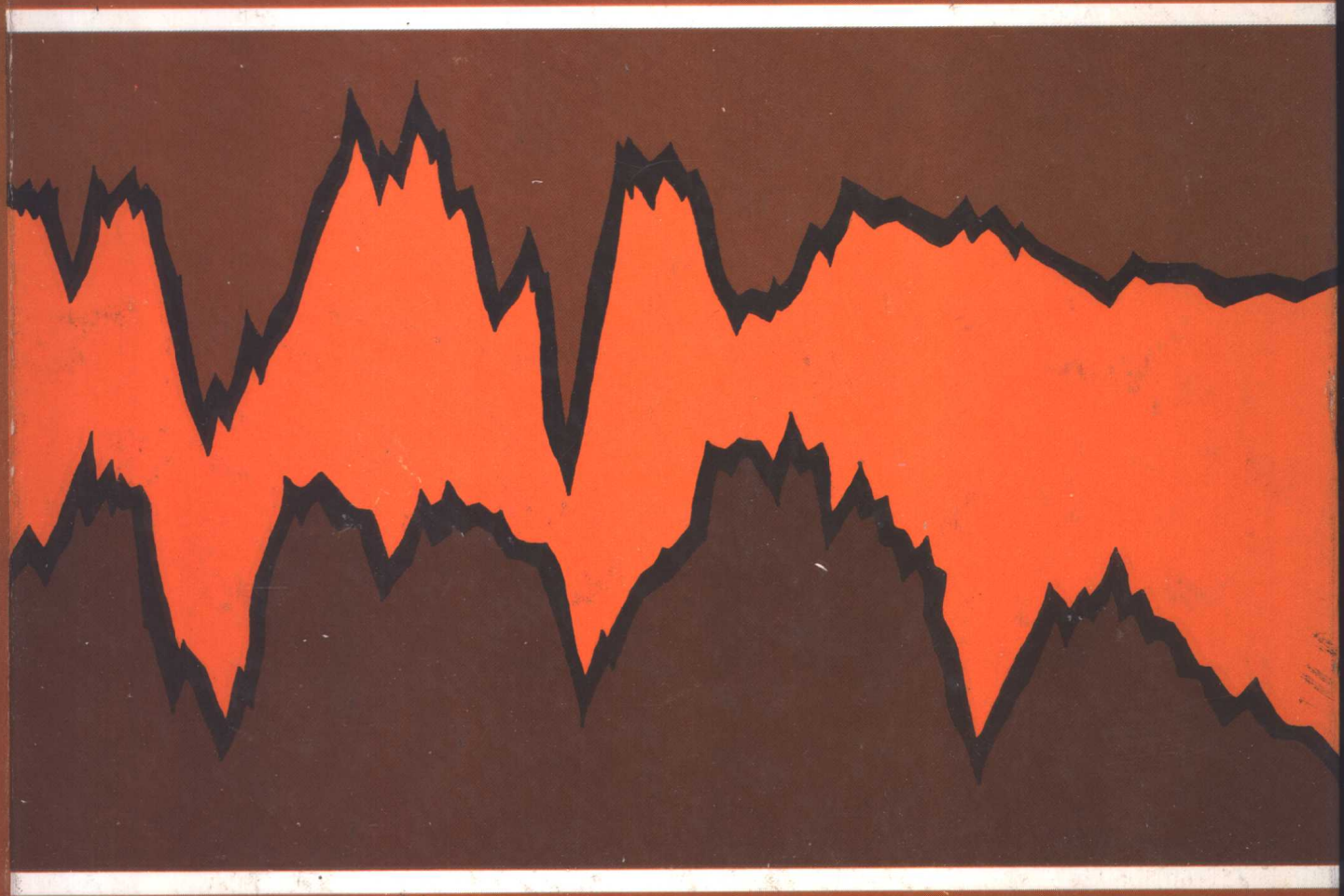
APPLIED BUSINESS STATISTICS

second edition



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to Irene,
Randy, and Mark

Preface

This second edition of *Applied Business Statistics* prepared for undergraduate students of business and economics resulted from a revision, updating, and expansion of the first edition. It contains the basic statistical methods but is somewhat different from most of the textbooks in that it has a more adequate discussion of data collection and presentation which are highly important to the field of statistics. It has a somewhat broader coverage of multiple correlation than many comparable texts. It also has more extensive coverage of index numbers and time-series analysis than most business statistics books designed for the typical undergraduate student.

