Fourth Edition

STATISTICS FOR MANAGEMENT

Richard I. Levin

Fourth Edition

STATISTICS FOR MANAGEMENT

Richard I. Levin

The University of North Carolina, Chapel Hill

Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

Library of Congress Cataloging-in-Publication Data

LEVIN, RICHARD I.
Statistics for management.

Includes index.
1. Social sciences—Statistical methods.
2. Commercial statistics. 3. Management—
Statistical methods. I. Title.
HA29.L3887 1987 519.5 86-21177
ISBN 0-13-845348-9

Editorial/production supervision: Esther S. Koehn and Cheryl Smith
Interior and cover design: Maureen Eide
Manufacturing buyer: Ed O'Dougherty
Photo research: Charlotte Green

P-H International Series in Management

© 1987, 1984, 1981, 1978 by Prentice-Hall, Inc.
A division of Simon & Schuster
Englewood Cliffs, New Jersey 07632

All rights reserved. No part of this book may be reproduced, in any form or by any means, without permission in writing from the publisher.

Printed in the United States of America

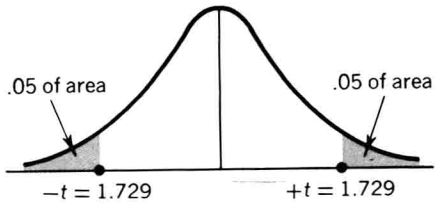
10 9 8 7 6 5 4 3 2 1

ISBN 0-13-845348-9 01

Prentice-Hall International (UK) Limited, *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall Hispanoamericana, S.A., *Mexico*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*

t DISTRIBUTION

Areas in Both Tails Combined for Student's *t* Distribution.*



EXAMPLE: To find the value of *t* which corresponds to an area of .10 in both tails of the distribution combined, when there are 19 degrees of freedom, look under the .10 column, and proceed down to the 19 degrees of freedom row; the appropriate *t* value there is 1.729.

Degrees of freedom	Area in both tails combined			
	.10	.05	.02	.01
1	6.314	12.706	31.821	63.657
2	2.920	4.303	6.965	9.925
3	2.353	3.182	4.541	5.841
4	2.132	2.776	3.747	4.604
5	2.015	2.571	3.365	4.032
6	1.943	2.447	3.143	3.707
7	1.895	2.365	2.998	3.499
8	1.860	2.306	2.896	3.355
9	1.833	2.262	2.821	3.250
10	1.812	2.228	2.764	3.169
11	1.796	2.201	2.718	3.106
12	1.782	2.179	2.681	3.055
13	1.771	2.160	2.650	3.012
14	1.761	2.145	2.624	2.977
15	1.753	2.131	2.602	2.947
16	1.746	2.120	2.583	2.921
17	1.740	2.110	2.567	2.898
18	1.734	2.101	2.552	2.878
19	1.729	2.093	2.539	2.861
20	1.725	2.086	2.528	2.845
21	1.721	2.080	2.518	2.831
22	1.717	2.074	2.508	2.819
23	1.714	2.069	2.500	2.807
24	1.711	2.064	2.492	2.797
25	1.708	2.060	2.485	2.787
26	1.706	2.056	2.479	2.779
27	1.703	2.052	2.473	2.771
28	1.701	2.048	2.467	2.763
29	1.699	2.045	2.462	2.756
30	1.697	2.042	2.457	2.750
40	1.684	2.021	2.423	2.704
60	1.671	2.000	2.390	2.660
120	1.658	1.980	2.358	2.617
Normal Distribution	1.645	1.960	2.326	2.576

* Taken from Table III of Fisher and Yates, *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver & Boyd, Edinburgh) and by permission of the authors and publishers.

STATISTICS FOR MANAGEMENT

此为试读,需要完整PDF请访问: www.ertongbook.com

Preface

A new edition of a textbook is a combination of ideas, which have stood the test of time, and new approaches and pedagogies, which will help both teacher and student. A few words, then about what we've done in the fourth edition.

Proven Approaches

This fourth edition of *Statistics for Management* retains all of those characteristics of the first three editions that made it an attractive choice for so many instructors and a learning help to so many students.

BASIC APPROACH. The teaching philosophy of this edition remains unchanged—to remove the anxiety students associate with statistics. Readers will find this edition is still the most easily understood major business statistics textbook written today.

TEACHING PEDAGOGY. Our careful step-by-step explanations of statistical tools and problem solving use extensions of what the student already knows. Each step in solving a problem is thoroughly covered—nothing is left out and we don't use the phrase "it can be shown." If it needs to be shown, we do it in the text.

