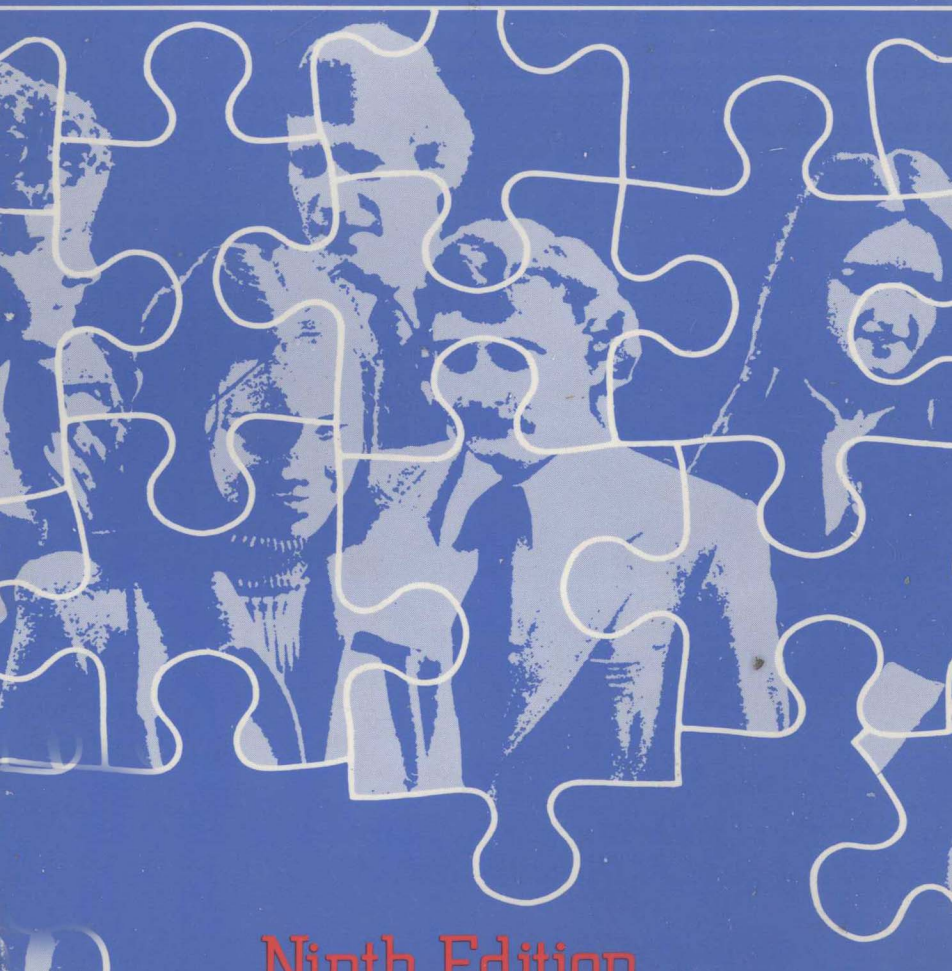
Wheldon's

Business Statistics

G.L.Thirkettle



Ninth Edition

WHELDON'S BUSINESS STATISTICS AND STATISTICAL METHOD

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WHELDON'S
BUSINESS STATISTICS
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Preface to the Ninth Edition

Competent administration, whether in commerce, industry or government, requires a knowledge of statistical method. This fact has become more and more recognised, as is evidenced by the large number of bodies that now include the subject of Statistics in their examinations.

There is also an ever-growing number of people in business who, whilst having no examination in view, are finding it more than useful to have a knowledge of statistics. Since this book avoids a purely theoretical approach and places emphasis on applications to business problems, it should be of great help to them.

So that this book should continue to serve students in the future as it has done so well in the past, this new up-dated edition has been extensively revised and a number of chapters entirely rewritten.

The main changes are:-

(a) much new material;

(b) a series of programmes on statistical procedures – many students find it useful to have a list of things to do when solving a statistical problem;

(c) the addition of many warning *Notes* where experience has shown students are prone to error;

(d) many new diagrams specially designed to clarify the accompanying text.

I thank all those bodies (a list of which appears at the beginning of *Appendix I*) who have kindly allowed me to reproduce questions from their examinations. Any solutions I have given are solely my responsibility.

Acknowledgments are also due to the Controller of HMSO for permission to reproduce copyright material from a number of government publications.

