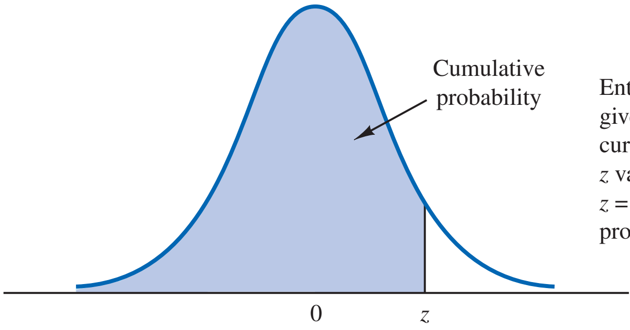
ANDERSON • SWEENEY • WILLIAMS

Modern Business Statistics

With Microsoft® Office Excel® • 5e

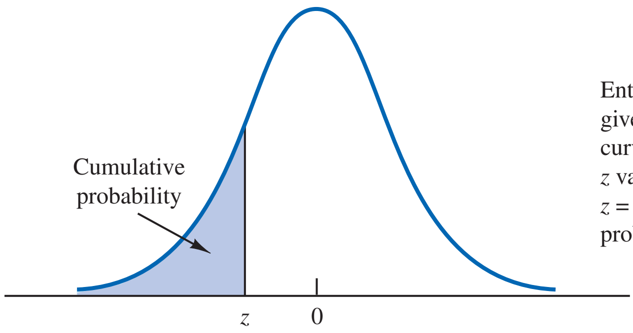
CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBUTION



Entries in the table give the area under the curve to the left of the z value. For example, for $z = 1.25$, the cumulative probability is .8944.

z	**.00**	**.01**	**.02**	**.03**	**.04**	**.05**	**.06**	**.07**	**.08**	**.09**
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBUTION



Entries in this table give the area under the curve to the left of the z value. For example, for $z = -.85$, the cumulative probability is .1977.

z	**.00**	**.01**	**.02**	**.03**	**.04**	**.05**	**.06**	**.07**	**.08**	**.09**
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

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WITH MICROSOFT® OFFICE EXCEL®, 5e

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Modern Business Statistics with Microsoft Excel, Fifth Edition

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Brief Contents

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Preface

The purpose of *Modern Business Statistics with Microsoft Office® Excel®* 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 knowledge 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 applications setting, with the statistical results providing insights to decisions and solutions to applied 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.

Use of Microsoft Excel for Statistical Analysis

Modern Business Statistics with Microsoft Excel is first and foremost a statistics textbook that emphasizes statistical concepts and applications. But since most practical problems are too large to be solved using hand calculations, some type of statistical software package is required to solve these problems. There are several excellent statistical packages available today. However, because most students and potential employers value spreadsheet experience, many schools now use a spreadsheet package in their statistics courses. Microsoft Excel is the most widely used spreadsheet package in business as well as in colleges and universities. We have written *Modern Business Statistics with Microsoft Excel* especially for statistics courses in which Microsoft Excel is used as the software package.

Excel has been integrated within each of the chapters and plays an integral part in providing an application orientation. Although we assume that readers using this text are familiar with Excel basics such as selecting cells, entering formulas, copying, and so on, we do not assume that readers are familiar with Excel 2013 or Excel's tools for statistical analysis. As a result, we have included Appendix E, which provides an introduction to Excel 2013 and tools for statistical analysis.

Throughout the text the discussion of using Excel to perform a statistical procedure appears in a subsection immediately following the discussion of the statistical procedure. We believe that this style enables us to fully integrate the use of Excel throughout the text, but still maintain the primary emphasis on the statistical methodology being discussed. In each of these subsections, we use a standard format for using Excel for statistical analysis. There are four primary tasks: Enter/Access Data, Enter Functions and Formulas, Apply Tools, and Editing Options. We believe a consistent framework for applying Excel helps users to focus on the statistical methodology without getting bogged down in the details of using Excel.

In presenting worksheet figures we often use a nested approach in which the worksheet shown in the background of the figure displays the formulas and the worksheet shown in the foreground shows the values computed using the formulas. Different colors and shades of colors are used to differentiate worksheet cells containing data, highlight cells containing

Excel functions and formulas, and highlight material printed by Excel as a result of using one or more data analysis tools.

