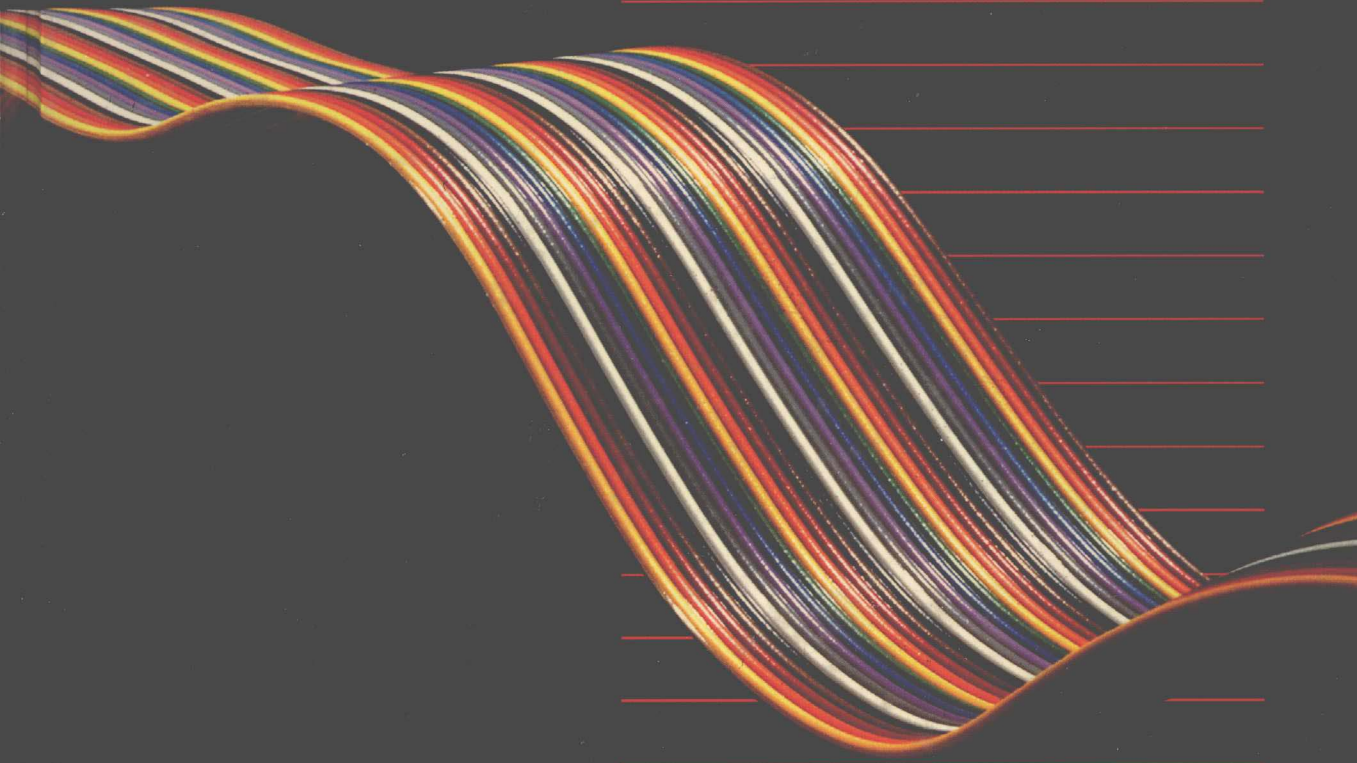


# Brief Business Statistics



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# **BRIEF**

# **BUSINESS**

# **STATISTICS**

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# PREFACE

*Brief Business Statistics* is an introductory statistics text for business and economics students. It is intended for a one-quarter or one-semester course, but it is also appropriate for a two-quarter course where computer applications are used extensively.

The major goal for this text is to present principles and practices of statistics in the context of substantive, interesting, and up-to-date applications in business and economics. Students will appreciate their instructors for giving them the opportunity to learn statistics from this text because the concepts and applications are presented with clarity, brevity, and accuracy.

