods 132
Simple Averages 133
Moving Averages 134
Double Moving Average 137
Exponential-Smoothing Methods 140
Tracking 144
Double Exponential Smoothing 146
Exponential Smoothing Adjusted for Trend: Holt's Method 151

Exponential Smoothing Adjusted for Trends and Seasonal Variation: Winter's Model 154
Application to Management 158
Glossary 159
Key Formulas 159
Problems 161
Case Study 5.1: The Solar Alternative Company 165
Case Study 5.2: Five-Year Revenue Projection for Downtown Radiology 166
Selected Bibliography 177

6 REGRESSION ANALYSIS 178
Regression Line 180
Standard Error of Estimate 185
Predicting Y 186
Coefficient of Determination 190
Residuals 194
Hypothesis Testing 197
Computer Output 201
Variable Transformations 204
Application to Management 208
Glossary 209
Key Formulas 209
Problems 210
Case Study 6.1: Tiger Transport 215
Case Study 6.2: Butcher Products, Inc. 218
Case Study 6.3: Ace Personnel Department 220
SPSS Example 221
SAS Example 223
Selected Bibliography 224

7 MULTIPLE REGRESSION 225
Predictor Variables 225
Correlation Matrix 226
Multiple Regression Equation 227
Regression Coefficients 230
Statistical Inference in Multiple Regression 231
Residuals 232
Standard Error of Estimate 234
Computer Output 235
Dummy Variables 237
Validation of the Model 242
Heteroscedasticity 242
Collinearity 243

Selecting the Best Regression Equation 245
All Possible Regressions 248
Stepwise Regression 251
Using Regression to Forecast Seasonal Data 254
Econometric Forecasting 257
Overfitting 258
Application to Management 259
Glossary 261
Key Formulas 261
Problems 262
Case Study 7.1: The Bond Market 269
Case Study 7.2: Restaurant Sales 272
Selected Bibliography 275

8 TIME SERIES ANALYSIS 276
Decomposition 277
Price Index 278
Trend 280
Nonlinear Trend 285
Cyclical Variation 287
Seasonal Variation 296
Seasonal Trend 300
Seasonally Adjusted Data 303
Short-Term Cyclical and Irregular Variations 305
Seasonal Forecasting 307
The Census II Decomposition Method 308
Application to Management 308
Glossary 310
Key Formulas 310
Problems 311
Case Study 8.1: The Small Engine Doctor 317
Case Study 8.2: Wheeler Electric Range 318
Case Study 8.3: Grand Coulee Dam Visitors 328
Selected Bibliography 336

9 REGRESSION OF TIME SERIES DATA 337
The Problem of Heteroscedasticity When Regressing Time Series Data 337
The Problem of Serial Correlation When Regressing Time Series Data 338
Durbin-Watson Test for Serial Correlation 343
Solutions to Serial Correlation Problems 346
Model Specification Error (Omitting a Variable) 347
Regression of Percentage Changes 351

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Autoregressive Models 356
Generalized Least Squares 358
First Differences 360
Iterative Approach 362
Application to Management 364
Glossary 364
Key Formulas 365
Problems 365
Case Study 9.1: Company of Your Choice 372
Case Study 9.2: Business Activity Index for Spokane County 373
TSP Example 378
Selected Bibliography 380

10 THE BOX-JENKINS (ARIMA) METHODOLOGY 381
Box-Jenkins Technique 381
Partial Autocorrelations 385
Autoregressive Model 386
Moving-Average Models 387
Autoregressive Moving-Average Models 388
Applying the Methodology 389
Stage 1: Model Identification 389
Stage 2: Model Estimation and Testing of Model Adequacy 390
Stage 3: Forecasting with the Model 391
A Seasonal Analysis 418
Application to Management 426
Glossary 427
Key Formulas 428
Problems 428
Case Study 10.1: Restaurant Sales 435
Case Study 10.2: Daily Demand for Trout Tags 437
Selected Bibliography 450