Use of StatTools

StatTools is a commercial Excel add-in which we and Palisade Corporation have made available to adopters of this text for free. StatTools extends the range of statistical and graphical options for Excel users. In an appendix to Chapter 1 we show how to download and install StatTools. Most chapters also include an appendix that shows the steps required to accomplish a statistical procedure using StatTools.

We have been very careful to make the use of StatTools completely optional. Users who want to teach using the standard tools available in Excel 2013 can continue to do so. But users who want additional statistical capabilities not available in Excel 2013 now have access to an industry standard statistics add-in that students will be able to continue to use in the workplace.

Changes in the Fifth Edition

We appreciate the acceptance and positive response to the previous editions of *Modern Business Statistics with Microsoft Excel*. Accordingly, in making modifications for this new edition, we have maintained the presentation style and readability of those editions. The significant changes in the new edition are summarized here.

- **Microsoft Excel 2013.** Step-by-step instructions and screen captures show how to use the latest version of Excel to implement statistical procedures.
- **Revised Chapter 2.** We have significantly revised Chapter 2 to incorporate new tools available with Excel 2013 and new material on data visualization. We now show how Excel's Recommended PivotTables tool can be used to construct a frequency distribution for a categorical variable and how Excel's Recommended Charts tool can be used to construct a histogram for a quantitative variable. Also, Chapter 2 has been reorganized to include new material on side-by-side and stacked bar charts, including showing how to use Excel's Recommended Charts tool to construct both types of charts. A new section has been added on data visualization, data dashboards, and best practices in creating effective visual displays.
- **Revised Chapter 3.** Chapter 3 now includes coverage of the weighted mean and geometric mean in the section on measures of location. The geometric mean has many applications in the computation of growth rates for financial assets, annual percentage rates, and so on. We have also completely rewritten the material on percentiles and quartiles, including a new procedure for computing percentiles that provides results consistent with Excel's PERCENTILE.EXC function. Chapter 3 also includes a new section on data dashboards and how summary statistics can be incorporated to enhance their effectiveness.
- **Revised Chapter 5.** The introductory material in this chapter has been revised to improve the explanation of the role of probability distributions and to show how the material on assigning probabilities in Chapter 4 can be used to develop discrete probability distributions. We point out that the empirical discrete probability distribution is developed by using the relative frequency method to assign probabilities. At the request of many users, we have added a new section (Section 5.4) that covers bivariate discrete distributions and financial applications.
- **Test of Goodness of Fit, Independence, and Multiple Proportions—Chapter 12.** This chapter has undergone a major revision. In Section 12.1 we show how the chi-square goodness of fit test can be used to determine if a frequency distribution

developed from categorical data is a good fit to a hypothesized probability distribution. In Section 12.2 we show how the chi-square test of independence is used to determine if two categorical variables sampled from one population are independent. Section 12.3 is a new section that describes how sample data from three or more populations can be used to determine if the population proportions are equal. For each test we show how Excel's Recommended PivotTables tool and Excel's CHISQ.TEST function can be used to compute the chi-square test statistic and corresponding p-value.

- **New Case Problems.** We have added 9 new case problems to this edition. The new case problems appear in the chapters on descriptive statistics and regression analysis. The 30 case problems in the text provide students with the opportunity to analyze somewhat larger data sets and prepare managerial reports based on the results of their analysis.
- **New Statistics in Practice Applications.** Each chapter begins with a Statistics in Practice vignette that describes an application of the statistical methodology in the chapter. New to this edition is a Statistics in Practice for Chapter 2 describing the use of data dashboards and data visualization at the Cincinnati Zoo. We have also added a new Statistics in Practice to Chapter 4 describing how a NASA team used probability to assist the rescue of 33 Chilean miners trapped by a cave-in.
- **New Examples and Exercises Based on Real Data.** We have added approximately 225 new examples and exercises based on real data and recently referenced sources of statistical information. Using data obtained from various data collection organizations and other sources, such as *The Wall Street Journal*, *USA Today*, *Fortune*, and *Barron's*, we have drawn upon actual studies to develop explanations and to create exercises that demonstrate many uses of statistics in business and economics. We believe the use of real data helps generate more student interest in the material and enables the student to learn about both the statistical methodology and its application.

Features and Pedagogy

Authors Anderson, Sweeney, and Williams 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.

