BUSINESS STATISTICS

For Contemporary Decision Making

8th Edition

Ken Black

WILEY

WileyPLUS

WileyPLUS is a research-based online environment for effective teaching and learning.

WileyPLUS builds students' confidence because it takes the guesswork out of studying by providing students with a clear roadmap:

- what to do
- how to do it
- if they did it right

It offers interactive resources along with a complete digital textbook that help students learn more. With *WileyPLUS*, students take more initiative so you'll have greater impact on their achievement in the classroom and beyond.

For more information, visit www.wileyplus.com

WileyPLUS

ALL THE HELP, RESOURCES, AND PERSONAL SUPPORT YOU AND YOUR STUDENTS NEED!

www.wileyplus.com/resources

1st DAY OF CLASS ... AND BEYOND!

2-Minute Tutorials and all of the resources you and your students need to get started

WileyPLUS

Student Partner Program

Student support from an experienced student user
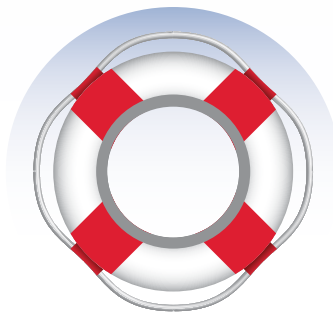
Wiley Faculty Network

Collaborate with your colleagues, find a mentor, attend virtual and live events, and view resources
www.WhereFacultyConnect.com

WileyPLUS

Quick Start

Pre-loaded, ready-to-use assignments and presentations created by subject matter experts

Technical Support 24/7
FAQs, online chat, and phone support
www.wileyplus.com/support

© Courtney Keating/iStockphoto

Your *WileyPLUS* Account Manager, providing personal training and support

Business Statistics
For Contemporary Decision Making

8TH EDITION

Business Statistics
For Contemporary
Decision Making

Ken Black
University of Houston—Clear Lake

STUDENT EDITION

WILEY

BRIEF CONTENTS

CONTENTS

UNIT IV

REGRESSION ANALYSIS AND FORECASTING

The eighth edition of *Business Statistics for Contemporary Decision Making* continues the tradition of presenting and explaining the wonders of business statistics through the use of clear, complete, student-friendly pedagogy. The author and Wiley have vast ancillary resources available through WileyPLUS with which to complement the text in helping instructors effectively deliver this subject matter and in assisting students in their learning. With WileyPLUS instructors have far greater latitude in developing and delivering their course than ever before.

In this edition, several changes have been made in an effort to improve the delivery and completeness of the text. While no new sections or chapters have been added to the text, there have been two topical changes. In Chapter 6, a new topic "Using Probabilities to Solve for the Mean, the Standard Deviation, or an *x* Value in a Normal Distribution" explains how to solve problems in which students are required to use their normal curve skills to work problems "backwards" to find an unknown mean, standard deviation, or *x* value using the standard normal distribution table. In addition, in Chapter 9, the more standard and well-known eight-step approach to testing hypotheses replaces the HTAB system of testing hypotheses. From Chapter 9 on through Chapter 17, all hypothesis testing demonstration problems and examples are given within the framework of the eight-step approach.

In the eighth edition, all the features of the seventh edition have been updated and changed as needed to reflect today's business world. Three new Decision Dilemmas located in Chapters 8, 9, and 10 have been added to the eighth edition. Chapter 8, which introduces the student to estimation, opens with a new Decision Dilemma titled "Batteries and Bulbs: How Long Do They Last?" Chapter 9 presents a very exciting new Decision Dilemma, "Valero Refining and Retailing," about the Valero Energy Corporation, which is a major success story in both refining and retailing. Chapter 10 contains a Decision Dilemma on "L. L. Bean" as a highly successful catalog and online retailer.

Every chapter in the eighth edition contains at least one or two Thinking Critically About Statistics in Business Today features that give real-life examples of how the statistics presented in the chapter apply in the business world today. Each of these contains thought-provoking questions called Things to Ponder in which the objective is to effect critical thinking on behalf of the student and generate discussion involving critical thinking in the classroom. Some of these include: "Plastic Bags vs. Bringing Your Own in Japan," "Where Are Soft Drinks Sold?," "Recycling Statistics," "Probabilities in the Dry Cleaning Business," "Warehousing," and "Teleworking Facts."

This edition is designed and written for a two-semester introductory undergraduate business statistics course or an MBA-level introductory course. In addition, with 19 chapters, the eighth edition lends itself nicely to adaptation for a one-semester introductory business statistics course. The text is written with the assumption that the student has a college algebra mathematical background. No calculus is used in the presentation of material in the text.

An underlying philosophical approach to the text is that every statistical tool presented in the book has some business application. While the text contains statistical rigor, it is written so that the student can readily see that the proper application of statistics in the business world goes hand-in-hand with good decision making. In this edition, statistics are presented as a means for converting data into useful information that can be used to assist the business decision maker in making more thoughtful, information-based decisions. Thus, the text presents business statistics as "value-added" tools in the process of converting data into useful information.

CHANGES FOR THE EIGHTH EDITION

Units and Chapters

In the eighth edition, the unit and chapter organization remains the same as in the seventh edition—there are 19 chapters organized into five units. Unit I, Introduction, contains the first four chapters of the text. In this unit, students learn some important foundational tools for understanding topics presented in the rest of the course. In Unit II, Distributions and Sampling, consisting of Chapters 5 through 7, students are presented with six population distributions and two sampling distributions. In Unit III, Making Inferences About Population Parameters, which includes Chapters 8 through 11, students learn about estimating and testing population parameters. Unit IV, Chapters 12 through 15, is called Regression Analysis and Forecasting. In this unit, students explore relationships between variables including developing models to predict a variable by other variables and developing models to forecast. Unit V, Nonparametric Statistics and Quality, includes Chapters 16 through 18. In these chapters, students are presented with a series of well-known nonparametric techniques along with a number of quality-improvement concepts and techniques. Chapter 19, Decision Analysis, is available only through WileyPLUS or custom versions of the text.

Topical Changes

Sections and topics from the seventh edition remain virtually unchanged in the eighth edition, with two exceptions. In Section 6.2 of Chapter 6, there is a new topic, "Using Probabilities to Solve for the Mean, the Standard Deviation, or an x Value in a Normal Distribution." This topic explains more formally how to understand and work examples and problems presented in previous editions in which student's were required to use their normal curve skills to solve problems "backwards" for an unknown mean, standard deviation, or x value using the standard normal distribution table.

