elementary statistics in social research

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preface

This book is an introduction to elementary statistics in social research. It does *not* purport to be a comprehensive reference work; nor should it be regarded as an appropriate text for advanced courses in statistical methods. On the contrary, this volume was written as a result of a perceived need for a genuinely understandable and meaningful treatment of basic statistics—one that could be used effectively to teach students in sociology (and related fields, such as political science, social work, and education) who have not had extensive training in mathematics and are taking their first course in statistics.

The text has been organized into three parts: Part I (Chapter 2–5) introduces the student to some useful methods (such as tabular and graphic presentations and measures of central tendency and variability) for describing and comparing raw data. Part II (Chapters 6 and 7) serves a transitional purpose, because it leads the student from the topic of the normal curve—an important descriptive device—to the first chapter in which the normal curve is used as a basis for generalizing from samples to populations. Continuing with this decision-making focus, Part III (Chapters 8–11) contains several well-known tests of significance, procedures for obtaining correlation coefficients, and an introduction to regression analysis.

Despite the similarity of topics which they cover, this text is different from other elementary statistics books in at least two important ways: (1) Every effort has been made to appropriately relate statistical concepts to research applications or to the everyday experiences of the student, so that he does not become alienated from the course materials, and (2) detailed step-by-step illustrations of statistical procedures have been located at important points throughout the text. Though the illustrative data are hypothetical, the problems on which they are based have been taken from actual research experiences in the social sciences.

Hopefully, the student who uses this text will come to regard statistics as a set of tools which aid the social researcher to better understand the nature of human behavior.

Jack Levin

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why the social researcher uses statistics

A little of the social scientist can be found in all of us. Almost daily, we take "educated guesses" concerning the future events in our lives in order to predict what will happen in new situations or experiences. As these situations occur, we are sometimes able to confirm or support our ideas; other times, however, we are not so lucky and must experience the sometimes unpleasant consequences.

To take some familiar examples: we might invest in the stock market, vote for a political candidate who promises to solve domestic problems, "play" the horses, take medicine to reduce the discomfort of a cold, throw a pair of dice at a gambling casino, try to "psych out" our instructors regarding a midterm, or accept a "blind date" on the word of a friend.

Sometimes we win; sometimes we lose. Thus, we might make a sound investment in the stock market, but be sorry about our voting decision; win money at the crap table, but discover

we have taken the wrong medicine for our illness; do well on a midterm, but have a miserable blind date, and so on. It is unfortunately true that not all of our everyday predictions will be supported by experience.

THE NATURE OF SOCIAL RESEARCH

In a somewhat similar manner, the social scientist has ideas about the nature of social reality (which he labels *hypotheses*) and frequently *tests* his ideas by doing systematic research. For instance, he might hypothesize that socially isolated children watch more television than children who are well integrated into their peer groups, and he might do a survey in which both socially isolated and well-integrated children are asked questions regarding the time they spend watching television. Or he might hypothesize that the one-parent family structure (absent mother or father) generates greater delinquency than the two-parent family structure (present mother and father) and might proceed to interview samples of delinquents and nondelinquents to determine whether one or both parents were present in their family backgrounds.

Thus, not unlike his counterparts in the physical sciences, the social researcher often conducts research to increase his understanding of the problems and issues in his field. Social research takes many forms and can be used to investigate a wide range of problems. The researcher may work on a participant observation of delinquent gangs, a sample survey of political likes and dislikes, an analysis of values in the underground press, or an experiment to determine the effects of forcing families to relocate their homes in order to make room for newly constructed highways.

WHY TEST HYPOTHESES?

It is usually desirable, if not necessary, to systematically test our hypotheses about the nature of social reality, even those that seem true, logical, or self-evident. Our everyday commonsensical "tests" are generally based upon very narrow, if not biased, preconceptions and personal experiences, which can lead us to ac-

cept invalid conclusions regarding the nature of social phenomena. To demonstrate this point, let us examine the following hypotheses, which were tested by sociologists on a large number of soldiers during World War II. Would you have predicted these results on the basis of your everyday experiences? Do you think they were worthy of testing? Or do they seem too obvious and self-evident for systematic research?