Self-Test Exercises

Certain exercises are identified as "Self-Test Exercises." Completely worked-out solutions for these exercises are provided in Appendix D. Students can attempt the Self-Test Exercises and immediately check the solution to evaluate their understanding of the concepts presented in the chapter.

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 Excel data files are available on the website that accompanies the text. Webfile logos are used in the text to identify the data sets that are available on the website. Data sets for all case problems as well as data sets for larger exercises are included.

Acknowledgments

A special thanks goes to our associates from business and industry who supplied the Statistics in Practice features. We recognize them individually by a credit line in each of the articles. We are also indebted to our product manager Aaron Arnsparger, our content developer Margaret Kubale, our content project manager Cliff Kallemeyn, and others at Cengage Learning for their editorial counsel and support during the preparation of this text.

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At the University of Cincinnati, Professor Anderson has taught introductory statistics for business students as well as graduate-level courses in regression analysis, multivariate analysis, and management science. He has also taught statistical courses at the Department of Labor in Washington, D.C. He has been honored with nominations and awards for excellence in teaching and excellence in service to student organizations.

Professor Anderson has coauthored 10 textbooks in the areas of statistics, management science, linear programming, and production and operations management. He is an active consultant in the field of sampling and statistical methods.

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Professor Sweeney has published more than 30 articles and monographs in the area of management science and statistics. The National Science Foundation, IBM, Procter & Gamble, Federated Department Stores, Kroger, and Duke Energy have funded his research, which has been published in *Management Science*, *Operations Research*, *Mathematical Programming*, *Decision Sciences*, and other journals.

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Professor Williams is the coauthor of 11 textbooks in the areas of management science, statistics, production and operations management, and mathematics. He has been a consultant for numerous Fortune 500 companies and has worked on projects ranging from the use of data analysis to the development of large-scale regression models.

CHAPTER 1

Data and Statistics

CONTENTS

STATISTICS *in* PRACTICE

*BLOOMBERG BUSINESSWEEK**
NEW YORK, NEW YORK

With a global circulation of more than 1 million, *Bloomberg Businessweek* is one of the most widely read business magazines in the world. Bloomberg's 1700 reporters in 145 service bureaus around the world enable *Bloomberg Businessweek* to deliver a variety of articles of interest to the global business and economic community. 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,* formerly *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 recent North American subscriber survey indicated that 90% of *Bloomberg Businessweek* subscribers use a personal computer at home and that 64% of *Bloomberg Businessweek* subscribers are involved with computer purchases at work. Such statistics alert *Bloomberg 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 using personal computers at home and 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.

Bloomberg Businessweek uses statistical facts and summaries in many of its articles. © Photoshot.

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

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

- In the first nine months of last year, Turkish Airlines' profit increased to about $482 million on sales of $6.2 billion (*Fortune*, February 25, 2013).
- Women account for 14.1% of the executive officers in Fortune 500 companies (*The Wall Street Journal*, April 30, 2012).

- The average annual cost for a college education is $17,100 for public, in-state universities and $38,600 for private universities (*Money Magazine*, March 2012).
- A Yahoo! Finance survey reported 51% of workers say the key to getting ahead is internal politics, whereas 27% say the key to getting ahead is hard work (*USA Today*, September 29, 2012).
- The California State Teachers' Retirement System has $154.3 billion under management (*Bloomberg Businessweek*, January 21–January 27, 2013).
- At a Sotheby's art auction held on February 5, 2013, Pablo Picasso's painting *Woman Sitting Near a Window* sold for $45 million (*The Wall Street Journal*, February 15, 2013).
- Over the past three months, the industry average for sales incentives per vehicle by GM, Chrysler, Ford, Toyota, and Honda was $2336 (*The Wall Street Journal*, February 14, 2013).

The numerical facts in the preceding statements—$482 million, $6.2 billion, 14.1%, $17,100, $38,600, 51%, 27%, $154.3 billion, $45 million, $2336—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 field, or 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 important role that the Internet now plays in obtaining data is also highlighted. The uses of data in developing descriptive statistics and in making statistical inferences are described in Sections 1.4 and 1.5. The last three sections of Chapter 1 provide the role of the computer in statistical analysis, an introduction to data mining, and a discussion of ethical guidelines for statistical practice. A chapter-ending appendix includes an introduction to the add-in StatTools which can be used to extend the statistical options for users of Microsoft Excel.

