SECOND EDITION

STATISTICS FOR MANAGEMENT AND ECONOMICS

A SYSTEMATIC APPROACH

KELLER
WARRACK
BARTEL

STATISTICS

FOR MANAGEMENT AND ECONOMICS

A SYSTEMATIC APPROACH

Second Edition

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Wadsworth Publishing Company
Belmont, California
A Division of Wadsworth, Inc.

Acquisition Editor: Kristine M. Clerkin
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Designer: Vargas/Williams/Design
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Technical Illustrator: Alexander Teshin Associates
Compositor: Polyglot Compositors Pte., Ltd.
Cover: Vargas/Williams/Design
Signing Representative: Peter Jackson
Cover Illustration: Pauline Phung

Printed in the United States of America
2 3 4 5 6 7 8 9 10—94 93 92 91 90

Library of Congress Cataloging-in-Publication Data

Keller, Gerald.
Statistics for management and economics.

1. Management—Statistical methods. 2. Economics—Statistical methods. I. Warrack, Brian. II. Bartel, Henry. III. Title.
HD30.215.K45 1990 658.4'033 89-70687
ISBN 0-534-12678-2

KEY TO EXERCISE CODES

The exercises and cases illustrate how statistics can be used in a wide range of applications. The areas of applications of the cases and many of the exercises are identified using the following codes:

Application	*Code*
Accounting	ACC
Economics	ECON
Education	EDUC
Finance	FIN
General	GEN
Management	MNG
Marketing	MKT
Production/Operations Management	POM
Politics and Government	PG
Real Estate	RE
Retailing	RET
Science/Health	SCI
Tourism	TOUR

PREFACE

The second edition of this textbook is a further attempt to make the basic business and economic statistics course a more effective and enjoyable learning experience for both instructors and students. In preparing this edition we have been influenced by the overwhelmingly positive response to the first edition, in which we formalized an approach to teaching that many instructors found to be consistent with their own pedagogy. Our approach derived from a general disenchantment with the existing teaching material. We believed that there was far too much emphasis on number crunching and too little on meaningful practical applications. The results were unhappy, fearful students who were unable to satisfactorily perform statistical techniques. We believe that our systematic approach addresses this problem in the following ways.

STATISTICS CAN BE TAUGHT SYSTEMATICALLY

In general, students have little difficulty in understanding the central concepts of statistics or in performing the calculations. Where students face their greatest difficulty is in recognizing which technique to use to solve a specific problem. Students can practice their arithmetic skills solving exercises at the end of chapters. However, since these exercises must inevitably employ the methods described in those chapters, students are not challenged to identify the correct technique. That is, they're not challenged until they write exams, or must use statistical methods in other courses or in a practical application once they enter the real world of business. This book attempts to prepare students to successfully overcome the key challenge of statistics.

Our philosophy in this book can be expressed quite clearly. We regard the calculation of the statistical procedure as the least important element of an application. Far more important is the ability to set up the problem properly, which includes recognizing which technique to use. Equally important is the ability to interpret the results and incorporate the statistics into the larger decision problem. This philosophy is made operational in several ways.

In Chapter 5 we introduce the system by describing the critical factors that determine the appropriate statistical technique. These are the problem objective and the data scale. We teach that fundamentally all statistical techniques are alike in that (except for nonparametric methods) we start by identifying a parameter of interest, the parameter's estimator, the estimator's sampling distribution, which leads to the confidence interval estimate, and the test statistic. Changing a factor merely changes one or more of the elements. Review Chapters 11 and 18, placed at the midpoint and conclusion of statistical inference, allow students to practice recognizing the correct method.

STATISTICS MUST BE PERCEIVED AS USEFUL TO BUSINESS AND ECONOMICS

Recent academic conferences devoted to improving the teaching of applied statistics have advocated the use of cases to help motivate students. A large proportion of business and economics students are required to analyze case studies in other courses (e.g., marketing, finance, operations management and policy), but seldom if ever must they analyze statistics cases. The lack of exposure to realistic applications in their statistics courses fosters the impression that there are no useful applications of statistics. Our approach relies heavily on cases adapted from actual business studies published in journals, magazines, and our own consulting experience. Most provide extensive real data sets drawn from the studies. Twenty-six of the 52 cases can be analyzed by computer software, and for these the data have been stored on a disk available from Wadsworth Publishing Company. We have also added many new sections showing computer output accompanied by guidance for student interpretation and analysis.

STATISTICS MUST MAKE USE OF THE COMPUTER

In the first edition of our book we included a number of teaching aids to help instructors proceed with computerizing the course: Minitab and SAS instructions in appendixes, a few cases with large data sets stored on disk, and tutorial software. The reaction to these aids was quite overwhelming: there is no doubt that the movement to bring computers into the statistics course will grow in strength and numbers. For example, the American Academy of Colleges and Schools of Business has made computerized curricula an absolutely essential element of its accreditation requirements.