1. Better-educated men showed more psychoneurotic symptoms than those with less education.
2. Men from rural backgrounds were usually in better spirits during their army life than soldiers from city backgrounds.
3. Southern soldiers were better able to stand the climate in the hot South Sea Islands than northern soldiers.
4. As long as the fighting continued, men were more eager to be returned to the States than they were after the German surrender.

If you believe that these relationships were too commonsensical for systematic testing, then you might be interested to learn that every statement "is the direct opposite of what actually was found. Poorly educated soldiers were more neurotic than those with high education; Southerners showed no greater ability than Northerners to adjust to a tropical climate; . . . and so on."[1] To depend upon common sense or everyday experience alone *obviously* has its limits!

THE STAGES OF SOCIAL RESEARCH

Systematically testing our ideas about the nature of social reality often demands carefully planned and executed research in which

1. the problem to be studied is reduced to a testable hypothesis (for example, "one-parent families generate more delinquency than two-parent families");

[1] Paul Lazarsfeld, "The American Soldier—An Expository Review," *Public Opinion Quarterly,* fall, 1949, p. 380.

2. an appropriate set of instruments is developed (for example, a questionnaire or an interview schedule is constructed);
3. data are collected (that is, the researcher might go into the field and do a poll or a survey);
4. the data are analyzed for their bearing on the initial hypotheses; and
5. results of the analysis are interpreted and communicated to an audience, for example, by means of a lecture or journal article.

As we shall see in subsequent chapters, the material presented in this book is most closely tied to the data-analyzing stage of research (see 4 above), in which the data collected or gathered by the researcher are analyzed for their bearing on the initial hypotheses. It is in this stage of research that the raw data are tabulated, calculated, counted, summarized, rearranged, compared or, in a word, *organized,* so that the accuracy or validity of our hypotheses can be tested.

USING SERIES OF NUMBERS TO DO SOCIAL RESEARCH

Anyone who has conducted social research knows that problems in the analysis of data must be confronted in the planning stages of a research project since they have a bearing on the nature of decisions at all other stages. Such problems often affect aspects of the research design and even the types of instruments that are to be employed in collecting data. For this reason, we constantly seek techniques or methods for enhancing the quality of data analysis.

Many researchers feel they can improve the quality of their studies by employing *measurement* or a series of numbers in analyzing data. Therefore, social researchers have developed measures of a wide range of sociological and psychological phenomena, including occupational prestige, political attitudes, authoritarianism, alienation, anomie, delinquency, social class, prejudice, dogmatism, conformity, achievement, ethnocentrism, neighborliness, religiosity, marital adjustment, occupational mobility, urbanization, sociometric status, and fertility.

Numbers have at least three important functions for the social researcher, depending upon the particular *level of measurement* which he employs. Specifically, series of numbers can be used

1. to *name* and *count* at the *nominal* level of measurement,
2. to *rank* or *order* at the *ordinal* level of measurement, and
3. to *score* at the *interval* level of measurement.

Before moving on to a discussion of the role of statistics in social research, let us stop here to examine some of the major characteristics of these levels of measurement, characteristics that will later take on considerable meaning when we attempt to apply statistical techniques to particular research situations.

THE NOMINAL LEVEL

The *nominal* level of measurement simply involves the process of naming or labeling; that is to say, of placing cases into categories and counting their frequency of occurrence. To illustrate, we might use a nominal-level measure to indicate whether each respondent is prejudiced or unprejudiced in his attitude toward Puerto Ricans. As shown in Table 1.1, we might question the 10 students in a given class and determine that 5 can be regarded as (1) prejudiced, and 5 can be considered (2) unprejudiced.