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 Wall Street Journal* (March 19, 2012) reported that the average dividend yield for the S&P 500 companies was 2.2%. Microsoft showed a dividend yield of 2.42%. In this case, the statistical information on dividend yield indicates a higher dividend yield for Microsoft than the average dividend yield for the S&P 500 companies. This and other information about Microsoft would help the analyst make an informed buy, sell, or hold recommendation for Microsoft stock.

Marketing

Electronic scanners at retail checkout counters collect data for a variety of marketing research applications. For example, data suppliers such as ACNielsen and Information Resources, Inc., purchase point-of-sale scanner data from grocery stores, process the data, and then sell statistical summaries of the data to manufacturers. Manufacturers spend hundreds of thousands of dollars per product category to obtain this type of scanner data. Manufacturers also purchase data and statistical summaries on promotional activities such as special pricing and the use of in-store displays. Brand managers can review the scanner statistics and the promotional activity statistics to gain a better understanding of the relationship between promotional activities and sales. Such analyses often prove helpful in establishing future marketing strategies for the various products.

Production

Today's emphasis on quality makes quality control an important application of statistics in production. A variety of statistical quality control charts are used to monitor the output of a production process. In particular, an x-bar chart can be used to monitor the average output. Suppose, for example, that a machine fills containers with 12 ounces of a soft drink. Periodically, a production worker selects a sample of containers and computes the average number of ounces in the sample. This average, or x-bar value, is plotted on an x-bar chart. A plotted value above the chart's upper control limit indicates overfilling, and a plotted value below the chart's lower control limit indicates underfilling. The process is termed "in control" and allowed to continue as long as the plotted x-bar values fall between the chart's upper and lower control limits. Properly interpreted, an x-bar chart can help determine when adjustments are necessary to correct a production process.

Economics

Economists frequently provide forecasts about the future of the economy or some aspect of it. They use a variety of statistical information in making such forecasts. For instance, in forecasting inflation rates, economists use statistical information on such indicators as the Producer Price Index, the unemployment rate, and manufacturing capacity utilization. Often these statistical indicators are entered into computerized forecasting models that predict inflation rates.

Information Systems

Information systems administrators are responsible for the day-to-day operation of an organization's computer networks. A variety of statistical information helps administrators assess the performance of computer networks, including local area networks (LANs), wide area networks (WANs), network segments, intranets, and other data communication systems. Statistics such as the mean number of users on the system, the proportion of time any component of the system is down, and the proportion of bandwidth utilized at various times of the day are examples of statistical information that help the system administrator better understand and manage the computer network.

Applications of statistics such as those described in this section are an integral part of this text. Such examples provide an overview of the breadth of statistical applications. To supplement these examples, practitioners in the fields of business and economics provided chapter-opening Statistics in Practice articles that introduce the material covered in each chapter. The Statistics in Practice applications show the importance of statistics in a wide variety of business and economic situations.

1.2 Data

Data are the facts and figures collected, analyzed, and summarized for presentation and interpretation. All the data collected in a particular study are referred to as the **data set** for the study. Table 1.1 shows a data set containing information for 60 nations that participate in the World Trade Organization. The World Trade Organization encourages the free flow of international trade and provides a forum for resolving trade dispute.

Elements, Variables, and Observations

Elements are the entities on which data are collected. Each nation listed in Table 1.1 is an element with the nation or element name shown in the first column. With 60 nations, the data set contains 60 elements.

A **variable** is a characteristic of interest for the elements. The data set in Table 1.1 includes the following five variables:

- WTO Status: The nation's membership status in the World Trade Organization; this can be either as a member or an observer.
- Per Capita GDP ($): The total market value ($) of all goods and services produced by the nation divided by the number of people in the nation; this is commonly used to compare economic productivity of the nations.
- Trade Deficit ($1000s): The difference between the total dollar value of the nation's imports and the total dollar value of the nation's exports.
- Fitch Rating: The nation's sovereign credit rating as appraised by the Fitch Group[1]; the credit ratings range from a high of AAA to a low of F and can be modified by + or −.
- Fitch Outlook: An indication of the direction the credit rating is likely to move over the upcoming two years; the outlook can be negative, stable, or positive.

Measurements collected on each variable for every element in a study provide the data. The set of measurements obtained for a particular element is called an **observation**. Referring to Table 1.1, we see that the first observation contains the following measurements:

[1]The Fitch Group is one of three nationally recognized statistical rating organizations designated by the U.S. Securities and Exchange Commission. The other two are Standard and Poor's and Moody's investor service.