In Chapter 9, the more standard and well-known eight-step approach to testing hypotheses replaces the HTAB system of testing hypotheses. From Chapter 9 on through Chapter 17, all hypothesis testing demonstration problems and examples are given within the framework of the eight-step approach.

Decision Dilemma and the Decision Dilemma Solved

Each chapter of the eighth edition begins with a Decision Dilemma. Decision Dilemmas are real business vignettes that set the tone for each chapter by presenting a business dilemma and asking a number of managerial or statistical questions, the solutions to which require the use of techniques presented in the chapter. At the end of each chapter, a Decision Dilemma Solved feature discusses and answers the managerial and statistical questions posed in the Decision Dilemma using techniques from the chapter, thus bringing closure to the chapter. In the eighth edition, all decision dilemmas have been revised and updated. Solutions given in the Decision Dilemma Solved features have been revised for new data and for new versions of computer output.

In addition, three new Decision Dilemmas located in Chapters 8, 9, and 10 have been added to the eighth edition. Chapter 8, which introduces the student to estimation, opens with a new Decision Dilemma titled "Batteries and Bulbs: How Long Do They Last?" This Decision Dilemma ponders the average life of a battery both in usage and shelf life. Presented in this feature are statistics regarding the average life of batteries for iPhones, tablet computers, and car batteries. This Decision Dilemma also discusses the burn life of various light bulbs including incandescent bulbs, compact fluorescent light bulbs, and light-emitting diodes (LEDs). Using statistics mentioned in the feature, the student is asked to consider such questions as: "How could an 8.09 hour mean battery life obtained from a sample of 60 tablet computers be used to estimate the average battery life for all such computers?" and "How can sample information regarding the average number of hours of burn of a light bulb be used to estimate the average number of hours of burn for all such light bulbs?"

Chapter 9 presents a very exciting new Decision Dilemma, "Valero Refining and Retailing," about the Valero Energy Corporation, which is a major success story in both refining and retailing. Besides giving historical background on the company that did not exist until 1980, the Decision Dilemma yields statistics on refining and the weight of crude oil. In addition, there is discussion on aspects of Valero's nearly 7,000 retail gas stations. In the managerial and statistical questions, the student is asked to develop at least four research hypotheses about why an oil refinery might be running below capacity. When given some statistics on the weight of a barrel of crude oil, students are asked to "test to determine if the average weight of a given shipment of crude oil is the same as or different from 320 pounds." Students are also asked to test to determine if the average in-store transaction for a convenience store is now higher than the $7.47 figure published in *Convenience Store News.*

In Chapter 10, we present a Decision Dilemma on a company, L. L. Bean, that is primarily a catalog and online retailer. L. L. Bean of Freeport, Maine, started out as a one-man operation in 1912 selling hunting boots and has been built into a catalog operation that ships catalogs to all 50 states and over 160 countries, with over 11 million customer contacts per year. In this Decision Dilemma, facts and figures are given on customer contacts, orders placed online, the average order size, and the time that L. L. Bean's e-commerce site home page takes to load. In the managerial and statistical questions, students are asked such questions as, "Given two samples, one taken during the day and the other at night, how would a statistician go about testing if night loading is faster given statistics on computer uploads done in the day and at night?" and, "Is the average order size for women greater than the average order size for men?"

Thinking Critically About Statistics in Business Today

Every chapter in the eighth edition contains at least one or two Thinking Critically About Statistics in Business Today features that give real-life examples of how the statistics presented in the chapter apply in the business world today. Each of these contains thought-provoking questions called Things to Ponder in which the objective is to effect critical thinking on behalf of the student and generate discussion involving critical thinking in the classroom. This approach to learning is in sync with various accreditation organizations and their current emphasis on developing critical thinking in our students. Some of these include: "Consumer Attitudes Toward Food in the U.S.," "Beverage Consumption: America vs. Europe," "Are Facial Characteristics Correlated with CEO Traits?" "Assessing Property Values Using Multiple Regression," "Can Scrap Metal Prices Forecast the Economy?" "City Images of Cruise Destinations in the Taiwan Strait," and "Does an Iranian Auto Parts Manufacturer's Orientation Impact Innovation?" As an example, from "Beverage Consumption: America vs. Europe," Americans drink nearly five times as much soda as do Europeans and almost twice as much beer. On the other hand, Europeans drink more than twice as much tea (hot or cold), more than three times as much wine, and over four times as much tap water as Americans. Statistics show that the average American consumes forty-eight 12 oz. containers of carbonated soda per month compared to only 10 for Europeans. Europeans consume an average of sixteen 4 oz. containers of wine per month compared to an average of only five for Americans. One of the Things to Ponder questions is, "Can you think of some reasons why Americans consume more carbonated soda pop and beer than Europeans, but less wine, hot or iced tea, or tap water? Do you think that these outcomes may change in time?"

Cases

Every chapter in this text contains a unique business case. All cases in the eighth edition have been updated and edited for today's market. These business cases are more than just long problems, and in the discussion that follows the business scenario, several issues and questions are posed that can be addressed using techniques presented in the chapter. Here are some excerpts from one case, "The Container Store":

"In the late 1970s, Kip Tindell (chairman and CEO), Garrett Boone (Chairman Emeritus), and John Mullen (architect) drew up plans for a first-of-its-kind retail store specializing in storage solutions for both the home and the office. The vision that they created was realized when on July 1, 1978, the Container Store opened its doors in a small 1,600 square foot retail space in Dallas. The store was stocked with products that were devoted to simplifying people's lives, such as commercial parts bins, wire drawers, mailboxes, milk crates, wire leaf burners, and many others. Some critics even questioned that a store selling "empty boxes" could survive. However, the concept took off, and in the past 33 years, the company has expanded coast to coast in the United States with stores in 49 locations. Now headquartered in Coppell, Texas, the Container Store has 4,000 employees and annual revenues of over $650 million. Besides their innovative product mix, one of the keys to the success of the Container Store is the enthusiasm with which their employees work, the care that employees give to the customer, and employee knowledge of their products."

New Problems

Every problem in the seventh edition has been examined for timeliness, appropriateness, and logic before inclusion in the eighth edition. Those that fell short were replaced or rewritten. In the eighth edition, there are 10 new problems bringing the total number of practice problems in the text to about 965.