Other nominal-level measures in social research are sex (male versus female), welfare status (recipient versus nonrecipient), political party (Republican, Democrat, Independent, and Socialist), social character (inner-directed, other-directed, and tradition-directed), mode of adaptation (conformity, innovation, ritualism, retreatism, and rebellion), time orientation (present,

TABLE 1.1 ATTITUDES TOWARD PUERTO RICANS OF TEN COLLEGE STUDENTS: NOMINAL DATA

Attitude Toward Puerto Ricans	Frequency
1 = prejudiced	5
2 = unprejudiced	5
Total	10

past, and future), and urbanization (urban, rural, and suburban), to mention only a few.

When dealing with nominal data, it must be kept in mind that *every case must be placed in one, and only one, category.* This requirement indicates that the categories must be non-overlapping or *mutually exclusive.* Thus, a respondent's race classified as "white" cannot also be classified as "black"; any respondent labeled "male" cannot also be labeled "female." The requirement also indicates that the categories must be *exhaustive*—there must be a place for every case that arises. For illustrative purposes, imagine a study in which all respondents are interviewed and categorized by race as either black or white. Where would we categorize a Chinese respondent, if he were to appear? In this case, it might be necessary to expand the original category system to include "Orientals" or, assuming that most respondents will be white or black, to include a miscellaneous category in which such exceptions can be placed.

THE ORDINAL LEVEL

The reader should note that nominal data are not graded, ranked, or scaled for qualities such as better or worse, higher or lower, more or less. Clearly, then, a nominal measure of sex does not signify whether males are "superior" or "inferior" to females. Nominal data are merely labeled, sometimes by name (male versus female or prejudiced versus unprejudiced), other times by number (1 versus 2), but always for the purpose of grouping the cases into separate categories to indicate sameness or differentness with respect to a given quality or characteristic.

When the researcher goes beyond this level of measurement and seeks to *order* his cases in terms of the degree they have any given characteristic, he is working at the *ordinal* level of measurement. The nature of the relationship among ordinal categories depends upon that characteristic which the researcher seeks to measure. To take a familiar example, he might classify individuals with respect to socioeconomic status as "lower class," "middle class," or "upper class." Or, rather than categorize the students in a given classroom as *either* prejudiced *or* unprejudiced, he might rank them according to their degree of prejudice against Puerto Ricans as indicated in Table 1.2.

TABLE 1.2 ATTITUDES TOWARD PUERTO RICANS OF TEN COLLEGE STUDENTS: ORDINAL DATA

Student	Rank
Joyce	1—most prejudiced
Mary	2—second
Bill	3—third
Jill	4—fourth
Kathy	5—fifth
Jack	6—sixth
Phillip	7—seventh
Steve	8—eighth
Patricia	9—ninth
Roberta	10—least prejudiced

THE INTERVAL LEVEL

The ordinal level of measurement yields information about the ordering of categories, but does not indicate the *magnitude of differences* between numbers. For instance, the social researcher who employs an ordinal-level measure to study prejudice toward Puerto Ricans *does not know how much more prejudiced one respondent is than another.* In the example given above, it is not possible to determine how much more prejudiced Joyce is than Mary or how much less prejudiced Roberta is than Patricia or Steve. This is because the intervals between the points or ranks on an ordinal scale are not known or meaningful. It is, therefore, not possible to assign *scores* to cases located at points along the scale.

By contrast, the *interval* level of measurement tells us about the ordering of categories and also indicates the exact *distance* between them. Interval measures use *constant units of measurement* (for example, dollars or cents, Fahrenheit or Centigrade, yards or feet, minutes or seconds), which yield *equal intervals* between points on the scale.

In this way, an interval measure of prejudice against Puerto Ricans—such as responses to a series of questions about Puerto Ricans that are scored from 0 to 100 (100 is extreme prejudice)—might yield the data shown in Table 1.3 about the 10 students in a given classroom.