TABLE 1.1 DATA SET FOR 60 NATIONS IN THE WORLD TRADE ORGANIZATION

WEB file
Nations

Data sets such as Nations are available on the website for this text.

Nation	WTO Status	Per Capita GDP ($)	Trade Deficit ($1000s)	Fitch Rating	Fitch Outlook
Armenia	Member	5,400	2,673,359	BB−	Stable
Australia	Member	40,800	−33,304,157	AAA	Stable
Austria	Member	41,700	12,796,558	AAA	Stable
Azerbaijan	Observer	5,400	−16,747,320	BBB−	Positive
Bahrain	Member	27,300	3,102,665	BBB	Stable
Belgium	Member	37,600	−14,930,833	AA+	Negative
Brazil	Member	11,600	−29,796,166	BBB	Stable
Bulgaria	Member	13,500	4,049,237	BBB−	Positive
Canada	Member	40,300	−1,611,380	AAA	Stable
Cape Verde	Member	4,000	874,459	B+	Stable
Chile	Member	16,100	−14,558,218	A+	Stable
China	Member	8,400	−156,705,311	A+	Stable
Colombia	Member	10,100	−1,561,199	BBB−	Stable
Costa Rica	Member	11,500	5,807,509	BB+	Stable
Croatia	Member	18,300	8,108,103	BBB−	Negative
Cyprus	Member	29,100	6,623,337	BBB	Negative
Czech Republic	Member	25,900	−10,749,467	A+	Positive
Denmark	Member	40,200	−15,057,343	AAA	Stable
Ecuador	Member	8,300	1,993,819	B−	Stable
Egypt	Member	6,500	28,486,933	BB	Negative
El Salvador	Member	7,600	5,019,363	BB	Stable
Estonia	Member	20,200	802,234	A+	Stable
France	Member	35,000	118,841,542	AAA	Stable
Georgia	Member	5,400	4,398,153	B+	Positive
Germany	Member	37,900	−213,367,685	AAA	Stable
Hungary	Member	19,600	−9,421,301	BBB−	Negative
Iceland	Member	38,000	−504,939	BB+	Stable
Ireland	Member	39,500	−59,093,323	BBB+	Negative
Israel	Member	31,000	6,722,291	A	Stable
Italy	Member	30,100	33,568,668	A+	Negative
Japan	Member	34,300	31,675,424	AA	Negative
Kazakhstan	Observer	13,000	−33,220,437	BBB	Positive
Kenya	Member	1,700	9,174,198	B+	Stable
Latvia	Member	15,400	2,448,053	BBB−	Positive
Lebanon	Observer	15,600	13,715,550	B	Stable
Lithuania	Member	18,700	3,359,641	BBB	Positive
Malaysia	Member	15,600	−39,420,064	A−	Stable
Mexico	Member	15,100	1,288,112	BBB	Stable
Peru	Member	10,000	−7,888,993	BBB	Stable
Philippines	Member	4,100	15,667,209	BB+	Stable
Poland	Member	20,100	19,552,976	A−	Stable
Portugal	Member	23,200	21,060,508	BBB−	Negative
South Korea	Member	31,700	−37,509,141	A+	Stable
Romania	Member	12,300	13,323,709	BBB−	Stable
Russia	Observer	16,700	−151,400,000	BBB	Positive
Rwanda	Member	1,300	939,222	B	Stable
Serbia	Observer	10,700	8,275,693	BB−	Stable
Seychelles	Observer	24,700	666,026	B	Stable
Singapore	Member	59,900	−27,110,421	AAA	Stable
Slovakia	Member	23,400	−2,110,626	A+	Stable
Slovenia	Member	29,100	2,310,617	AA−	Negative

South Africa	Member	11,000	3,321,801	BBB+	Stable
Sweden	Member	40,600	−10,903,251	AAA	Stable
Switzerland	Member	43,400	−27,197,873	AAA	Stable
Thailand	Member	9,700	2,049,669	BBB	Stable
Turkey	Member	14,600	71,612,947	BB+	Positive
UK	Member	35,900	162,316,831	AAA	Negative
Uruguay	Member	15,400	2,662,628	BB	Positive
USA	Member	48,100	784,438,559	AAA	Stable
Zambia	Member	1,600	−1,805,198	B+	Stable

Member, 5,400, 2,673,359, BB−, and Stable. The second observation contains the following measurements: Member, 40,800, −33,304,157, AAA, Stable, and so on. A data set with 60 elements contains 60 observations.