All demonstration problems and example problems were thoroughly reviewed and edited for effectiveness. A demonstration problem is an extra example containing both a problem and its solution and is used as an additional pedagogical tool to supplement explanations and examples in the chapters. Virtually all example and demonstration problems in the eighth edition are business oriented and contain the most current data available.

As with the previous edition, problems are located at the end of most sections in the chapters. A significant number of additional problems are provided at the end of each chapter in the Supplementary Problems. The Supplementary Problems are "scrambled"—problems using the various techniques in the chapter are mixed—so that students can test themselves on their ability to discriminate and differentiate ideas and concepts. In addition, there are 10 new demonstration problems in the eighth edition.

Databases

Available with the eighth edition are nine databases that provide additional opportunities for students to apply the statistics presented in this text. These nine databases represent a wide variety of business areas, such as agribusiness, consumer spending, energy, finance, healthcare, international labor, manufacturing, and the stock market. Altogether, these databases contain 61 variables and 7,722 observations. The data are gathered from such reliable sources as the U.S. government's Bureau of Labor, the U.S. Department of Agriculture, the American Hospital Association, the Energy Information Administration, *Moody's Handbook of Common Stocks,* and the U.S. Census Bureau. Five of the nine databases contain time-series data. The databases are 12-Year Gasoline Database, Consumer Food Database, Manufacturing Database, International Labor Database, Financial Database, Energy Database, U.S. and International Stock Market Database, Hospital Database, and Agribusiness Time-Series Database.

VIDEO TUTORIALS BY KEN BLACK

An exciting feature of the eighth edition package that will impact the effectiveness of student learning in business statistics and significantly enhance the presentation of course material is the series of videotape tutorials by Ken Black. With the advent of online business statistics courses, increasingly large class sizes, and the number of commuter students who have very limited access to educational resources on business statistics, it is often difficult for students to get the learning assistance they need to bridge the gap between theory and application on their own. There are now 21 videotaped tutorial sessions on key difficult topics in business statistics delivered by Ken Black and available for all adopters on

WileyPLUS. In addition, these tutorials can easily be uploaded for classroom usage to augment lectures and enrich classroom presentations. Because there is at least one video for each of the first 12 chapters, the instructor has the option to include at least one video in the template of each chapter's plan for most, if not all, of the course. While the video tutorials vary in length, a typical video is about 10 minutes in length. The 21 video tutorials are:

1. Chapter 1: Levels of Data Measurement
2. Chapter 2: Stem-and-Leaf Plot
3. Chapter 3: Computing Variance and Standard Deviation
4. Chapter 3: Understanding and Using the Empirical Rule
5. Chapter 4: Constructing and Solving Joint Probability Tables
6. Chapter 4: Solving Probability Word Problems
7. Chapter 5: Solving Binomial Distribution Problems, Part I
8. Chapter 5: Solving Binomial Distribution Problems, Part II
9. Chapter 6: Solving Problems Using the Normal Curve
10. Chapter 7: Solving for Probabilities of Sample Means Using the z Statistic
11. Chapter 8: Confidence Intervals
12. Chapter 8: Determining Which Inferential Technique to Use: Confidence Intervals
13. Chapter 9: Hypothesis Testing Using the z Statistic
14. Chapter 9: Establishing Hypotheses
15. Chapter 9: Understanding p-Values
16. Chapter 9: Type I and Type II errors
17. Chapter 9: Two-Tailed Tests
18. Chapter 10: Hypothesis Tests of the Difference in Means of Two Independent Populations Using the t Statistic
19. Chapter 11: Computing and Interpreting a One-Way ANOVA
20. Chapter 12: Testing the Regression Model I—Predicted Values, Residuals, and Sum of Squares of Error
21. Chapter 12: Testing the Regression Model II—Standard Error of the Estimate and r^2

FEATURES AND BENEFITS

Each chapter of the eighth edition contains sections called Learning Objectives, a Decision Dilemma, Demonstration Problems, Section Problems, Thinking Critically About Statistics in Business Today, Decision Dilemma Solved, Chapter Summary, Key Terms, Formulas, Ethical Considerations, Supplementary Problems, Analyzing the Databases, Case, Using the Computer, and Computer Output from both Excel 2013 and Minitab Release 16.

- **Learning Objectives.** Each chapter begins with a statement of the chapter's main learning objectives. This statement gives the reader a list of key topics that will be discussed and the goals to be achieved from studying the chapter.
- **Decision Dilemma.** At the beginning of each chapter, a short case describes a real company or business situation in which managerial and statistical questions are raised. In most Decision Dilemmas, actual data are given and the student is asked to consider how the data can be analyzed to answer the questions.
- **Demonstration Problems.** Virtually every section of every chapter in the eighth edition contains demonstration problems. A demonstration problem contains both an example problem and its solution, and is used as an additional pedagogical tool to supplement explanations and examples.
- **Section Problems.** There are over 960 problems in the text. Problems for practice are found at the end of almost every section of the text. Most problems utilize real data gathered from a plethora of sources. Included here are a few brief excerpts

from some of the real-life problems in the text: "*The Wall Street Journal* reported that 40% of all workers say they would change jobs for 'slightly higher pay.' In addition, 88% of companies say that there is a shortage of qualified job candidates." "In a study by Peter D. Hart Research Associates for the Nasdaq Stock Market, it was determined that 20% of all stock investors are retired people. In addition, 40% of all U.S. adults have invested in mutual funds." "A survey conducted for the Northwestern National Life Insurance Company revealed that 70% of American workers say job stress caused frequent health problems." "According to Padgett Business Services, 20% of all small-business owners say the most important advice for starting a business is to prepare for long hours and hard work. Twenty-five percent say the most important advice is to have good financing ready."

- **Thinking Critically About Statistics in Business Today.** Every chapter in the eighth edition contains at least one Thinking Critically About Statistics in Business Today feature. These focus boxes contain an interesting application of how techniques of that particular chapter are used in the business world today and ask probing questions of the student. They are usually based on real companies, surveys, or published research.

- **Decision Dilemma Solved.** Situated at the end of the chapter, the Decision Dilemma Solved feature addresses the managerial and statistical questions raised in the Decision Dilemma. Data given in the Decision Dilemma are analyzed computationally and by computer using techniques presented in the chapter. Answers to the managerial and statistical questions raised in the Decision Dilemma are arrived at by applying chapter concepts, thus bringing closure to the chapter.

