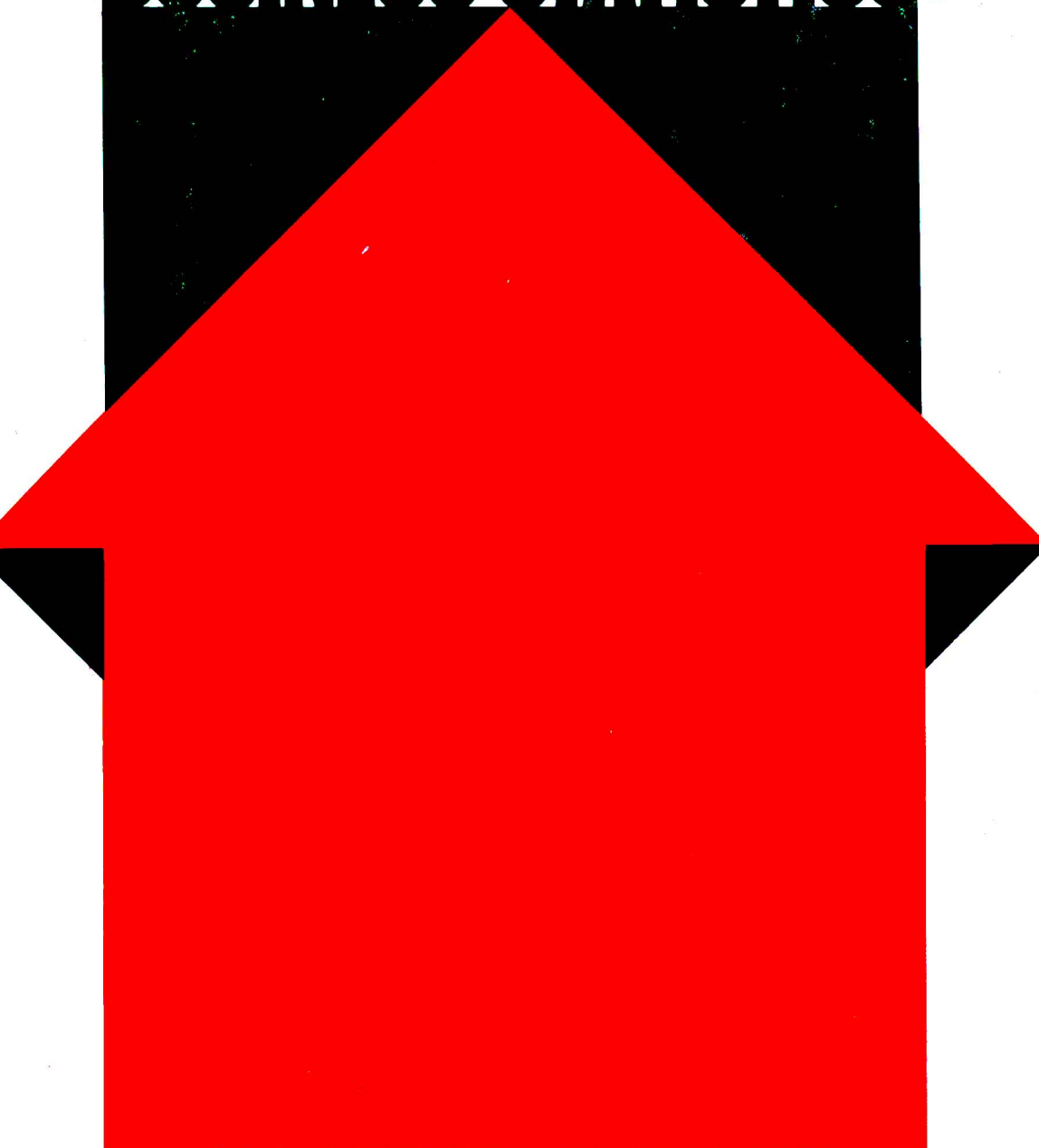
BUSINESS STATISTICS



WHY AND WHEN

LARRY E. RICHARDS/JERRY J. LaCAVA

SECOND EDITION

BUSINESS STATISTICS: Why and When

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Business Statistics

Preface

We are certainly grateful to those who used and provided feedback on the first edition. Although the approach and format were strongly applauded, two major shortcomings were identified. First, there was a consensus among the reviewers that our brevity was overdone in certain areas. Second, the problems in the first edition were viewed as *challenging* and closer to minicases and that there was a need for a more gradual progression from exercises designed to build computational skills to the more directive problems on the way to the minicases.

We have attempted to address both of the above issues by expanding the explanation in identified areas and by the addition of exercises and directive problems. With the addition of the exercises and directive problems, we have easily *quadrupled* the number of problems contained in the first edition.