MINIMUM MATHEMATICAL/STATISTICAL NOTATION. We have never believed in obscuring the teaching of statistics by complex difficult-to-understand mathematical/statistical notation. We limit our use of notation to what is absolutely necessary. We keep it consistent throughout the text and we explain the notation we do use thoroughly with examples. We have always been committed to teaching students how to *use* statistics effectively, not how to make things unnecessarily complex.

COMPREHENSIVE TOPIC COVERAGE. Our third edition contained the most comprehensive set of topics of any major business statistics textbook; this new edition maintains that position by adding important useful new statistical topics. These are discussed individually under "new with this edition" which follows.

PEDAGOGICAL AIDS. Both previous users and new users of *Statistics for Management* will be pleased with the broad set of pedagogical aids built into

this text and its accompanying manuals:

- A comprehensive computer data base exercise continued throughout the book with problems and questions for each chapter
- An annotated equation review at the end of each chapter
- Consistent and complete numbering of every equation in the book each time it is used
- A glossary of terms for each new idea introduced in the chapter
- An extensive set of mixed chapter review exercises at the end of every chapter
- A flow chart at the end of each chapter to review the statistical procedures discussed in the chapter and to aid in determining which procedure to use in various situations
- Over 1,500 marginal notes to make studying easier
- Over 1,000 text exercises, with answers provided for the even-numbered exercises
- A chapter concepts test at the end of each chapter in which true-false, multiple-choice, and short-answer questions are used to reinforce what students have learned
- Art and color used extensively to explain difficult concepts
- A photographically described situation introducing each chapter, in which a decision maker is attempting to use statistical concepts in his or her work; this problem is later worked out in detail in the chapter
- A comprehensive instructor's manual with completely worked-out answers to every exercise, a student workbook and study guide, and a test bank
- Each chapter now provides the student with a "conceptual case," a decision-making situation *without any data,* in which managers are being asked to reflect on (1) what data should be collected, (2) what kinds of statistical analyses might be appropriate given the organization's needs, and (3) what we should do with the answer when we find it. Use of this approach will encourage students to worry more about what you do with the answer when you get it and somewhat less about how to "crank it out."
- An index of applications listing each exercise under one or more of nearly a hundred possible areas in which it is applied.

New with This Edition

Major changes in this fourth edition of *Statistics for Management* fall into three categories:

NEW TOPICS. All of the statistical topics found in the third edition have been retained . . . some expanded. Multiple chapter treatment of statistical inference, regression, probability, and statistical fundamentals put emphasis where it belongs. In this edition we've added an additional useful nonparametric test (the Kruskal-Wallis test). New material on the use of Bayes' Theorem and evaluating new information in decision trees further expands the applicability of this very useful technique. New applied material has replaced those parts of the descriptive statistics sections that are really not relevant to instructors and students seeking understanding, not repetitive drill. The material from the "Afterword" section of the third edition has been expanded and integrated into several of the main chapters in this edition.

NEW LEARNING AIDS. Previous users of *Statistics for Management* made good use of the broad set of teaching aids that were built into the book. In addition to those already described, this edition provides:

- A new section for all applied chapters called "From the Textbook to the Real World" in which we demonstrate interesting real world applications of the techniques explained in the chapters.
- Half of all the exercises in the entire text are new with this edition.
- Service and "high tech" industries and firms are the subject of many more of the exercises in this edition.
- To each chapter we've added a handful of challenging exercises for students who want to test their limits and for instructors who want to upgrade assignments.

ADDITIONAL USE OF THE COMPUTER. In this edition we retain the very successful computer data base exercise at the end of each chapter. In addition, we have added extensive new computer material to the chapters on descriptive statistics, hypothesis testing, chi-square and analysis of variance, and regression. Users of this edition will find a great deal more computer output in these chapters.

Many People Deserve Credit

A textbook is never the work of one person — more a combination of ideas, suggestions, reviews, contributions, and work involving many folks. Of all the people involved in this edition, none contributed more than my friend David S. Rubin of the University of North Carolina. He has influenced my life these last ten years as a colleague, a contributor, and a sounding board, but mostly as a good friend.

Sincere thanks are due to my editor Dennis Hogan, without whose encouragement, advice, and sense of publishing *Statistics for Management* would not be the book it is today.

Thanks are also due to the reviewers of this edition and users of previous editions for their help, support, and many, many fine ideas. In

particular I would like to thank Dr. E. N. Onunkwo, South Carolina State College; Dr. Carol Lee Stamm, Western Michigan University; Dr. Donald Goldschen, University of the District of Columbia; Dale Sauers, York College; Janeth M. Avary, Angelo State University; John McGill, Merrimack College; Dr. Marca Scafe, Walsh College of Business and Accountancy; Anthony R. Paige, Walsh College of Business and Accountancy; Glen Behler, Walsh College of Business and Accountancy; Dr. Robert Rogan, Slippery Rock University; Dr. John Daughtry, East Carolina University; Dr. Bill Jedicka, Harper College; Dr. Irene Hammerbacher, Iona College; Dr. Frederick Derrick, Loyola College, and Dr. Gary Kelley, West Texas State University.