- **Chapter Summary.** Each chapter concludes with a summary of the important concepts, ideas, and techniques of the chapter. This feature can serve as a preview of the chapter as well as a chapter review.

- **Key Terms.** Important terms are bolded and their definitions italicized throughout the text as they are discussed. At the end of the chapter, a list of the key terms from the chapter is presented. In addition, these terms appear with their definitions in the end-of-book glossary.

- **Formulas.** Important formulas in the text are highlighted to make it easy for a reader to locate them. At the end of the chapter, most of the chapter's formulas are listed together as a handy reference.

- **Ethical Considerations.** Each chapter contains an Ethical Considerations feature that is very timely, given the serious breach of ethics and lack of moral leadership of some business executives in recent years. With the abundance of statistical data and analysis, there is considerable potential for the misuse of statistics in business dealings. The important Ethical Considerations feature underscores this potential misuse by discussing such topics as lying with statistics, failing to meet statistical assumptions, and failing to include pertinent information for decision makers. Through this feature, instructors can begin to integrate the topic of ethics with applications of business statistics. Here are a few excerpts from Ethical Considerations features: "It is unprofessional and unethical to draw cause-and-effect conclusions just because two variables are correlated." "The business researcher needs to conduct the experiment in an environment such that as many concomitant variables are controlled as possible. To the extent that this is not done, the researcher has an ethical responsibility to report that fact in the findings." "The reader is warned that the value lambda is assumed to be constant in a Poisson distribution experiment. Business researchers may produce spurious results if the value of lambda is used throughout a study, but because the study is conducted during different time periods, the value of lambda is actually changing." "In describing a body of data to an audience, it is best to use whatever statistical measures it takes to present a 'full' picture of the data. By limiting the descriptive measures used, the business researcher may give the audience only part of the picture and skew the way the receiver understands the data."

- **Supplementary Problems.** At the end of each chapter is an extensive set of additional problems. The Supplementary Problems are divided into three groups:

Calculating the Statistics, which are strictly computational problems; Testing Your Understanding, which are problems for application and understanding; and Interpreting the Output, which are problems that require the interpretation and analysis of software output.

- **Analyzing the Databases.** There are nine major databases located on the student companion Web site that accompanies the eighth edition and in WileyPLUS. The end-of-chapter Analyzing the Databases section contains several questions/problems that require the application of techniques from the chapter to data in the variables of the databases. It is assumed that most of these questions/problems will be solved using a computer.

- **Case.** Each chapter has an end-of-chapter case based on a real company. These cases give the student an opportunity to use statistical concepts and techniques presented in the chapter to solve a business dilemma. Some cases feature very large companies—such as Shell Oil, Coca-Cola, or Colgate Palmolive. Others pertain to small businesses—such as Virginia Semiconductor, Delta Wire, or DeBourgh—that have overcome obstacles to survive and thrive. Most cases include raw data for analysis and questions that encourage the student to use several of the techniques presented in the chapter. In many cases, the student must analyze software output in order to reach conclusions or make decisions.

- **Using the Computer.** The Using the Computer section contains directions for producing the Excel 2013 and Minitab Release 16 software output presented in the chapter. It is assumed that students have a general understanding of a Microsoft Windows environment. Directions include specifics about menu bars, drop-down menus, and dialog boxes. Not every detail of every dialog box is discussed; the intent is to provide enough information for students to produce the same statistical output analyzed and discussed in the chapter. The eighth edition has a strong focus on both Excel and Minitab software packages. More than 250 Excel 2013 or Minitab Release 16 computer-generated outputs are displayed.

WILEYPLUS

WileyPLUS is a powerful online tool that provides instructors and students with an integrated suite of teaching and learning resources, including an online version of the text, in one easy-to-use Web site. To learn more about WileyPLUS and view a demo, please visit www.wileyplus.com.

WileyPLUS Tools for Instructors

WileyPLUS enables you to:

- Assign automatically graded homework, practice, and quizzes from the end of chapter and test bank.
- Track your students' progress in an instructor's grade book.
- Access all teaching and learning resources, including an online version of the text, and student and instructor supplements, in one easy-to-use Web site. These include full color PowerPoint slides, teaching videos, case files, and answers and animations.
- Create class presentations using Wiley-provided resources, with the ability to customize and add your own materials.

WileyPLUS Resources for Students

In WileyPLUS, students will find various helpful tools, such as an ebook, the student study manual, videos with tutorials by the author, applets, Decision Dilemma and Decision Dilemma Solved animations, learning activities, flash cards for key terms, demonstration problems, databases in both Excel and Minitab, case data in both Excel and Minitab, and problem data in both Excel and Minitab.

- **Ebook.** The complete text is available on WileyPLUS with learning links to various features and tools to assist students in their learning.
- **Videos.** There are 21 videos of the author explaining concepts and demonstrating how to work problems for some of the more difficult topics.
- **Applets.** Statistical applets are available, affording students the opportunity to learn concepts by iteratively experimenting with various values of statistics and parameters and observing the outcomes.
- **Learning Activities.** There are numerous learning activities to help the student better understand concepts and key terms. These activities have been developed to make learning fun, enjoyable, and challenging.
- **Data Sets.** Virtually all problems in the text along with the case problems and the databases are available to students in both Excel and Minitab format.
- **Animations.** To aid students in understanding complex interactions, selected figures from the text that involve dynamic activity have been animated using Flash technology. Students can download these animated figures and run them to improve their understanding of dynamic processes.
- **Flash Cards.** Key terms will be available to students in flash card format along with their definition.
- **Student Study Manual.** Complete solutions to all odd-numbered questions.
- **Demo Problems.** Step-by-step solved problems for each chapter.

ANCILLARY TEACHING AND LEARNING MATERIALS
www.wiley.com/college/black

Students' Companion Site

The student companion Web site contains:

- All databases in both Excel and Minitab formats for easy access and use.
- Excel and Minitab files of data from all text problems and all cases. Instructors and students now have the option of analyzing any of the data sets using the computer.
- Full and complete version of Chapter 19, Decision Analysis, in PDF format. This allows an instructor the option of covering the material in this chapter in the normal manner, while keeping the text manageable in size and length.
- A section on Advanced Exponential Smoothing Techniques (from Chapter 15) that offers the instructor an opportunity to delve deeper into exponential smoothing if so desired, and derivation of the slope and intercept formulas from Chapter 12.
- A tutorial on summation theory.