Scales of Measurement

Data collection requires one of the following scales of measurement: nominal, ordinal, interval, or ratio. The scale of measurement determines the amount of information contained in the data and indicates the most appropriate data summarization and statistical analyses.

When the data for a variable consist of labels or names used to identify an attribute of the element, the scale of measurement is considered a **nominal scale.** For example, referring to the data in Table 1.1, the scale of measurement for the WTO Status variable is nominal because the data "member" and "observer" are labels used to identify the status category for the nation. In cases where the scale of measurement is nominal, a numerical code as well as a nonnumerical label may be used. For example, to facilitate data collection and to prepare the data for entry into a computer database, we might use a numerical code for the WTO Status variable by letting 1 denote a member nation in the World Trade Organization and 2 denote an observer nation. The scale of measurement is nominal even though the data appear as numerical values.

The scale of measurement for a variable is considered an **ordinal scale** if the data exhibit the properties of nominal data and in addition, the order or rank of the data is meaningful. For example, referring to the data in Table 1.1, the scale of measurement for the Fitch Rating is ordinal because the rating labels which range from AAA to F can be rank ordered from best credit rating AAA to poorest credit rating F. The rating letters provide the labels similar to nominal data, but in addition, the data can also be ranked or ordered based on the credit rating, which makes the measurement scale ordinal. Ordinal data can also be recorded by a numerical code, for example, your class rank in school.

The scale of measurement for a variable is an **interval scale** if the data have all the properties of ordinal data and the interval between values is expressed in terms of a fixed unit of measure. Interval data are always numeric. College admission SAT scores are an example of interval-scaled data. For example, three students with SAT math scores of 620, 550, and 470 can be ranked or ordered in terms of best performance to poorest performance in math. In addition, the differences between the scores are meaningful. For instance, student 1 scored $620 - 550 = 70$ points more than student 2, while student 2 scored $550 - 470 = 80$ points more than student 3.

The scale of measurement for a variable is a **ratio scale** if the data have all the properties of interval data and the ratio of two values is meaningful. Variables such as distance, height, weight, and time use the ratio scale of measurement. This scale requires that a zero value be included to indicate that nothing exists for the variable at the zero point. For example, consider the cost of an automobile. A zero value for the cost would indicate that the automobile has no cost and is free. In addition, if we compare the cost of $30,000 for one automobile to the cost of $15,000 for a second automobile, the ratio property shows that the first automobile is $30,000/$15,000 = 2 times, or twice, the cost of the second automobile.

Categorical and Quantitative Data

Data can be classified as either categorical or quantitative. Data that can be grouped by specific categories are referred to as **categorical data**. Categorical data use either the nominal or ordinal scale of measurement. Data that use numeric values to indicate how much or how many are referred to as **quantitative data**. Quantitative data are obtained using either the interval or ratio scale of measurement.

The statistical method appropriate for summarizing data depends upon whether the data are categorical or quantitative.

A **categorical variable** is a variable with categorical data, and a **quantitative variable** is a variable with quantitative data. The statistical analysis appropriate for a particular variable depends upon whether the variable is categorical or quantitative. If the variable is categorical, the statistical analysis is limited. We can summarize categorical data by counting the number of observations in each category or by computing the proportion of the observations in each category. However, even when the categorical data are identified by a numerical code, arithmetic operations such as addition, subtraction, multiplication, and division do not provide meaningful results. Section 2.1 discusses ways for summarizing categorical data.

