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Statistics for Business & Economics

Metric Version · 14th Edition

METRIC VERSION





Statistics for Business & Economics

14e Metric Version

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Australia • Brazil • Mexico • Singapore • United Kingdom • United States

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Preface

This text is the 14th edition of *STATISTICS FOR BUSINESS AND ECONOMICS, Metric Version*. In this edition, we include procedures for statistical analysis using Excel 2016 and JMP Student Edition 14. In MindTap Reader, we also include instructions for using the exceptionally popular open-source language R to perform statistical analysis. We are excited to introduce two new coauthors, Michael J. Fry of the University of Cincinnati and Jeffrey W. Ohlmann of the University of Iowa. Both are accomplished teachers and researchers. More details on their backgrounds may be found in the About the Authors section.

The remainder of this preface describes the authors' objectives in writing *STATISTICS FOR BUSINESS AND ECONOMICS* and the major changes that were made in developing the 14th edition. The purpose of the text is to give students, primarily those in the fields of business administration and economics, a conceptual introduction to the field of statistics and its many applications. The text is applications-oriented and written with the needs of the nonmathematician in mind; the mathematical prerequisite is understanding of algebra.

Applications of data analysis and statistical methodology are an integral part of the organization and presentation of the text material. The discussion and development of each technique is presented in an application setting, with the statistical results providing insights to decisions and solutions to problems.

Although the book is applications oriented, we have taken care to provide sound methodological development and to use notation that is generally accepted for the topic being covered. Hence, students will find that this text provides good preparation for the study of more advanced statistical material. A bibliography to guide further study is included as an appendix.

The text introduces the student to the software packages of JMP Student Edition 14e and Microsoft® Office Excel 2016 and emphasizes the role of computer software in the application of statistical analysis. JMP is illustrated as it is one of the leading statistical software packages for both education and statistical practice. Excel is not a statistical software package, but the wide availability and use of Excel make it important for students to understand the statistical capabilities of this package. JMP and Excel procedures are provided in appendices so that instructors have the flexibility of using as much computer emphasis as desired for the course. MindTap Reader includes appendices for using R for statistical analysis. R is an open-source programming language that is widely used in practice to perform statistical analysis. The use of R typically requires more training than the use of software such as JMP or Excel, but the software is extremely powerful. To ease students' introduction to the R language, we also use RStudio which provides an integrated development environment for R.

This international metric version is designed for classrooms and students outside of the United States. The units of measurement used in selected examples and exercises have been changed from U.S. Customary units to metric units.

Changes in the 14th Edition

We appreciate the acceptance and positive response to the previous editions of *Statistics for Business and Economics*. Accordingly, in making modifications for this new edition, we have maintained the presentation style and readability of those editions. There have been many changes made throughout the text to enhance its educational effectiveness. The most substantial changes in the new edition are summarized here.

Content Revisions

- **Software.** In addition to step-by-step instructions in the software appendices for Excel 2016, we also provide instructions for JMP Student Edition 14 and R. This provides students exposure to and experience with the current versions of several of the most commonly used software for statistical analysis in business. Excel 2016 and JMP appendices are contained within the textbook chapters, while R appendices are provided in MindTap Reader. In this latest edition, we no longer provide discussion of the use of Minitab.

- **Case Problems.** We have added 12 new case problems in this edition; the total number of cases is now 42. One new case on graphical display has been added to Chapter 2. Two new cases using discrete probability distributions have been added to Chapter 5, and one new case using continuous probability distributions has been added to Chapter 6. A new case on hypothesis testing has been added to Chapter 11, and two new cases on testing proportions have been added to Chapter 12. The Chapter 16 case on regression model building has been updated. A new case utilizing nonparametric procedures has been added to Chapter 18, and a new case on sample survey has been added to Chapter 22. The 42 case problems in this book provide students the opportunity to work on more complex problems, analyze larger data sets, and prepare managerial reports based on the results of their analyses.
- **Examples and Exercises Based on Real Data.** In this edition, we have added headers to all Applications exercises to make the application of each problem more obvious. We continue to make a substantial effort to update our text examples and exercises with the most current real data and referenced sources of statistical information. We have added more than 160 new examples and exercises based on real data and referenced sources. Using data from sources also used by *The Wall Street Journal*, *USA Today*, *The Financial Times*, and others, we have drawn from actual studies and applications to develop explanations and create exercises that demonstrate the many uses of statistics in business and economics. We believe that the use of real data from interesting and relevant problems helps generate more student interest in the material and enables the student to learn about both statistical methodology and its application. The 14th edition contains more than 350 examples and exercises based on real data.