- **Clarity:** Statistical ideas, methods, and applications are presented with understandable, straightforward explanations and with practical, stimulating examples in business and economics. Clear discussion makes learning easier for students and pedagogy more effective for instructors.
- **Brevity:** Our treatment of statistics is concise and crisp. We have capsulized the key topics in business statistics so they can be covered in a one-semester or one-quarter course.
- **Accuracy:** Concepts and formulas are developed with logic suitable for the application of statistics in business and economics. Discussion is given for the conditions that must hold for readers to apply the methods correctly. Insights are provided for the assumptions made in statistical models.

Readers of this book will gain an appreciation of the fact that realistic business problems often require thinking in terms of variation; that data collection, data analysis, and interpretation of results are important processes in making business decisions; and that statistical methods and models are invaluable in understanding, explaining, and controlling variation.

## FEATURES

This book contains many special features.

- **Topics:** All of the key concepts and methods that are required for a fundamental understanding of the use and interpretation of statistics for business and economics are included in this brief text—from exploratory data analysis to hypothesis testing and from analysis of variance to multiple regression. The outline follows a logical sequence.
- **Substantive Business Examples:** Business examples that are practical and relevant are used in each chapter.

- **Real Business Problems:** Problems taken from actual business settings let students develop an appreciation for business applications of statistics. Real business applications are contained in practice problems that are presented with solutions and in assignment problems for each chapter.
- **Abundant Assignment Problems:** Abundant assignment problems are located at the ends of sections and at the ends of chapters. Up-to-date problems are taken from all of the functional areas of business including accounting, finance, management, marketing, production, and economics. Many questions are based on graphics that accompany the problems. Answers to odd-numbered problems are included in Appendix D. Questions at the end of each chapter that refer to a larger set of actual business data emphasize the use of data analysis.
- **Actual Data:** Data taken from practical business periodicals like *Business Week*, *Forbes*, *Fortune*, and *The Sporting News*, and data from the COMPUSTAT files enhance the realism of problems. A larger data set that contains information taken from an anonymous organization concerning 113 credit applicants is included as Appendix A.
- **Graphical Excellence:** Well-designed, attractive graphics that make statistics easier to comprehend are used to present concepts, functions, and data. Introductory statistical graphics that can be produced with spreadsheet or charting software are discussed. Graphs of density functions are plotted with precision. The graphics in this text present concepts clearly, precisely, and efficiently; furthermore, they encourage readers to think about statistics. For graphical excellence in statistics, this text is unrivaled.
- **Simulations:** Simulations, or sampling exercises, are used to enhance student comprehension of key statistical concepts such as the central limit theorem, confidence interval estimation, analysis of variance, and correlation. Simulation results are presented in unique graphics.
- **Computer Applications:** Computer applications are used to demonstrate data analysis throughout the book.
- **Data Analysis Packages:** Outputs from MINITAB, SAS, SPSS<sup>X</sup>, MYSTAT, BMDP, MICROSOFT CHART, and ARBORIST are included in the text. Interactive data analysis sessions using MINITAB are presented in most chapters with explanations of commands given in boxes. Printouts from SAS, SPSS<sup>X</sup>, MYSTAT, and BMDP are accompanied by program statement listings. Explanations of commands or procedures in the program statement listings are given in boxes. ARBORIST is used in a decision theory application. Adapting the material so it can be used with any data analysis system is very simple. The text is designed so readers can use data analysis systems extensively (including personal computers); albeit, it is also viable for readers to simply rely on the printouts that are provided in the text.
- **Easing the Computational Burden:** Problems with simple data that result in integer-valued means, grand means, deviations, standard deviations, intercepts,



slopes, and so forth, are included to help ease the computational burden. These problems are suitable for hand computations (without need for even a calculator, for the most part). To assist readers to locate these problems, they are marked with a hand icon.



Problems suitable for use with data analysis systems, due to size of the data set or burdensome arithmetic, are marked with a microcomputer icon. Students can enter most of these data sets into interactive data analysis systems easily. Other problems have data sets that are suitable for use with hand-held calculators.