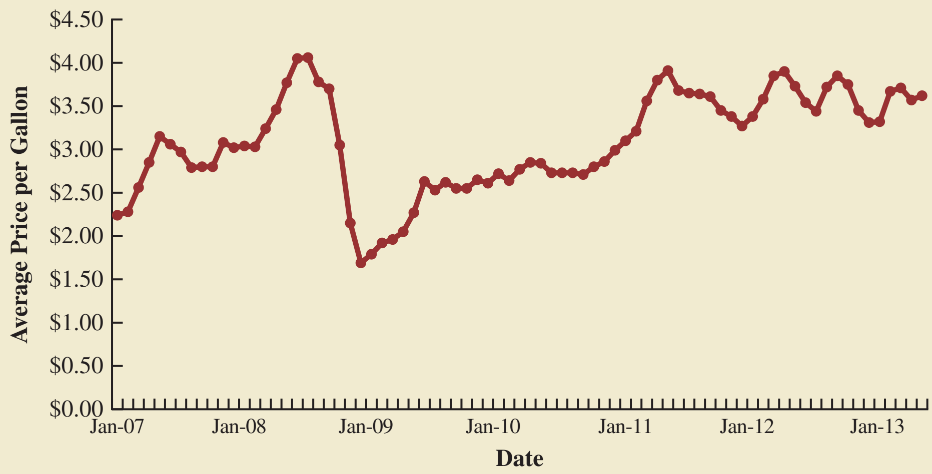
Arithmetic operations provide meaningful results for quantitative variables. For example, quantitative data may be added and then divided by the number of observations to compute the average value. This average is usually meaningful and easily interpreted. In general, more alternatives for statistical analysis are possible when data are quantitative. Section 2.2 and Chapter 3 provide ways of summarizing quantitative data.

Cross-Sectional and Time Series Data

For purposes of statistical analysis, distinguishing between cross-sectional data and time series data is important. **Cross-sectional data** are data collected at the same or approximately the same point in time. The data in Table 1.1 are cross-sectional because they describe the five variables for the 60 World Trade Organization nations at the same point in time. **Time series data** are data collected over several time periods. For example, the time series in Figure 1.1 shows the U.S. average price per gallon of conventional regular gasoline between 2007 and 2013. Note that gasoline prices peaked in the summer of 2008 and then dropped sharply in the fall of 2008. Between January, 2009 and May, 2011, the average price per gallon continued to climb steadily. Since then prices have shown more fluctuation, reaching an average price per gallon of $3.62 in May, 2013.

Graphs of time series data are frequently found in business and economic publications. Such graphs help analysts understand what happened in the past, identify any trends over time, and project future values for the time series. The graphs of time series data can take on a variety of forms, as shown in Figure 1.2. With a little study, these graphs are usually easy to understand and interpret. For example, Panel (A) in Figure 1.2 is a graph that shows the Dow Jones Industrial Average Index from 2002 to 2013. In April 2002, the popular stock market index was near 10,000. Over the next five years the index rose to slightly over 14,000 in October 2007. However, notice the sharp decline in the time series after the high in 2007. By March 2009, poor economic conditions had caused the Dow Jones Industrial Average Index to return to the 7000 level. This was a scary and discouraging period for investors. However, by late 2009, the index was showing a recovery by reaching 10,000. The index has climbed steadily since then and was above 15,000 in early 2013.

FIGURE 1.1 U.S. AVERAGE PRICE PER GALLON FOR CONVENTIONAL REGULAR GASOLINE



Source: Energy Information Administration, U.S. Department of Energy, June, 2013.

The graph in Panel (B) shows the net income of McDonald's Inc. from 2005 to 2012. The declining economic conditions in 2008 and 2009 were actually beneficial to McDonald's as the company's net income rose to all-time highs. The growth in McDonald's net income showed that the company was thriving during the economic downturn as people were cutting back on the more expensive sit-down restaurants and seeking less-expensive alternatives offered by McDonald's. McDonald's net income continued to new all-time highs in 2010 and 2011, but decreased slighty in 2012.

Panel (C) shows the time series for the occupancy rate of hotels in South Florida over a one-year period. The highest occupancy rates, 95% and 98%, occur during the months of February and March when the climate of South Florida is attractive to tourists. In fact, January to April of each year is typically the high-occupancy season for South Florida hotels. On the other hand, note the low occupancy rates during the months of August to October, with the lowest occupancy rate of 50% occurring in September. High temperatures and the hurricane season are the primary reasons for the drop in hotel occupancy during this period.

NOTES AND COMMENTS

1. An observation is the set of measurements obtained for each element in a data set. Hence, the number of observations is always the same as the number of elements. The number of measurements obtained for each element equals the number of variables. Hence, the total number of data items can be determined by multiplying the number of observations by the number of variables.
2. Quantitative data may be discrete or continuous. Quantitative data that measure how many (e.g., number of calls received in 5 minutes) are discrete. Quantitative data that measure how much (e.g., weight or time) are continuous because no separation occurs between the possible data values.