We have continued these aids and added many more (as described below), but what's most important about this movement is how it can favorably change the teaching and learning style of the course. Teachers can now focus on interesting problems, examples, and cases rather than calculations. As they move away from calculation, students begin to see the course as necessary and applicable while learning important microcomputer skills. The course becomes more interactive: instead of listening to a lecture, students can be called upon to reason through problems and interpret results. We continue to believe that students benefit from doing some calculations manually, particularly when a new technique is introduced. The key concepts of statistical reasoning are reinforced in this way. Consequently, most examples in this second edition are solved in three ways: manually, using Minitab, and using SAS. Instructors can emphasize any one of the three or, as we do, briefly describe the manual calculations and then discuss how to interpret the Minitab printout.

Our experiences with the first edition taught us that though nearly all of our colleagues are committed in the long term to having students use the computer for analytical work, some do not yet have the actual resources to do so. As an interim step, these instructors often decide to rely extensively on analysis and interpretation of computer output—the scenario business students are most likely to encounter.

Our much more extensive presentation of computer output in this second edition was designed to be of use in these classes.

In summary, through the features and teaching aids described above, we have attempted in this text to make teaching and learning business and economic statistics a more positive and useful experience. We try to make our business statistics classrooms minimodels of the business world—to help students step into the shoes of the business managers and executives they hope to be someday. To do this, we've developed a logical system that allows students to recognize easily the appropriate technique to use in a given situation. Once they've mastered this easy-to-use system, they can concentrate on analyzing data and interpreting the results—the real guts of the course, which computers now allow us to emphasize. We give them many exercises and cases to solve using real data, so they can put what they have learned to use. We even ask them to work in teams to solve problems and present case reports, as they might be required to do in business situations. We've tried to take the "math anxiety" out of the course and out of this textbook. During our almost ten years' experience, we've found that our students like this approach: they say it gives them more confidence and makes learning statistics more fun. We hope that your students have the same reaction to this textbook.

LEARNING AIDS

Though we have mentioned several of the book's learning aids above, it may be useful to summarize them here:

Cases. There are 52 cases scattered throughout the book. These have been adapted from real studies and provide real data. Students are expected to analyze the cases and draw conclusions in the same way as the authors of the studies. These cases are marked with a logo identifying the discipline most closely associated with the subject (accounting, finance, marketing, etc.).

Computer Output. For most of the worked examples throughout the text, we provide both the Minitab and SAS output. This exposes students to how statistics is actually applied in the real world. Whenever possible, we guide students in the interpretation of the output.

Minitab and SAS Instructions and Exercises. We provide instructions and commands for the actual use of these two popular packages in the appendixes of many chapters where they might actually be used. We have also included exercises in those appendixes permitting students to practice using the software.

Review Chapters. There are two review chapters in the text to help students identify the correct techniques. Chapter 11 appears midway through our discussion of statistical inference, and Chapter 18 reviews all of the statistical methods covered. Both feature flowcharts that summarize the systematic approach, as well as exercises and cases that require the use of *several, different* statistical procedures.

Exercises. There are approximately 1,300 exercises of varying levels of difficulty in this book:

- *Learning the Techniques* exercises appear at the end of most sections. These were developed to help students learn the arithmetic involved in a specific procedure.
- *Applying the Techniques* exercises follow. These stress when and why the technique is used and show how the results assist in the decision-making process.
- *Supplementary Exercises* appear at the end of each chapter. Because they cover all the topics presented in that chapter, they offer students practice in identifying which of the techniques encountered in that chapter should be employed. They also tend to be more realistic and are considered somewhat more difficult than the other two types of exercises.

NEW IN THIS EDITION

This second edition features a number of improvements suggested by reviewers and users of the first edition that we hope will make the task of teaching and learning statistics more enjoyable. The major changes are as follows:

1. We now treat the analysis of variance (Chapter 12) much as we do multiple regression—as a technique involving too much calculation to be done by hand. Aside from two examples, which are computed the "long way," all examples and many exercises deal with interpreting computer output. Some exercises require students to complete the calculation of the relevant statistics in situations where most of the preliminary calculations have already been provided. For instructors and students who prefer to perform the analysis of variance by hand, Appendix 12.A provides the shortcut computations.
2. Chapters 19 (Time Series Analysis and Forecasting) and 20 (Index Numbers) have been rewritten to emphasize understanding the concepts as well as calculating the statistics.
3. Most sections now have *Self-Correcting Exercises.* These are exercises for which complete solutions have been provided in the chapter appendix. Students can work on these exercises and correct any mistakes themselves.
4. We've added about 500 new exercises and improved some of the others. Many exercises now have codes identifying the particular area of business and economics to which they apply.
5. New cases have been created, many of which require the use of a computer software package. The term *minicase* has been eliminated, and some former minicases are now called *cases.*
6. We now refer to the *required conditions* of statistical techniques, as opposed to the *assumptions.*
7. The overall appearance and readability of the text has been improved in a variety of ways, including the creation of many additional summary boxes for easy student reference.