11 JUDGMENTAL ELEMENTS IN FORECASTING 451
Judgmental Forecasting 451
Growth Curves 453
The Delphi Method 454
Scenario Writing 455
Combining Forecasts 455
Summary of Judgmental Forecasting 456
Other Judgmental Elements in Forecasting 457
Managing the Forecasting Process 462
The Forecasting Process 462
Monitoring Forecasts 466
Forecasting Steps Reviewed 470

Forecasting Responsibility 471
Forecasting Costs 472
Selling Management on Forecasting 472
Forecasting and the MIS System 472
The Future of Forecasting 473
Glossary 474
Key Formula 474
Case Study 11.1: Boundary Electronics 474
Case Study 11.2: Golden Gardens Restaurant 475
Case Study 11.3: Busby Associates 476
Case Study 11.4: Metropolitan Mortgage 481
Selected Bibliography 490

APPENDIXES 489

A DERIVATIONS 490

B RATIO OR SEMILOGARITHMIC GRAPHS 492

C TABLES 497

D DATA FOR CASE STUDY 7.1 509

E DATA SETS AND DATABASE 511

INDEX 523

CHAPTER 1

Introduction to Forecasting

This book is concerned with the process of business forecasting. This process involves the study of historical data to discover their underlying tendencies and patterns and the use of this knowledge to project the data into future time periods as forecasts. As the world of business has become more complex, the need to assess the future on some rational basis has grown, and forecasting has assumed a prominent position in the business administration process.

HISTORY OF FORECASTING

Many of the forecasting techniques used today and discussed in this book were developed in the nineteenth century; regression analysis procedures are an example. By contrast, some of the topics in this book were developed and have received attention only recently. The Box–Jenkins procedures fall into this category.

With the development of more sophisticated forecasting techniques, along with the advent of the electronic computer, forecasting has achieved more and more attention during recent years. This statement is especially true since the proliferation of the small, personal computer. Every manager now has the ability to utilize very sophisticated data analysis techniques for forecasting purposes, and an understanding of these techniques is now essential for business managers.

New techniques for forecasting continue to be developed as management attention to the forecasting process continues to grow. A particular focus of this attention is on the errors that are an inherent part of any forecasting procedure. Predictions as to future outcomes rarely are precisely on the mark; the forecaster can only endeavor to make the inevitable errors small.

NEED FOR FORECASTING

In view of inherent inaccuracies in the process, why is forecasting necessary? The answer is that all organizations operate in an atmosphere of

uncertainty and that, in spite of this fact, decisions must be made that affect the future of the organization. Educated guesses about the future are more valuable to organization managers than are uneducated guesses. This book discusses various ways of making forecasts that rely on logical methods of manipulating the data that have been generated by historical events.

This is not to say that intuitive forecasting is bad. On the contrary, the "gut" feelings of persons who manage organizations are often the best forecasts available. This text discusses forecasting techniques that can be used to supplement the common sense and management ability of decision makers. A decision maker is better off understanding quantitative forecasting techniques and using them wisely than being forced to plan for the future without the benefit of valuable supplemental information.

The role of judgmental forecasting appears to have changed during recent years. Before the advent of modern forecasting techniques and the power of the computer, the manager's judgment was the only forecasting tool available. There is now evidence that forecasts using judgment only are not as accurate as those involving judicious application of quantitative techniques:

> Humans possess unique knowledge and inside information not available to quantitative methods. Surprisingly, however, empirical studies and laboratory experiments have shown that their forecasts are not more accurate than those of quantitative methods. Humans tend to be optimistic and underestimate future uncertainty. In addition, the cost of forecasting with judgmental methods is often considerably higher than when quantitative methods are used.[1]

It is our view that the most effective forecaster is able to formulate a skillful mix of quantitative forecasting techniques and good judgment and to avoid the extremes of total reliance on either. At the one extreme we find the executive who, through ignorance and fear of quantitative techniques and computers, relies solely on intuition and feel. At the other extreme is the forecaster skilled in the latest sophisticated data manipulation techniques who is unable or unwilling to relate the forecasting process to the needs of the organization and its decision makers. We view the quantitative forecasting techniques discussed in this book to be only the starting point in the effective forecasting of outcomes important to the organization: analysis, judgment, common sense, and business experience must be brought to bear at the point where these important techniques have generated their results.