I am also grateful to the literary executor of the late Sir Ronald Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group, Ltd. London for permission to reprint tables III and IV from their book, *Statistical Tables for Biological, Agricultural and Medical Research* (6th edition, 1974).

A new colleague came with this edition, Esther Koehn, of Prentice-Hall. She has suffered with us for more than a year now in the production of this new edition and her patience, mild manner, endless telephone calls, and marvelous equanimity when everything goes wrong all deserve our respect and thanks!

Those people who have been involved with us from the first edition in 1978 to today, colleagues, reviewers, students, instructors, editors, publishers, and many, many good friends, make the difference. They are the character and soul of our book. We sincerely hope all of them and all of you like what we have done.

DICK LEVIN
Chapel Hill, N.C.

Chapter Opening Photo Credits: Chapter 2: Alan Carey/The Image Works Chapter 3: Camerique Chapter 4: Barbara Rios/Photo Researchers Chapter 5: Resorts International Casino Hotel Chapter 6: Coca-Cola Company Chapter 7: Ken Karp Chapter 8: Camerique Chapter 9: Bohdam Hrynewych/Southern Light Chapter 10: Peter Menzel/Stock Boston Chapter 11: MIT photo by Calvin Campbell Chapter 12: Laimute E. Druskis Chapter 13: United Nations Chapter 14: Bolton Valley Resort, VT. Chapter 15: Bethlehem Steel Corp. Chapter 16: Irene Springer

Contents

Preface x

1 Introduction 2

1-1 Getting Started 1-2 History 1-3 Subdivisions within Statistics
1-4 Strategy, Assumptions, and Approach

2 Arranging Data to Convey Meaning; Tables and Graphs 6

2-1 How Can We Arrange Data? 2-2 Examples of Raw Data
2-3 Arranging Data Using the Data Array and the Frequency Distribution 2-4 Constructing a Frequency Distribution
2-5 Graphing Frequency Distributions
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise Flow Chart

3 Summary Measures of Frequency Distributions 58

3-1 Beyond Tables and Graphs; Descriptive Measures of Frequency Distributions
3-2 A Measure of Central Tendency: The Arithmetic Mean
3-3 A Second Measure of Central Tendency: The Weighted Mean
3-4 A Third Measure of Central Tendency: The Geometric Mean
3-5 A Fourth Measure of Central Tendency: The Median
3-6 A Final Measure of Central Tendency: The Mode
3-7 Comparing the Mean, Median, and Mode
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise Flow Chart

此为试读,需要完整PDF请访问: www.ertongbook.com

4 Measuring Variability 108

4-1 Measures of Dispersion 4-2 Dispersion: Distance Measures
4-3 Dispersion: Average Deviation Measures 4-4 Relative Dispersion: The Coefficient of Variation 4-5 Exploratory Data Analysis
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise Flow Chart

5 Probability 1: Introductory Ideas 148

5-1 History and Relevance of Probability Theory
5-2 Some Basic Concepts in Probability 5-3 Three Types of Probability
5-4 Probability Rules 5-5 Probabilities under Conditions of Statistical Independence 5-6 Probabilities under Conditions of Statistical Dependence
5-7 Revising Prior Estimates of Probabilities: Bayes' Theorem
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise Flow Chart

6 Probability 11: Distributions 204

6-1 Introduction to Probability Distributions 6-2 Random Variables
6-3 Use of Expected Value in Decision Making
6-4 The Binomial Distribution 6-5 The Poisson Distribution
6-6 The Normal Distribution: A Distribution of a Continuous Random Variable
6-7 Choosing the Correct Probability Distribution
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise Flow Chart

7 Sampling and Sampling Distributions 272

7-1 Introduction to Sampling 7-2 Random Sampling
7-3 Introduction to Sampling Distributions 7-4 Sampling Distributions in More Detail 7-5 An Operational Consideration in Sampling: The Relationship between Sample Size and Standard Error
7-6 Design of Experiments
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise Flow Chart

8 Estimation 318

8-1 Introduction 8-2 Point Estimates 8-3 Interval Estimates: Basic Concepts 8-4 Interval Estimates and Confidence Intervals
8-5 Calculating Interval Estimates of the Mean from Large Samples
8-6 Calculating Interval Estimates of the Proportion from Large Samples 8-7 Interval Estimates Using the *t* Distribution
8-8 Determining the Sample Size in Estimation
Terms Equations Review Exercises Concepts Test Conceptual Case Computer Data Base Exercise Flow Chart