Instructor's Resource Kit

All instructor ancillaries are provided on the Instructor Resource Site. Included in this convenient format are:

- **Instructor's Manual.** Prepared by Ken Black, this manual contains the worked-out solutions to virtually all problems in the text. In addition, this manual contains chapter objectives, chapter outlines, chapter teaching strategies, and solutions to the cases.
- **PowerPoint Presentation Slides.** The presentation slides, prepared by Lee Revere of the University of Texas School of Public Health, contain graphics to help instructors create stimulating lectures. The PowerPoint slides may be adapted using PowerPoint software to facilitate classroom use.
- **Test Bank.** Prepared by Lee Revere of the University of Texas School of Public Health, The Test Bank includes multiple-choice questions for each chapter. The Test Bank is provided in Microsoft Word format.

ACKNOWLEDGMENTS

Ken Black is currently professor of decision sciences in the School of Business at the University of Houston–Clear Lake. Born in Cambridge, Massachusetts, and raised in Missouri, he earned a bachelor's degree in mathematics from Graceland University, a master's degree in math education from the University of Texas at El Paso, a Ph.D. in business administration (management science), and a Ph.D. in educational research from the University of North Texas.

Since joining the faculty of UHCL in 1979, Professor Black has taught all levels of statistics courses, forecasting, management science, market research, and production/operations management. In 2005, he was awarded the President's Distinguished Teaching Award for the university. He has published over 20 journal articles and 20 professional papers, as well as two textbooks: *Business Statistics: An Introductory Course* and *Business Statistics for Contemporary Decision Making.* Black has consulted for many different companies, including Aetna, the city of Houston, NYLCare, AT&T, Johnson Space Center, Southwest Information Resources, Connect Corporation, and Eagle Engineering.

Ken Black and his wife, Carolyn, have two daughters, Caycee and Wendi. His hobbies include playing the guitar, reading, and traveling.

This page is intentionally left blank

INTRODUCTION

The study of business statistics is important, valuable, and interesting. However, because it involves a new language of terms, symbols, logic, and application of mathematics, it can be at times overwhelming. For many students, this text is their first and only introduction to business statistics, which instructors often teach as a "survey course." That is, the student is presented with an overview of the subject, including a waterfront of techniques, concepts, and formulas. One of the main difficulties in studying business statistics in this way is to be able to see "the forest for the trees," that is, sorting out the myriad of topics so they make sense. With this in mind, the 18 chapters of this text have been organized into five units with each unit containing chapters that tend to present similar material. At the beginning of each unit, there is an introduction presenting the overlying themes to those chapters.

Unit I is titled Introduction because the four chapters (1–4) contained therein "introduce" the study of business statistics. In Chapter 1, students will learn what statistics are, the concepts of descriptive and inferential statistics, and levels of data measurement. In Chapter 2, students will see how raw data can be organized using various graphical and tabular techniques to facilitate their use in making better business decisions. Chapter 3 introduces some essential and basic statistics that will be used to both summarize data and as tools for techniques introduced later in the text. There will also be discussion of distribution shapes. In Chapter 4, the basic laws of probability are presented. The notion of probability underlies virtually every business statistics topic, distribution, and technique, thereby making it important to acquire an appreciation and understanding of probability. In Unit I, the first four chapters, we are developing "building blocks" that will enable students to understand and apply statistical concepts to analyze data that can assist present and future business managers in making better decisions.

Introduction to Statistics

LEARNING OBJECTIVES

The primary objective of Chapter 1 is to introduce you to the world of statistics, thereby enabling you to:

1. List quantitative and graphical examples of statistics within a business context.
2. Define important statistical terms, including population, sample, and parameter, as they relate to descriptive and inferential statistics.
3. Explain the difference between variables, measurement, and data.
4. Compare the four different levels of data: nominal, ordinal, interval, and ratio.

Lindsay Hebberd/Corbis Corp.

Statistics Describe the State of Business in India's Countryside

India is the second largest country in the world, with more than a billion people. Nearly three-quarters of the people live in rural areas scattered about the countryside in 6,000,000 villages. In fact, it may be said that 1 in every 10 people in the world live in rural India. Presently, the population in rural India can be described as poor and semi-illiterate. With an annual per capita income of less than $1 (U.S.) per day, rural India accounts for only about one-third of total national product sales. Less than 50% of households in rural India have electricity, and many of the roads are not paved. The annual per capita consumption for toothpaste is only 30 grams per person in rural India compared to 160 grams in urban India and 400 grams in the United States.

Besides the impressive size of its population, there are compelling reasons for companies to market their goods and services to rural India. The market of rural India has been growing at five times the rate of the urban India market. There is increasing agricultural productivity, leading to growth in disposable income, and there is a reduction in the gap between the tastes of urban and rural customers. The literacy level is increasing, and people are becoming more conscious about their lifestyles and opportunities for a better life.

Nearly two-thirds of all middle-income households in India are in rural areas, with the number of middle- and high-income households in rural India expected to grow from 80 million to 111 million over the next three years. More than one-third of all rural households now have a main source of income other than farming. Virtually every home has a radio, almost 20% have a television, and more than 30% have at least one bank account.

In the early 1990s, toothpaste consumption in rural India doubled, and the consumption of shampoo increased fourfold. Recently, other products have done well in rural India, accounting for nearly one-half of all of the country's sales of televisions, fans, bicycles, bath soap, and other products. According to MART, a New Delhi–based research organization, rural India buys 46% of all soft drinks and 49% of motorcycles sold in India. In one year alone, the market for Coca-Cola in rural India grew by 37%, accounting for 80% of new Coke drinkers in India. Because of such factors, many U.S. and Indian firms, such as Microsoft, General Electric, Kellogg's, Colgate-Palmolive, Hindustan Lever, Godrej, Nirma Chemical Works, and Mahotra Marketing, have entered the rural Indian market with enthusiasm. Marketing to rural customers often involves building categories by persuading them to try and adopt products that they may not have used before. Rural India is a huge, relatively untapped market for businesses. However, entering such a market is not without risks and obstacles. The dilemma facing companies is whether to enter this marketplace and, if so, to what extent and how.

Managerial and Statistical Questions

1. Are the statistics presented in this report exact figures or estimates?
2. How and where could the researchers have gathered such data?
3. In measuring the potential of the rural India marketplace, what other statistics could have been gathered?
4. What levels of data measurement are represented by data on rural India?
5. How can managers use these and other statistics to make better decisions about entering this marketplace?

