A Report on the Use of Statistics in Social Science Research

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SUMMARY

At the request of the Social Science Research Council, and with the support of the Council of the Royal Statistical Society, a series of visits to university departments, institutes and research units was carried out to enquire into the position of statistics in social science research and the influence of teaching in the subject. The Report discusses both these aspects together with the related subject of research careers and makes a number of recommendations including the setting up of departments of social statistics, the establishment of research units and the provision of a hierarchy of purely research posts. There are further recommendations for improvements in S.S.R.C. procedures and for putting the recommendations into effect.

INTRODUCTION

1. The Heyworth Report (1965) which recommended the establishment of the Social Science Research Council stressed the importance of mathematics and statistics in the development of the social sciences. "Without mathematics and statistics the social sciences as a whole cannot flourish. They are necessary in both the collection and the treatment of data. Many statistical techniques and methods have developed

in response to the special needs of experiment and analysis in agriculture, medicine, psychology, and sociology, and have in turn made possible new approaches to experiment and observation in all these subjects. This need for students to be able to understand statistics and use them intelligently presents a problem. Many opt for the social sciences whose weakness in mathematics deters them from courses in the natural sciences. Some are paralysed by fear of the subject which has arisen at some time during their schooldays; others have given up the study of mathematics too soon. But new approaches to the teaching of mathematics and statistics to schoolchildren are being developed; and it is essential that these methods be also developed in universities and colleges so that no student will in future graduate in the social sciences without a good working knowledge of statistics."

2. In 1967, the Statistics Committee of the Social Science Research Council already had in mind the desirability of undertaking a research review based on visits to universities but were unable to arrange for it to be done. Subsequently it was borne in upon them, through their function in examining applications for research grants, that relatively few involving statistics primarily were made, that the statistical aspects incidental to other research projects were too limited and that the standard in general was disappointingly low. Hypotheses could be advanced in explanation of these facts: for instance, that research into statistical methodology is not usually a team affair and is unlikely to lead to applications for grants to build up a research team; again, that very few people competent to do applied work in statistics at an advanced level were researching in the social sciences. Insofar as the latter situation arose from the lack of social scientists who were able statisticians, or with sufficient knowledge of statistics even to appreciate the value of getting the research done by statisticians, it was thought to result from a non-numeracy prevalent among social science graduates, with its origin in the schools. The Social Science Research Council has felt sufficiently strongly about this for its Chairman to write a letter to all head-teachers of schools with sixth forms urging them to advise pupils intending to study social sciences at university to continue with mathematics to A-level if possible (S.S.R.C. Newsletter, No. 3). The other side of the coin, in accounting for the scant statistical content of much social science research, is a failure on the part of a sufficient number of mathematical statisticians to be attracted into the field of the social sciences.

3. The various hypotheses all seemed to have their place in an overall explanation of the state of statistics in the social sciences, and were attested to by present or former members of the Statistics Committee who had experienced the situation at one or more universities. The S.S.R.C., however, was not confident that it had a complete picture either of research or of the statistics taught to social scientists who might do research. It therefore decided that a review should be carried out and I was invited to undertake this on their behalf, with the agreement of the Central Statistical Office and the support also of the Council of the Royal Statistical Society. Accordingly the Chairman of the S.S.R.C. wrote to Vice-Chancellors on October 10th, 1969 (Annex 1) and asked them to agree to a series of informal visits.

OBJECTIVES

4. The principal objective was to increase the quantity, and improve the quality, of statistical research in the social sciences. It was essential first to establish what the current situation was in order to draw conclusions about what needed to be done—if anything. The concern about statistics in the social sciences seemed to be general, but it had to be verified.

5. The first step was to ascertain the research in progress in the social sciences, in which statistics could be used, or for which statistical methods could be developed. Here at the outset there was a multiplicity of aims, for clearly one could concern oneself with theoretical statistics, and with the methodology for applying it, and also with the way it was used by social scientists. The shortcomings in the first two would manifest themselves in an absence of research grants that came before the Statistics Committee, the last in the poor quality of some of the projects submitted to other committees.

6. The next step would be to obtain, if possible, a brief account of the statistical aspects of each research project including the techniques used and the nature of the data. It was essential also to enquire into the degree of collaboration between social scientists on the one hand and statisticians in the mathematics departments on the other hand, and to find out about the statistical training and background of the researchers.

7. Another main line of enquiry was into the teaching of statistics in the social sciences, since it was a reasonable argument that research could not develop satisfactorily if future social scientists were not suitably trained. The information to be looked for would include the content of courses and the characteristics both of students and teachers. In particular, did students have a sufficient foundation of mathematics, and were they learning about statistics from mathematicians or social scientists or some rare combination of the two?

8. Further objects of the visits were to bring the S.S.R.C. to the notice of mathematics and statistics departments, to explore ways of encouraging mathematicians to enter the social science field, and finally to ask about equipment. The stated intention was to find out what needed to be done; the implication seemed to be that the S.S.R.C. would follow this with direct support where it could, and representations where its writ did not run.

SCOPE AND NATURE OF VISITS

9. There have been two encyclopaedias of the social sciences, the first edited by E. R. A. Seligman and published in 1930 and the second, the *International Encyclopedia of the Social Sciences*, edited by D. L. Sills and published in 1968. In the introduction to the latter work it is stated that the social sciences differ in their scope from one generation to another. Despite the shift in content that undoubtedly takes place, a listing of the subjects included shows a fair constancy over the years. One can go back to the first edition of W. McDougall's *Introduction to Social Psychology* in 1908 and find the social sciences described by the list in the table below, which compares also the two encyclopaedias and the subject committees of the S.S.R.C. The first two works distinguish certain groups of "semi-social" sciences, etc. which are given at the foot of the table.

10. It is noteworthy in the present context that statistics is included in the *International Encyclopedia* although, as it says there, "today statistics is not generally considered to be one of the social sciences. Some of its main origins, however, were in the social sciences, and it has always had a close and mutually fruitful relationship with the social sciences. All the social sciences today depend increasingly upon statistical methods for the gathering and interpretation of their data; accordingly, we have treated statistics as a critical auxiliary discipline". The earlier *Encyclopaedia* (1930) was sponsored, among others, by the American Statistical Association.

Subjects included in the field of the social sciences

An Introduction to Social Psychology (1908)	Encyclopaedia of the Social Sciences (1930)	International Encyclopedia of the Social Sciences (1968)	*S.S.R.C. Committees* (1970)
anthropology, cultural	anthropology	anthropology*	anthropology,* social
economics	economics	economics	economics
[see "special" social sciences]	[see "semi-social" sciences]	[see psychology]	educational research board
ethics	[see "semi-social" sciences]		
	[see sciences with social implications]	geography (not physical)	geography human
history, philosophy of	history (social aspects)	history	history, economic and social
[see "special" social sciences]	law	law	
			management and industrial relations
			next thirty years
	penology		
			planning
political science	politics	political science (including public administration)	political science and international relations
		psychiatry	
psychology (social)	[see "semi-social" sciences]	psychology (including educational psychology)	psychology
			social science and government
	social work		
sociology	sociology	sociology	sociology and social administration
		statistics	statistics
"special" social sciences	"semi-social" sciences		also within scope of S.S.R.C.:
art	education		accountancy
education	ethics		area studies
law	philosophy		criminology
religion	psychology		demography (incl. with economic and social statistics)
	sciences with social implications		
	art	* including—	* including—
	biology	archaeology	ethnology
	geography	ethnography	
	medicine	ethnology	
	philology	linguistics	

11. These subjects consequently defined the scope of the investigation but it was deliberately restricted in one important respect by the exclusion of economics. Partly this was in order to reduce the effort involved and partly because it was thought that the position was more satisfactory in economics than in other social sciences. However this may be, economics departments were eschewed during the visits except where it might happen that there was a joint department with other social studies.

12. The places to be visited included as many as were feasible of the universities in the United Kingdom, of which there are 44 including the former colleges of advanced technology, independent institutes and, possibly, polytechnics. However, the latter were to some extent being covered by the Joint Committee of the Royal Statistical Society and the Institute of Statisticians on the teaching of probability and statistics in technical colleges and colleges of technology, under the chairmanship of Miss Joan Keen, and it was thought better that they should extend their enquiries to the subject of research at these institutions. (The places visited are listed in Annex 2.)

13. It is important to realize the limitations of an enquiry of this nature. The letter from the Chairman of the S.S.R.C. to Vice-Chancellors (Annex 1) pointed out that the visits were to be of an informal character, resembling in this respect the visits made by representatives of H.M. Treasury to economics departments over a number of years. Their practice was to call upon those individuals who were available at the time of the visit and it was obviously not feasible to attempt more on the present occasion. Many more disciplines were to be covered, though the visits were only concerned directly with the statistical aspects, and there was a bewildering variety of faculty structures covering all or some of the subjects in the table. A bias existed towards visiting those places where arrangements could more easily be made, particularly through the good offices of people known personally to me or of those who were especially interested in the objects of the exercise. Some of them came with me and were able to renew useful contacts in the social science departments. On occasion I was accompanied by a member of the Statistics Committee of the S.S.R.C. or one of its staff.

14. The informality of the visits had one great disadvantage, that it would render the task of reporting and making recommendations exceedingly difficult. However freely the discussions might range—as it was the intention that they should do—there needed to be some commonly recurring themes to link them. A list of questions was therefore prepared to serve as a framework for the interviews and these were put to people at the time of the visit, or sometimes beforehand, and they were invited to respond in writing, which many of them did. The questions are given in Annex 3 and fall into three categories:

Research in Progress (Q1)
Teaching (Q2, 3, 4)
Equipment (Q5)

Particular stress was laid in Question 1 on the statistical aspects of each research project and on the collaboration between social scientists and statisticians. These were in essence what the visits were about.

The next three questions sought to ascertain some facts about the numbers and mathematical capability of social science students being taught statistics, the content of their courses, and the way in which teaching was organized. The final question was about equipment, which could be put to use either in research or in teaching.

15. The written replies, coupled with the notes made at the time of the visits, enable one to get at least a partial picture of what was happening under these headings. In the following section the questions are considered one at a time and a synoptic view taken over all establishments. Partly this is because it would be unfair to rely on a short and informal visit for a description of a particular department, although it is hoped that the accumulation of a number of such visits has proved enlightening. The lessons to be drawn, if any, are of a general nature and it is for individual universities, which differ so greatly from one another, to decide whether the cap fits in any respect.

ANSWERS TO QUESTIONS PUT

*Q*1. *Research in progress*

16. The question was in four parts and asked firstly for a brief description of each research project, secondly about the statistical aspects, thirdly (where appropriate) about the degree of collaboration with statisticians and fourthly the statistical qualifications of the investigators.

17. Q1(a). Simply to quote all the projects that were reported would give an incomplete and probably biased representation of the research going on in the social sciences. Moreover, there is now a fairly complete coverage of titles in the Department of Education and Science's publication *Scientific Research in British Universities and Colleges*. Fuller synopses of those projects which are supported by the S.S.R.C. are published in their *Annual Report*; similar accounts usually appear in the reports of the independent institutions. The tally of university research is probably not complete in respect of the work done by students. There is also a certain amount of unsung work on the quality of data such as ensuring the consistency of a series over time, which all acknowledge as essential, but most consider to be an inadequate peg on which to hang an academic reputation.

18. Nevertheless, a selection of the topics that registered on one palate may disclose something of the flavour to others. Education received a great deal of attention—not only in education departments—from psychologists and sociologists among others. Some aim to develop techniques for instilling knowledge; the use of the computer for this purpose has stimulated a number of projects. Others are concerned with the organization of teaching, for instance the value of sandwich courses and their effect on careers. The link with careers is a natural extension of work that has been done on educational models (since attendance at school is but one kind of occupation). Behind this is the quest for the relevance of education to a student's subsequent life and work. Manpower studies are carried out in an occupational framework and tend to be by economists.

19. Psychological studies range from work on individuals, or small groups, to the attitude survey that may be classed as social psychology. The former, more traditional type of investigation, seeks to study personality and modes of thought under strict laboratory conditions, in imitation of the natural sciences. Such conditions are conducive to experimental work, whereas attitude surveys rely on field observations, where quasi-experimental situations are difficult to engineer. Political scientists have concentrated on attitudes to political issues, though some have been interested in political administration. These interests shade into problems of public administration, including law.

20. Public administration covers the social services, and research is being done in the field of social administration to ascertain people's needs and the extent to which they are satisfied. Many problems of the socially handicapped are related to medical handicaps, and departments of social medicine are working in the area of medical sociology, for example on problems of the mentally subnormal (there is a department of medical sociology at Bedford College and an M.R.C. unit at Aberdeen). Social medicine is clearly a subject where the interests of the social and medical sciences overlap, and where social statistics may have something to learn from developments in medical statistics (and vice versa).

21. Most universities have strong local affiliations and the material for their research is frequently close at hand. Thus an ecological study of crime at one university conveniently took the neighbouring city as its arena. Similarly traffic and other planning problems arise from local needs. The results obtained from research have more general applicability of course, and the successful investigator may be called upon to advise on situations in more remote areas.

22. Q1(b). The question on the use of statistics in research was intended to elicit the techniques commonly used and promising new ones. To assist in the former objective an *aide-mémoire* was provided in the form of a list of techniques (see appendix to Annex 3) based upon the list used by Kathleen Gales in her survey of Fellows of the Royal Statistical Society (1959). The impression gained was of a general familiarity with standard techniques, though little of novel developments or of the scope among social scientists for such developments. On the whole unsophisticated techniques were used.

23. The problems of data collection dominated much of the research activity. Data were often sought by questionnaire, and the methodology was that of the social survey, with its attendant problems of specifying aims, selecting samples and classifying responses. Data from the Census of Population were also used—in effect someone else's survey, with problems of confidentiality attached. Psychologists, in particular, carried out tests on individuals, giving them an obvious opportunity for experimental design. At the other extreme, existing records and published series provided the only raw material for the investigator, apart from anything that might be generated as the result of simulation exercises.

24. More than once the emphasis was put on data analysis as the prime contribution that statistics could make to social science research, whilst sampling problems in connection with surveys were relegated to a subsidiary place. Nevertheless, there were difficulties over such things as biased response and missing data, which required solution. Data analysis was, however, most limited by the scarcity of quantitative measures, much of the observational work being classificatory in nature. The development of measurement scales would seem to be of particular advantage to sociologists.

25. What methods other than basic descriptive statistics are generally used? (To ask such a question is not to dismiss descriptive statistics as of little interest; one political scientist pointed out the problems involved in the interpretation of tables for instance.) Some respondents laid claim to occasional use of all the techniques listed in the appendix. Another popular sub-set was the first half of the list. From notes made at the time of the interviews, relating to particular investigations, the following may be quoted: demographic methods, correlation, regression, factor analysis, spatial distributions (in geography), gravity models, cluster analysis, model-building. Others received a mention but were either not in widespread use or merely

gleams in the eye. Some people were pessimistic about finding a use for advanced mathematics in the social sciences, but there have been notable proofs to the contrary, for example the application of stochastic processes to population studies and, as beautifully illustrated at the British Museum exhibition during the 37th Session of the International Statistical Institute in London, the reduction of archaeological data by multivariate methods. (Current Notes, 1970.)

26. Further developments are not easy to predict. There will doubtless be a greater exploitation of methods of proven value, including some of those listed above, and some, such as cluster analysis, which are only beginning to catch on. If one can venture to identify a neglected area it is experimentation, psychology being the only one of the social sciences that seems to make much use of experimental design. The equivalent to the psychologist's laboratory is, of course, the field trial; the data analyst's task of evaluation is made much easier, and the results are more trustworthy, if a controlled trial has been designed in the first place.

27. Q1(c). The question on the use of statistics in research was followed by one on collaboration with statisticians; as a sociologist said during one conversation, it is rare to find a person who can span both fields. On this and other occasions, the visits may have served to fortify the intention to collaborate. A distinction needs to be drawn between collaboration in the full sense, leading to joint publication, and collaboration in the form of consultancy. The former was very rare, but consultancy was quite commonly claimed, whilst practically everybody acknowledged the need for a consultant to be available. In a number of cases this need could not be supplied. In others, although there was a statistics department, it was not approached for help. This could, for instance, happen where a social science department had its own statistical staff, and there was generally a preference for getting advice from people experienced in the subject matter, rather than mathematical specialists. Some of the advice sought was from computer departments.

28. The person looking for advice was frequently not unfamiliar with statistical method, but wanted perhaps to discuss a sampling problem or a more refined technique of analysis than he was accustomed to using. Survey design was a staple item among the subjects for consultancy. The range of advice sought was such that at one end it could have been satisfactorily accommodated by a textbook reference, and at the other end meant that the applied statistician should have brought the theoretical statistician in for a second opinion. The involvement in respect of time might be anything from an hour or two up to six months and more. This is unlikely to be known initially; statisticians will not readily commit themselves to a long period ahead, and at the same time social scientists often prefer a prompt answer to an exact and potentially more revealing one.

29. Q1(d). Many people doing research in the social sciences appreciate how necessary statistics is to their subject. But for historical reasons their statistical background has often been informally acquired and some would like to have time off to study statistics, an opportunity which they believe is available only during a period of sabbatical leave. Formal statistical training has usually been acquired as part of a social science degree course or on a postgraduate course, while some people have attended courses of lectures in their spare time.

30. An earlier background of mathematics would seem to be essential to the understanding of statistical methods, and the level needs to be quite high if some of the advances in statistical theory are to be applied to problems of social science research.

Q2. Statistics taught to social scientists

31. The question on the teaching of statistics to social scientists was again in four parts, the first concerned with syllabuses, the second with the numbers of students and their mathematical background, the third with the relative importance of statistics to the rest of the course, the fourth with advanced courses in statistics.

32. Q2(a). As in Q1, the reporting was incomplete, indeed fragmentary, and even if it could be summarized would not necessarily be representative. It would be quite an undertaking even to collect all the syllabuses and examination papers, and a major task to analyse them. (A method is given in Morris (1968). The committee on teaching in technical colleges (paragraph 12) is attempting to summarize syllabuses.) One reason is that the aims are so variable, some courses being directed at a general understanding of the statistical approach as a background to social science studies, others at examinations that count as options in a degree course or that qualify for a diploma.

33. In the first category the emphasis is on data, their definition, collection, reliability, classification, presentation and interpretation (the latter sounds ambitious but without it the subject is arid). The students are taught about frequency distributions and descriptive statistics, such as means and standard deviations. They go on to elementary time series analysis and correlation. In some universities all the social science students get this much in a basic course in their first year. They may then go on to probability, the mathematical form of distribution functions (e.g. normal, binomial), significance tests and regression. It is worth remarking here that many students consider that the statistics teaching is too mathematical, although the emphasis is on methods rather than theory. Special topics are brought in as appropriate, for instance design of experiments for psychologists and life tables for demographers, whilst surveys and sampling methods are widely taught.

34. Whether it is connected with lack of motivation or maturity in the students, some teachers find it difficult to convey statistical ideas in a compulsory first course. Postgraduates may be more persuaded about the relevance of the subject. At any rate postgraduate teaching will retain its importance while there are graduates who have not previously done any statistics. It will also tend to be more specialized than teaching which is part of an undergraduate course.

35. In the absence of a systematic appraisal of courses and examinations, a reading list may throw some light upon what has been taught. The following well-known texts are chosen from courses that vary in standard, and in some cases only selected chapters would be recommended.

Blalock, H. M.	*Social Statistics*	McGraw-Hill
Cochran, W. G.	*Sampling Techniques*	Wiley
Freund, J. E. and Williams, F. J.	*Modern Business Statistics*	Pitman
Guilford, J. P.	*Fundamental Statistics in Psychology and Education*	McGraw-Hill
Hoel, P. G.	*Introduction to Mathematical Statistics*	Wiley
Hope, K.	*Methods of Multivariate Analysis*	University of London Press
Ilersic, A. R.	*Statistics*	H.F.L. (Publishers)
Maxwell, A. E.	*Analysing Qualitative Data*	Methuen
Mood, A. M. and Graybill, F. A.	*Introduction to the Theory of Statistics*	McGraw-Hill

Moser, C. A.	*Survey Methods in Social Investigation*	Heinemann
Quenouille, M. H.	*Associated Measurements*	Butterworth
Schlaifer, R.	*Probability and Statistics for Business Decisions*	McGraw-Hill
Siegel, S.	*Nonparametric Statistics for the Behavioral Sciences*	McGraw-Hill
Stuart, A.	*Basic Ideas of Scientific Sampling*	Griffin
Suits, D. B.	*Statistics*	Murray
Weatherburn, C. E.	*A First Course in Mathematical Statistics*	Cambridge University Press
Yeomans, K. A.	*Statistics for the Social Scientist*	Penguin

36. A more pertinent approach is to look at examination questions, and a few examples are quoted below. An attempt at impartial selection has been made by choosing the third question from each paper. (Examples 6 and 7 are included to indicate the questions set for mathematicians.)

Example 1. B.A. in Sociology *Methods of Social Statistics I*

Let μ be the true I.Q. of student X. It is known that his scores on test Y are normally distributed with mean μ and standard deviation 4·00. The test is administered to him on occasion Z and he scores 125.

(i) What is the maximum-likelihood estimator of μ?
(ii) Test the hypothesis that $\mu = 120$.
(iii) Comment upon the statistical bases of the methods used to solve (i) and (ii).

Example 2. Hons. B.Sc. in Social Studies. Part I. Economic and Social Statistics *Statistics I*

A survey of labour mobility which was made in 1963 gave the following results:

Education	*No. of changes of address in last 10 years*		*Total*
	0–3	4 *or more*	
University	172	49	221
Technical college	192	38	230

Is there evidence here of association between education and number of changes of address?

This labour mobility survey is described as a two-stage stratified random sample covering England, Wales and Scotland and was conducted in three phases. Explain the terms "two-stage", "stratified" and "three phases".

Example 3 *Statistics II*

Write a short account of each of the following: sampling units, sampling frames, stratified samples. Illustrate your answer using either real or imaginary surveys for this purpose.

Example 4. M.Sc. in Management *Quantitative Methods*

A diet is required to provide an animal with 3,000 calories and 240 units of protein a day. Four basic foods may be used:

Food No.	*Cost per lb.*	*Calorie content*	*Units of protein*
I	4*s.*	700	40
II	3*s.*	500	60
III	5*s.*	600	100
IV	6*s.*	900	50

Formulate the problem of determining the cheapest food content that will satisfy the diet requirement. Solve graphically and also by the simplex algorithm the simplified case in which only foods I and III are available.

Example 5. B.A. in Social Sciences. Final Examination, Paper IV. *Social Statistics*

(a) A survey of the factories in Much-Grinding-in-the-Mill is to be conducted in order to compare the "Management to Workers" ratios of the major industries. The table below shows the number of factories in each of the industries.

Type of industry	*No. of factories*	*Estimated standard deviation (no. of employees per factory)*
A	1,710	2
B	1,160	4
C	600	5
D	960	9
E	410	5
F	160	6
	5,000	

It has been decided to study 10 per cent of the factories. How many factories in each industry would be chosen if (i) a constant sampling fraction is employed, and (ii) a variable sampling fraction is employed? Give reasons why one might choose a variable sampling fraction.

(b) A radio station advertisement in a trade journal stated "A survey has been conducted to find out exactly what kind of music listeners want to hear, the results of which prove that 50 per cent more people want to hear classical music than 'pop'." What further information would be needed to convince *you* that these findings are correct?

Example 6. M.A. General and First B.Sc. *Statistics* (First Paper).

It is known that an event X must happen between 2 p.m. and 4 p.m. If the probability density function that X occurs at time t, measured in hours after 2 p.m. is proportional to t^2 find the probability density function for the time at which X occurs. Find to the nearest minute the median time at which X occurs.

If an event Y has constant probability density function and Y must happen between 3 p.m. and 5 p.m. find the probabilities that (i) X happens before Y; (ii) Y happens before X.

Example 7. M.A. Honours and Honours B.Sc. *Statistics* (Paper IV)

A four-variate normal distribution has covariance matrix

$$\Sigma = \begin{bmatrix} 1 & \rho & \rho & \rho \\ \rho & 1 & \rho & \rho \\ \rho & \rho & 1 & \rho \\ \rho & \rho & \rho & 1 \end{bmatrix},$$

where $\rho > 0$. Find the unique first principal component and discuss the nature of the other three principal components giving one possible solution.

If the distribution is regarded as consisting of the two sets of variates (X_1, X_2) and (X_3, X_4) find the two pairs of canonical variates and the corresponding canonical correlations.

Example 8. Diploma in Statistics. Qualifying examination: Paper (ii) *Statistical Investigation*

Quantitative measurements are made on a random sample of size n, drawn from each of two populations. Describe briefly a test which may be used to test the hypothesis that the two samples have a common mean, and which makes no assumption concerning the normality of the parent populations.

An inspector is given two samples each consisting of ten pieces of dyed cloth. The same lot of dye has been used for all twenty pieces but the method used to dye the first ten pieces differs from that used for the remainder. The inspector ranks the pieces according to increasing depths of colour, his results being

$$A\ A\ A\ B\ B\ B\ B\ A\ A\ A\ A\ B\ B\ A\ A\ A\ B\ B\ B\ B,$$

where A denotes a piece from the first sample and B a piece from the second sample. How would you test the null hypothesis that there is no difference between the two methods? Derive the probability distribution of your test statistic under the null hypothesis.

Example 9. M.Sc. in Statistics *Social Statistics*

Attempt a definition of social mobility. Indicate the measures that have been proposed and critically discuss their validity.

Example 10. M.Sc. in Demography *Demography II*

An approximate formula for relating certain measures in a population is

$$nc_1/W = F_1\{1 - \tfrac{1}{2}p(n - 2m_1)\},$$

where

- c_1 is the number of first births in a year,
- n the range of ages of women to whom these births occur,
- W The number of women in that age range in the population,
- F_1 the proportion of women who become mothers at current rates,
- m_1 the mean of the distribution of age-specific first birth rates measured from the start of the age range,
- p the average proportional change per year of age in the number of women over the range (negative for decrease with age).

Use the formula to examine the completeness of registration of first births in the population for which data are shown below.

Age in years	*No. of women (thousands)*	*Per cent mothers*
10–14	127	1
15–19	132	37
20–24	130	84
25–29	118	90
30–34	93	95
35–39	76	95

First births registered per year—16,800.

Estimated value of m_1 measured from 15 years— 8·5 years.

Discuss the value of approximate formulae of this kind (a) with reference to the particular example and (b) in general.

37. Q2(b). Again the information is too fragmentary to be put together, but Tables 9 and 10, compiled from data supplied by the University Grants Committee, give the overall numbers of social science students who graduated with first degrees and higher degrees each year. Until the individualized data system planned by the Department of Education and Science is effective it will not be possible to obtain details of the courses taken, and even then it is unlikely that information will be given on the statistical content of the courses.

38. There is generally a compulsory course in elementary statistics in the first year of a social studies course, but some faculties make it optional, and others which consider their subject to have only a marginal use for statistics, for example economic history, and some departments of politics, do not offer a course. Not all the statistics courses are described simply as such although no one would cavil at a course entitled "Research methods and statistics". In some cases the teaching of statistical techniques may be incidental to the teaching, say, of psychology.

39. After the introductory course more advanced courses are widely offered which are not necessarily taken up, or sometimes only by a few. The proportion taking the statistics option may be of the order of one in five in some departments. The view is sometimes expressed that a social *scientist* must be numerate and in a very few places this is pursued to the extent of making the course compulsory.

40. The fact is, however, that the majority reading for a social science degree are not deeply numerate. The most commonly held qualification is an O-level in mathematics, which has been left behind at the age of about 16 or 17. It is not always obligatory in obtaining admission to the course, and any shortcomings in mathematical knowledge have to be made good by extra tuition. Blame is often laid upon a crowded school curriculum, which is, of course, attuned to university requirements. It does seem superfluous to insist, for instance, on an O-level pass in history before admitting anyone to a degree course in social studies, and—matching it on the natural sciences side—to require O-level chemistry as well as physics and mathematics before being able to take a degree in mathematics or statistics. However, these are isolated instances.

41. For whatever reason, and it may not be entirely due to the schools, there is resistance on the part of some students to the mathematical or numerical treatment

of their subject. There is sometimes, therefore, a division into streams whereby A-level mathematics students, who may number as many as a quarter of the intake, are given the opportunity of more advanced instruction.

42. Q2(c). A basic statistics course, typically, consists of 10 to 20 lectures or thereabouts, apart from tutorials. This is not always examined for the purpose of awarding a degree, although a reasonable level of performance may be required in class work. The next stage is likely to be an optional course spread over 2 years, though it can be compressed—in one case into 40 hours in the second year of the degree course—so that the techniques learnt are available for the final year. There are not many departments in which a second-year course is compulsory.

43. The proportion of statistical papers in finals, corresponding to the taught courses, is likely to be of the order of 1 in 8. Lindley (1966), reporting the results of a questionnaire on university courses with statistics as a main subject, defined this as spending one-quarter of the overall time on statistics. Such a definition, of course, embraces a larger group than the U.G.C. in its figures of graduates in statistics (Table 1). Lindley gives a figure of 249 in 1964, compared with the U.G.C.'s figure of 54.

44. Q2(d). There are very few social scientists who have taken a full course, such as a diploma, in statistics, though a number of courses are on offer. Postgraduate courses in, for example, social studies sometimes reach a more advanced level of statistics than undergraduate courses, but cannot be compared with a full course in statistics. Dissertations in the latter are occasionally in a social science field.

45. Some universities are thinking of introducing joint degree courses in statistics and social sciences and, in fact, it is already possible to combine the disciplines in a course of quantitative social studies. However, a combination which could be described as sociometrics is rare compared with econometrics, probably, as somebody said, because economics is more easily detached from the other social sciences. The assemblage of variegated units is, it need hardly be said, only the first step in developing a course which could truly be called "sociometrics".

Q3. Teaching staff

46. Opinions differed as to whether statistics should be taught to social scientists by suitably trained persons brought up in the subject field, or by mathematicians—who might not be able to "communicate". Certainly the practice varied; a course might be taught in some places by the mathematics department and in others by the social science department. The qualifications of the teaching staff in the latter tended to be as described in Q1(d), since there was an overlap between teaching and research staff, but the teaching was generally in the hands of the most suitable staff that could be recruited, some of whom could be described as social statisticians.

47. Where a mathematics or statistics department was engaged in service teaching, the load could be heavy because of the numbers of departments involved. The criticism that examples cannot be relevant to all disciplines at once was dealt with in one university by arranging that lectures in the mathematics department should be followed by tutorials in separate and more homogeneous groups in the social studies departments. Other joint arrangements existed in which the division of labour depended on the specialisms of the people concerned; it happened, for instance, that in one university the expert in actuarial methods was in the statistics department, while in another university he was in the department of social studies. The formal framework for these arrangements was often provided by an inter-faculty board or committee.

Q4. *Mathematicians entering the social sciences*

48. The question of drawing mathematicians into the social sciences was touched upon in Q2(d), and pursued further in Q4. There is very little to report, because mathematicians, interested though they may be in the human and social problems dealt with by the social sciences, have not seen much scope for their particular talents. Statistics departments are certainly not resistant to the idea of using applications from the social sciences in their teaching. In one university they had asked in vain for examples that they could use. This probably indicates a chicken-and-egg problem which will only be resolved by collaboration in research.

49. The availability of conversion courses for mathematicians is not widely publicized, possibly in the belief that they will not be taken up. It is more usual to find social scientists anxious to learn some mathematics. There are two major difficulties as far as mathematicians are concerned, one of which is to provide a suitably abbreviated course in the social sciences, and the other to persuade them that there are interesting problems to be solved other than those of data collection.

Q5. *Equipment*

50. Most departments were adequately supplied with desk calculating machines. A few have seen advantages in more elaborate machines capable of being programmed. As far as computers are concerned not all departments had immediately accessible facilities and some had difficulty in adapting programs. Much depended on the service provided by the university's computer laboratory. A potential danger was the availability of programs carrying labels such as "Canonical Analysis" which enabled the social scientist to by-pass the statistician. One form of protection would be for the programs to be properly documented and to carry a hallmark of approval by some qualified person, though this would not supply a guarantee against misuse.

51. Computer-based methods for teaching statistics through programmed instruction are being developed. (This is, of course, quite distinct from using the computer as a work-horse for performing tiresome calculations.) Another promising method of instruction uses television, essentially as a means of enlarging a teacher's audience.

52. To include buildings under the head of "equipment" is perhaps rather to stretch a point. Nevertheless this is as good a place as any to stress the importance of the precise physical location of a statistics department in relation to the social science departments, for this can substantially affect the degree of contact between them.

PROPOSALS ON TEACHING

53. The Council of the Royal Statistical Society has, over many years, sponsored working parties, committees, etc. to look into the teaching of statistics at all levels, and a number of reports have appeared in the *Journal* of the Society. Perhaps the earliest, at any rate in relatively modern times, was a paper read before the Society in 1939 by J. Wishart. At the time there were very few courses offered at an advanced level and only at University College London could a degree in statistics be obtained. He laid some stress on the need for a standard treatise on mathematical statistics, which at that time did not exist. It was a need that was soon fulfilled by M. G. Kendall's *Advanced Theory of Statistics*, the first volume of which appeared in 1943.

54. Next the Council set up a committee under the chairmanship of E. S. Pearson which reported in 1947 on the teaching of statistics in universities and similar

institutions. This important report called for courses at three levels. Elementary courses of about 10 lectures were to be part of the curriculum for all students in the social and natural sciences; it was noted that a sufficient training in elementary mathematics was a prerequisite. Ultimately the courses might become redundant if the subject were taught in schools where, in any case, the statistical approach should be inculcated as part of general education. Somewhat more advanced courses should be taken by most university students in the social and biological sciences. Finally, advanced courses of varying scope were required, but could not be offered at all universities.

55. With regard to the organization of teaching in universities the report recommended that where there was an important school of statistics it should form an autonomous department, and that elsewhere it should be attached to the mathematics department. Other departments would use statistical methods and some would teach them; all these should be represented on a board of studies to ensure co-ordination. The elementary courses and the advanced courses on general theory and method could be given in the statistics school or centre, and some also of the applied courses, though this would depend on the statistical staff available to other departments and would vary with local circumstances.

56. The report was discussed at a meeting of the Society held in 1948, at which the discussion was opened by J. Wishart, who had served on the committee, and had played a leading part over many years in getting the subject established at universities, particularly at Cambridge where he had to contend with what was in his view an entrenched and unco-operative mathematics department. He posed a number of questions arising out of the report and commented on the difficulties of organization caused by the strong faculty barriers that existed in most universities. The discussion cannot be shortly summarized, but it gave the views, among others, of users of statistics outside the universities.

57. In 1955 there was again a discussion meeting of the Society, on the teaching of mathematical statistics at university level, opened by E. S. Pearson. A number of departmental heads presented the syllabuses given at various levels, including the most elementary, and to all kinds of students, including postgraduate. The spread of subjects offered was impressive though some of the advanced courses were being taken by only two or three students. Some lectures, on the other hand, had audiences running into hundreds.

58. Meanwhile the committee on the teaching of statistics in universities had followed up its 1947 report by one on the teaching of statistics in schools (1952). This developed the theme of the statistical approach as part of general education and also of some specialized training in sixth forms as part of the mathematics syllabus. Examples were given of the syllabuses offered by certain examination boards as optional parts of General Certificate of Education examinations at the Ordinary and Advanced levels. It is evidence of the uncertainty regarding the ability of schoolchildren to absorb statistical ideas that one board decided after a trial period that the syllabus at O-level was too difficult, and it thenceforward became the A-level syllabus.

59. Much more recently a committee chaired by G. B. Wetherill (Interim Report, 1968) took the view that the time had come for statistics to be developed as a school subject in its own right and presented a syllabus for A-level study which could be taken as a whole subject or jointly with pure mathematics. In a lengthy discussion led by F. Downton the fear was again expressed that the syllabus was too difficult.

There seems, in fact, to be some doubt whether the difficulties both at school and at university come from a lack of maturity that can only be attained through experience of data such as a research scientist acquires in interpreting his results, or whether the experience could be accumulated through a long process of familiarizing schoolchildren with statistical concepts from early days at school. That there is some urgency in these developments is certain, because there are signs that statistics will be rapidly introduced into school curricula whether we like it or not, possibly as part of a reformed mathematics syllabus. It is, therefore, timely that an Educational Study Group has been formed to go into these problems, under the direction of a joint steering committee comprising members of the Royal Statistical Society and of the Mathematical Association;† its first chairman is T. Lewis, with V. D. Barnett acting as organizing secretary.

60. To round off the tale of committees there is the joint committee of the Royal Statistical Society and the Institute of Statisticians referred to in paragraph 12, on teaching in technical colleges and colleges of technology, which is still at work.

61. Finally, attention should be paid to a symposium on the teaching of statistics (1964) in which a paper by F. Yates and M. J. R. Healy entitled "How should we reform the teaching of statistics?" (essentially at university level) was followed by contributions on training for various sectors of employment. Yates and Healy's paper was particularly valuable in presenting a view from a statistics department, at Rothamsted, which is not in a university and does little teaching, although it does have recognized teachers for the purposes of London University's regulations, and it has, of course, always had an immense influence on the development of the subject. The authors made the distinction between those students who aimed to become professional statisticians and those others who required a working knowledge of statistical methods in their own subject. Their case for reform was based in part on the lack of grasp of principles, in their experience, of many in the first category, and in the second category the poor statistical quality of papers submitted to scientific journals (in the biological field, which is Rothamsted's province). The latter was partly attributable to the failure of some university statistics departments, according to certain biologists, to help them, possibly through the statisticians' inability to appreciate the practical problems. Yates and Healy suggested that a statistics department could only get involved in practical work if it offered a service, such as consultancy, otherwise the statisticians (whether trained or not) in the other departments would be relied on exclusively for these departments' research work. A useful suggestion for keeping these outlying statisticians in close touch with the statistics department was that they should take part in its teaching programmes. Conversely the lecturers in the statistics department should give courses for the other departments, but intelligibly and with an awareness of practical problems.

62. The above outline indicates the extent, and a study of the original papers would prove the thoroughness, of the discussion that has taken place over a period of 30 years on the subject of the teaching of statistics. The present report does not claim to make a major contribution on this front. Teaching, whilst obviously important, took second place to the primary objective of investigating the use of statistics in research; the supposition was, however, that some of the failings that were discovered in research would be attributable to weaknesses in the teaching of statistics. Another limitation was that departments were visited and data obtained

† Since joined by the Institute of Mathematics and its Applications.

on a selective basis, so that the resulting impression is not necessarily representative of all social science departments. Progress is most likely to be made in the actual improvement of courses and methods of instruction through teachers in the different universities getting together. At professorial level (not necessarily the right level for meetings such as have just been proposed) there is in existence a Committee of Professors of Statistics, under the chairmanship of R. L. Plackett, who have provided answers to a number of questions put to them in connection with the present investigation.

63. The overriding impression from the many interviews, and from the answers to the written questions, was of great variety in what was taught and the manner of teaching; so much so that it becomes well-nigh impossible to summarize the situation, and to advise anyone other than by drawing their attention to the various syllabuses and examination questions. This is not intended as a criticism, for the social sciences cover a wide range of subjects, and what is appropriate for experimental psychologists is not necessarily of great interest to political scientists. It provides, certainly, a challenge to statisticians who are involved in the teaching, not merely to graft suitable examples on to their basic syllabuses but to devise courses which match the needs of the students of particular subjects.

64. A greater similarity might be expected in a particular subject, such as sociology, when contrasting one university with another. But the difficulty remains of comparing syllabuses, even if their descriptions tally, and of examination questions (which may or may not have been attempted by the candidates). I have not felt able to deal with this problem which would require a study of its own by educational experts. Presumably the important thing is to enable a student and potential research worker to find his own way through the statistical literature and learn without pedagogic help when he has a need for it, or at least to learn when he must seek advice; for it would be quite impossible to teach him the whole gamut of statistical methods. It follows that different collations may serve equally well, as they must for different cohorts of students, owing to the changes that take place in knowledge and techniques. One can get a shrewd idea of the standard of a course from the textbooks that have been recommended, in so far as the course depends on them. Thus the first of the books listed in paragraph 35, by H. M. Blalock, was given in more than one book list. (It does not appear in the bibliography of the Interim Report (1968) which is about the teaching of statistics at A-level.)

65. There are understandable fears about what are disparagingly called "cook-books", through which formulae are communicated uncomprehendingly; similar fears exist over computer packages. The criticisms come from both wings: on the one hand from those who consider it essential to the understanding (if one may exaggerate) to know how to derive sampling distributions, and on the other hand from those who are concerned with interpreting real situations. The question whether cook-books are really to be despised was put to the Committee of Professors, whose view was that it depended on the cook, and gave R. A. Fisher's *Statistical Methods for Research Workers* as an example. From the consumers' point of view, it is fairly certain that most students to whom statistics is an ancillary subject want, as Plackett said in the 1955 discussion, a series of recipes for standard problems. In these circumstances what can the tutor do but aim at a *cordon bleu* standard of cookery?

66. The level of the courses offered to social scientists is sometimes that of the elementary courses recommended by the 1947 report, and referred to in paragraph 54, and sometimes the more advanced courses. The prerequisite of O-level mathematics

is usually acknowledged to be desirable, although some social science students may be admitted to universities without this qualification. Thus the standard of the elementary courses is probably no higher than would be aimed at in a school course, indeed the mathematics is well below the standard needed for the A-level syllabus outlined in the Interim Report (1968). In endorsing the generally held view that O-level mathematics represents a desirable standard of attainment for social scientists, it is not being implied that present O-level syllabuses have exactly the right content for a later introduction to statistics; if there is a proposal to revise the mathematics syllabus, due weight should be given to the mathematics needed for statistics.

67. Valuable though it is for social scientists to be given appreciation courses in statistics, they would obviously have to take the subject much further before their research could commend itself to the Statistics Committee of the S.S.R.C. as significant statistically. Even a subsidiary statistics course at the more advanced level recommended by the 1947 report, or an A-level course as proposed in the Interim Report (1968), would hardly suffice by itself. But it would be a good basis to build upon and would improve the statistical content of a subject-orientated piece of research. Such courses are undoubtedly on offer at some universities, but too few social scientists take them up.

68. An interesting survey was made among university geography departments in 1969 by a study group in quantitative techniques (there is a rapidly growing appreciation of the value of such techniques among geographers). Some of the results have been published in a short paper by Robson (1970), who gives a table of the topics taught at different universities, ranging from probability, sampling, dispersion and regression—which appeared in everyone's list—to scaling, Mann–Whitney (*sic*) and matrix algebra—which were least common. Comments were received, in particular, about the difficulty of linking quantitative teaching with general lecture courses, and the lack of practical worked examples in the literature. Other problems were the inadequate mathematical background of students and the lack of teaching time.

69. The degree of statistical sophistication varies between one social science and another; for instance, one gets the impression that psychology departments are more mathematically inclined, and certainly they concentrate on the techniques needed for experimental work. It is doubtful, however, whether a true hierarchy of statistical competence, such as an employer might be interested in, could be deduced from a knowledge of the various syllabuses and examination papers. Not all syllabuses are examined, and course work is often regarded as of equal importance to a set of 3-hour papers in the final examination. But non-examinable topics, understandably, are usually taken less seriously by students.

70. The course is dependent on the head of the department, who largely determines his own syllabus, and it may well change when he leaves or even cease if it is a small department. It is not easy, therefore, for an employer to tell what product has emerged from a course or for a prospective student to know the best course to pursue. Such a situation is not unique to statistics departments.

71. The undependability, and the risk even of extinction, of a course is one of the penalties of having a small department for teaching purposes, even if this is immaterial to success in research. Thus the arguments for having statisticians dispersed among the different social science departments, persuasive though they are, must be weighed against a certain weakness from the teaching point of view. To cope with the apparent contradictions, different departmental structures have been conceived which admittedly are not ideal, and fortunately are not considered sacrosanct; frequently they have

been built round the personalities who were available. One that ought to work reasonably well is to have a mathematical statistics department as well as a social statistics department, provided there is good collaboration between the two. Another solution that may be more appropriate in a smaller university is to have an applied statistics department where theoretical studies are probably subordinated to a wider range of applications, of which social studies form only part. Since, however, the tendency is for universities to get larger, and we can expect the demand for statistics to become greater, it seems not unreasonable to predict that additional departments will be set up.

72. Departments of social statistics (if one can use the term as an abbreviation for social science statistics) are extremely rare, especially if one excludes joint departments of economic and social statistics, in which economic statistics tend to dominate. But on the grounds of teaching, and also of research, there is a strong case for having them. They would still have a wide spectrum of subjects to cover, the organization for which could be in terms of readerships or senior lectureships in, for example, geographical statistics.

73. One advantage in such an arrangement would be in terms of the career it could offer to a social statistician whose interests at the moment are peripheral to the department in which he is stationed. Another advantage is in overcoming the lack of contact which results from the fragmentation of statistics in several departments. At least to belong to a central department, even if "detached for special duties", would help to keep people in touch and provide opportunities for widening experience by moving from one field of application to another. A useful co-ordinating job could also be done by a central department in respect of joint courses, say for sociologists and political scientists, and in holding seminars for staff. There is a danger always that this kind of arrangement will fall off with time unless there is a central department which feels an obligation to keep it going.

74. What should the relationship in that case be between the mathematical statistics department and the social statistics department? The possibilities range from no relationship at all—to having a common board of studies (where the two are in separate faculties)—to full relationship in a super-department. In practice it should be made to work as it might in a single department of statistics, where courses are given to social scientists or mathematicians by the people best qualified to do the teaching, for instance of probability theory to social scientists or of application to the social sciences to mathematicians. As far as personnel are concerned the social statistician needs a thorough grounding in mathematical statistics and should be able to keep up with new developments. There need be no hindrance to a move from mathematical to social statistics and vice versa as interests change.

TRAINING OF SOCIAL STATISTICIANS FOR RESEARCH

75. The S.S.R.C. may be able to contribute in several small but useful ways to the training of social statisticians, of whom there are too few in the universities. For instance, it can give precedence in the award of postgraduate studentships to courses enabling mathematical statisticians to devote a period of study to the social sciences. Another method is for mathematical statisticians to be employed as research workers on projects supported by S.S.R.C. grants while at the same time studying for higher degrees (as permitted under the existing system).

76. M.Sc. courses in statistics will often include a dissertation in some applied field, and it would be advantageous from the S.S.R.C.'s point of view to steer some

of them in the direction of the social sciences. Whether they can make this a condition in granting a studentship is something they would have to discuss with the university concerned.

77. A careful reading of the conversion fellowship scheme (S.S.R.C., 1970), intended for people at the Ph.D. level, reveals that there is already an opportunity for a mathematical statistician to take a course in the social sciences, and for a social scientist to "obtain training in methods of research". This would almost certainly cover any course in statistics, but a more explicit statement could draw attention to this fact. The fixing of an upper age limit at 30 years seems somewhat arbitrary; there may well be older research workers who could benefit from a course in statistics. In none of the courses mentioned in this or the previous two paragraphs should grants be limited to one year, if two years appear necessary—for instance, where some basic instruction is called for in advance of an M.Sc. course.

ORGANIZATION AND FINANCING OF RESEARCH

78. The editor of the *Encyclopaedia of the Social Sciences* (1930) wrote about the frequent association of scientific inquiry with social action, where:

> "the investigation of a concrete situation is followed by recommendations for remedial action and the actual organization and administration of remedial measures".

In such situations it is obviously the responsibility of those with problems to commission the research. Not quite so obvious is the responsibility of those with data, but at the least they should make their data available for research, and at a low cost; the Government can give a lead in this respect, for example over Census material. The S.S.R.C. has a role as a third party with patronage in supporting the research and in assisting when there are difficulties over obtaining access to data. Its patronage is not unlimited, but when it comes up against the boundaries imposed by its terms of reference there are often other sources of finance which could usefully be brought to the attention of an applicant for research funds. It would indeed be a useful service for someone—and why not the S.S.R.C.?—to become a clearing house for applications or, if that were regarded as trespassing on other people's territory, to be recognized as the source of information and advice about the various bodies who could support a project.

79. The notion of a clearing house for applications should be quite acceptable when two or more quasi-governmental bodies such as Research Councils are involved. Complaints have been voiced about the treatment of research projects which do not fall precisely inside the boundaries of a Research Council, as for example business studies. There is border territory between the M.R.C. and the S.S.R.C. where provision should be made lest worth-while projects fail to get started for lack of sponsorship, projects concerned for instance with the social aspects of medical treatment. This is particularly needful in respect of methodological work, since applied research in the medical field can more readily find support from other organizations, including the Department of Health and Social Security. Other border territories are with the Natural Environment Research Council (recreational aspects of water resources) and with industry, which, for example, supports work at the Tavistock Institute of Human Relations.

80. All this is confusing to the potential applicant for research funds, who is likely to stick to well-established links that he may already have, say with the S.R.C. or M.R.C., and to be reluctant to try a new channel such as the S.S.R.C.

81. Another boundary exists with the University Grants Committee. Research is carried out not only for higher degrees awarded for a thesis, but also in some taught courses, and money may be needed to provide subsidiary services, such as computer programming. This may not be within the province of the S.S.R.C., but it is plainly their concern if the quality of the research suffers.

82. A more expensive bone of contention is over the use of buildings paid for out of U.G.C. funds, which apparently are not always eligible for use with S.S.R.C. projects, though some understanding must exist at present about the housing of units and individuals who are being accommodated. If, nevertheless, there are difficulties over accommodation, the S.S.R.C. should feel bound to enter the lists on their clients' behalf, since this is one of their essential needs. There may be book-keeping advantages in not having to debit accommodation costs together with other expenditure on research; provided an appropriate allowance is made, the true cost of the research can be reasonably well established. What is less satisfactory is the remoteness of control over the actual housing, which is entirely at someone else's disposal. The situation that can arise, if a university is hard up for accommodation, is that an application for a research grant is not even allowed to go forward. It is not at all clear whether the U.G.C. has a definite responsibility for the housing of grant-aided research, or whether this is an act of benevolence on the part of universities. The S.S.R.C., whose business it is to grant the aid, has a duty to establish where the responsibility should lie, in order that provision can be made on the appropriate scale to match the research awards.

83. An award is generally made following an application for a grant to carry out a specific piece of research, and the organization at the S.S.R.C. is geared closely to this function, with a system of subject committees and reliance on academic referees for the technical appraisal of projects. If one is looking to expansion—and it seems to be agreed that statistics comes into that category—it will be necessary not only to publicize the present system, as perhaps this series of visits has succeeded in doing, but also to take the initiative in promoting work. An invitation to statisticians to do work in particular areas could go out, say, through the S.S.R.C. Newsletter. The S.S.R.C. does in fact directly commission a small amount of research already, through the medium of contracts—but these can be awarded only for the obtaining of information required for its own immediate policy purposes.

84. A natural way of developing new work is to follow up the old. There is frequently a feeling of incompleteness when a project is terminated, even successfully. One kind of a gap is that between research and the practitioner, needing a bridging expert of a type that is rare. Another is the bringing up to date of results and methods that are no longer applicable. Research that has terminated in computer programs is, at the present state of development, particularly liable to become outdated. Even contemporaneously, there is trouble in the dissemination of programs because of problems of adapting them to other computers.

85. The gap that is most serious in the long run is in research leading to advances in statistical theory or method. The S.S.R.C. leans towards applied topics, perhaps because a two-year programme with a clearly anticipated outcome seems a relatively safe investment for its research funds. Certain institutes have a similar bias towards applied areas of research, simply because their funds come from organizations with a problem to solve. The S.S.R.C., however, has no need to be tied in the same way, and indeed should feel it has a duty to correct the bias, for the sake of advancing the social sciences as a whole. Hitherto topics in the field, say, of decision theory, or

stochastic processes, have not been coming the way of the S.S.R.C.; perhaps they go to the S.R.C. or A.R.C. or M.R.C. A fair share of theoretical work will improve the standing of S.S.R.C. statistical awards generally and arouse interest among theoretical statisticians in the problems of the social sciences, just as they have in the natural sciences, in agriculture and in medicine. The domain of the social sciences should be given the widest interpretation and it should be accepted that statistical methodology, whilst its results are not unique to the social sciences, is essential to them and must be developed for their benefit.

86. If this principle is accepted several variants become possible; they could be troublesome from an administrative point of view if regarded too rigidly as being only on the fringe of the Council's activities. For example, research which had been subject-orientated in the beginning might give rise to methodological problems, work upon which would be worth supporting in a further year. It is worth noting that work of this nature cannot be guaranteed a satisfactory outcome. If all goes well the end-product will be recorded in the form of a report and, if acceptable, published in an appropriate journal. (As an illustration, see Thomas (1969), a paper which arose out of psychological work and was supported by an S.R.C. grant.) Of course, it is not an essential part of the argument that the applied work giving rise to the statistical methodology should itself have been supported by a Research Council grant. This kind of mathematical statistics is freely applicable to different subject fields and there might be circumstances in which it seems appropriate for the support to be shared. A further variation is that support should be given for part-time work, the rest of the work being on another topic or not necessarily research at all.

87. Methodology which depends on the manipulation of data is not rendered useless by the poor quality of the data; indeed this might be the justification for its being developed—as in the classic case of missing plots. One should therefore be wary of rejecting an application on the grounds of poor data unless the research is critically dependent upon it.

88. A final suggestion that complements the previous ones is to encourage statisticians to apply for S.S.R.C. research grants, not in order to develop new methodology, but so that their skills are put to use in the social sciences field.

89. A recommendation which is regarded as particularly important is for one or more research units to be established, to promote statistical excellence and advances in methodology in the social sciences. It is not that I see the less need for research in teaching departments at universities, as is witnessed by the other recommendations in this report. But the existence of a research unit focuses the attention of workers in the field and has a role in identifying it for others. At present there is scarcely a sufficient awareness of statistics in the social sciences as a coherent discipline, such as medical statistics appears to be. The Statistical Research Unit of the M.R.C. under its successive directors has surely played a role historically in this, though there is no suggestion that its organization should be photocopied. A unit is essentially what its director makes it, and the form it takes will depend on his other commitments, if any, his interests and the staff he can obtain. However, one would think it essential in a statistical research unit for both mathematical and applied statistics to be developed. (For an earlier discussion on research units see Kendall, 1958.)

90. There is a question of strategy as to whether a unit should be specialized (which may suit a particular field of application or a branch of methodology) or should have broad interests (and this may cover all the social sciences, but be narrow as to method, or vice versa). Such a question is liable to be settled by the availability of

personnel and the certainty nowadays that no one is expert in every field. A similar point arises over university departments of statistics, although, as regards teaching and consultancy, every university needs to have a fairly broad-based department of statistics. A possible way to set up a statistical research unit is, of course, to build on the existing foundation of a university department where proven ability already exists. The choice of strategy becomes less crucial if more than one unit is to be set up and although it may seem over-ambitious to plan for such a situation before even the first unit is agreed, there is a danger otherwise that this may seem sufficient and that unfair expectations may be placed upon it.

91. These remarks are made without prejudice to such other questions as the size of a unit, and whether it should be expanded to form an institute when the time comes, as opposed to encouraging a further separate unit to be formed. There is no justification for being dogmatic about such an issue; in the case of statistics few of the arguments for "big science", such as the need for elaborately equipped laboratories, seem relevant, except perhaps where large data-handling facilities are required.

92. Certainly there is a need to rub shoulders with colleagues, and one of the problems for instance of the statistician in a social science department is his isolation —perhaps this is a reason for the good attendances at meetings of the Royal Statistical Society. Equally, if there were, say, a research unit in social statistics, with a sociologist attached, it would be important for *him* not to lose touch with *his* colleagues.

93. It cannot be taken for granted that a statistical research unit must be formed in association with a university department. As was noted by Gani (1963), in relation to the Council for Scientific and Industrial Research in Australia, for certain types of scientific problem it may be preferable to set up teams of research workers outside the universities. In the particular context, it is interesting to observe that there was a lack of strong postgraduate schools in the universities.

94. A disadvantage that is said to exist at some universities whose researchers are concerned with data collection and so on is that there is no infrastructure for the research, that is to say there is a lack of supporting staff. Money may be allocated for this purpose in respect of a particular project, but there seems to be a need for a general service such as a centre might provide. A research unit would be better placed in some ways than a university department in having a continuing programme of research as its *raison d'être*, and it could fit in demands for data preparation and processing which are a great deal more difficult for the individual researcher to organize.

95. The snag is that the S.S.R.C. is accustomed to giving grants for this kind of research facility only on a short-term basis. A unit would naturally be financed for a longer period, and conceivably one that was renewed indefinitely. Insufficient attention seems to have been paid in the past to the problems created by recruiting staff for short periods only. There would be advantages, for the research as well as the staff, in having at least a permanent cadre. A contribution to their cost could still be made via the grant system for particular projects, by paying for an anonymous x man-years of research assistance instead of the usual arrangement of engaging a specific person.

96. There are, of course, other possible sources of finance: industry, foundations, government departments. One disadvantage encountered—it was at a small unit doing research in the social sciences, with industry backing—was that the research

was so tightly budgeted that there was no margin for a statistician. It would seem to be a case where the S.S.R.C. might profitably fund a fellowship in statistics even though it has no responsibility for the unit. There is an obvious danger when there are industrial deadlines for research, that the results will be pedestrian; the S.S.R.C. would do well to consider whether a similar danger attaches to the system of awarding grants with definite time limits—as opposed to one in which research is conducted in permanent establishments.

97. The strength of a research unit, whether associated with a university or not, is that its members do less teaching than members of a university statistics department, who are being called upon to do more than ever before and are likely to have even greater demands made upon them in the future. There are nevertheless advantages in a university link and in some teaching; it becomes easier, for instance, to transfer to teaching duties if the research comes to an end and an individual wishes to change direction in his career. Not all university posts, of course, have a heavy teaching load, and research lectureships have in fact been set up aimed at freeing the incumbent from too much teaching. The exact nature of the association between a university and a research unit is a matter for judgment in the particular circumstances; for instance, joint appointments can be a useful device.

98. If applied research is to be emphasized in a unit's programme, there is something to be said for its being associated with an establishment other than a university. This could be more useful when collecting data and could lead more readily to development work. Again, the research personnel would find it easier to transfer to duties connected with the development work, if they so desired.

99. The size of a unit and the scope of its activities are important factors in determining its affiliation. If there is a limited programme of research to be carried out on a well-defined problem, the people involved should almost certainly be attached to a larger group; the same is probably also true where there is not a strict limitation in respect of time, and it is expected that useful work could be continued indefinitely on the problem.

100. To return to the question of teaching versus research, though it may be over-dramatic to put it in this form, there is certain to be great pressure at the universities towards more teaching. It may be accepted that a certain amount can be beneficial to the research worker in making him clarify his notions, provided that he is teaching in his own field—even teaching at an elementary level is not without value in this respect. However, it can hardly be claimed that teaching is an essential condition for successful research, since there are independent research institutions with no teaching function, other than perhaps a little lecturing.

101. The converse proposition is that university teaching benefits from being closely associated with research. Certainly if the object is to make the student acquainted with the latest advances in research and its methods there could be no better arrangement. Even at a lower level of instruction the lecturer's original work can give a liveliness to his lectures that provides interest for the student. Probably no one would contest the value of research for teaching, or deny the researcher's duty to make a contribution to the latter. But research is a vulnerable pursuit, and if it is mixed with other activities, whether teaching or administration or work of some other kind, it tends to be put aside for more urgent business; it needs to be protected by applying a fairly strict quota to, for instance, the teaching load. Thus the undoubted demand for more teaching of statistics must be met by more teaching staff if the research activity of existing staff is not to suffer.

RESEARCH CAREERS

102. Reference has already been made to the problems created by having to recruit support staff for short periods. There are likewise problems over research staff. Research assistants are sometimes paid on a scale which seems to bear more relationship to student grants than to their worth in other occupations, for instance in teaching. The reasoning behind this may be that they can use the opportunity to take higher degrees, though they were discouraged from doing so by the S.S.R.C. until fairly recently. There is an equivalent prohibition on the part of some universities against graduate students doing more than a limited amount of paid work, although it has been pointed out that the training could be useful to them, and it would of course be an additional source of research assistance. The situation obviously needs controlling to prevent abuse but a re-examination of the rules could do no harm, and a clear exposition of them would be of service to the prospective researcher who has a choice between studying for a degree on a postgraduate grant and taking it as a by-product of a research appointment.

103. The full-time research assistant is not necessarily entering upon a lifetime of research or even academic work. Just as in other professions, the early years are ones of trial and turnover (M. S. Bartlett, in a contribution to Kendall (1958), referred to the value of outside experience)—and also of marriage resulting in some girls resigning. There is possibly a tendency to remain in a department if the opportunity offers until a suitable job opening occurs. As far as statisticians are concerned the outside opportunities have been good in recent years and one would expect this to be reflected in a lower propensity to continue studying or do post-graduate research. Figures supplied by the University Grants Committee, of the subsequent employment of graduates in the years 1963–69, show that only 8·4 per cent of those with higher degrees in statistics undertook further academic study or training, compared with 19·3 per cent in mathematics and 14·4 per cent in economics (Table 4. These subjects were chosen for their relevance and because they provide interesting contrasts).

104. The figures show trends in the number of graduates and indicate the type of employment they have taken up, and they are worth a short digression as a background to the discussion of research careers and to the investigation as a whole, which began with an inadequate knowledge of developments in the output of statisticians by the universities. (For definitions and other commentary see U.G.C., (1970). See also the 1959 report on the supply of and demand for statisticians. A P.E.P. (Political and Economic Planning) survey of economists and statisticians, sponsored by the S.S.R.C., is also relevant but it uses the term "statistician" differently from the U.G.C. and confines its attention to the year 1968. It would be useful if the U.G.C. could obtain from universities a more precise description of statistics degrees and the statistical content of other degrees. Further study is also needed on the appropriateness of degree courses to future jobs.)

105. The numbers with first degrees in statistics grew at 16 per cent a year on average, as against 12 per cent in other subjects—in mathematics a little more (Table 1); note the turn-down in numbers of economists. Higher degrees in statistics grew very rapidly, at over twice the rate as all subjects together, which themselves increased at an average rate of 18 per cent a year: mathematics and economics were intermediate, the former growing at somewhat the greater rate (27 per cent a year).

106. The main expansion in the numbers of statistics undergraduates took place outside London, with the universities awarding degrees going up from 1 in 1962–63

TABLE 1

Graduates in statistics, mathematics and economics in Great Britain 1963–69

Academic year	Men								Women							
	Statistics		*Mathematics*		*Economics*		*All subjects*†		*Statistics*		*Mathematics*		*Economics*		*All subjects*†	
	No.	%	*No.*	%	*No.*	%	*No.*	%	*No.*	%	*No.*	%	*No.*	%	*No.*	%
							First degrees									
1963–64	44	0·24	880	4·78	672	3·65	18,396	100	10	0·14	348	4·96	81	1·15	7,022	100
1964–65	57	0·29	1,100	5·57	722	3·66	19,739	100	9	0·12	415	5·31	85	1·09	7,810	100
1965–66	46	0·20	1,289	5·47	980	4·16	23,562	100	9	0·10	435	5·06	131	1·52	8,604	100
1966–67	55	0·21	1,452	5·50	1,234	4·67	26,411	100	8	0·08	484	4·78	151	1·49	10,117	100
1967–68	79	0·26	1,599	5·30	1,242	4·12	30,151	100	20	0·16	587	4·71	169	1·36	12,464	100
1968–69	95	0·30	1,671	5·28	1,159	3·66	31,669	100	18	0·13	637	4·78	154	1·15	13,334	100
							Higher degrees									
1963–64	18	0·45	136	3·41	129	3·24	3,985	100	4	1·10	9	2·47	10	2·74	365	100
1964–65	14	0·32	190	4·29	136	3·07	4,432	100	3	0·65	12	2·60	15	3·25	462	100
1965–66	43	0·81	220	4·15	168	3·17	5,307	100	2	0·39	16	3·11	21	4·09	514	100
1966–67	49	0·74	291	4·39	265	4·00	6,632	100	7	0·94	30	4·03	16	2·15	745	100
1967–68	77	0·94	405	4·97	341	4·18	8,150	100	11	1·12	41	4·16	34	3·45	985	100
1968–69	104	1·16	428	4·77	339	3·78	8,971	100	12	1·04	53	4·58	36	3·11	1,156	100

† Excluding medicine, dentistry and veterinary science.
Source: University Grants Committee.

to 9 in 1968–69 (Table 2). It should be remarked that the 9 universities in 1968–69 did not include every one of those which had awarded degrees in earlier years, i.e. some had dropped out. Nor did all of these universities award higher degrees in statistics. The latter were obtained at 14 universities apart from London, where

TABLE 2

Number of universities in the United Kingdom producing graduates in statistics

	No. of universities from which persons graduated (excluding London)	*Persons graduating (excluding London)*	*Persons graduating from London*	*Total No. of persons graduating*
First degrees				
1962–63	1	5	33	38
1963–64	2	11	43	54
1964–65	3	24	42	66
1965–66	3	17	38	55
1966–67	3	20	43	63
1967–68	6	58	41	99
1968–69	9	74	39	113
Higher degrees				
1962–63	3	3	16	19
1963–64	4	8	14	22
1964–65	3	5	12	17
1965–66	4	8	37	45
1966–67	10	21	35	56
1967–68	13	31	58	89
1968–69	14	56	60	116

Source: University Grants Committee.

the number of postgraduate students has grown so that it now exceeds the number of undergraduates. (Higher degrees in statistics are, of course, awarded to people whose first degree is in another subject, e.g. mathematics.)

107. There are two features which complicate the employment picture and which deserve special mention. One is that overseas students who return to their own countries are numbered among the totals graduating and are an important element in economics, especially in the case of higher degrees (Table 4). Over the period as a whole, returning overseas students amounted to a third of those with higher degrees in economics and one-sixth of those with higher degrees in statistics. The other feature complicating the picture is the considerable number entering upon teacher training, particularly among women mathematicians (Table 3). Tables 5–8 ignore these groups in presenting the data on employment obtained in Great Britain, and it is advisable to bear teacher training in mind when considering the numbers taking up employment in schools (Tables 5–6) and engaging in teaching (Tables 7–8).

TABLE 3

Further training of those not undertaking employment, among graduates with a first degree in statistics, mathematics and economics in Great Britain 1963–69

	Teacher training		*Other training, research or academic study*		*Overseas students returned to own country*		*Total graduating*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics								
1963–64	1	—	4	1	6	—	44	10
1964–65	2	1	16	2	2	—	57	9
1965–66	—	1	8	1	2	—	46	9
1966–67	1	—	18	2	1	—	55	8
1967–68	2	1	11	4	—	—	79	20
1968–69	2	3	17	3	—	—	95	18
Mathematics								
1963–64	119	115	269	51	18	3	880	348
1964–65	139	128	371	61	16	—	1,100	415
1965–66	162	112	398	66	9	1	1,289	435
1966–67	164	136	448	52	10	1	1,452	484
1967–68	213	177	464	77	12	2	1,599	587
1968–69	211	189	444	87	9	1	1,671	637
Economics								
1963–64	56	8	117	17	52	3	672	81
1964–65	40	8	121	12	53	2	722	85
1965–66	47	15	192	21	66	3	980	131
1966–67	78	20	254	18	81	2	1,234	151
1967–68	79	17	222	36	82	7	1,242	169
1968–69	47	14	204	24	41	1	1,159	154

Source: University Grants Committee.

TABLE 4

Further training of those not undertaking employment, among graduates with a higher degree in statistics, mathematics and economics in Great Britain 1963–69

	Teacher training		*Other training, research or academic study*		*Overseas students returned to own country*		*Total graduating*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics								
1963–64	—	—	1	—	7	—	18	4
1964–65	—	—	2	—	3	2	14	3
1965–66	—	—	3	—	12	—	43	2
1966–67	—	—	4	2	11	—	49	7
1967–68	—	—	6	—	12	1	77	11
1968–69	2	—	11	—	9	1	104	12
Mathematics								
1963–64	2	—	15	2	9	3	136	9
1964–65	2	—	26	1	27	1	190	12
1965–66	1	—	34	5	27	—	220	16
1966–67	—	—	79	7	34	—	291	30
1967–68	2	—	80	7	48	1	405	41
1968–69	4	3	88	9	37	5	428	53
Economics								
1963–64	—	—	7	—	68	6	129	10
1964–65	1	—	15	5	74	4	136	15
1965–66	—	—	21	4	67	5	168	21
1966–67	—	—	39	2	87	4	265	16
1967–68	—	—	57	3	113	16	341	34
1968–69	1	1	59	5	71	3	339	36

Source: University Grants Committee.

108. Of the remainder, a considerable proportion of first-degree graduates entered industry (Table 5), and among economists many also went into accountancy and other commerce. Those with higher degrees tended more to go into university jobs or to technical colleges, etc. (Table 6), though recently an increasing number have gone into industry. The numbers entering government service, though relatively small, were not negligible.

TABLE 5

First-degree graduates obtaining employment in Great Britain by type of employer

	Home civil, diplomatic and armed services		*Local government and hospital services*		*Schools*		*Technical colleges and places of further education*		*Universities*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics										
1963–64	3	3	1	—	1	2	—	—	3	1
1964–65	1	1	1	—	3	—	—	—	1	1
1965–66	1	3	—	—	—	1	2	—	1	—
1966–67	2	2	—	—	—	1	1	1	—	—
1967–68	—	—	1	—	1	2	2	1	3	1
1968–69	3	—	2	—	1	—	—	—	2	—
Mathematics										
1963–64	20	15	4	2	43	57	8	1	5	5
1964–65	29	15	4	3	34	49	4	2	3	5
1965–66	31	15	5	6	28	48	14	6	5	12
1966–67	36	15	14	4	28	44	10	5	6	11
1967–68	27	16	15	6	48	49	5	5	7	6
1968–69	36	16	23	22	27	31	7	2	8	8
Economics										
1963–64	12	4	10	3	23	1	16	2	14	1
1964–65	20	5	18	7	12	6	14	1	17	5
1965–66	26	7	22	7	18	6	14	—	16	5
1966–67	31	8	22	5	17	6	19	4	8	5
1967–68	20	8	24	8	20	7	6	2	10	1
1968–69	26	10	21	2	5	3	10	1	9	7

TABLE 5 (*cont.*)

	Industry		*Accountancy private practice*		*Banking, insurance and other commerce*		*Others*		*Total*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics										
1963–64	12	3	—	—	8	—	2	—	30	9
1964–65	16	3	—	—	6	—	—	1	28	6
1965–66	17	1	—	—	6	—	1	—	28	5
1966–67	19	—	1	—	6	—	—	—	29	4
1967–68	41	10	1	—	6	—	1	—	56	14
1968–69	35	9	—	—	10	1	1	—	54	10
Mathematics										
1963–64	230	60	6	—	69	5	7	2	392	147
1964–65	302	101	7	3	60	8	4	1	447	187
1965–66	418	119	11	—	67	10	13	1	592	217
1966–67	487	153	13	4	96	15	9	1	699	252
1967–68	507	168	21	2	117	26	10	7	757	285
1968–69	491	178	24	6	148	40	11	3	775	306
Economics										
1963–64	137	9	72	1	58	10	12	5	354	36
1964–65	173	12	67	1	54	8	17	4	392	49
1965–66	221	23	94	2	52	5	17	1	480	56
1966–67	275	19	87	1	76	10	29	5	564	63
1967–68	267	23	86	4	97	15	29	4	559	72
1968–69	261	31	96	1	113	20	17	5	558	80

Source: University Grants Committee.

TABLE 6

Higher degree graduates obtaining employment in Great Britain by type of employer

	Home civil, diplomatic and armed services		*Local government and hospital services*		*Schools*		*Technical colleges and places of further education*		*Universities*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics										
1963–64	1	—	—	—	—	—	—	—	2	1
1964–65	—	—	—	—	—	—	1	—	4	—
1965–66	3	—	1	—	—	—	—	—	5	1
1966–67	1	—	—	—	1	—	2	—	7	2
1967–68	4	3	1	1	—	—	2	—	8	1
1968–69	4	1	2	—	—	—	9	—	9	3
Mathematics										
1963–64	5	—	—	—	4	—	8	—	45	1
1964–65	7	2	—	—	7	2	9	—	64	3
1965–66	6	1	—	—	6	—	11	4	74	2
1966–67	3	2	2	—	11	4	21	5	52	4
1967–68	13	—	1	—	8	4	30	5	79	10
1968–69	13	2	—	—	7	3	25	3	76	11
Economics										
1963–64	—	—	—	—	1	—	1	—	12	—
1964–65	2	—	2	—	—	—	—	—	16	1
1965–66	5	1	—	—	1	—	1	2	24	—
1966–67	3	1	—	—	1	—	9	—	29	2
1967–68	19	1	2	—	1	1	12	2	33	3
1968–69	9	3	6	3	2	1	8	—	35	7

TABLE 6 (*cont.*)

	Industry		*Accountancy private practice*		*Banking, insurance and other commerce*		*Others*		*Total*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics										
1963–64	—	—	—	—	1	—	—	—	4	1
1964–65	3	—	—	—	—	—	—	—	8	—
1965–66	2	—	—	—	3	—	—	—	14	1
1966–67	5	1	—	—	—	—	1	—	17	3
1967–68	20	1	—	1	6	—	4	—	45	7
1968–69	16	1	1	—	3	—	1	1	45	6
Mathematics										
1963–64	7	—	—	—	—	—	—	—	69	1
1964–65	10	—	—	—	—	—	—	—	97	7
1965–66	21	1	—	—	—	—	—	—	118	8
1966–67	30	4	—	—	2	—	—	—	121	19
1967–68	47	5	—	—	3	—	2	1	183	25
1968–69	60	2	1	—	2	1	2	—	186	22
Economics										
1963–64	1	—	—	—	—	—	1	—	16	—
1964–65	2	—	—	—	1	—	1	—	24	1
1965–66	3	—	—	—	1	—	2	1	37	4
1966–67	15	—	—	—	1	—	2	—	60	3
1967–68	15	—	—	—	3	—	5	—	90	7
1968–69	25	1	1	1	9	—	1	—	96	16

Source: University Grants Committee.

109. The type of work done (Tables 7 and 8) seems appropriate to the subject of the degree. At a glance mathematicians have a wider range of opportunities in scientific work, and quite a number enter statistics and economics jobs. The question

TABLE 7

First-degree graduates obtaining employment in Great Britain by type of work

	General administration or traineeship		*Postgraduate apprenticeships*		*Scientific research, design and development*		*Scientific analysis and investigation*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics								
1963–64	2	—	5	—	4	3	7	—
1964–65	—	—	—	—	1	—	1	1
1965–66	3	—	—	—	1	—	3	—
1966–67	4	—	—	—	—	—	10	—
1967–68	2	—	2	—	1	5	13	—
1968–69	2	1	—	—	3	2	15	4
Mathematics								
1963–64	18	5	22	1	74	22	97	31
1964–65	22	5	15	—	54	21	153	68
1965–66	36	5	16	4	72	20	214	91
1966–67	55	8	25	1	74	30	251	98
1967–68	55	12	29	4	88	23	274	115
1968–69	50	17	34	3	103	26	245	123
Economics								
1963–64	75	6	4	—	5	2	6	2
1964–65	91	4	2	2	9	2	10	2
1965–66	117	12	10	—	9	—	17	9
1966–67	137	10	9	1	6	1	20	8
1967–68	138	11	10	—	3	1	16	4
1968–69	127	9	8	1	3	3	19	12

TABLE 7 (*cont.*)

	Technical advisory work, production, operation and maintenance		*Buying and selling*		*Statistics and economics*		*Accounting and finance*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics								
1963–64	—	—	—	—	11	4	—	—
1964–65	—	—	—	—	20	5	2	—
1965–66	2	—	1	—	16	4	—	—
1966–67	1	—	—	—	11	2	2	—
1967–68	5	1	—	—	28	6	2	—
1968–69	1	—	—	—	31	3	1	—
Mathematics								
1963–64	7	4	4	—	86	13	25	2
1964–65	13	5	12	2	98	25	33	5
1965–66	39	10	10	3	110	21	38	1
1966–67	60	16	16	3	134	32	40	5
1967–68	47	15	11	2	130	47	55	7
1968–69	65	20	9	3	155	53	63	13
Economics								
1963–64	7	—	21	1	65	11	116	3
1964–65	5	1	28	1	82	20	119	3
1965–66	16	2	34	1	80	16	144	3
1966–67	26	2	43	2	94	18	161	4
1967–68	20	3	59	3	104	23	155	11
1968–69	14	5	61	7	98	27	190	5

TABLE 7 (*cont.*)

	Teaching†		*Other*		*Total*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics						
1963–64	1	2	—	—	30	9
1964–65	3	—	1	—	28	6
1965–66	2	1	—	—	28	5
1966–67	1	2	—	—	29	4
1967–68	3	2	—	—	56	14
1968–69	1	—	—	—	54	10
Mathematics						
1963–64	53	58	6	11	392	147
1964–65	43	51	4	5	447	187
1965–66	43	58	14	4	592	217
1966–67	38	51	6	8	699	252
1967–68	57	53	11	7	757	285
1968–69	35	35	16	13	775	306
Economics						
1963–64	41	3	14	8	354	36
1964–65	31	8	15	6	392	49
1965–66	34	6	19	7	480	56
1966–67	38	11	30	6	564	63
1967–68	28	9	26	7	559	72
1968–69	20	4	18	7	558	80

† Includes teaching at Universities and Technical Colleges.

Source: University Grants Committee.

TABLE 8

Higher-degree graduates obtaining employment in Great Britain by type of work

	General administration or traineeship		*Postgraduate apprenticeships*		*Scientific research, design and development*		*Scientific analysis and investigation*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics								
1963–64	—	—	—	—	1	—	—	—
1964–65	—	—	—	—	—	—	—	—
1965–66	—	—	—	—	1	—	—	—
1966–67	—	—	—	—	1	—	1	—
1967–68	1	1	—	—	3	—	5	1
1968–69	1	—	1	—	4	1	1	—
Mathematics								
1963–64	—	—	—	—	16	—	3	—
1964–65	—	—	—	—	21	2	1	—
1965–66	1	1	—	—	28	1	5	2
1966–67	—	—	1	—	30	1	7	6
1967–68	3	—	—	—	36	3	22	5
1968–69	1	—	—	—	37	2	34	5
Economics								
1963–64	1	—	—	—	1	—	—	—
1964–65	3	—	—	—	—	1	—	—
1965–66	1	—	—	—	1	—	—	—
1966–67	5	—	—	—	2	—	2	—
1967–68	9	—	—	—	2	—	—	—
1968–69	6	—	—	—	4	1	5	—

TABLE 8 (*cont.*)

	Technical advisory work, production, operation and maintenance		*Buying and selling*		*Statistics and economics*		*Accounting and finance*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics								
1963–64	—	—	—	—	2	—	1	—
1964–65	—	—	—	—	3	—	—	—
1965–66	—	—	—	—	9	—	—	—
1966–67	—	—	—	—	7	2	—	—
1967–68	4	1	—	—	23	4	—	—
1968–69	—	1	—	—	22	3	2	—
Mathematics								
1963–64	—	—	—	—	1	—	—	—
1964–65	—	—	—	—	2	—	—	—
1965–66	—	—	—	—	8	—	—	—
1966–67	3	—	—	—	2	2	1	—
1967–68	4	2	1	—	12	—	1	—
1968–69	6	—	2	—	13	2	—	—
Economics								
1963–64	—	—	—	—	2	—	1	—
1964–65	—	—	—	—	5	—	—	—
1965–66	—	—	—	—	10	2	1	—
1966–67	1	—	—	—	16	1	1	—
1967–68	—	—	3	—	31	2	1	—
1968–69	—	—	4	—	27	7	8	1

TABLE 8 (*cont.*)

	Teaching†		*Other*		*Total*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*
Statistics						
1963–64	—	1	—	—	4	1
1964–65	5	—	—	—	8	—
1965–66	4	1	—	—	14	1
1966–67	8	1	—	—	17	3
1967–68	9	—	—	—	45	7
1968–69	14	1	—	—	45	6
Mathematics						
1963–64	49	1	—	—	69	1
1964–65	73	5	—	—	97	7
1965–66	76	4	—	—	118	8
1966–67	77	10	—	—	121	19
1967–68	103	15	1	—	183	25
1968–69	93	13	—	—	186	22
Economics						
1963–64	11	—	—	—	16	—
1964–65	16	—	—	—	24	1
1965–66	24	2	—	—	37	4
1966–67	32	2	1	—	60	3
1967–68	41	5	3	—	90	7
1968–69	37	7	5	—	96	16

† Includes teaching at Universities and Technical Colleges.

Source: University Grants Committee.

of the qualifications of people doing statistical and economics work is investigated further in Tables 9 and 10, bringing in other degree courses in science, arts and social studies. The latter include law, geography, politics, psychology, business and management studies and some combined courses. In many of these courses there is at least the option of doing some statistics, as there is in mathematics and economics degree courses.

110. The first set of percentages in Tables 9 and 10 shows the proportions entering statistics or economics posts who had taken degrees in the various disciplines. The largest source of entrants appears to be among those who had taken other social studies. There is a difference between the sexes in that male mathematicians and economists with first degrees were relatively more common, compensated to some extent by female arts graduates entering these jobs. It is rather more dubious to draw conclusions for graduates with higher degrees because of the small numbers involved, but this tendency is not contradicted in Table 10. There is also a greater representation of statistics degrees among graduates with higher degrees than among those with first degrees in statistics and economics posts.

111. The second set of percentages indicates, for each subject, the proportion entering statistics and economics posts. Thus it shows how relatively important these posts were as an outlet for degree-holders in each subject. Of course it does not imply that statistics and economics were not used in other types of employment; statisticians for instance could be employed for their technical knowledge in scientific investigations. A substantial proportion however, some 30 per cent of first-degree graduates in statistics, went into statistics and economics posts; this was perhaps three times as great as the proportion of economists to do so. About the same proportion of male mathematicians as of economists, but fewer women, went into statistics and economics posts. (It has already been noted that a large number of women mathematicians went into teacher training.) The proportions with higher degrees among statisticians, economists and mathematicians to take up these posts were all lower, on average, partly because of the greater tendency to enter upon university careers.