As presented in Table 1.3, we are able to order the students in terms of their prejudices and, in addition, indicate the dis-

TABLE 1.3 ATTITUDES TOWARD PUERTO RICANS OF TEN COLLEGE STUDENTS: INTERVAL DATA

Student	Score[a]
Joyce	98
Mary	96
Bill	95
Jill	94
Kathy	22
Jack	21
Phillip	20
Steve	15
Patricia	11
Roberta	6

[a] *Higher scores indicate greater prejudice against Puerto Ricans.*

tances separating one from another. For instance, it is possible to say that Roberta is the least prejudiced member of the class since she received the lowest score. We can say also that Roberta is only slightly less prejudiced than Patricia or Steve, but much less prejudiced than Joyce, Mary, Bill, or Jill, all of whom received extremely high scores. Depending upon the purpose for which the study is designed, such information might be important to determine, but is not available at the ordinal level of measurement.

FUNCTIONS OF STATISTICS

It is when the social researcher uses numbers—when he *quantifies his data* at the nominal, ordinal, or interval level of measurement—that he is likely to employ statistics as a tool of (1) *description* or (2) *decision making*. Let us now take a closer look at these important functions of statistics.

DESCRIPTION

To arrive at conclusions or obtain results, the sociologist often studies hundreds, thousands, or even larger numbers of persons or groups. As an extreme case, the United States Bureau of the Census conducts a complete enumeration of the United States population, in which more than 200 million individuals are con-

TABLE 1.4 EXAMINATION GRADES FOR 80 STUDENTS

72	83	91	29
38	89	49	36
43	60	67	49
81	52	76	62
79	62	72	31
71	32	60	73
65	28	40	40
59	39	58	38
90	49	52	59
83	48	68	60
39	65	54	75
42	72	52	93
58	81	58	53
56	58	77	57
72	45	88	61
63	52	70	65
49	63	61	70
81	73	39	79
56	69	74	37
60	75	68	46

tacted. Despite the aid of numerous sophisticated procedures designed for the purpose, it is always a formidable task to describe and summarize the masses of data that are generated from projects in social research.

To take a familiar example, the examination grades of a class of only 80 students have been listed in Table 1.4. Do you see any patterns in these grades? Can you describe these grades in a few words? In a few sentences? Are they particularly high or low on the whole?

Using even the most basic principles of descriptive statistics as presented in subsequent chapters of this text, it is possible to characterize the distribution of examination grades in Table 1.4 with a good deal of clarity and precision, so that overall tendencies or group characteristics can be more quickly discovered and easily communicated to almost anyone. First, we might rearrange the grades in consecutive order (from highest to lowest) in order to group them into a much smaller number of categories. As shown in Table 1.5, this *grouped frequency distribution* (to be discussed in detail in Chapter 2) would present the grades within broader categories along with the number or *frequency* (f) of students whose grades fell into these categories.

TABLE 1.5 EXAMINATION GRADES FOR 80 STUDENTS: A GROUPED FREQUENCY DISTRIBUTION

Grades	*f*
90–99	3
80–89	7
70–79	16
60–69	17
50–59	15
40–49	11
30–39	9
20–29	2

It can readily be seen, for example, that 17 students received grades between 60 and 69; only 2 students got grades between 20 and 29.

Another useful procedure (explained in Chapter 3) might be to rearrange the grades graphically. As shown in Figure 1.1, we might place the categories of grades (from 20–29 to 90–99) along one line of a graph (that is, the *horizontal base line*) and their numbers or frequencies along another line (that is, the *vertical axis*).

This arrangement would result in a rather easily visualized graphic representation (for example, the bar graph), in which it can be seen that most grades fell between 50 and 80, whereas relatively few grades were much higher or lower.

As will be elaborated in Chapter 4, a particularly convenient and useful statistical method—one with which we are already more or less familiar—is to ask: what is the grade of the *average* person in this group of 80 students? The arithmetic average (or *mean*), which can be obtained by adding the entire list of grades and dividing this sum by the number of students, gives us a clearer picture of the overall group tendency. The arithmetic average in the present illustration happens to be 60.5, a rather low grade as compared against class averages with which most students may already be familiar. Apparently, this group of 80 students did relatively poorly as a whole!

Thus, with the help of statistical devices, such as grouped frequency distributions, graphs, and the arithmetic average, it is possible to detect and describe patterns or tendencies in distributions of scores (for example, the grades located in Table 1.4), which