Source: Adapted from Raja Ramachandran, "Understanding the Market Environment of India," *Business Horizons*, January 2000; P. Balakrishna and B. Sidharth, "Selling in Rural India," *The Hindu Business Line*—Internet Edition, February 16, 2004; Rohit Bansal and Srividya Easwaran, "Creative Marketing for Rural India," research paper, http://www.indiainfoline.com; Alex Steffen, "Rural India Ain't What It Used to Be," *WorldChanging,* http://www.worldchanging.com/archives/001235.html; "Corporates Turn to Rural India for Growth," BS Corporate Bureau in New Delhi, August 21, 2003, http://www.rediff.com/money/2003/aug/21rural.htm; Rajesh Jain, "Tech Talk: The Discovery of India: Rural India," June 20, 2003, http://www.emergic.org/archives/indi/005721.php; "Marketing to Rural India: Making the Ends Meet," March 8, 2007, in *India Knowledge@Wharton,* http://knowledge.wharton.upenn.edu/india/article.cfm?articleid=4172; "Rural Economy in India," businessmapsofindia.com, http://business.mapsofindia.com/rural-economy/.

Every minute of the working day, decisions are made by businesses around the world that determine whether companies will be profitable and growing or whether they will stagnate and die. Most of these decisions are made with the assistance of information gathered about the marketplace, the economic and financial environment, the workforce, the competition, and other factors. Such information usually comes in the form of data or is accompanied

by data. Business statistics provides the tool through which such data are collected, analyzed, summarized, and presented to facilitate the decision-making process, and business statistics plays an important role in the ongoing saga of decision making within the dynamic world of business.

STATISTICS IN BUSINESS

Virtually every area of business uses statistics in decision making. Here are some recent examples:

- According to a TNS Retail Forward ShopperScape survey, the average amount spent by a shopper on electronics in a three-month period is $629 at Circuit City, $504 at Best Buy, $246 at Walmart, $172 at Target, and $120 at RadioShack.
- A survey of 1465 workers by Hotjobs reports that 55% of workers believe that the quality of their work is perceived the same when they work remotely as when they are physically in the office.
- A survey of 477 executives by the Association of Executive Search Consultants determined that 48% of men and 67% of women say they are more likely to negotiate for less business travel compared with five years ago.
- A survey of 1007 adults by RBC Capital Markets showed that 37% of adults would be willing to drive 5 to 10 miles to save 20 cents on a gallon of gas.
- A Deloitte Retail "Green" survey of 1080 adults revealed that 54% agreed that plastic, non-compostable shopping bags should be banned.
- A recent Household Economic Survey by Statistics New Zealand determined that the average weekly household net expenditure in New Zealand was $956 and that households in the Wellington region averaged $120 weekly on recreation and culture. In addition, 75% of all households were satisfied or very satisfied with their material standard of living.
- The Experience's Life After College survey of 320 recent college graduates showed that 58% moved back home after college. Thirty-two percent then remained at home for more than a year.
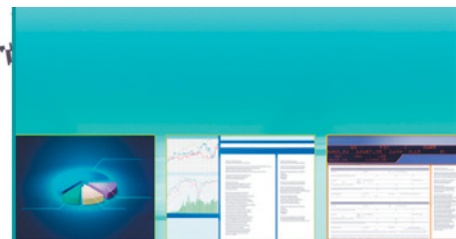
You can see from these few examples that there is a wide variety of uses and applications of statistics in business. Note that in most of these examples, business researchers have conducted a study and provided us rich and interesting information.

In this text we will examine several types of graphs for depicting data as we study ways to arrange or structure data into forms that are both meaningful and useful to decision makers. We will learn about techniques for sampling from a population that allow studies of the business world to be conducted more inexpensively and in a more timely manner. We will explore various ways to forecast future values and examine techniques for predicting trends. This text also includes many statistical tools for testing hypotheses and for estimating population values. These and many other exciting statistics and statistical techniques await us on this journey through business statistics. Let us begin.

1.2 BASIC STATISTICAL CONCEPTS

Business statistics, like many areas of study, has its own language. It is important to begin our study with an introduction of some basic concepts in order to understand and communicate about the subject. We begin with a discussion of the word *statistics*. The word *statistics* has many different meanings in our culture. *Webster's Third New International Dictionary* gives a comprehensive definition of **statistics** as *a science dealing with the collection, analysis, interpretation, and presentation of numerical data.* Viewed from this perspective, statistics includes all the topics presented in this text. Figure 1.1 graphically displays the key elements of statistics.

The study of statistics can be organized in a variety of ways. One of the main ways is to subdivide statistics into two branches: descriptive statistics and inferential statistics. To understand the difference between descriptive and inferential statistics, definitions of *population* and *sample* are helpful. *Webster's Third New International Dictionary* defines **population** as *a collection of persons, objects, or items of interest.* The population can be a widely defined category, such as "all automobiles," or it can be narrowly defined, such as "all Ford Mustang cars produced from 2011 to 2013." A population can be a group of people, such as "all workers presently employed by Microsoft," or it can be a set of objects, such as "all dishwashers produced on February 3, 2012, by the General Electric Company at the Louisville plant." The researcher defines the population to be whatever he or she is studying. When researchers *gather data from the whole population for a given measurement of interest,* they call it a **census**. Most people are familiar with the U.S. Census. Every 10 years, the government attempts to measure all persons living in this country.

A **sample** is *a portion of the whole* and, if properly taken, is representative of the whole. For various reasons (explained in Chapter 7), researchers often prefer to work with a sample of the population instead of the entire population. For example, in conducting quality-control experiments to determine the average life of lightbulbs, a lightbulb manufacturer might randomly sample only 75 lightbulbs during a production run. Because of time and

FIGURE 1.1

The Key Elements of Statistics

Collect Data   Analyze Data   Interpret Data   Present Findings
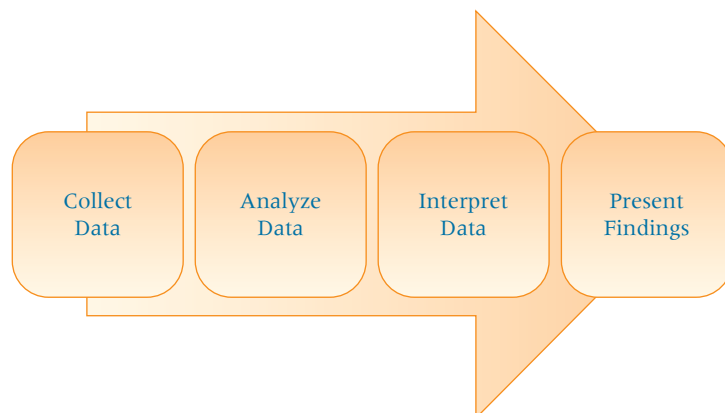
money limitations, a human resources manager might take a random sample of 40 employees instead of using a census to measure company morale.

