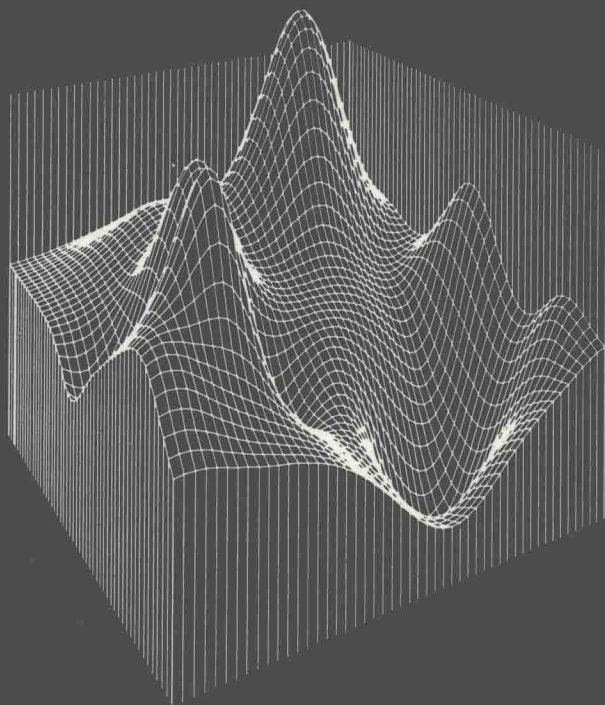


STATISTICS for the SOCIAL SCIENCES



R. Mark Sirkin

STATISTICS for the SOCIAL SCIENCES



R. Mark Sirkin



SAGE Publications

International Educational and Professional Publisher

Thousand Oaks London New Delhi

Copyright © 1995 by Sage Publications, Inc.

All rights reserved. No part of this book may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without permission in writing from the publisher.

For information address:



SAGE Publications, Inc.
2455 Teller Road
Thousand Oaks, California 91320
E-mail: order@sagepub.com

SAGE Publications Ltd.
6 Bonhill Street
London EC2A 4PU
United Kingdom

SAGE Publications India Pvt. Ltd.
M-32 Market
Greater Kailash I
New Delhi 110 048 India

Printed in the United States of America

Library of Congress Cataloging-in-Publication Data

Sirkin, R. Mark.

Statistics for the social sciences / R. Mark Sirkin.

p. cm.

Includes index.

ISBN 0-8039-5144-2 (cl). — ISBN 0-8039-5145-0 (pb)

1. Social Sciences—Statistical methods. 2. Statistics.

I. Title.

HA29.S5763 1995

519.5—dc20

94-18897

97 98 99 00 01 10 9 8 7 6 5 4

Sage Production Editor: Diane S. Foster

Preface

To the students and the instructors using this text, welcome! This book is designed to teach introductory statistics primarily to undergraduates majoring in the social sciences. I have tried to use a wide variety of examples that are both relevant to the social and behavioral sciences and of interest to today's undergraduate students. This book may be used as a text in a statistics course geared to any of the social sciences, or it may be used as part of a course or sequence of courses in research methodology.

Why another statistics text? After years of teaching students, many of whom claim to be victims of math anxiety, I wanted to provide a teaching device that could be used by the nonmathematically inclined, but at the same time would cover all relevant topics thoroughly enough to meet the needs of all students. To do this, (a) I am assuming that the only recent math courses that readers have had did not go much beyond introductory algebra and (b) many of the more onerous calculations encountered can be done on a computer. So, while all relevant calculations are presented here, emphasis—particularly in the later chapters—is also placed on the analysis of computer printouts.

Another thing that I have done is to begin with as little computational work as possible and move slowly into the math. This approach should enable students to gradually overcome their fear of numbers, build confidence in their ability to handle quantitative work, and (who knows?) even come to enjoy what they are doing. Note that many of the earlier topics, such as those on the scientific method, levels of measurement, and interpretation of tables, are given far less attention in many other statistics texts than is given here. By including them, it is my hope that students will see statistics as linked to the more comprehensive field of research methodology, rather than just as an entity unto itself. My

emphasis is on the analysis and interpretation of data, rather than on how those data are collected. However, I do want the reader to have a feel for the way interpretation of data is related to the methods whereby the data were obtained. This approach also guards the student from immediate inundation in calculation.

