FIFTH EDITION

# BUSINESS STATISTICS

*A Decision-Making Approach*


*David F. Groebner*

*Patrick W. Shannon*

*Phillip C. Fry*

*Kent D. Smith*

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# BUSINESS STATISTICS: A DECISION-MAKING APPROACH

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*To Jane and my family, who survived the process one more time.*

**David F. Groebner**

*To Kathy, my wife and best friend; to our children, Jackie and Jason; and to my parents, John and Ruth Shannon.*

**Patrick W. Shannon**

*To my wonderful family: Susan, Alex, Allie, Candace, and Courtney.*

**Phillip C. Fry**

*To Dottie, my loving wife, who dances much better than I write.*

**Kent D. Smith**

# About the Authors

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Dr. Smith began teaching as a part-time lecturer at the California State University, San Bernardino. While completing his doctoral dissertation, he served as a lecturer at the University of California, Riverside. Currently, he is a Professor of Statistics at the California Polytechnic State University, San Luis Obispo, one of the minority of universities that offer an undergraduate degree in statistics. The subjects he teaches include upper-division courses in regression, analysis of variance, nonparametrics, linear models, and probability and mathematical statistics, as well as a full array of service courses.

# PREFACE

New business school graduates face an increasingly competitive job market. While the U.S. economy continues to perform well, corporate downsizing along with competitive pressures to trim costs have affected the demand for new graduates in most business majors. In order to stand out in today's competitive job market, graduates need to bring to an organization special skills and abilities that give them the potential to hit the ground running and contribute immediately.

One area where a student can have an immediate competitive advantage over both new graduates and existing employees is in the application of statistical analysis skills to business problems. While most colleges of business require their graduates to have completed either one or two business statistics courses, too many students complete their academic programs without having mastered the statistical skills necessary to meet the needs of business. One reason for this may be that their statistics courses did not adequately prepare them in applying statistical tools and concepts to real-world decision-making problems.

Our intent in writing a fifth edition of *Business Statistics: A Decision-Making Approach* is to build on the strengths of the previous four additions (readability, decision-making focus, content coverage, pedagogical aids, etc.) and to take the text to a new level of performance. In doing so, we have made substantive changes throughout the text so that students can more fully and completely appreciate the value of business statistics to both their academic and professional careers. Dr. Phil Fry of Boise State University and Dr. Kent Smith of Cal Polytechnic State University of San Luis Obispo have joined Professors David Groebner and Patrick Shannon as co-authors. All the authors share a passion for the subject as well as a devotion to teaching, and have significant experience in applying the statistical tools in business and industry settings. Following is a description of the major improvements we have made to this edition.

## MOTIVATING STUDENTS USING REAL BUSINESS APPLICATIONS

The fifth edition of *Business Statistics: A Decision-Making Approach* provides real-world applications as a motivation for learning business statistics. While previous editions have focused on decision making and business applications, the new edition has more applications than ever before. Not only do the chapters focus on real companies and actual applications, increased effort has been placed on providing the student with an understanding of the role business statistics plays in decision making. This text is designed to help the instructor create a climate in which students are motivated to learn and apply statistical techniques.

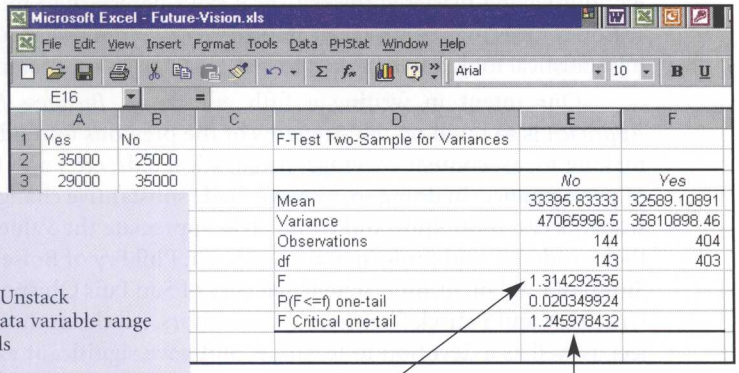
We believe that students will relate well to the writing style used throughout the text. The writing style and subject presentation are intended to facilitate student interest and involvement in the material. Statistical concepts and techniques are introduced through realistic business situations and we have made every effort to communicate ideas using a nontechnical writing style. This is a business statistics text that students will actually read and use it to increase their understanding of business statistics.