If a business analyst is *using data gathered on a group to describe or reach conclusions about that same group,* the statistics are called **descriptive statistics**. For example, if an instructor produces statistics to summarize a class's examination effort and uses those statistics to reach conclusions about that class only, the statistics are descriptive.

Many of the statistical data generated by businesses are descriptive. They might include number of employees on vacation during June, average salary at the Denver office, corporate sales for 2013, average managerial satisfaction score on a company-wide census of employee attitudes, and average return on investment for the Lofton Company for the years 1992 through 2012.

Another type of statistics is called **inferential statistics**. If a researcher *gathers data from a sample and uses the statistics generated to reach conclusions about the population from which the sample was taken,* the statistics are inferential statistics. The data gathered from the sample are used to infer something about a larger group. Inferential statistics are sometimes referred to as *inductive statistics.* The use and importance of inferential statistics continue to grow.

One application of inferential statistics is in pharmaceutical research. Some new drugs are expensive to produce, and therefore tests must be limited to small samples of patients. Utilizing inferential statistics, researchers can design experiments with small randomly selected samples of patients and attempt to reach conclusions and make inferences about the population.

Market researchers use inferential statistics to study the impact of advertising on various market segments. Suppose a soft drink company creates an advertisement depicting a dispensing machine that talks to the buyer, and market researchers want to measure the impact of the new advertisement on various age groups. The researcher could stratify the population into age categories ranging from young to old, randomly sample each stratum, and use inferential statistics to determine the effectiveness of the advertisement for the various age groups in the population. The advantage of using inferential statistics is that they enable the researcher to study effectively a wide range of phenomena without having to conduct a census. Most of the topics discussed in this text pertain to inferential statistics.

A *descriptive measure of the population* is called a **parameter**. Parameters are usually denoted by Greek letters. Examples of parameters are population mean (μ), population variance (σ^2), and population standard deviation (σ). A *descriptive measure of a sample* is called a **statistic**. Statistics are usually denoted by Roman letters. Examples of statistics are sample mean ($\bar{x}$), sample variance (s^2), and sample standard deviation (s).

Differentiation between the terms *parameter* and *statistic* is important only in the use of inferential statistics. A business researcher often wants to estimate the value of a parameter or conduct tests about the parameter. However, the calculation of parameters is usually either impossible or infeasible because of the amount of time and money required to take a census. In such cases, the business researcher can take a random sample of the population, calculate a statistic on the sample, and infer by estimation the value of the parameter. The basis for inferential statistics, then, is the ability to make decisions about parameters without having to complete a census of the population.

For example, a manufacturer of washing machines would probably want to determine the average number of loads that a new machine can wash before it needs repairs. The parameter is the population mean or average number of washes per machine before repair. A company researcher takes a sample of machines, computes the number of washes before repair for each machine, averages the numbers, and estimates the population value or parameter by using the statistic, which in this case is the sample average. Figure 1.2 demonstrates the inferential process.

Inferences about parameters are made under uncertainty. Unless parameters are computed directly from the population, the statistician never knows with certainty whether the estimates or inferences made from samples are true. In an effort to estimate the level of confidence in the result of the process, statisticians use probability statements. For this and other reasons, part of this text is devoted to probability (Chapter 4).

FIGURE 1.2

The Inferential Process

FIGURE 1.2
The Inferential Process
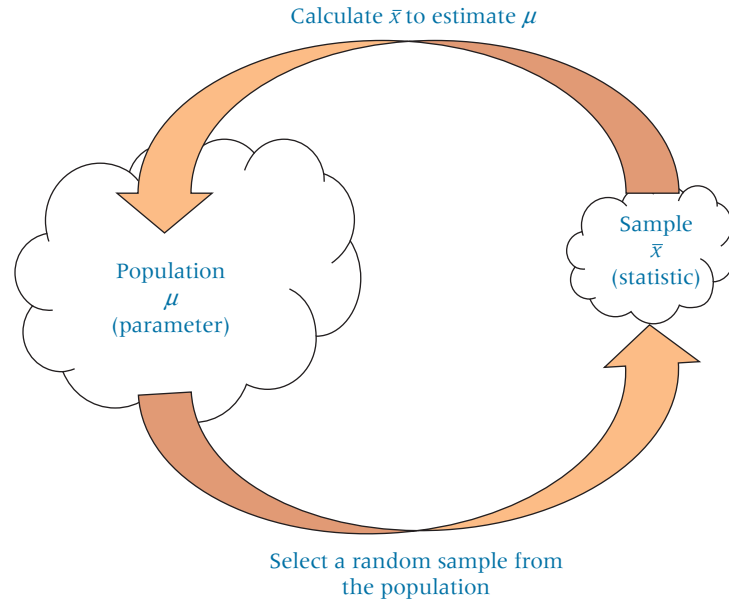
1.3 VARIABLES AND DATA

Business statistics is about measuring phenomena in the business world and organizing, analyzing, and presenting the resulting numerical information in such a way such that better, more informed business decisions can be made. Most business statistics studies contain variables, measurements, and data.

In business statistics, a **variable** is *a characteristic of any entity being studied that is capable of taking on different values.* Some examples of variables in business might include return on investment, advertising dollars, labor productivity, stock price, historical cost, total sales, market share, age of worker, earnings per share, miles driven to work, time spent in store shopping, and many, many others. In business statistics studies, most variables produce a measurement that can be used for analysis. A **measurement** is *when a standard process is used to assign numbers to particular attributes or characteristics of a variable.* Many measurements are obvious, such as time spent in a store shopping by a customer, age of the worker, or the number of miles driven to work. However, some measurements, such as labor productivity, customer satisfaction, and return on investment, have to be defined by the business researcher or by experts within the field. Once such measurements are recorded and stored, they can be denoted as "data." It can be said that **data** are *recorded measurements.* The processes of measuring and data gathering are basic to all that we do in business statistics. It is data that are analyzed by a business statistician in order to learn more about the variables being studied. Sometimes, sets of data are organized into databases as a way to store data or as a means for more conveniently analyzing data or comparing variables. Valid data are the lifeblood of business statistics, and it is important that the business researcher give thoughtful attention to the creation of meaningful, valid data before embarking on analysis and reaching conclusions.