Since the world in which organizations operate has always been changing, forecasts have always been necessary. However, recent years

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[1] S. Makridakis, "The Art and Science of Forecasting," *International Journal of Forecasting*, Vol. 2 (1986), p. 17.

have brought about increased reliance on techniques which involve sophisticated data manipulation techniques. New technology and new disciplines have sprung up overnight; government activity at all levels has intensified; competition in many areas has become more keen; international trade has stepped up in almost all industries; social help and service agencies have been created and have grown. These factors have combined to create an organizational climate that is more complex, more fast-paced, and more competitive than ever before. Organizations that cannot react quickly to changing conditions and that cannot foresee the future with any degree of accuracy are doomed to extinction.

Electronic computers, along with the quantitative techniques they make possible, have become more than a convenience for modern organizations: they have become essential. The complexities discussed above generate tremendous amounts of data and an overwhelming need to extract useful information from these data. The modern tools of forecasting, along with the capabilities of the electronic computer, have become indispensable for organizations operating in the modern world.

Who needs forecasts? Almost every organization, large and small, private and public, uses forecasting either explicitly or implicitly, because almost every organization must plan to meet the conditions of the future for which it has imperfect knowledge. In addition, the need for forecasts cuts across all functional lines as well as across all types of organizations. Forecasts are needed in finance, marketing, personnel, and production areas; in government and profit-making organizations; in small social clubs and in national political parties. Consider the following questions that suggest the need for some forecasting procedures.

- If we increase our advertising budget by 10%, how will sales be affected?
- What revenue might the state government expect over the next two-year period?
- How many units might we sell in an effort to recover our fixed investment in production equipment?
- What factors can we identify that will help explain the variability in monthly unit sales?
- What is a year-by-year prediction for the total loan balance of our bank over the next ten years?
- Will there be a recession? If so, when will it begin, how severe will it be, and when will it end?

TYPES OF FORECASTS

When organization managers are faced with the need to make decisions in an atmosphere of uncertainty, what types of forecasts are available to them?

Forecasting procedures might first be classified as long-term or short-term. Long-term predictions are necessary to set the general course of an organization for the long run; they thus become the particular focus of top management. Short-term forecasts are used to design immediate strategies and are used by mid-management and first-line management to meet the needs of the immediate future.

Forecasts might also be classified in terms of their position on a micro-macro continuum, that is, on the extent to which they involve small details vs. large summary values. For example, a plant manager might be interested in forecasting the number of workers needed for the next several months (a micro-forecast), while the federal government is forecasting the total number of people employed in the entire country (a macro-forecast). Again, different levels of management in an organization tend to focus on different levels of the micro-macro continuum. Top management would be interested in forecasting the sales of the entire company, for example, while individual salespersons would be much more interested in forecasting their own sales volumes.

Forecasting procedures can also be classified according to whether they tend to be more quantitative or qualitative. At one extreme, a purely qualitative technique is one requiring no overt manipulation of data. Only the "judgment" of the forecaster is used. Even here, of course, the forecaster's "judgment" is actually a result of the mental manipulation of past historical data. At the other extreme, purely quantitative techniques need no input of judgment; they are mechanical procedures that produce quantitative results. Some quantitative procedures require a much more sophisticated manipulation of data than do others, of course. This book emphasizes the quantitative forecasting techniques because a broader understanding of these very useful procedures is needed in the effective management of modern organizations. However, we must emphasize again that judgment and common sense must be used along with the mechanical and data manipulative procedures discussed here. Only in this way can intelligent forecasting take place.

MACROECONOMIC FORECASTING

We usually think of forecasting in terms of predicting important variables for an individual company or perhaps one component of a company. Monthly company sales, unit sales for one of a company's stores, and absent hours per employee per month in a factory are examples.

By contrast, there is growing interest in forecasting important variables for the entire economy of a country. Much work has been done in evaluating methods for doing this kind of overall economic forecasting, called *macroeconomic forecasting*. Examples of interest to the federal govern-

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