Examples and exercises are designed to mirror the subject matter explored in all the social science disciplines. Easily spotted throughout the text are examples that can be identified with sociology, political science, communications, psychology, social work, management, education, and other disciplines. In selecting examples, I have chosen topics that should be of general interest to undergraduates in each field or to all undergraduates in the social sciences. I have also sought to include examples that reflect applied research as well as basic research. Such examples and exercises should help students retain interest in the course material. This has been my experience with my own students after having “test marketed” drafts of these chapters.

Each chapter begins with an introduction and a list of key concepts that are introduced for the first time in that particular chapter. In the body of each chapter, key concepts are presented in boldface type with their accompanying definitions in italics. Boxes are used to provide supplemental information reinforcing certain topics presented in the chapter. The exercises at the end of the chapter are presented in the same order in which the material is presented within the chapters, so that they may be undertaken prior to the completion of all topics presented in the chapter. There are ample exercises so that instructors may assign at their discretion a subset of the problems and still cover all the appropriate statistical procedures presented in the chapter. Thus more homework problems are included than one may need to assign.

A word about the ordering of the chapters: Chapters 1 through 6 are designed to introduce students to concepts of empirical research and the basic working vocabulary of statistics. These chapters cover the scientific method, levels of measurement and formats for manipulating and presenting data, operational definitions and index construction, central tendency and dispersion measures, and contingency tables. Although all statistics introductions cover central tendency and dispersion, few give as much emphasis to the other topics I have done here. This additional coverage will be of particular value if you are using this text in a combined methods/statistics course or if students have not already taken a separate methods course.

Chapters 7 through 10, together with Chapter 12, cover inferential statistics. Chapter 7 is an overview of the entire area and should be read

first, followed by Chapter 11. From that point, it is possible to cover the remaining inferential statistics chapters in any order. Although generally one presents the two-sample t test prior to covering analysis of variance, it is possible, for instance, to cover chi-square without having first covered ANOVA.

Chapters 11 (association measures) and 13 (linear regression) cover additional topics in descriptive statistics and could be presented prior to the chapters on statistical inference. Chapter 14, however, can only be fully utilized if students have already had several of the inferential statistics topics in addition to linear regression. If you have a two-course sequence, it is possible to group the descriptive statistics chapters in the first course (Chapters 1-6, 11, and 13) and the inferential chapters in the second course (Chapters 7-10 and 12), culminating with Chapter 14, which interweaves the two threads. In short, I have designed the chapters with the knowledge that there are many possible sequences of topics and that we all march to different drummers.

For the instructor, I will save more of my comments for the instructor's manual that accompanies the book. In that manual, I will give suggestions gleaned from years of teaching this material. In turn, I hope that you will share your observations—both positive and negative—with me. You may contact me in care of Sage Publications. Best wishes for a positive teaching and learning experience.

Note to Students

Unlike many other courses, the material presented here is often cumulative in nature. This means that to understand today's assignment, you need to understand the material previously presented. If you do not understand today's topic, you may not be able to understand tomorrow's. Accordingly, do not try to "cram" this material. Learn it at a regular pace. If something confuses you, stop and reread it. If you still do not understand the topic, ask your instructor. Don't feel self-conscious about raising your hand in class and asking. You need to understand the material! Moreover, if you are confused, the odds are that others are likewise having trouble. Never assume that you are the only one "snowed." One other suggestion: attend class! You will learn better with the reinforcement provided by your instructor in class and you will have your instructor at hand to help explain any material that is causing you difficulty. Statistics calls for attendance.

It is my hope that this book will help contribute to a worthwhile educational experience for you. Best wishes with it!

Acknowledgments

There are many people who contributed directly or indirectly to this book. Indirectly, all those professors and colleagues who helped me develop my interest in statistics and methodology deserve my thanks. Likewise, my family deserves my gratitude for their patience and support during a period when the demands of the book interfered with my family activities and responsibilities. Finally, I owe a debt to all of my colleagues in the Wright State University Department of Political Science and the College of Liberal Arts for their encouragement and support.

Of those who contributed directly, nobody deserves greater praise than Joanne Ballmann, who typed, retyped, and often re-retyped the manuscript. I don't think that Joanne realized how difficult a job it would be to prepare a text so full of symbols, Greek letters, and algebraic equations. However, she tackled the project with much patience and good humor. Thanks! My gratitude also goes to Bruce Stiver and Gloria Sparks, in the graphic arts office of Wright State's Media Services, who prepared the many figures and graphs found throughout this book.