1.4 DATA MEASUREMENT

Video

Millions of numerical data are gathered in businesses every day, representing myriad items. For example, numbers represent dollar costs of items produced, geographical locations of retail outlets, weights of shipments, and rankings of subordinates at yearly reviews. All such data should not be analyzed the same way statistically because the entities represented by the numbers are different. For this reason, the business researcher needs to know the *level of data measurement* represented by the numbers being analyzed.

The disparate use of numbers can be illustrated by the numbers 40 and 80, which could represent the weights of two objects being shipped, the ratings received on a consumer test by two different products, or football jersey numbers of a fullback and a wide receiver. Although 80 pounds is twice as much as 40 pounds, the wide receiver is probably not twice as big as the fullback! Averaging the two weights seems reasonable, but averaging the football jersey numbers makes no sense. The appropriateness of the data analysis depends on the level of measurement of the data gathered. The phenomenon represented by the numbers determines the level of data measurement. Four common levels of data measurement follow.

1. Nominal
2. Ordinal
3. Interval
4. Ratio

Nominal is the lowest level of data measurement followed by ordinal, interval, and ratio. Ratio is the highest level of data, as shown in Figure 1.3.

Nominal Level

The *lowest level of data measurement* is the **nominal level**. Numbers representing nominal-level data (the word *level* often is omitted) can be *used only to classify or categorize.* Employee identification numbers are an example of nominal data. The numbers are used only to differentiate employees and not to make a value statement about them. Many demographic questions in surveys result in data that are nominal because the questions are used for classification only. The following is an example of such a question that would result in nominal data:

Which of the following employment classifications best describes your area of work?

1. Educator
2. Construction worker
3. Manufacturing worker
4. Lawyer
5. Doctor
6. Other

Suppose that, for computing purposes, an educator is assigned a 1, a construction worker is assigned a 2, a manufacturing worker is assigned a 3, and so on. These numbers should be used only to classify respondents. The number 1 does not denote the top classification. It is used only to differentiate an educator (1) from a lawyer (4).

Some other types of variables that often produce nominal-level data are sex, religion, ethnicity, geographic location, and place of birth. Social Security numbers, telephone numbers, employee ID numbers, and ZIP code numbers are further examples of nominal data. Statistical techniques that are appropriate for analyzing nominal data are limited. However,

FIGURE 1.3

Hierarchy of Levels of Data

Highest Level of Data Measurement

Ratio

Interval
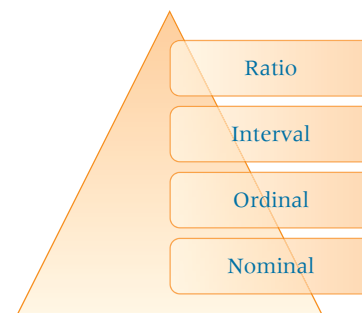
Ordinal

Nominal

Lowest Level of Data Measurement

some of the more widely used statistics, such as the chi-square statistic, can be applied to nominal data, often producing useful information.

Ordinal Level

Ordinal-level data measurement is higher than the nominal level. In addition to the nominal-level capabilities, ordinal-level measurement can be used to rank or order people or objects. For example, using ordinal data, a supervisor can evaluate three employees by ranking their productivity with the numbers 1 through 3. The supervisor could identify one employee as the most productive, one as the least productive, and one as somewhere between by using ordinal data. However, the supervisor could not use ordinal data to establish that the intervals between the employees ranked 1 and 2 and between the employees ranked 2 and 3 are equal; that is, she could not say that the differences in the amount of productivity between workers ranked 1, 2, and 3 are necessarily the same. With ordinal data, the distances or spacing represented by consecutive numbers are not always equal.

Some questionnaire Likert-type scales are considered by many researchers to be ordinal in level. The following is an example of one such scale:

This computer tutorial is	___	___	___	___	___
	not helpful	somewhat helpful	moderately helpful	very helpful	extremely helpful
	1	2	3	4	5

When this survey question is coded for the computer, only the numbers 1 through 5 will remain, not the adjectives. Virtually everyone would agree that a 5 is higher than a 4 on this scale and that ranking responses is possible. However, most respondents would not consider the differences between not helpful, somewhat helpful, moderately helpful, very helpful, and extremely helpful to be equal.

Mutual funds as investments are sometimes rated in terms of risk by using measures of default risk, currency risk, and interest rate risk. These three measures are applied to investments by rating them as having high, medium, and low risk. Suppose high risk is assigned a 3, medium risk a 2, and low risk a 1. If a fund is awarded a 3 rather than a 2, it carries more risk, and so on. However, the differences in risk between categories 1, 2, and 3 are not necessarily equal. Thus, these measurements of risk are only ordinal-level measurements. Another example of the use of ordinal numbers in business is the ranking of the top 50 most admired companies in *Fortune* magazine. The numbers ranking the companies are only ordinal in measurement. Certain statistical techniques are specifically suited to ordinal data, but many other techniques are not appropriate for use on ordinal data. For example, it does not make sense to say that the average of "moderately helpful" and "very helpful" is "moderately helpful and a half."

Because nominal and ordinal data are often derived from imprecise measurements such as demographic questions, the categorization of people or objects, or the ranking of items, *nominal and ordinal data* are **nonmetric data** and are sometimes referred to as *qualitative data*.

Interval Level

Interval-level data measurement is the *next to the highest level of data in which the distances between consecutive numbers have meaning and the data are always numerical.* The distances represented by the differences between consecutive numbers are equal; that is, interval data have equal intervals. An example of interval measurement is Fahrenheit temperature. With Fahrenheit temperature numbers, the temperatures can be ranked, and the amounts of heat between consecutive readings, such as 20°, 21°, and 22°, are the same.

In addition, with interval-level data, the zero point is a matter of convention or convenience and not a natural or fixed zero point. Zero is just another point on the scale and does not mean the absence of the phenomenon. For example, zero degrees Fahrenheit is not the lowest possible temperature. Some other examples of interval-level data are the