## INCREASED COMPUTER EMPHASIS

To enhance the students' appreciation for business statistics, we emphasize computer-based analysis, rather than manual computations. Toward this end, Microsoft's Excel (Office 2000 version) is featured extensively throughout the textbook. Minitab is also used as a supplement to Excel at various places throughout the text. Chapter examples, exercises, and case studies are based on real industry data or data motivated by real-world examples. In this way, students gain a greater understanding of what statistical tools to use, when and how to apply them, and how to interpret the results of their analyses to decision making.

Unlike some computer-based textbooks that provided only end-of-chapter computer instructions, this text seamlessly integrates the computer applications with the text examples, with a focus on interpreting the output. The goal is for the students to appreciate the role of spreadsheet and statistical software as business statistics tools. We do not dwell on the specifics of how the software is used within the text. However, the screen shots do show the students the key instructions needed to generate the output they are seeing. In addition, callouts highlight the important output that is being discussed in the example. The following figure from Chapter 9 is typical of this approach.

FIGURE 9-6
PHStat Test for Equality of Two Variances for Future-Vision




Excel Instructions:

1. Open file: Future-Vision.xls
2. Select PHStat
3. Click on Data Preparation and Unstack
4. Define grouping variable and data variable range
5. With unstacked data select Tools
6. Select Data Analysis
7. Select F-Test for Differences in Two Variances
8. Enter data range for two variables (Group 1 is the "No" Group since it has the largest sample variance.)
9. Select alpha level

$F$-statistic $= 1.314 > F_{\alpha/2} = 1.246$
Therefore, reject the null.

## TOOLS OF QUALITY

Statistics have played a major role in the quality movement. The fifth edition integrates quality concepts throughout the text. For example, many chapters contain one or more "Tools of Quality" segments. These segments, which are specially marked in the text, feature applications of statistical techniques (e.g., data check sheets, Pareto charts, and process capability analysis) that are frequently employed by organizations in their quality and process improvement activities. Many other examples and applications throughout the text have a quality theme. In addition, Chapter 13 presents an overview of quality issues

and introduces statistical process control charts. This SPC chapter is strategically placed to emphasize that SPC is a direct application of the important statistical concepts of estimation and hypothesis testing.

## EXTENSIVE EXERCISE SETS

The Business Application Exercises at the end of each section provide realistic decision-making situations in which the statistical concepts from the section are applied. Not only do these exercises reinforce the statistical techniques presented in the book, but they also provide a useful motivation for the study of business statistics.

In addition to the end-of-section exercises, each chapter contains numerous Business Application Exercises at the end of the chapter. These end-of-chapter questions and problems require the student to identify what needs to be done and what statistical tool is required. In many instances, the problems are integrative by requiring students to draw upon material from earlier chapters. For example, problems in Chapter 3 that introduce numerical descriptive measures might also require development of appropriate charts or graphs taught in Chapter 2. In this way, students are continually reviewing and applying material learned in previous chapters, gaining a greater appreciation for how the different techniques fit together to provide an integrated set of business analysis tools.

Where appropriate, many of the Business Application Exercises include data sets to be analyzed using either Excel or Minitab. A special data set icon is used to distinguish these problems.

As a special feature, additional application problems and skill development exercises are located on the CD-ROM that accompanies the text.

## CHAPTER CASES

We have included short cases at the end of each chapter. Like the Business Application Exercises, these cases are based on actual business situations. However, the cases are less directed and more open-ended than the exercises and also require the students to integrate the statistical techniques covered in the chapter into the decision-making situation. The purpose of the cases is to give the students an opportunity to apply the tools and techniques they have learned to more loosely defined business problems, requiring them to identify key issues, apply relevant statistical techniques, draw conclusions, and provide reports detailing their findings.

## REVISED TABLE OF CONTENTS

For the fifth edition, we have made some changes to the order in which the chapters are presented based on feedback we have had from reviewers, students, and faculty who have used prior editions. For example, as mentioned previously, we have added a chapter on quality and statistical process control. We have moved the chapters on categorical data and nonparametric statistics to follow immediately after the quality and SPC chapter. In addition, we have added some topics, most notably an emphasis on model building in the multiple regression chapter. The ANOVA chapter now contains a section on two-factor analysis of variance. We have also expanded our discussion of descriptive statistics and data presentation, since that aspect of a business statistics course is highly relevant to graduates in the workplace.

It is always a challenge to include all the topics that professors would like to see in a business statistics textbook while keeping the text length to a manageable size. This is a special challenge to us since we have opted for a descriptive writing style with fully devel-

oped examples and applications. To help accomplish our objective in terms of topic coverage and presentation while staying within a manageable length, the fifth edition includes a number of optional topics on the CD-ROM that accompanies the text.

## SPECIAL FEATURES

A variety of other special features are included in this text and ancillary materials. Their brief descriptions follow.

