READINGS AND PROBLEMS

IN

STATISTICAL METHODS

BY

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INTRODUCTION

THE selections included in this book were chosen to illustrate concretely the attitude of mind in which statistical analysis must be undertaken, and to develop logically the steps and processes through which statistical data must be carried in order to be used as bases for logical inferences. They constitute within themselves an independent treatment of statistical principles; but, undoubtedly, will have their greatest value when used in connection with a text on statistical methods. They are intended primarily to be used in this manner.

The *use* of statistics is consciously emphasized. "Embalmed" statistics have no part in the treatment, as they have no place in the writer's interest. The collection, use, and interpretation of statistical data are justified largely, if not solely, in the service which they have for planning, whether it is related to questions of social control, business policy, or statecraft.

It has seemed wise to accompany the selections with pertinent, thought-provoking questions, which students and others may use as a basis for criticism and constructive analysis. Accordingly, review questions are made component parts of the treatment. It is not intended that these shall be used solely as a means of making easy the assimilation of the contents of the selections, but rather, that they shall serve to connect the subject matter with the experience and training of the reader.

Review Problems have been added at the close of those chapters, the subject matter of which seems to lend itself

to concrete application or to laboratory use. It is the teachers' obligation to make his laboratory exercises of interest to those whom he asks to take part in them, and to couple them with concrete business, industrial and social experiences. The *make-work* problems to which students are too often assigned, as part of their laboratory work, not only fail to arouse intellectual interest, but have the effect of divorcing the laboratory from the life which the student is living. They are too often looked upon as tasks or penalties, rather than as opportunities to take part in explaining, illustrating, and summarizing data which have to be manipulated before they can be used as bases for business and social judgments.

Laboratory problems should be chosen from business and social fields, and should include topics in which the student himself has an interest, and which he would be willing and eager to study statistically, in order more fully to understand. It is not difficult to select problems of this character and to secure data relating to them. In no other single problem, in the writer's experience as a teacher, has so much interest been developed on the part of his students in statistics, as in the study of expenditures for food at a local cafeteria. Theater tickets, types of business buildings, real estate valuations, show window decorations, classified advertisements, types of news items, stock and bond quotations, money rates, etc., all lend themselves to statistical treatment and arouse statistical interest. The writer has never been at a loss to find problems which create interest and which are worthy of study.

It is, therefore, with considerable hesitation that so-called *Review Problems* have been included in this book. The repeated requests on the part of instructors in Statistics for laboratory problems is the primary excuse which the

writer has for including them here. It is hoped that they will be found of some interest to instructors in solving their laboratory difficulties, or of calling their attention to the problems immediately about them which may be used in their stead.

The frequent references to the *Text* in the *Reviews* and *Review Problems* are to the author's *Introduction to Statistical Methods*. While the *Introduction* and *Readings* are intended to be used together, either of them may be used separately for text or general purposes. It has seemed wise to employ the same chapter headings in the two volumes and this plan is followed. Chapters VI and VII, VIII, IX and X, XI, and XII in the *Introduction*, however, become Chapters VI, VII, VIII, IX, and X, respectively, in the *Readings*.

It is a pleasure for the writer to acknowledge his obligation to the authors and publishers of the selections included for the privilege of reprinting them, and to express his appreciation of the value which they have been to him in clarifying his own ideas on the meaning, function, and use of statistical methods in the understanding of business and social problems. It is the writer's hope that they will be equally interesting to those into whose hands this volume may come.

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CONTENTS

READINGS AND PROBLEMS IN STATISTICAL METHODS

CHAPTER I

THE MEANING AND APPLICATION OF STATISTICS AND STATISTICAL METHODS

Scientific Method — Its Scope and Meaning [1]

Within the past forty years so revolutionary a change has taken place in our appreciation of the essential facts in the growth of human society, that it has become necessary not only to rewrite history, but to profoundly modify our theory of life and gradually, but none the less certainly, to adapt our conduct to the novel theory. The insight which the investigations of Darwin, seconded by the suggestive but far less permanent work of Spencer, have given us into the development of both individual and social life, has compelled us to remodel our historical ideas and is slowly widening and consolidating our moral standards. This slowness ought not to dishearten us, for one of the strongest factors of social stability is the inertness, nay, rather active hostility, with which human societies receive all new ideas. It is the crucible in which the dross is separated from the