Thanks also to the College of Liberal Arts at Wright State and its dean, Perry Moore. The college provided me with funds for travel, graphics, and manuscript preparation. In the process of gaining this seed money, I received support and assistance also from Jim Jacob and Charlie Funderburk, my department chairs, Bill Rickert, associate dean of our college, and of course, my colleagues on the college's Faculty Development Committee. And to my many friends at Wright State who provided me with ideas and examples from their various social science disciplines, my gratitude goes out to you.

Many faculty members at universities throughout the country read and commented on drafts of chapters. Specifically, I would like to thank

professors Rick Brown, California State University at Fresno; Alfred DeMaris, Bowling Green State University, Ohio; David Dooley, University of California at Irvine; Donald Gross, University of Kentucky, Lexington; Carl J. Huberty, University of Georgia, Athens; Garth Lipps, Statistics Canada, Ottawa; and John P. McIver, University of Colorado, Boulder. Many other helpful reviewers provided useful assistance during the course of this manuscript's development.

Thanks also to C. Deborah Laughton and Diane Foster, my editors; their assistants, Nancy Hale and Tricia Howell Bennett; and Andrea Swanson and Christina Hill, my typesetters; as well as all of the many other fine people at Sage who worked with me on the project.

Also, one learns from one's students. I wish to thank my students at Wright State University who took my classes in quantitative methods during the past 2 years and used earlier drafts of the chapters as text material. Their comments and feedback contributed greatly to improvements I was able to make in these chapters. In particular, Marge Gibson, Ann Koch, and Connie Weber, three of my students, were kind enough to supply detailed commentary—and proofreading—for several draft chapters. Thanks also to Chang Li for assisting in the index preparation and to Farah Sirkin for helping type the index.

I am grateful to the Longman Group UK Ltd., on behalf of the Literary Executor of the late Sir Ronald A. Fisher, F.R.S., and Dr. Frank Yates, F.R.S., for permission to reproduce tables II1, III, IV, V, and VII from *Statistical Tables for Biological, Agricultural and Medical Research* 6/e (1974).

Thanks to the SAS Institute, Inc., whose software is used to generate printouts incorporated into this text and the accompanying Instructor's Manual. Also, in the Instructor's Manual, several printouts are reproduced using SPSS Release 3.0. SPSS is a registered trademark of SPSS, Inc.

I wish to thank CQ Press for permission to reprint material from H. Stanley and R. Niemi (1992), *Vital Statistics on American Politics* (3rd ed.) and to Americans for Democratic Action for allowing me to use their ratings of members of Congress.

Yale University Press permitted my use of data and excerpts from C. L. Taylor and D. Jodice (1983), *World Handbook of Political and Social Indicators* and Freedom House, Inc. allowed the use of data from R. Gastil (1980), *Freedom in the World* as initially reprinted in Taylor and Jodice, above. I appreciate their cooperation.

Data were also utilized from *Global Studies: The Middle East*, 2nd ed., by William Spencer. Copyright © 1988 by The Dushkin Publishing Group, Inc., Guilford, CT 06437. I thank them for providing the permission.

Others too numerous to mention have contributed to this textbook. To all of them, thanks! Any errors to be found are, of course, not theirs but mine.

◆ KEY CONCEPTS ◆

empirical	concept	positively related/ a positive relationship
normative	variable	off diagonal
scientists	induction	inversely related/ an inverse relationship
hypothesis/hypotheses	deduction	causation
social sciences	experiment	temporal sequence
scientific method	scientific law	dependent variable
table/cross-tabulation/ contingency table	data (pl.)/datum or piece of data (sing.)	independent variable
marginal totals	necessary condition	criterion variable
grand total	sufficient condition	predictor variable
cell (of a table)	theory	unit of analysis
association	main diagonal	statistics

Brief Contents

1	How We Reason	1
2	Levels of Measurement and Forms of Data	33
3	Defining Variables	59
4	Measuring Central Tendency	77
5	Measuring Dispersion	115
6	Constructing and Interpreting Contingency Tables	135
7	Statistical Inference and Tests of Significance	175
8	Probability Distributions and One-Sample z and t Tests	207
9	Two-Sample t Tests	247
10	One-Way Analysis of Variance	279
11	Measuring Association in Contingency Tables	315
12	The Chi-Square Test	345
13	Correlation-Regression Analysis	383
14	Additional Aspects of Correlation- Regression Analysis	425

Detailed Contents

Preface	xv
Note to Students	xix
Acknowledgments	xxi

1

How We Reason

1

KEY CONCEPTS	xxiv
INTRODUCTION	1
SETTING THE STAGE	2
SCIENCE	5
THE SCIENTIFIC METHOD	8
TESTING HYPOTHESES	10
FROM HYPOTHESES TO THEORIES	14
TYPES OF RELATIONSHIP	16
ASSOCIATION AND CAUSATION	21
THE UNIT OF ANALYSIS	23
CONCLUSION	27
EXERCISES	28