Some of the other major changes between the first and second editions are:

1. A discussion of p values and the computation of Type II error has been added to Chapter 8.
2. Chapter 9 has been partitioned into decisions with and without sample information.
3. A discussion of multicollinearity and the use of dummy or indicator variables has been included in Chapter 11.
4. The approach taken in Chapter 15 to time series and forecasting has been totally changed to the more modern autoregressive models.

The motivation for the second edition remains ostensibly the same as for the first edition. The authors see three interrelated situations that demand a change in the format of the introductory course and text on basic business statistics. These situations are discussed below.

1. ***Basic business statistics texts are written with the right format for the wrong objective.*** Without exception, basic business statistics texts have a format which

is consistent with the "training of statisticians"—the "how to do it." Little if any effort is spent on WHY, WHERE, or WHEN—just HOW. These texts tend to follow the format of an introductory mathematical statistics text, omitting the math. Our objective in the first course is *not* the training of statisticians. Most of the students going through the first course in statistics will never perform a statistical analysis outside the classroom. Rather, they will find themselves in the roles of decision makers and consumers of analyses. We would argue that it is the WHY, WHEN, and WHERE of statistics that will truly be of value to most students. No doubt the first thing the student will forget is HOW. However, in his or her eventual role as decision maker and/or consumer of statistical analyses, what is important is an awareness of and an appreciation for existing statistical techniques. Thus, we believe the objective of introductory courses should be to *introduce* statistical procedures and techniques and thereby *motivate* students to (1) become aware of statistical techniques, (2) understand the logic of statistical inference, and (3) identify applications.

2. *Undergraduate business students are not motivated by basic statistics.* The typical business student comes into the first statistics course with a relatively weak mathematical background—convinced that he or she cannot do well in a mathematically oriented course. These students are subjected to abstract concepts, notation and symbolism, and a battery of irrelevant problems, and they are asked to perform statistical analyses. The texts devote little if any effort toward motivating the students but get right to their job of "training" statisticians. The implicit assumption is that students are already aware of the value and importance of the area, and the only job remaining is to "show them how." The result is that student motivation is virtually nonexistent after a few weeks, and the course is viewed as a drudgery that someone has required. Since the problems are typically stripped of any realism, the students are unable to identify applications or to appreciate the value of the techniques. All of which leads to the question asked by the better student: "Does anyone really use this stuff?"

Clearly the general lack of student motivation is a function of text format and objective. These two situations understandably lead to the third.

3. *There is a growing dissatisfaction among the professors of introductory business statistics.* The dissatisfaction comes both from the lack of student comprehension and retention of the presented material and from the "cookbook" approach that most students adopt.

It is our feeling that if the format of the texts were changed to be consistent with WHY, WHEN, and WHERE, along with HOW, student motivation could be achieved. The objective would be to *truly* introduce and provide the much-needed motivation. We believe that such a *change in direction* of the first course would be a progressive step. It is our hope that this text represents such a change.

The specific characteristics of this text which we consider as distinguishing assets toward obtaining our objectives are:

1. Programmed mathematics review in Chapter 1
2. Introduction of each statistical technique through a realistic business situation
3. Elimination of unnecessary topics
4. Emphasis placed on identifying applications
5. Self-motivating problems
6. Cases

Chapter 1 contains a short review of the mathematical operations required both to follow the text and to solve problems. This section gives the students with a relatively weak math background a chance to "brush up" on just what is needed and introduces Σ, !, inequalities, and points on a rectangular coordinate system, without having to *stop* in the text.

Each statistical technique is introduced by describing a realistic business situation, reducing the situation to "need to do something," and then introducing the statistical technique designed to fill the specific need. Such an approach seems both logical and more likely to "sell" the techniques. Our objective has been to present realistic situations and answer the question "Why?"—thus providing relevance.

A conscious attempt has been made to eliminate topics that are usually covered in basic statistical texts but that do not contribute or are not necessary, given our objective of introducing applications and motivating students rather than training statisticians. Such topics as average deviation and the Poisson, exponential, and rectangular distributions are not needed or used in the basic statistics course and thus only detract from the relevance of the course. Yes, the Poisson and exponential distributions are important and used in operations research. However, a student would most likely not remember them if they were introduced in a previous term or year in a statistics course, and an operations research course would certainly review or reintroduce them when needed. Our argument is that they are not needed in the basic statistics course, and thus their inclusion is not an asset in relation to motivation or relevance.