[1] Adapted with permission from Pearson, Karl, *The Grammar of Science*, Second edition, revised and enlarged, Chapter I, pp. 1–14. A. and C. Black, London.

genuine metal, and which saves the body-social from a succession of unprofitable and possibly injurious experimental variations. That the reformer should often be also the martyr is, perhaps, a not over-great price to pay for the caution with which society as a whole must move; it may require years to replace a great leader of men, but a stable and efficient society can only be the outcome of centuries of development.

If we have learned, it may be indirectly, from the writings of Darwin that the methods of production, the mode of holding property, the forms of marriage, the organizations of the family and of the commune are the essential factors which the historian has to trace in the growth of human society; if in our history books we are ceasing to head periods with the names of monarchs and to devote whole paragraphs to their mistresses, still we are far indeed from clearly grasping the exact interaction of the various factors of social evolution, or from understanding why one becomes predominant at this or that epoch. We can indeed note periods of great social activity and others of apparent quiescence, but it is probably only our ignorance of the exact course of social evolution which leads us to assign fundamental changes in social institutions either to individual man or to reformations and revolutions. We associate, it is true, the German Reformation with a replacement of collectivist by individualist standards, not only in religion but also in handicraft, art, and politics. The French Revolution in like manner is the epoch from which many are inclined to date the rebirth of those social ideas which have largely remolded the medieval relations of class and caste, relations little affected by the sixteenth-century Reformation. Coming somewhat nearer to our own time we can indeed measure with some degree of accuracy the social influence of the great changes

in the methods of production, the transition from home to capitalistic industry, which transformed English life in the first half of this century, and has since made its way throughout the civilized world. But when we actually reach our own age, an age one of the most marked features of which is the startlingly rapid growth of the natural sciences and their far-reaching influence on the standards of both the comfort and the conduct of human life, we find it impossible to compress its social history into the bald phrases by which we attempt to connote the characteristics of more distant historical epochs. . . .

The contest of opinion in nearly every field of thought — the struggle of old and new standards in every sphere of activity, in religion, in commerce, in social life — touches the spiritual and physical needs of the individual far too nearly for him to be a dispassionate judge of the age in which he lives. That we play our parts in an era of rapid social change can scarcely be doubted by any one who regards attentively the marked contrasts presented by our modern society. It is an era alike of great self-assertion and of excessive altruism; we see the highest intellectual power accompanied by the strangest recrudescence of superstition; there is a strong socialist drift and yet not a few remarkable individualist teachers; the extremes of religious faith and of unequivocal freethought are found jostling each other. Nor do these opposing traits exist only in close social juxtaposition. The same individual mind, unconscious of its own want of logical consistency, will often exhibit our age in microcosm.

It is little wonder that we have hitherto made small way towards a common estimate of what our time is really contributing to the history of human progress. The one man finds in our age a restlessness, a distrust of authority, a

questioning of the basis of all social institutions and long-established methods — characteristics which mark for him a decadence of social unity, a collapse of the time-honored principles which he conceives to be the sole possible guides of conduct. A second man with a different temperament pictures for us a golden age in the near future, when the new knowledge shall be diffused through the people, and when those modern notions of human relations, which he finds everywhere taking root, shall finally have supplanted worn-out customs.

One teacher propounds what is flatly contradicted by a second. "We want more piety," cries one; "We must have less," retorts another. "State interference in the hours of labor is absolutely needful," declares a third; "It will destroy all individual initiation and self-dependence," rejoins a fourth. "The salvation of the country depends upon the technical education of its work people," is the shout of one party; "Technical education is merely a trick by which the employer of labor thrusts upon the nation the expense of providing himself with better human machines," is the prompt answer of its opponents. "We need more private charity," say some; "All private charity is an anomaly, a waste of the nation's resources and a pauperizing of its members," reply others. "Endow scientific research and we shall know the truth, when and where it is possible to ascertain it"; but the counterblast is at hand: "To endow research is merely to encourage the research for endowment; the true man of science will not be held back by poverty, and if science is of use to us, it will pay for itself." Such are but a few samples of the conflict of opinion which we find raging around us. The prick of conscience and the spur of highly wrought sympathy have succeeded in arousing a wonderful restlessness

in our generation — and this at a time when the advance of positive knowledge has called in question many old customs and old authorities. . . .