2

Levels of Measurement and Forms of Data

33

KEY CONCEPTS	32	
INTRODUCTION	33	
MEASUREMENT	34	
NOMINAL LEVEL OF MEASUREMENT	34	
ORDINAL LEVEL OF MEASUREMENT	38	
LIKERT SCALES	40	
SCORES VERSUS FREQUENCIES	42	
INTERVAL AND RATIO LEVELS OF MEASUREMENT	43	
TABLES CONTAINING NOMINAL LEVEL OF MEASUREMENT VARIABLES		50
CONCLUSION	52	
EXERCISES	53	

3

Defining Variables

59

KEY CONCEPTS	58	
INTRODUCTION	59	
GATHERING THE DATA	60	
OPERATIONAL DEFINITIONS	61	
INDEX AND SCALE CONSTRUCTION	65	
VALIDITY	69	
RELIABILITY	71	
CONCLUSION	72	
EXERCISES	74	

4

Measuring Central Tendency

77

KEY CONCEPTS	76
INTRODUCTION	77
CENTRAL TENDENCY	78
THE MEAN	79
THE MEDIAN	84
USING CENTRAL TENDENCY	91
THE MODE	92
CENTRAL TENDENCY AND LEVELS OF MEASUREMENT	96
SKEWNESS	98
OTHER GRAPHIC REPRESENTATIONS	101
CONCLUSION	105
EXERCISES	105

5

Measuring Dispersion

115

KEY CONCEPTS	114
INTRODUCTION	115
VISUALIZING DISPERSION	116
THE RANGE	117
THE MEAN DEVIATION	117
THE VARIANCE AND STANDARD DEVIATION	120
THE COMPUTATIONAL FORMULAS FOR VARIANCE AND STANDARD DEVIATION	123
VARIANCE AND STANDARD DEVIATION FOR DATA IN FREQUENCY DISTRIBUTIONS	125
CONCLUSION	127
EXERCISES	128

6

Constructing and Interpreting Contingency Tables

135

KEY CONCEPTS	134
INTRODUCTION	135
CONTINGENCY TABLES	136
REGROUPING VARIABLES	137
GENERATING PERCENTAGES	140
INTERPRETING	144
CONTROLLING FOR A THIRD VARIABLE	150
PARTIAL TABLES	152
CAUSAL MODELS	157
CONCLUSION	158
EXERCISES	160

7

Statistical Inference and Tests of Significance

175

KEY CONCEPTS	174
INTRODUCTION	175
WHAT IS STATISTICAL INFERENCE?	176
RANDOM SAMPLES	178
COMPARING MEANS	180
THE TEST STATISTIC	185
PROBABILITIES	188
DECISION MAKING	189
DIRECTIONAL VERSUS NONDIRECTIONAL ALTERNATIVE HYPOTHESES (ONE-TAILED VERSUS TWO-TAILED TESTS)	192
CONCLUSION	197
EXERCISES	198

8

Probability Distributions and One-Sample z and t Tests

207

KEY CONCEPTS	206
INTRODUCTION	207
NORMAL DISTRIBUTIONS	208
THE ONE-SAMPLE z TEST FOR STATISTICAL SIGNIFICANCE	214
THE CENTRAL LIMIT THEOREM	217
THE NORMALITY ASSUMPTION	221
THE ONE-SAMPLE t TEST	223
DEGREES OF FREEDOM	226
THE t TABLE	227
AN ALTERNATIVE t FORMULA	229
A z TEST FOR PROPORTIONS	230
INTERVAL ESTIMATION	231
CONFIDENCE INTERVALS FOR PROPORTIONS	233
MORE ON PROBABILITY	235
PERMUTATIONS AND COMBINATIONS	239
CONCLUSION	240
EXERCISES	240

9

Two-Sample t Tests

247

KEY CONCEPTS	246
INTRODUCTION	247
INDEPENDENT SAMPLES VERSUS DEPENDENT SAMPLES	248
THE TWO-SAMPLE t TEST FOR INDEPENDENTLY DRAWN SAMPLES	250
ADJUSTMENTS FOR SIGMA-HAT SQUARED	261
INTERPRETING A COMPUTER GENERATED t TEST	263
THE TWO-SAMPLE t TEST FOR DEPENDENT SAMPLES	266