9 Testing Hypotheses 366

9-1 Introduction 9-2 Concepts Basic to the Hypothesis-Testing Procedure 9-3 Testing Hypotheses 9-4 Hypothesis Testing of Means—Samples with Population Standard Deviations Known
9-5 Measuring the Power of a Hypothesis Test 9-6 Hypothesis Testing of Proportions—Large Samples 9-7 Hypothesis Testing of Means under Different Conditions 9-8 Hypothesis Testing for Differences between Means and Proportions 9-9 Prob Values—Another Way to Look at Testing Hypotheses 9-10 Using the Computer to Test Hypotheses
Terms Equations Review Exercises Concepts Test Conceptual Case Computer Data Base Exercise From the Textbook to the Real World Flow Chart

10 Chi Square and Analysis of Variance 440

10-1 Introduction 10-2 Chi-Square as a Test of Independence
10-3 Chi-Square as a Test of Goodness of Fit 10-4 Analysis of Variance 10-5 Inferences about a Population Variance
10-6 Inferences about Two Population Variances
Terms Equations Review Exercises Concepts Test Conceptual Test Computer Data Base Exercise From the Textbook to the Real World Flow Chart

11 Simple Regression and Correlation 506

11-1 Introduction 11-2 Estimation Using the Regression Line
11-3 Correlation Analysis 11-4 Making Inferences about Population Parameters
11-5 Using Regression and Correlation Analyses: Limitations, Errors, and Caveats

Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise
From the Textbook to the Real World Flow Chart

12 Multiple Regression and Modeling Techniques 566

12-1 Multiple Regression and Correlation Analysis 12-2 Finding the Multiple Regression Equation 12-3 The Computer and Multiple Regression
12-4 Making Inferences about Population Parameters
12-5 Modeling Techniques
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise
From the Textbook to the Real World Flow Chart

13 Nonparametric Methods 624

13-1 Introduction to Nonparametric Statistics 13-2 The Sign Test for Paired Data 13-3 Rank Sum Tests: The Mann-Whitney U Test, the Kruskal-Wallis Test 13-4 One-Sample Runs Test
13-5 Rank Correlation 13-6 The Kolmogorov-Smirnov Test
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise From the Textbook to the Real World Flow Chart

14 Time Series 682

14-1 Introduction 14-2 Variations in Time Series 14-3 Trend Analysis 14-4 Cyclical Variation 14-5 Seasonal Variation
14-6 Irregular Variation 14-7 A Problem Involving All Four Components of a Time Series 14-8 Time Series Analysis in Forecasting
Terms Equations Review Exercises Concepts Test
Conceptual Case Computer Data Base Exercise From the Textbook to the Real World Flow Chart

15 Index Numbers 728

15-1 Defining an Index Number 15-2 Unweighted Aggregates Index
15-3 Weighted Aggregates Index 15-4 Average of Relatives Methods
15-5 Quantity and Value Indices 15-6 Issues in Constructing an Index Number

Terms Equations Review Exercises Concepts Test Conceptual Case Computer Data Base Exercises From the Textbook to the Real World Flow Chart

16 Decision Theory 768

16-1 The Decision Environment 16-2 Expected Profit under Uncertainty: Assigning Probability Values 16-3 Using Continuous Distributions in Decision Theory: Marginal Analysis 16-4 Utility as a Decision Criterion 16-5 Helping Decision Makers Supply the Right Probabilities 16-6 Decision-Tree Analysis
Terms Equations Review Exercises Concepts Test Conceptual Case From the Textbook to the Real World

Answers to Chapter Concepts Tests 819

Appendix Tables 823

Answers to Selected Even-Numbered Exercises 850

Bibliography 883

Index 887

STATISTICS FOR MANAGEMENT

1 Introduction

1. GETTING STARTED, 2
2. HISTORY, 3
3. SUBDIVISIONS WITHIN STATISTICS, 4
4. STRATEGY, ASSUMPTIONS, AND APPROACH, 5

This book was written for students taking statistics for the first time. A glance at this chapter should convince any concerned citizen and future manager that a working knowledge of basic statistics will be quite useful in coping with the complex problems of our society. Your first look will also convince you that this book is dedicated to helping you acquire that knowledge with virtually no previous formal mathematical training and with no pain at all.

1-1 GETTING STARTED

Different meanings of statistics depending on use

The word *statistics* means different things to different people. To a football fan, statistics are the information about rushing yardage, passing yardage, and first downs, given at halftime. To the manager of a power generating station, statistics may be information about the quantity of pollutants being released into the atmosphere. To a school principal, statistics are information on absenteeism, test scores, and teacher salaries. To a medical researcher investigating the effects of a new drug, statistics are evidence of the success of research efforts. And to a college student, statistics are the grades made on all the quizzes in a course this semester.

此为试读,需要完整PDF请访问: www.ertongbook.com