- **Exploratory Data Analysis:** Stem-and-leaf displays are discussed. Data analysis systems are used to obtain descriptive measures, stem-and-leaf displays, and box plots for purposes of exploratory data analysis.
- **P-Values:** The use of  $P$ -values in hypothesis testing is discussed, and  $P$ -values are included on many of the computer printouts.
- **Design:** Two colors are used to enhance readability and strengthen prominent points; important definitions and equations are in colored boxes. Each chapter begins with an introductory section that introduces topics and ties chapters together, and each ends with a summary section in which important ideas, formulas, assumptions, and cautionary notes are given in tabular form. Key words are in boldface type and italic type is used to emphasize important passages.
- **MINITAB Command Reference:** A brief command reference is included in Appendix E for those using MINITAB.

## ORGANIZATION AND FLEXIBILITY

This book has four major sections. The first section (Chapters 1–3) comprises an introduction to the nature of statistical problems and descriptive statistical procedures. The only required mathematical background is algebra. Summation notation is introduced in Chapter 3 and is discussed more comprehensively in an appendix.

The second major section of the book (Chapters 4–6) covers the subject of probability. Chapter 4 is an introduction to probability; Chapter 5 covers random variables and probability distributions; and Chapter 6 discusses sampling, sampling distributions, and the central limit theorem.

The third section is on statistical inference and is covered in Chapters 7 and 8. Methods for estimating population parameters are discussed in Chapter 7, and various methods of testing hypotheses are presented in Chapter 8.

Chapters 9–13 form the fourth section of the book. These chapters present analysis of variance, simple regression and correlation, multiple regression, time series analysis and index numbers, and decision theory.

Instructors will ordinarily take up Chapters 1–8 in sequence. Material from Chapters 9–13 can be selected in a variety of ways depending on the length of the course and interests of the class. Titles of some sections are preceded by a square symbol indicating that these sections are more difficult or are not required in subse-

quent chapters. The book has been designed to allow instructors a great deal of flexibility in the selection of topics, depending on the length and objectives of the course.

## SUPPLEMENTS

- **For Instructors:** A complete supplements package is available for instructors.

**Instructor's manual** with teaching suggestions and detailed, accurate solutions for all problems.

A 1,000 item **test manual** is available upon adoption.

**Flexible disk** containing over 20 files of data from the text, including the sample data set, is available upon adoption.

**MYSTAT**, an educational version of SYSTAT—a highly-rated, nationally recognized, and comprehensive statistics package for microcomputers—and documentation are available upon adoption.

- **For Students:** Supplements to make studying easier and to enhance learning are available at the bookstore.

*Student Solutions Manual to Accompany Brief Business Statistics* provides detailed solutions to the odd-numbered problems given in the text. Fully worked-out solutions, comments, suggestions, and printouts from data analysis systems are included in this manual to help students work each problem quickly and correctly. Students save time, check their own answers, avoid frustration, improve problem-solving abilities, gain confidence, and learn more efficiently and effectively by using the student solutions manual.

*Study Guide to Accompany Brief Business Statistics* outlines each chapter in detail and provides realistic problems with worked-out solutions to help students assess their progress.

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# CHAPTER 1

## INTRODUCTION

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**B**asic concepts that are important for understanding and applying statistical methods to business and economic problems are introduced in this chapter. First, we will discuss the modern meaning of the term *statistics* as it applies to managerial and economic problems. Second, we will discuss several types of business and economic statistical problems. Four areas into which statistical methods can be categorized, depending on the types of problems that these methods are used to solve, are discussed.

The four areas of statistical methods are *descriptive statistics*, *probability*, *statistical inference*, and *statistical techniques*. These areas do not stand alone. For example, statistical inference requires the use of descriptive statistics and probability, and the special topics in statistics involve the methods of statistical inference. We define *population* and *sample* in this chapter because they are important to understanding applications in all areas of statistics, especially in the area of statistical inference.

In this chapter we also discuss some common *misuses of statistics*, *sources of statistical data*, and *introductory statistical graphics*. We use statistical graphics throughout the text to present statistical methods in a form that makes them easier to understand. In the remainder of the text, we will also see how to apply the statistical methods from each of the four areas to

business and economic problems. Illustrating applications of statistical methods to aid business and economic decision making is a major objective of this text.