### CD-ROM

Optional CD-ROM Topic

Chapter 4

The Hypergeometric Distribution

Additional Example 9-a on CD-ROM

Estimating the Difference Between Two Population Means—Small Samples

Excel and Minitab Tutorial included on CD-ROM

Data Files

Excel Simulation

*t*-Distribution

Accompanying the text is a CD-ROM with many special features, including:

- **CD-ROM Topics**—Topics, listed as "Optional CD-ROM Topics" in the text. The benefit is that we are able to provide a wider array of topics and at the same time keep the length and cost of the text within acceptable limits. The CD-ROM topics tend to be of the optional variety that many faculty do not cover in their courses. However, for those who do, the topics are easily available.
- **Additional Examples**—Although among the strengths of the text are the quality and quantity of the examples and applications that are presented in each chapter, students always want more examples. At various places throughout the text we have included an icon that identifies an additional example contained on the CD-ROM. These examples are like the ones in the text and are applications involving business situations.
- **Excel and Minitab Tutorials**—Customized PowerPoint tutorials for both Minitab and Excel, which use data sets from text examples, are included on the CD-ROM. Students who need additional instruction in Excel or Minitab can access the menu-driven tutorial, which will show the exact steps needed to replicate all computer examples in the text. The benefits are that the CD-ROM tutorials free instructors from spending significant time on computer instruction during class time and the students can access specific help with the software at any time.
- **Solved Problems**—Most chapters have one or more solved problems included on the CD-ROM. In addition to providing the students with more examples and applications, these solved problems illustrate to the student a proper method for laying out their answers to the chapter exercises and problems. Another benefit is that the instructor who has computer projection in the classroom could use these solved problems in class as examples and for discussion purposes.
- **Data Files**—An extensive number of data files for examples, cases, and problems in the text are included on the CD-ROM, in both Excel and Minitab format. The text references these data files with a special icon.
- **Additional Exercises**—More exercises and application problems are included on the CD-ROM. Although the fifth edition will be among the industry leaders in the numbers of exercises and application problems provided, the CD-ROM makes it possible for instructors to select from an even greater number of problems.
- **Excel Simulations**—The CD-ROM also contains several interactive Excel simulations that are used to illustrate important statistical concepts, such as hypothesis testing and confidence interval estimation. These simulations allow the students to make changes and immediately observe the impact. The Excel simulations can also be used effectively by instructors in the classroom to illustrate statistical issues through the use of "what if" questioning.

### PHStat

Included on the CD-ROM is a specially developed Excel add-in package called PHStat that can be installed on any PC running Excel 97 or higher. PHStat contains a number of statistical features that are not included with Microsoft Excel, but which are useful in the study and application of business statistics. For example, the regression section on PH-Stat contains both *All-Possible Subsets* and *Stepwise Regression* tools. Another tool is the *Box Plot* option. There are several instances in the text where the Excel output screen shows the results when a PHStat add-in has been used.

### Student Solutions Manual

The Solutions Manual contains the worked-out solutions to all the odd-numbered problems in the text. More than just showing the answer, the Solutions Manual shows the detailed process that students should use to work each problem. The manual also provides interpretation of the answers and serves as a valuable learning tool for the student.

### Text Web Site

This text has a Web site that can be accessed directly or as a link from the Prentice Hall Home Page. The features that are included at the Web site benefit both students and instructors.

## ACKNOWLEDGMENTS

Publishing a textbook is a team effort and involves many people. At the risk of overlooking someone, we take this space to express our appreciation to many of the key contributors to this text. Throughout the more than two years that this revision has been in process, many faculty members from across the country have taken time from their busy schedules to provide valuable input and suggestions for improvement. We offer thanks to:

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Many people have also participated by preparing the ancillary materials that support the text and add to the students' learning experience. We wish to thank the following people: Dr. Mark Karscig, Central Missouri State University, who prepared the PowerPoint slides; Dan Cooper and staff at Active Learning Technology, who developed and continues to support the text Web page; Mohammed Z. Bsat and his team at Jackson State University, who developed the Test Bank and Interactive Study Guide, and Susan Fry, Boise State University, who prepared the Instructors and Student Solutions Manuals.

The team of professionals at Prentice Hall is the finest publishing group with whom we had the pleasure of working. Carol Samet oversaw the technical end of the publishing process and kept us on schedule; Cindy Harford coordinated the CD-ROM materials; Jennifer Surich supervised the preparation of supplements; and Debbie Clare handled the very important marketing component with great creativity and enthusiasm.

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David F. Groebner
Patrick W. Shannon
Phillip C. Fry
Kent D. Smith

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