The relevance of statistics in business and economics is brought out through examples and exercises which have been based on both actual and life-like data and situations. As the title implies, emphasis is placed on the practical application of statistical methods rather than theory and derivation of formulas. Business and Economics students with sound backgrounds in elementary algebra should be able to handle the mathematics without difficulty.

The first nine chapters could be used for a first semester course and the last nine for second semester course. However, the instructor of a one-semester course who wishes to move faster can use the first nine chapters and Chapters 11 and 12, or 12 and 14. A one-semester accelerated course for students in economics might incorporate the first nine chapters, Chapter 12 and Chapters 14–17. Several other chapter combinations can be made to fit an instructors particular needs. Also, an instructor in a one-semester course could use all of the chapters but omit certain topics. For example, the material on correlation of grouped data in Chapter 12 and the graphic method of measuring seasonality in Chapter 17 could be omitted.

I am grateful for the assistance of numerous people in the preparation of the revised manuscript. Helpful suggestions were given by Professors James Beckett, L. B. Blackwell, John Chiu, David D. Farris, Ke. T. Hsia, Ronald S. Koot, Robert A. McLean, Gerald T. Simon, and Edwin A. Swanson. Thanks are extended to Joseph Ragonese, a graduate assistant, for checking the accuracy of many of the problems and to Dolores Rewolinski who did a superb job of typing the manuscript.

I am also indebted to the Literary Executive of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Oliver and Boyd Ltd., Edinburgh, for permission to reprint Tables A-4 and A-5 from *Statistical Tables for Biological, Agricultural and Medical Research*. I appreciate the assistance of Michael Bass, Douglas Bullis, and Holden-Day executives and employees in the preparation of the manuscript and production of the book.

Milwaukee, Wisconsin
September, 1978

ELAM E. McELROY

Contents

1

Business Statistics — Foundations for Decisions

Business firms, government agencies, and numerous other types of organizations routinely apply theories and tested methodologies in collecting, presenting, analyzing and interpreting quantitative data. When you study these theories and methodologies you are studying "statistics." In this sense, then, statistics is a body of knowledge or a subject of study rather than just a collection of data, figures, or numerical facts.

A *statistician* is not, as many people believe, one who merely assembles numerical data. He designs experiments and analyzes their results, which hopefully lead to the accumulation of additional information upon which useful decisions may be based. To do this he uses the methodologies discussed in this book and perhaps many that are too complex to be included in a first course in statistics. Statisticians have their own particular terminology, as we are about to discover.

USES OF STATISTICS IN BUSINESS

Estimating and Projecting

Statistics, as we have defined it, is comprised of a variety of methods that enable businessmen, economists, and others to make better decisions because they help maximize the accuracy of the estimates and forecasts upon which such decisions are based. Three of the main tools of estimating and forecasting are sampling, time series analysis, and regression and correlation analysis.

Sampling. The subject of sampling encompasses the scientific methods used to select and analyze samples of universes, or populations. A *universe,* or *population,* consists of all elements or members of a well-defined group that is to be investigated; a *sample* is a subset of a universe. For example, if an analyst wishes to determine what percentage of the households in the Dallas, Texas, metropolitan area have color television sets, then the universe consists of *all* households in the Dallas metropolitan area, while a sample consists of *some* of those households. When we use a scientifically selected sample in a study, we can estimate characteristics of the universe from which the sample has been drawn and test hypotheses concerning both sample and universe values. A properly conducted sample study provides information about the universe much more quickly and cheaply than a study of the entire universe. For this reason, more and more sample data are being published by private organizations and government agencies. Many economic indicators consulted by businesses to facilitate decision-making are composed partly or entirely of sample data. Such indicators include the Consumer Price Index, the Index of

Industrial Production, Value Added by Manufacture, and series that show what part of the working force is employed or unemployed.

A businessman needs a good knowledge of sampling theory and practice so that not only will he use the right methods to conduct a sample study, but also so that he will be able to evaluate sample data from other sources to analyze and solve his problems. Sampling theory and the analysis of sample data are the subjects of chapters 8, 9, 10, and 11.

Time series analysis. Time series analysis, which is analysis of data classified by years, quarters, months, or other periodic intervals, is mainly a tool of forecasting. Analysis of time series data reveals past patterns of growth and change that often can be averaged or measured in such a way that a projection into the future can be made. Both long-range and short-range projections can be used to determine what the volume or level of business activity will be in the future. Some of the basic methods for making projections are covered in Chapters 16 and 17.

Regression and correlation analysis. Regression and correlation analysis, or analysis of the nature and closeness of the movements of two or more sets of data, are also tools of estimation and forecasting. For example, we might find that changes in retail sales and income in a given area move in such unison over a period of time that an accurate estimate of sales could be made, based on income projections.