If most students in the basic statistics course eventually become decision makers in business, what they need is the ability to recognize when they have a problem capable of solution through the application of statistical techniques. Given this, it is the ability to identify applications rather then the ability to perform analyses that is important. For those chapters that introduce statistical techniques, the final section "Identification of Applications" is designed to point out the conditions under which the application of the studied technique would be of value. The idea is to focus attention on identifying applications. It seems to us that being able to identify a realistic business application for a given statistical technique is really the acid test of understanding.

The problems that appear toward the end of each chapter problem set have been designed to contain an explanation of why someone would want to do or solve the problem. Again, the objective is to show relevance.

Finally, to be consistent with the objective of identifying applications, a number of cases are included. The main objective for the student in relation to

the cases is to identify which, if any, of the studied techniques would be appropriate and to explain why.

The authors of the text have prepared a comprehensive *Instructor's Manual* with chapter notes and solutions to text exercises for adoptors of the text. Professor Arno Rethans of the Pennsylvania State University has prepared a detailed *Student Workbook* for students who would like additional materials to help them in their review process. The workbook contains study hints and additional sample problems, with answers provided for the student to check his progress and understanding of the concepts and skills required in the various chapters.

We would like to express our thanks for the many useful comments and suggestions provided by colleagues who reviewed this text during the course of its development, especially to Professor Alan J. Brokaw, Michigan Technical University; Major James W. Downey, United States Air Force Academy; Professor William R. Eadington, University of Nevada-Reno; Professor William Feist, Monmouth College; Professor William J. Hepburn, Rollins College; Professor Allen D. Kartchner, Utah State University; Professor Ronald S. Koot, The Pennsylvania State University; Professor Albert N. Link, Auburn University; and Professor Paul Paschke, Oregon State University.

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Business Statistics

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Chapter 1

Introduction

1.1 WHAT IS STATISTICS?

You are embarking on the study of a field of science called STATISTICS. Specifically, we will study the field of statistics as it is and can be applied to business and economics. Just what is this field? What kind of procedures will we study? What are the objectives of statistics? And, of primary importance: Why should you study statistics?

As we progress through this text, you will gain a *clear* understanding of the field of statistics, its objectives, its logic, and a variety of the more basic statistical techniques. You will find that statistics encompasses the collection, summarization, presentation, and analysis of data. These activities and their techniques are designed to aid the process of decision making—certainly an important function in business.

STATISTICS IS A FIELD OF SCIENCE ENCOMPASSING PROCEDURES DESIGNED TO AID THE PROCESS OF DECISION MAKING UNDER UNCERTAINTY.

1.2 WHY STUDY STATISTICS?

If there is one universally most important function of persons working within a business organization, it must be *decision making*. With the tremendous increase in the availability of data (via computers) and the increasing complexity of business operations, extraordinary pressures are placed on the process of

decision making. Thus we come to the inescapable conclusion that techniques that aid the process of decision making *are of value.* Tomorrow's decision makers will need to be sufficiently familiar with existing statistical techniques to identify *when* a problem can be analyzed through the application of statistics. True, most decision makers will not actually perform the analysis. This operation would fall in the domain of the business statistician—a staff member within the organization or an outside consultant. However, the decision maker must have the required level of statistical understanding to be an intelligent consumer of such analyses.

The need for such an understanding of statistics is not limited to the decision maker within business. The nineteenth-century English novelist H. G. Wells claimed that "statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write." History has proved that Wells had an uncanny perception of the future. Today there is no way of escaping our role as consumers of statistical analyses. These analyses come to us as advertising claims, economic indicators and forecasts, results of opinion and political polls, statements of average per capita income, and so forth. Clearly this is not an exhaustive list, for such a list would be virtually endless. There is no doubt that *we are all consumers of statistical analyses.*

1.3 REQUIRED MATHEMATICS

It has been our experience that many students approach the first course in statistics with great reluctance. These students typically have limited backgrounds in mathematics. They have experienced frustration with little reward in prior mathematics courses and come to the course convinced that statistics will be another bad experience.

This text is *not* a course in mathematics. Yes, because of the nature of statistics, we will be involved with some mathematical operations. However, the level of mathematics required in this text is minimal.

The remainder of this chapter contains *all* the mathematical operations required to follow the material presented. If you study this material (most of it will certainly be a review) and can solve the problems at the end of the chapter, your background is sufficient, and mathematics will not impede your study and understanding.

The next part of this chapter is in the *programmed text format.* The reasons for this format selection are: (1) the programmed text format is particularly well suited for self-study, and (2) many instructors presume that the student has previously acquired this background, and thus it is not covered in class as an integral part of the course.

The following material is arranged in a vertical series of frames along the right-hand side of each page. The correct response to a frame is located in the left-hand side of the following frame. We encourage you to cover the following frame with a piece of paper, write your answer in the blank, and then check it.