1980 G.L.T.

Contents

CHAPTER 1

Introduction

THE MEANINGS OF "STATISTICS"

This word is used with two quite distinct meanings. It can refer to facts which can be put into a numerical form, as in the phrase "unemployment statistics". This is the meaning the man in the street gives to the word. It can also refer to statistical methods, which is the subject-matter of this book. Statistical methods are, to use Bowley's description, devices for abbreviating and classifying numerical statements of facts in any department of inquiry and making clear the relations existing between them.

When used with the first meaning, "statistics" is a plural noun, and the statistician usually uses the word data instead. When "statistics" refers to the science it is a singular noun, and this is the meaning usually given to it by the statistician.

THE NATURE OF STATISTICAL DATA

Statistics can only deal with numerical data. Often, however, data which are of a qualitative nature can be put into a quantitative form. Health can be measured by the number of days' illness; intelligence, as is well known, by specially designed tests. There is a considerable amount of arbitrariness about this, but it does allow statistical methods to be used, and thus provides additional evidence not otherwise available in given inquiries.

Sometimes the material of an inquiry can be divided up into "cases" possessing a certain attribute and those not possessing it. It is often possible to put qualities in order of rank. Thus, in the case of colours, the lightest could be given rank 1, the next lightest rank 2 and so on. In business, however, most data can be measured or

counted directly. Examples would be the number of absentees, sales, quantity produced, wages, etc.

THE IMPORTANCE OF DEFINITION

Before any data are collected it is absolutely necessary to define clearly and unambiguously all the terms used and every piece of information required. Failure to do so will mean that the conclusions drawn from the inquiry will not be valid, and that comparisons over time and between areas will not be true comparisons. The conclusions drawn will be inaccurate because answers to questions will not be answers to the same questions, but only apparently so, the questions having many interpretations unless all terms are clearly defined.

STATISTICAL INQUIRIES

The business man, and indeed anyone who has to administer any organisation, is concerned with inquiries of many kinds. Some of these are capable of being treated statistically, and statistical evidence can be provided in respect of the information wanted.

The steps in a statistical inquiry are as follows.

(a) The problem must be clearly stated. Suppose the problem concerns wages in a factory. Is it about wages earned or wage rates? Must the statistics concern all employees, or separate grades, both men and women? Should lost time, overtime, piece-work and bonus payments be included or allowed for? Should receipts in kind be included? The purpose of the investigation will provide guidance as to the exact information to be obtained.

(b) Selection of the sample. If complete coverage of the information available is not made, then the size of the sample and method of sampling will have to be determined. This will depend on the kind of information wanted, the cost and the degree of accuracy required. The best example of a sample inquiry in business is market research.

(c) Drafting the questionnaire. This is quite a difficult job if the answers obtained are to be of value. Usually a number of questions have to be redrafted to get the exact information wanted. A pilot survey is useful to enable a satisfactory questionnaire to be obtained.

A great deal of information in business, however, is already available in the form of accounting records, costings, administrative information about personnel and so on; questionnaires apart from market research are therefore used only for special inquiries.

(d) Collection of data. Where not available as administrative

records or published, the most satisfactory way is by means of enumerators. Enumerators ask the questions and fill in the questionnaires.

(e) Editing the schedules. Questionnaires require to be checked, sometimes coded, and calculations made before tabulation can be done.

(f) Organisation of data. The items require to be counted or the values summed either in total or in various categories before they can be tabulated.

(g) Analysis and interpretation. Before the information acquired can be used it is analysed and then interpreted. This requires a sound knowledge of statistical methods and also, and this is often lost sight of, a sound knowledge of the subject for which statistical evidence has been obtained.

(h) Presentation. This may take the form of tables, charts and graphs.

(i) The writing of the report. This will give the results of the investigation and, where required, will make recommendations. Tables and charts usually play an important part in business reports.

STATISTICS AS A TOOL OF MANAGEMENT

In order that the student at the beginning of his studies shall have some idea of the value of statistics to the business man, some problems, which are the concern of management and for which statistical methods are appropriate, are given below.

(a) Stock control. Carrying too large a stock means idle capital and unnecessary costs of storage. Too small a stock means that materials are not available when required, resulting perhaps in lost sales. The "right" amount is a matter, therefore, of considerable importance.

(b) Market research. The business man, in order to be successful, requires to sell what his customers want in the right types and qualities. He wants to know what to sell, in what quantities, when and where.

(c) Quality control. If he produces a mass-produced article, the business man can usually check the quality of his output more efficiently by means of statistical methods.