Features and Pedagogy

Authors Anderson, Sweeney, Williams, Camm, Cochran, Fry, and Ohlmann have continued many of the features that appeared in previous editions. Important ones for students are noted here.

Methods Exercises and Applications Exercises

The end-of-section exercises are split into two parts, Methods and Applications. The Methods exercises require students to use the formulas and make the necessary computations. The Applications exercises require students to use the chapter material in real-world situations. Thus, students first focus on the computational “nuts and bolts” and then move on to the subtleties of statistical application and interpretation.

Margin Annotations and Notes and Comments

Margin annotations that highlight key points and provide additional insights for the student are a key feature of this text. These annotations, which appear in the margins, are designed to provide emphasis and enhance understanding of the terms and concepts being presented in the text.

At the end of many sections, we provide Notes and Comments designed to give the student additional insights about the statistical methodology and its application. Notes and Comments include warnings about or limitations of the methodology, recommendations for application, brief descriptions of additional technical considerations, and other matters.

Data Files Accompany the Text

Over 200 data files accompany this text. Data files are provided in Excel format and step-by-step instructions on how to open Excel files in JMP are provided in Appendix 1.1. Files for use with R are provided in comma-separated-value (CSV) format for easy loading into the R environment. Step-by-step instructions for importing CSV files into R are provided in MindTap Reader Appendix R 1.2.

The data files can be accessed from WebAssign within the resources section, directly within the MindTap Reader by clicking on the DATAfile icon, or on the publisher’s website at <https://login.cengage.com>.

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Chapter 1

Data and Statistics

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STATISTICS IN PRACTICE

Bloomberg Businessweek*

NEW YORK, NEW YORK

Bloomberg Businessweek is one of the most widely read business magazines in the world. Along with feature articles on current topics, the magazine contains articles on international business, economic analysis, information processing, and science and technology. Information in the feature articles and the regular sections helps readers stay abreast of current developments and assess the impact of those developments on business and economic conditions.

Most issues of *Bloomberg Businessweek* provide an in-depth report on a topic of current interest. Often, the in-depth reports contain statistical facts and summaries that help the reader understand the business and economic information. Examples of articles and reports include the impact of businesses moving important work to cloud computing, the crisis facing the U.S. Postal Service, and why the debt crisis is even worse than we think. In addition, *Bloomberg Businessweek* provides a variety of statistics about the state of the economy, including production indexes, stock prices, mutual funds, and interest rates.

Bloomberg Businessweek also uses statistics and statistical information in managing its own business. For example, an annual survey of subscribers helps the company learn about subscriber demographics, reading habits, likely purchases, lifestyles, and so on. *Bloomberg Businessweek* managers use statistical summaries from the survey to provide better services to subscribers and advertisers. One North American subscriber survey indicated that 64% of *Bloomberg Businessweek* subscribers are involved with computer purchases at work. Such statistics alert *Bloomberg*



Bloomberg Businessweek uses statistical facts and summaries in many of its articles. AP Images/Weng lei-Imaginechina

Businessweek managers to subscriber interest in articles about new developments in computers. The results of the subscriber survey are also made available to potential advertisers. The high percentage of subscribers involved with computer purchases at work would be an incentive for a computer manufacturer to consider advertising in *Bloomberg Businessweek*.

In this chapter, we discuss the types of data available for statistical analysis and describe how the data are obtained. We introduce descriptive statistics and statistical inference as ways of converting data into meaningful and easily interpreted statistical information.