The subject of correlation probably is not entirely foreign, for you have certainly read of the relationship between the amount of smoking people do and the rate of occurrence of certain diseases. You undoubtedly have observed too the relationships between alcohol consumption and drunkenness, food consumption and body weight, and studying and learning.

In Chapter 12 we will study the correlation analysis of two variables. Multiple correlation, which concerns the associated movements of three or more variables, is covered in Chapter 13.

Management Areas Using Statistics

Almost every part of a business organization uses statistical methods in its operations. Some of these are discussed below.

Marketing research. Suppose the marketing research department of a firm wants to find new markets for the company's products. To do this they need data on the characteristics of potential customers in the proposed market areas. Only part of the necessary data may be available from published sources, so a field survey requiring the formulation of questionnaires and the selection of a sample may be called for. The researchers would use the statistical methods for surveying, sampling, and analyzing their data.

Sales management. If the sales manager of a firm wants to estimate sales potentials in established territories in order to evaluate the performance of his salesmen, he must gather and analyze data concerning each territory. Incidentally, this might be done for the sales department by the marketing research department.

Personnel management. The personnel department of a firm uses statistical methods to keep management apprised of the makeup of the firm's work force. If, for example, the board of directors wants an estimate of the cost of a proposed pension plan, they need data on the age composition of the firm's employees. The statistical methods discussed in this text could be used by the personnel department to provide management with simple measurements indicating age composition rather than, say, a long list of the employees' ages.

Production management. Statistical methods are used in controlling the quality of products as they are being manufactured, in time and motion studies, and in inventory control. Statistical quality control operations are often supervised by an engineer with training in scientific sampling theory.

Economic analysis. Economic analyses and forecasts of general economic conditions in the nation, in specific geographic areas, and in industry aid in planning sales campaigns, inventories, production volumes, plant expansions, and employment levels. Statistical methods are used in collecting and presenting economic information and so must be used to analyze and interpret the data. The economist, in predicting general business levels, makes extensive use of time series analysis and correlation analysis.

Accounting and finance. Statistical techniques also aid in the analysis of accounting and financial records. For example, sampling techniques are useful in auditing, and time series analyses provide a tool for long-range planning.

STATISTICAL METHODS

In order to solve a problem, a businessman must have facts pertaining to the problem. These facts must be gathered in a manner that assures their accuracy and authenticity and then assembled and presented so that their general characteristics become evident. Moreover, mathematical analyses are often required to reveal the detailed characteristics and nature of assembled facts. It is important to interpret the results of these analyses correctly because decisions are based on interpretations. A general discussion of these aspects of statistics will help you to understand the more detailed discussion that follows.

Collecting Data

When gathering data we must choose the sources carefully. Published data should be selected from sources with established reputations for reliability. Data obtained directly from the files of organizations or from individuals should be solicited only from those held in high esteem by the public or by professional societies and business organizations. When information must be gathered by surveys taken by interviewers or by means of mail questionnaires, certain rules and procedures should be applied if useful information is to be obtained. When samples are selected from which to collect data, techniques based on sampling theory should be used. Chapter 2 gives a detailed discussion on many aspects of data collection, and Chapter 8 provides a somewhat comprehensive discussion of types of sample used in collecting data.

Presenting Data

Masses of unorganized figures are of little or no value. They must be assembled in systematic groups or classifications. Charts or graphs often aid in showing significant aspects of the data. Statistical tables and charts must be organized so that their intent can be easily understood by the reader. The rules or guides that have been developed for determining the general format, proper classifications, dimensions, rulings, and wordage for tables and charts are discussed in Chapter 3. When properly applied, these rules enable us to present numerical information more effectively, with the least bias.

Analyzing Data

Tables and charts showing simple classifications of data do not always reveal or describe important characteristics of the data. Therefore, we may need to compute statistical measures that *describe* these characteristics or enable us to *make inferences* about an entire body of data from which a sample has been selected. These measures may be simple ratios, percentages, or averages, or perhaps, geometric averages, standard deviations, secular trends, confidence intervals and coefficients of correlation. These are some of the statistical measures discussed in Chapters 4 through 18. When you have learned how to compute them, you will be able not only to use these tools to analyze business problems, but you will also have a foundation for learning more advanced statistical techniques.

Interpreting Data

When we interpret data, we decide what the comparisons and analyses mean and draw conclusions. Many correct interpretations require only the application of common sense. To insure a high degree of accuracy in interpreting the results of a statistical study,