The state has become in our day the largest employer of labor, the greatest dispenser of charity, and, above all, the schoolmaster with the biggest school in the community. Directly or indirectly the individual citizen has to find some reply to the innumerable social and educational problems of the day. He requires some guide in the determination of his own action or in the choice of fitting representatives. He is thrust into an appalling maze of social and educational problems; and if his tribal conscience has any stuff in it, he feels that these problems ought not to be settled, so far as he has the power of settling them, by his own personal interests, by his individual prospects of profit or loss. He is called upon to form a judgment apart, if it possibly may be, from his own feelings and emotions — a judgment in what he conceives to be the interests of society at large. It may be a difficult thing for the large employer of labor to form a right judgment in matters of factory legislation, or for the private schoolmaster to see clearly in questions of state-aided education. None the less we should probably all agree that the tribal conscience ought for the sake of social welfare to be stronger than private interests, and that the *ideal* citizen, if he existed, would form a judgment free from personal bias.

Science and Citizenship

How is such a judgment — so necessary in our time with its hot conflict of individual opinions and its increased responsibility for the individual citizen — how is such a judgment to be formed? In the first place it is obvious

that it can only be based on a clear knowledge of facts, an appreciation of their sequence and relative significance. The facts once classified, once understood, the judgment based upon them ought to be independent of the individual mind which examines them. Is there any other sphere, outside that of ideal citizenship, in which there is habitual use of this method of classifying facts and forming judgments upon them? For if there be, it cannot fail to be suggestive as to methods of eliminating individual bias; it ought to be one of the best training grounds for citizenship. The *classification of facts and the formation of absolute judgments upon the basis of this classification — judgments independent of the idiosyncrasies of the individual mind — essentially sum up the aim and method of modern science.*[1] The scientific man has above all things to strive at self-elimination in his judgments, to provide an argument which is as true for each individual mind as for his own. *The classification of facts, the recognition of their sequence and relative significance is the function of science,* and the habit of forming a judgment upon those facts unbiased by personal feeling is characteristic of what may be termed the scientific frame of mind. The scientific method of examining facts is not peculiar to one class of phenomena and to one class of workers; it is applicable to social as well as to physical problems, and we must carefully guard ourselves against supposing that the scientific frame of mind is a peculiarity of the professional scientist.

The First Claim of Modern Science

I have gone a rather roundabout way to reach my definition of science and scientific method. But it has been of

[1] The italics are not found in the original.

purpose, for in the spirit — and it is a healthy spirit — of our age we are accustomed to question all things and to demand a reason for their existence. The sole reason that can be given for any social institution or form of human activity — I mean not how they came to exist, which is a matter of history, but why we continue to encourage their existence — lies in this: their existence tends to promote the welfare of human society, to increase social happiness, or to strengthen social stability. In the spirit of our age we are bound to question the value of science; to ask in what way it increases the happiness of mankind or promotes social efficiency. We must justify the existence of modern science, or at least the large and growing demands which it makes upon the national exchequer. Apart from the increased physical comfort, apart from the intellectual enjoyment which modern science provides for the community . . . there is another and more fundamental justification for the time and energy spent in scientific work. From the standpoint of morality, or from the relation of the individual unit to other members of the same social group, we have to judge each human activity by its outcome in *conduct*. How, then, does science justify itself in its influence on the conduct of men as citizens? I assert that the encouragement of scientific investigation and the spread of scientific knowledge by largely inculcating scientific habits of mind will lead to more efficient citizenship and so to increased social stability. Minds trained to scientific methods are less likely to be led by mere appeal to the passions or by blind emotional excitement to sanction acts which in the end may lead to social disaster. In the first and foremost place, therefore, I lay stress upon the educational side of modern science, and state my position in some such words as these: