Book Reviews

Lectures in Statistics

Probability, Statistics and Time. A Collection of Essays. M. S. BARTLETT. Chapman and Hall, London, and Halsted (Wiley), New York, 1976. viii, 148 pp. $12.75. Monographs on Applied Probability and Statistics.

M. S. Bartlett, recently retired as professor of biomathematics at Oxford University, has in the last 45 years or so made basic contributions over the whole fields of statistics and stochastic processes. Since World War II he has been the dominant figure on the English scene. It is my impression that in the United States he is not read as much as he should be, perhaps because of his style. I recall finding his book *Stochastic Processes* (1953) very difficult when it appeared and regretting that the fascinating and novel material in it was not presented with the clarity of Feller's famous textbook first published in 1950. Even so, Bartlett's book and his papers have, at least as much as anyone else's, spurred the development of the statistical theory and applications of stochastic processes to scientific problems. While this may be his greatest achievement, his contributions to "classical" statistics are manifold. He was one of the first good mathematicians to take up the subject and immediately made his mark in multivariate analysis. In his early days Bartlett suffered the enmity of the late Sir Ronald Fisher because he quietly differed with Fisher on the nature of statistical inference.

Bartlett's first book of essays appeared in 1962. Three of the essays dealt with statistical inference, one with multivariate analysis, three with stochastic processes, and one with irreversibility in statistical mechanics. In this collection, the mix is similar. In both cases, most of the essays are lectures that marked some auspicious occasion and that have been published before.

Reading the second collection drove me back to the first. Despite my early experience, I am now a fan of Bartlett's. Statistical books have become boringly technical, and it is a great relief to read broad accounts written in fine prose and with a sense of history. A quotation from the preface to Bartlett's first set of essays gives a further justification for reading both books.

> Survey articles and lectures usually receive scanty attention from reviewers and abstracters, being dismissed as expository, or even without comment at all. Yet among the welter of new research contributions much represents temporary and even useless activity, which a little more general reflection might have avoided. Moreover, there is not often much opportunity to indicate one's general philosophy and outlook in research papers.

It might be remarked that many of these "survey" articles contain new material or treatments and that Bartlett has a new book coming out this year on the statistical analysis of spatial pattern. With this warning not to be misled by his modesty, we turn to the present volume.

The nine essays vary greatly in depth and style. "Probability, statistics and time," an inaugural lecture to University College, London, gives a brief history and some examples of work on stochastic processes (including a nice discussion of caves) and concludes with a nontechnical discussion of probability, entropy, and the paradoxes of statistical mechanics. Bartlett returns to this latter topic in the context of quantum theory in "The paradox of probability in physics." In "R. A. Fisher and the last fifty years of statistical methodology," the first R. A. Fisher Memorial Lecture to the American Statistical Association, Bartlett gives a very just summary that begins, "I have always tried to combine my profound admiration of [Fisher's] scientific achievements with a reluctance to be blinded by their brilliance." After a lengthy discussion of Fisher's main contributions he notes that it is strange that Fisher did not do more with time series analysis. It may be worth mentioning that in a 1920 paper on the variation of crop yields with time, Fisher makes a study of the serial correlation of the residuals from polynomial regression. "Inference and stochastic processes" is mostly about inference except for two technical appendices. "Biomathematics" is Bartlett's Oxford inaugural address and deals largely with population genetics—one assumes it was given before rather than after a good dinner. By contrast, "Epidemics" gives a very easy introduction to the subject. "Equations and models of population change" treats both epidemics and genetic examples rather technically. In "When is inference *statistical* inference?" Bartlett tries to put in a nutshell his own views on Bayesian methods and likelihood ratios. Other aspects of this appear, of course, in his essay on Fisher. Bartlett's attitude is, in fact, like Fisher's early view—that statistics, as a subject, "cannot from its very nature be concerned with single individuals or events as such." The final essay, "Some historical remarks and recollections on multivariate analysis," is unfortunately short and technical. Since this topic is receiving a great deal of attention nowadays there is great justification for a much longer article.

Everyone will profit from reading these essays.

GEOFFREY S. WATSON
Department of Statistics, Princeton University, Princeton, New Jersey

General Knowledge in the Populace

The Enduring Effects of Education. HERBERT H. HYMAN, CHARLES R. WRIGHT, and JOHN SHELTON REED. University of Chicago Press, Chicago, 1975. x, 315 pp. $12.50.

Compared with the unfavorable conclusions of many recent research reports about the American educational enterprise, this volume—166 pages of which are tables—is highly laudatory. The title, however, promises more than the contents produce, for only one effect of education, "general knowledge," is studied. This of course is one fundamental purpose of education.

Evidence on the accomplishment of this purpose has been somewhat restricted to academic subjects covered in testing programs with students or recent graduates, except for the 1969 excursion of the National Assessment of Educational Progress into a sample of adults aged 26 to 35. Compilations of evidence on a national scale covering information

about academic subjects, public affairs, and popular culture over a period of time representing several cycles of operation of the educational system and testing how long the effects of education endure into adult life have without doubt been nonexistent.

Hyman and his associates have reanalyzed old data and have in doing so provided strong evidence for the accreting capability of the social science community to conduct significant secondary analyses on the steadily growing archives of data about society. What the authors have done is assemble 54 national sample surveys, involving about 77,000 individuals, over the period 1949–71 (clumped around four points in time), adding a small additional inquiry of their own in 1974. The surveys with suitable data were chosen without regard to whatever statistical relations they might show between knowledge and education. From these studies the authors selected some 300 measures of knowledge. People interviewed during each time period were grouped into four age cohorts, in 12-year groupings, between the ages of 25 and 72. Younger and older individuals are left out because of the likelihood that many of them, being in institutions, would not have been caught in the household-sampling net of surveys. The authors also chose to exclude blacks for various reasons related to their limited number in various comparisons. Where identifiable, persons with advanced degrees were also eliminated so that the effects of college experience could be better estimated.

This design permits a welter of comparisons. The authors look at an age cohort as it grows older and at particular age groups who went through their educational experiences at different periods of time from the 1930's to the 1950's. Comparing various age groups allows the authors to examine the effects of education taken all the way back in the early decades of this century.

The information items by no means scale the peaks of knowledge—typical questions are, "Which planet is nearest the sun?" "Can you tell me what some of the U.S. cabinet positions are?" and "Who wrote *A Tale of Two Cities*?" The items do touch on a variety of areas—domestic and foreign public figures and events, history, geography, humanities, civics, science, and so on. The measures are shallow assessments of what (it is hoped) is imparted in a college education, but many are items of knowledge that "should" be acquired regardless of specialization or concentration, and they are not denied to less educated people simply because they do not have specialized college courses.

The findings make it clear that the benefits of higher education in acquired knowledge and continued learning are substantial in magnitude, pervasive over all content areas, and persistent among the oldest cohorts whatever time period and corresponding generation they represent. The benefits of high school, over elementary school, are similarly substantial, pervasive, and enduring, and there is evidence that even a fragmentary amount of high school or college has considerable effect in increasing knowledge. There is an increment of every kind of knowledge with each step up the education ladder, and the increment is preserved no matter how old the individual and no matter which of the four time periods is examined. The effects of education by time period for adults at any given age stage show a dramatic uniformity. The changes in schooling and the distinctive climates of events for different generations seem to make little difference. It is as if the sheer benefit from more education—no matter what kind prevailed and no matter what surrounded it in life—is so substantial that these other factors do not blunt it. The least schooled, whatever their background and later experiences, do not seem to make up for their lack of education. The more educated, however characterized, still have a big advantage. The results provide compelling evidence of the power of formal education, in contrast to what may be called the school of life. These conclusions are not true for every individual or every item, but group differences are large and the majority of items show statistically significant differences at the .001 level.

People with more education not only are more likely to have learned about a given subject, they are more likely to have learned about it in some depth. They make greater use of print and electronic media. They appear to have a lifelong interest in learning and in staying aware of current events. The findings establish that the better-educated of several generations and historical periods have wider and deeper knowledge not only of bookish facts but also of many aspects of the contemporary world. A cluster of 11 items on "popular culture" is no exception. These items, from half a dozen different surveys spread over a 15-year period, deal with sports, romances, popular heroes, and media stars and might therefore be seen as of special interest to the young or to one sex over the other. The sustained pattern even among older age groups and within both sexes provides evidence for the sweeping and enduring effects of education.

One cannot isolate the educational experience as a causative factor. A dozen other explanations of the findings jump to mind, but the authors deny one alternative explanatory factor after another. It is true that we find large differences in the educational attainments of socioeconomic groups, for instance, but when controls, as they are available in the data, are applied for age, sex, religion, social class of origin, ethnicity, and rural origin, the superiority in knowledge of the better educated persists. The authors even control for union membership in analyzing questions about union laws and personalities.

Finally, unmeasured factors such as early intelligence and propensity or stimulation to learn may have determined subsequent educational attainment and knowledgeability, or the educated may do better in answering questionnaires. However, it is impressive that, with all the changes in education and the varieties and large numbers of survey respondents, the general finding is not weakened among different cohorts and periods (as larger proportions of the population go further in schooling) or among various subgroups and analytic controls. When the "unlucky" or "ordinary" highly educated whose circumstances are lowly and the "lucky" or "extraordinary" uneducated who have arrived at a high station in life are compared the pattern still holds significantly, although the effects of education are somewhat enhanced among those whose circumstances are advantaged and are somewhat attenuated among those in less advantaged positions.

These findings that the schools succeed in increasing knowledgeability are not incompatible with the schools' failing in many other respects. Various accusations about drop-out and push-out rates, discrimination, and school inequalities are given added weight. The findings establish how valuable a thing it is that is being disdained by some and denied to others. The differential or detrimental effects of various social contexts do not negate the conclusion that schools in general do produce significant increments in learning. Although there are a large number of other questions about the enduring effects of education, the one posed in this report is comprehensively answered.

STEPHEN B. WITHEY
Institute for Social Research, University of Michigan, Ann Arbor