---

## 1.1 ■ WHAT IS STATISTICS?

The word *statistics* often conjures up images of numbers piled upon numbers in vast and forbidding arrays and tables, of volume after volume of figures pertaining to births, deaths, taxes, populations, incomes, debits, credits, and the like, ad infinitum. That is, in common usage the word *statistics* is synonymous with *data*, as, for example, when we speak of the statistics of a football game, the statistics of an election, or the statistics of highway accidents. This conception of the word does not correspond to the discipline that carries the name statistics, nor does it give a clue to the activities of present-day statisticians, who are no longer to be defined as collectors and tabulators of numerical facts. An up-to-date definition of **statistics** follows.

### DEFINITION

**Statistics** is concerned with the development and application of processes, methods, and techniques for collecting, analyzing, and interpreting quantitative data to aid decision making.

When there is uncertainty as to the conclusions that should be made or the inferences that should be drawn during decision making, concepts of probability are used to evaluate the reliability of conclusions and inferences based on data. Evaluating the reliability of conclusions and inferences based on data is the unique and major contribution of the statistical approach to inductive decision making. For this reason, concepts and rules of probability play a fundamental role in the theory and application of statistics.

While statistical methods can be used in many fields of work and research, the following chapters will concentrate on their use in decision making by managers and economists in profit and nonprofit organizations. Most managers are very interested in avoiding disastrous decisions that might cost them their jobs, lose customers or clients, or deny the public a needed product or service. Decision makers are interested in statistical methods because these methods can help them avoid making those inept decisions and can help them make intelligent, reliable decisions. Thus they are most interested in the *applications* of statistics to their particular problems, but they must also have a good foundation in the *theory* of probability and statistics in order to use these applications wisely.

Statistical activities are usually classified into the two major areas mentioned previously: theoretical, or mathematical, statistics and applied statistics. Theoretical statistics is concerned with the mathematical elements of the subject—with lemmas,



theorems, and proofs—and in general with the mathematical foundations of statistical methodology. We look to the mathematical statistician for the development of new theories that will provide new methods with which to attack practical problems. But to the applied statistician and the decision maker, statistics is a means to an end. They face problems and select from the available statistical methods those best fitted to the job at hand. The applied statistician may be asked by the decision maker to participate in designing a sample survey or experiment, or the statistician may be consulted about sampling inspection schemes for statistical quality control. Statistical work directly involves the statistician in the subject area whence the problem arose—accounting and auditing, production control, marketing, management, economics, financial management, or whatever it may be. Frequently, the statistician is presented with a set of data and asked to provide an analysis and interpretation. This task is often difficult, since the methods of analysis must depend on the way the data were collected. If the statistician was not consulted on the methods used in obtaining the data, he or she is too often obliged to say that owing to the way in which the figures were obtained, they are inadequate or of the wrong kind to give the desired information.

In the main, statisticians are consultants to administrators, executives, and research workers in business, in government, in academic institutions, and in industry. Although we have made a distinction between theoretical and applied statistics, the majority of statisticians engage in both.

## 1.2 ■ TYPES OF PROBLEMS IN STATISTICS

As mentioned in the chapter introduction, statistical methods can be divided into four areas, depending on the type of problems they are used to solve. The first area is **descriptive statistics**. Methods of organizing, summarizing, and presenting numerical data fall into this area of statistics. Chapters 2 and 3 cover the topics of descriptive statistics. Chapter 2 deals with pictorial and graphic summary of data, and Chapter 3 deals with numerical summaries.

The second area of statistical study is **probability**. Probability problems arise when a statistician takes a **sample** from a **population** and wishes to make statements about the likelihood of the sample's having certain characteristics.

### DEFINITION

A **population** is a set, or collection, of items of interest in a statistical study.

A **sample** is a subset of items that have been selected from the population.

A typical probability problem is stated next:

The manager of a retail store knows that 40% of the customers who enter the store will purchase one or more items and 60% will leave without making a purchase.