(d) Sales trends. This is vital information for future planning. Statistical methods are preferable to optimistic guesses, usually called judgment.

(e) The relationship between costs and methods of production. Unless such information is forthcoming, the most efficient method of manufacture will probably not be used.

This matter of statistics and business management is returned to in Chapter 24. Before that, statistical method is dealt with in some detail. The student must master the methods before he can apply them.

QUESTIONS

1. "Statistics is the science of counting." Criticise this definition. If you are not satisfied with it, state your own.

2. Why is definition important in any statistical investigation?

3. *(i)* "The more facts one has, the better the judgment one can make."

(ii) "The more facts one has, the easier it is to put them together wrong."

Comment on these two views in relation to the principle that statistics are an aid to, not a substitute for, business judgment.

Chartered Institute of Transport.

4. Enumerate the main steps in undertaking a statistical inquiry.

5. In what practical ways can statistics be of service to a business man?

CHAPTER 2

Collection of Data

PRIMARY AND SECONDARY DATA

Data may be expressly collected for a specific purpose. Such data are known as primary data. The collection of facts and figures relating to the population in the census provides primary data. The great advantage of such data is that the exact information wanted is obtained. Terms are carefully defined so that, as far as humanly possible, misunderstanding is avoided.

Often, however, data collected for some other purpose, frequently for administrative reasons, may be used. Such data are known as secondary data. Details of imports and exports are compiled by the Statistical Office and Customs and Excise from declarations made by importers and exporters to the local Customs and Excise Officers. This material is obtained for administrative reasons. It is used, however, for compiling quite a large number of statistics relating to overseas trade, including, for example, import and export price indices. The Retail Price Index, on the other hand, uses primary data, the officials of the Department of Employment collecting retail prices expressly for the Retail Price Index each month.

Secondary data must be used with great care. Such data may not give the exact kind of information wanted, and the data may not be in the most suitable form. Great attention must be paid to the precise coverage of all information in the form of secondary data.

Much of the business data used in compiling business statistics is also secondary data, the source often being the accounting, costing, sales and other records. Such data will often require to be adjusted. In finding a sales trend, for example, it may be necessary to adjust the sales figures as given by the accountant for the varying days in the month. Other secondary data used by the business man are

published statistics. Before any such material can be used with safety it will be necessary to know the source of the figures, how they were obtained, exact definitions and methods of compilation.

METHODS OF COLLECTING DATA

Business data are often collected in the normal course of administration, and not specifically for statistical purposes. However, there is no reason why records should not serve the two purposes, and in such cases care should be taken to ensure that the record is adequate statistically as well as administratively.

The following list covers the most important methods of collecting data.

(a) Postal questionnaire. This takes the form of a list of questions sent by post. Unless, however, the respondent (the person who is required to answer the questions) has an interest in answering it or is under legal compulsion to do so, the postal questionnaire is generally unsatisfactory, producing few replies, and those of a biased nature.

The postal questionnaire is satisfactory when the law compels the respondent to reply. The Statistics of Trade Act 1947 makes it compulsory for firms to answer the questionnaire sent out in respect of the census of production.

The postal questionnaire is also satisfactory when sent by trade associations to their members, since the members have an interest in answering it.

Some firms have tried to get answers by offering small gifts. This is not a very good idea, since it will produce biased answers, because the respondent tries to please the donor.

(b) Questionnaires to be filled in by enumerators. This is the most satisfactory method. The enumerators or field-workers can be briefed so that they understand exactly what the questions mean; they can get the "right" answers; and they fill in the questionnaires more accurately than would the respondents themselves.

In the case of the Census of Population of the UK, the enumerators do not fill in the schedules. This, however, is quite exceptional.

(c) Telephone. Asking questions by telephone is not usually a very good method, because people who possess telephones form a biased sample. Telephone interviews are, however, useful for certain kinds of radio research.

(d) Observation. This method entails sending observers to record what actually happens while it is happening. An example where this method is suitable is in the case of traffic censuses.

Actual measurements or counting also come under the heading of observations. Examples occur in Statistical Quality Control.

(e) Reports. These may be based on observations or informal conversations. They are usually incomplete and biased, but in certain cases may be useful.

(f) Results of experiments. This method is of greater interest to the production engineer, the agronomist and other applied scientists than to the business man.

STATISTICAL UNITS

Since the compilation of statistics necessarily entails counting or measurement, it is very important to define the statistical unit which is to be counted or measured.

The definition of the unit is not always as simple as would at first appear. A little reflection on the following words will reveal the need for precise specification in each case: prices may be wholesale, retail, delivered or ex-works; accident may refer to a slight or serious injury, one officially reported or one resulting in a compensation claim; wages may refer to earnings or wage rates.

REQUIREMENTS FOR A STATISTICAL UNIT

The requirements for a statistical unit are as follows.

(a) It must be clearly defined and unambiguous.

(b) It must be homogeneous. This uniformity is essential; the unit must not imply different characteristics at different times and places. If the selected unit is not applicable to all cases coming under review, it is often possible to overcome the difficulty *(i)* by subdividing the data into groups or classes until sufficient uniformity has been secured, *(ii)* by expressing dissimilar units in terms of equivalents of the selected unit. For example, if the output of bakeries for a period were being compared, some producing 1-, 2- and 4-kg loaves, all sizes could be reduced to the equivalent of, say, 2-kg loaves.

(c) It should be stable. If it is desired to use a fluctuating unit, such as a calendar month, then adjustments will require to be made before comparisons will be valid.

(d) It must be approriate to the inquiry and capable of correct

ascertainment. When compiling labour statistics it is necessary to select the unit appropriate to the information required, e.g. workers engaged directly on production, those employed in indirect factory services, those in administrative offices or those in the sales department.

TYPES OF STATISTICAL UNIT

A simple statistical unit—e.g. metres, litres, £ sterling—are not difficult to define, but care must be used in some cases. For example, a ream may be 480 sheets, but often consists of 500 or 516 sheets. A ton may be 2,240 lb or it may be a short ton of 2,000 lb, or again it may be a metric ton (tonne).

A composite unit may have to be used in some cases. Thus, electric power is measured in units of kilowatt-hours. Education authorities measure the amount of instruction in student-hours.

QUESTIONNAIRES

THE FORM OF QUESTIONNAIRE

The questionnaire is often in two parts. The first part is a classification section. This requires such details of the respondent as sex, age, marital status, occupation. The second part has the questions relating to the subject-matter of the inquiry. The answers given in the second part can be analysed according to the information in the first part. There will also be questions of a purely administrative nature, such as the date of the interview, the name of the interviewer, etc. Market research and social survey questionnaires are usually of this form.

Concerning the layout of questionnaires, there is a tendency, where it is possible, to provide all the answers that could be given to a question on the form, and the appropriate answer is circled or ticked. This treatment can only, of course, apply to certain questions.

THE CHARACTERISTICS OF A GOOD QUESTIONNAIRE

The list of desirable qualities that a questionnaire should possess given below would seem to be a matter of common sense. Nevertheless, the drafting of questionnaires is one of the most difficult tasks of an inquiry. A pilot survey—that is, a trial survey, carried out prior to the actual survey—invariably leads to alterations and improvements in the questionnaires.

(a) Questions should not be ambiguous. This means that the questions must be capable of only one interpretation.

(b) Questions must be easily understood. Technical terms should be avoided, except where the questionnaire is addressed to specialists.

(c) Questions should be capable of having a precise answer. The answer should take the form of "yes" or "no", a number, a measurement, a quantity, a date, a place; facts are required, not opinions (except where opinions are wanted, as in opinion polls).

(d) Questions must not contain words of vague meaning. To ask if something is large or if a man is unskilled are examples of such questions. When does something become large? What jobs are unskilled?

(e) Questions should not require calculations to be made. Such questions give rise to unnecessary sources of error. If for the purpose of the inquiry it is necessary to know annual earnings, but the respondent is paid weekly, the weekly earnings are asked for. The calculations necessary are done by the statistician's staff.

(f) Questions should not require the respondent to decide upon classification.

(g) Questions must not be in such a form that the answers will be biased. The questions will not therefore contain emotionally coloured words, they will not be leading questions—that is, they will not put answers into the respondents' mouths—and, of course, they must not give offence.

(h) The questionnaire should not be too long. If a questionnaire is too long, the respondent will not be co-operative, and this may mean inaccurate answers; often a way out is for some of the respondents to answer part of the questions and other respondents to answer other questions.

(i) The questionnaire should cover the exact object of the inquiry. However, provided the questionnaire is not made too long, advantage can be taken of the arrangements made to obtain information relating to a different inquiry. In one population census of the UK, questions were asked about sanitary arrangements.

When drafting questionnaires, it is a good plan to check the questions against the above list.