8. Two new sections—describing the exponential distribution (Section 4.8) and the sign test (Section 14.3) have been created. The description of the *p*-value of a test (Section 7.6) appears earlier in Chapter 7. We now explain more fully what this statistic measures and how it is interpreted. In addition, we show how to calculate the *p*-value only when the test statistic is normally distributed.
9. New *computer output exercises* appear in many sections. These require students to analyze and interpret computer output. There are also new *software practice* exercises in the Minitab and SAS appendixes of many chapters. These exercises provide drill and practice in the use of the software.

TEACHING AIDS

To assist professors, we have provided a number of teaching aids. All of these aids are available from Wadsworth Publishing.

An *Instructor's Resource Book with Test Bank* includes the following elements:

1. Suggestions about teaching statistics using the systematic approach.
2. Transparency masters keyed to the teaching suggestions.
3. Teaching notes for each case, detailing goals of the case, assignment questions, analysis and solution, teaching strategy, and (where necessary) Minitab computer instructions.
4. A write-up of supplemental topics that have been omitted from the text but that some instructors may wish to cover (these have been formatted for easy reproduction and distribution to students):
   a. Joint probability distributions and covariance
   b. Continuous probability distributions with calculus
   c. Deriving the normal equations
5. SPSS instructions which can be used instead of Minitab and SAS (these too can be copied and distributed).
6. A test bank containing about 600 problems and answers, and a description of our approach to testing.

A *Solutions Manual* is also available. It furnishes detailed solutions to almost all of the textbook's exercises. These were produced by the authors with independent assistance from teaching assistants.

A *Data Disk* is available that stores the data from 26 of the cases as well as data for exercises requiring computer use.

For students, we have written a *Study Guide* that contains overviews of each chapter in the text, examples illustrating specific techniques, and exercises and their solutions. For use with the *Study Guide,* we offer the *Study Guide Tutorial Software,* which enables students to practice using appropriate statistical techniques as they work through 35 problems from the two review chapters (Chapters 11 and 18).

Interested instructors are advised to contact Wadsworth Publishing for the *Study Guide Tutorial Software*, which can be copied for student or computer laboratory use as they wish.

Wadsworth Publishing has made available an *option* to purchase this text packaged with the *Student Edition of Microstat II*, a powerful and easy-to-use statistical package. For less than the price of a study guide, students can have a personal copy of this software for use in the business and economic statistics course as well as other courses throughout their academic career. For further information on this option, please contact Wadsworth Publishing Company.

This book was developed from several courses we've taught in business and economics programs in a total of ten universities over a combined 45 years of teaching. We are most grateful to our colleagues, our teaching assistants, and especially our students, whose helpful suggestions, comments, and criticisms have benefited this text. We also acknowledge the excellent work of our word processor, Elsie Grogan.

The following reviewers also provided valuable suggestions and comments: Bruce Bowerman, Miami University; Maggie Capen, East Carolina University; Henry Crouch, Pittsburg State University (Kansas); Tim Daciuk, Ryerson Polytechnic Institute; Paul Eaton, Northern Illinois University; David Eldredge, Murray State University; Myron Golin, Widener University; Bhisham Gupta, University of Southern Maine; Robert C. Hannum, University of Denver; Iris B. Ibrahim, Clemson University; J. Morgan Jones, University of North Carolina; Howard Kaplon, Towson State University (Maryland); John Lawrence, California State University, Fullerton; Charles Lienert, Metropolitan State College (Denver); Yih-Wu Liu, Youngstown State University; Alan Neebe, University of North Carolina at Chapel Hill; Dennis Oberhelman, University of South Carolina; Nancy V. Phillips, University of Texas at Austin; Carl Quitmeyer, George Mason University; Farhad Raiszadeh, University of Tennessee at Chattanooga; Andrew Russakoff, St. John's University; Mike Ryan, University of South Carolina; Sunil Sapra, State University of New York, Buffalo; Stanley Schultz, Cleveland State University; Edwin Sexton, Wichita State University; Dale Shafer, Indiana University of Pennsylvania; Michael Sklar, Emory University; Craig Slinkman, University of Texas at Arlington; Jae H. Song, St. Cloud State University; William Stein, Texas A & M University; Jeffrey Strieter, State University of New York, Brockport; Will Terpening, Gonzaga University; Martin T. Wells, Cornell, University; Jim Willis, Louisiana State University; Marvin Wolfmeyer, Winona State University; Chin Yang, Clarion University; and Ben Zirkle, Virginia Western Community College.

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