*The authors are indebted to Charlene Trentham, Research Manager, for providing the context for this Statistics in Practice.

Frequently, we see the following types of statements in newspapers and magazines:

- Unemployment dropped to an 18-year low of 3.8% in May 2018 from 3.9% in April and after holding at 4.1% for the prior six months (*Wall Street Journal*, June 1, 2018).
- Tesla ended 2017 with around \$5.4 billion of liquidity. Analysts forecast it will burn through \$2.8 billion of cash this year (*Bloomberg Businessweek*, April 19, 2018).
- The biggest banks in America reported a good set of earnings for the first three months of 2018. Bank of America and Morgan Stanley made quarterly net profits of \$6.9 billion and \$2.7 billion, respectively (*The Economist*, April 21, 2018).
- According to a study from the Pew Research Center, 15% of U.S. adults say they have used online dating sites or mobile apps (*Wall Street Journal*, May 2, 2018).

- According to the U.S. Centers for Disease Control and Prevention, in the United States alone, at least 2 million illnesses and 23,000 deaths can be attributed each year to antibiotic-resistant bacteria (*Wall Street Journal*, February 13, 2018).

The numerical facts in the preceding statements—3.8%, 3.9%, 4.1%, \$5.4 billion, \$2.8 billion \$6.9 billion, \$2.7 billion, 15%, 2 million, 23,000—are called **statistics**. In this usage, the term *statistics* refers to numerical facts such as averages, medians, percentages, and maximums that help us understand a variety of business and economic situations. However, as you will see, the subject of statistics involves much more than numerical facts. In a broader sense, statistics is the art and science of collecting, analyzing, presenting, and interpreting data. Particularly in business and economics, the information provided by collecting, analyzing, presenting, and interpreting data gives managers and decision makers a better understanding of the business and economic environment and thus enables them to make more informed and better decisions. In this text, we emphasize the use of statistics for business and economic decision making.

Chapter 1 begins with some illustrations of the applications of statistics in business and economics. In Section 1.2 we define the term *data* and introduce the concept of a data set. This section also introduces key terms such as *variables* and *observations*, discusses the difference between quantitative and categorical data, and illustrates the uses of cross-sectional and time series data. Section 1.3 discusses how data can be obtained from existing sources or through survey and experimental studies designed to obtain new data. The uses of data in developing descriptive statistics and in making statistical inferences are described in Sections 1.4 and 1.5. The last four sections of Chapter 1 provide an introduction to business analytics and the role statistics plays in it, an introduction to big data and data mining, the role of the computer in statistical analysis, and a discussion of ethical guidelines for statistical practice.

1.1 Applications in Business and Economics

In today's global business and economic environment, anyone can access vast amounts of statistical information. The most successful managers and decision makers understand the information and know how to use it effectively. In this section, we provide examples that illustrate some of the uses of statistics in business and economics.

Accounting

Public accounting firms use statistical sampling procedures when conducting audits for their clients. For instance, suppose an accounting firm wants to determine whether the amount of accounts receivable shown on a client's balance sheet fairly represents the actual amount of accounts receivable. Usually the large number of individual accounts receivable makes reviewing and validating every account too time-consuming and expensive. As common practice in such situations, the audit staff selects a subset of the accounts called a sample. After reviewing the accuracy of the sampled accounts, the auditors draw a conclusion as to whether the accounts receivable amount shown on the client's balance sheet is acceptable.

Finance

Financial analysts use a variety of statistical information to guide their investment recommendations. In the case of stocks, analysts review financial data such as price/earnings ratios and dividend yields. By comparing the information for an individual stock with information about the stock market averages, an analyst can begin to draw a conclusion as to whether the stock is a good investment. For example, the average dividend yield for the S&P 500 companies for 2017 was 1.88%. Over the same period, the average dividend yield for Microsoft was 1.72% (Yahoo Finance). In this case, the statistical information on dividend yield indicates a lower dividend yield for Microsoft