112. Returning now to the main subject of research careers, it appears likely that university expansion has created many opportunities for statisticians but that outside jobs have also kept pace with the limited supply. The research assistant who does not have a fixed term in mind—after which he or she intends to take up other employment—is probably directed towards a permanent career in teaching or research; there are, however, few established research posts at universities. The hierarchy of scales aligns a senior research fellow, which is about the highest level of appointment, with a senior lecturer, but it is commonly not an established post. (The senior research fellowships awarded by the S.S.R.C. are more junior appointments, made with the object of providing research training.)

113. Hence a university research career, apart from the opportunities offered by independent institutes and the Research Councils, is suitably regarded as one with a teaching career. Prospects in this profession have been gone into in detail elsewhere, e.g. by Young (1965), and there is no call to do so here. A proper treatment of the problem involves the consideration of the age of promotion and retirement, natural wastage due to various causes in mid-career, the existence of a fringe of short-term appointments, and so on. Probably the most indicative factor is the relative size of the several grades of appointments, details of which are published in *Statistics of Education* (1970). The totals for the United Kingdom at the end of 1968, for full-time

TABLE 9

First-degree graduates in all subjects obtaining employment in statistics or economics posts

Degree course	Total who graduated		First employment in statistics or economics post		Percentage in previous column by subject of degree		Percentage of graduates in each subject obtaining employment in statistics or economics posts	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Mathematics								
1963–64	880	348	86	13	24·7	9·4	9·8	3·7
1964–65	1,100	415	98	25	22·4	15·7	8·9	6·0
1965–66	1,289	435	110	21	25·2	12·4	8·5	4·8
1966–67	1,452	484	134	32	27·9	16·8	9·2	6·6
1967–68	1,599	587	130	47	21·7	15·8	8·1	8·0
1968–69	1,671	637	155	53	26·7	17·3	9·3	8·3
Statistics								
1963–64	44	10	11	4	3·2	2·9	25·0	40·0
1964–65	57	9	20	5	4·6	3·1	35·1	55·6
1965–66	46	9	16	4	3·7	2·4	34·8	44·4
1966–67	55	8	11	2	2·3	1·0	20·0	25·0
1967–68	79	20	28	6	4·7	2·0	35·4	30·0
1968–69	95	18	31	3	5·3	1·0	32·6	16·7
Other pure science								
1963–64	5,334	1,678	62	22	17·8	15·9	1·2	1·3
1964–65	5,567	1,835	85	24	19·5	15·1	1·5	1·3
1965–66	6,272	1,951	69	17	15·8	10·0	1·1	0·9
1966–67	6,830	2,195	69	24	14·4	12·6	1·0	1·1
1967–68	7,879	2,829	95	44	15·8	14·8	1·2	1·6
1968–69	8,172	2,951	103	48	17·7	15·6	1·3	1·6
Applied science								
1963–64	4,245	105	15	1	4·3	0·7	0·4	1·0
1964–65	4,755	110	10	3	2·3	1·9	0·2	2·7
1965–66	6,465	169	24	3	5·5	1·8	0·4	1·8
1966–67	7,324	158	23	1	4·8	0·5	0·3	0·6
1967–68	7,978	220	24	6	4·0	2·0	0·3	2·7
1968–69	8,003	278	39	3	6·7	1·0	0·5	1·1

TABLE 9 (*cont.*)

	Degree course	*Total who graduated*		*First employment in statistics or economics post*		*Percentage in previous column by subject of degree*		*Percentage of graduates in each subject obtaining employment in statistics or economics posts*	
		Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
	Arts								
1963–64		3,974	3,496	30	24	8·6	17·4	0·8	0·7
1964–65		3,941	3,902	35	28	8·0	17·6	0·9	0·7
1965–66		4,336	4,091	24	41	5·5	24·1	0·6	1·0
1966–67		4,438	4,462	37	28	7·7	14·7	0·8	0·6
1967–68		4,957	5,319	38	46	6·3	15·4	0·8	0·9
1968–69		5,159	5,500	27	32	4·6	10·4	0·5	0·6
	Economics								
1963–64		672	81	65	11	18·7	8·0	9·7	13·6
1964–65		722	85	82	20	18·8	12·6	11·4	23·5
1965–66		980	131	80	16	18·3	9·4	8·2	12·2
1966–67		1,234	151	94	18	19·6	9·4	7·6	11·9
1967–68		1,242	169	104	23	17·3	7·7	8·4	13·6
1968–69		1,159	154	98	27	16·9	8·8	8·5	17·5
	Other social studies								
1963–64		3,247	1,304	79	63	22·7	45·7	2·4	4·8
1964–65		3,597	1,454	107	54	24·5	34·0	3·0	3·7
1965–66		4,174	1,818	114	68	26·1	40·0	2·7	3·7
1966–67		5,078	2,659	112	86	23·3	45·0	2·2	3·2
1967–68		6,417	3,320	181	126	30·2	42·3	2·8	3·8
1968–69		7,410	3,796	128	141	22·0	45·9	1·7	3·7
	All subjects								
1963–64		18,396	7,022	348	138	100	100	1·9	2·0
1964–65		19,739	7,810	437	159	100	100	2·2	2·0
1965–66		23,562	8,604	437	170	100	100	1·9	2·0
1966–67		26,411	10,117	480	191	100	100	1·8	1·9
1967–68		30,151	12,464	600	298	100	100	2·0	2·4
1968–69		31,669	13,334	581	307	100	100	1·8	2·3

Source: University Grants Committee.

TABLE 10

Higher-degree graduates in all subjects obtaining employment in statistics or economics posts

	Degree course	*Total who graduated*		*First employment in statistics or economics post*		*Percentage in previous column by subject of degree*		*Percentage of graduates in each subject obtaining employment in statistics or economics posts*	
		Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
	Mathematics								
1963–64		136	9	1	—	4·0	—	0·7	—
1964–65		190	12	2	—	5·7	—	1·1	—
1965–66		220	16	8	—	9·9	—	3·6	—
1966–67		291	30	2	2	2·9	11·8	0·7	6·7
1967–68		405	41	12	—	8·5	—	3·0	—
1968–69		428	53	13	2	8·3	7·1	3·0	3·8
	Statistics								
1963–64		18	4	2	—	8·0	—	11·1	—
1964–65		14	3	3	—	8·6	—	21·4	—
1965–66		43	2	9	—	11·1	—	20·9	—
1966–67		49	7	7	2	10·1	11·8	14·3	28·6
1967–68		77	11	23	4	16·2	14·8	29·9	36·4
1968–69		104	12	22	3	14·0	10·7	21·2	25·0
	Other pure science								
1963–64		1,763	163	3	3	12·0	37·5	0·2	1·8
1964–65		1,939	187	4	—	11·4	—	0·2	—
1965–66		2,238	207	7	—	8·6	—	0·3	—
1966–67		2,499	263	11	1	15·9	5·9	0·4	0·4
1967–68		3,027	370	14	5	9·9	18·5	0·5	1·4
1968–69		3,184	349	14	2	8·9	7·1	0·4	0·6
	Applied science								
1963–64		1,014	14	8	—	32·0	—	0·8	—
1964–65		1,136	21	3	2	8·6	40·0	0·3	9·5
1965–66		1,442	25	11	—	13·6	—	0·8	—
1966–67		2,045	39	14	2	20·3	11·8	0·7	5·1
1967–68		2,233	47	8	—	5·6	—	0·4	—
1968–69		2,439	54	19	1	12·1	3·6	0·8	1·9

TABLE 10 (*cont.*)

	Degree course	*Total who graduated*		*First employment in statistics or economics post*		*Percentage in previous column by subject of degree*		*Percentage of graduates in each subject obtaining employment in statistics or economics posts*	
		Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
	Arts								
1963–64		643	123	—	3	—	37·5	—	2·4
1964–65		633	160	5	1	14·3	20·0	0·8	0·6
1965–66		715	168	11	7	13·6	58·3	1·5	4·2
1966–67		869	279	3	3	4·3	17·6	0·3	1·1
1967–68		1,191	345	2	5	1·4	18·5	0·2	1·4
1968–69		1,318	411	8	—	5·1	—	0·6	—
	Economics								
1963–64		129	10	2	—	8·0	—	1·6	—
1964–65		136	15	5	—	14·3	—	3·7	—
1965–66		168	21	10	2	12·3	16·7	6·0	9·5
1966–67		265	16	16	1	23·2	5·9	6·0	6·2
1967–68		341	34	31	2	21·8	7·4	9·1	5·9
1968–69		339	36	27	7	17·2	25·0	8·0	19·4
	Other social studies								
1963–64		282	42	9	2	36·0	25·0	3·2	4·8
1964–65		384	64	13	2	37·1	40·0	3·4	3·1
1965–66		481	75	25	3	30·9	25·0	5·2	4·0
1966–67		614	111	16	6	23·2	35·3	2·6	5·4
1967–68		876	137	52	11	36·6	40·7	5·9	8·0
1968–69		1,159	241	54	13	34·4	46·4	4·7	5·4
	All subjects								
1963–64		3,985	365	25	8	100	100	0·6	2·2
1964–65		4,432	462	35	5	100	100	0·8	1·1
1965–66		5,307	514	81	12	100	100	1·5	2·3
1966–67		6,632	745	69	17	100	100	1·0	2·3
1967–68		8,150	985	142	27	100	100	1·7	2·7
1968–69		8,971	1,156	157	28	100	100	1·8	2·4

Source: University Grants Committee.

teaching and research staff, were as follows:

Full-time teaching and research staff in the United Kingdom at December 31st, 1968

Professors	3,199
Readers and senior lecturers	5,554
Lecturers	16,648
Assistant lecturers	4,182
Total	29,583

It is quite easy to do some rough-and-ready calculations concerning the probability of a promotion provided certain simplifying assumptions are made, such as a retirement age at 64 and a constant rate of wastage in mid-career. If the latter is at a rate k per annum, the proportion of survivors of any cohort after y years is $\exp(-ky)$ and, under stationary conditions (that is no growth in the number of appointments to each grade), the number in post with up to y years' seniority, per appointment, including the number in more senior grades, is $\{1-\exp(-ky)\}/k$. A convenient further assumption is a fixed age of promotion, for those who are promoted—the results are unlikely to be very sensitive to having a small range of ages instead.

114. Suppose, for illustration, $k = 0{\cdot}04$ and lecturers are appointed at 28 years of age, senior lecturers at 35, that is there is a 7-year interval before promotion, and a further 29 years before retirement. Then the probability that a lecturer who survives to age 35 is promoted is $r\{1-\exp(-36k)\}/\{\exp(-7k)-\exp(-36k)\}$, where r is the ratio of senior posts, in this case 8,753/25,401. Substituting $k = 0{\cdot}04$, we get the answer 0·51 for the probability. Evidently one can adjust the ages and the ratio of senior posts to get any required probability. It is worth noting that in a time of growth, the probability increases; if the staff is growing steadily the effect is as if the wastage rate in the above formula were increased by the growth rate. For instance, if the growth were at a rate of 0·05 per annum, we would write $k = 0{\cdot}09$ above, and obtain an answer of 0·67.

115. The situation for statisticians can be gauged relatively to other disciplines by the grade structure, assuming that the other factors are no different. Lindley (1966) found from a questionnaire circulated in 1964 that the numbers then in the different grades, full time, were:

Professors	15
Readers and senior lecturers	29
Lecturers	71
Assistant lecturers	16
Total	131

These are broadly in line with the numbers for all subjects. Currently the number of professors of statistics is of the order of 50. Other staff are not easily determined from a source such as the *Commonwealth Universities Year Book* because they are sometimes shown as members of mathematics departments; a directory of academic statisticians supplied by the Committee of Professors of Statistics lists about 290 staff other than professors in the U.K. in September 1970. (The facts about the teaching of statistics are difficult to ascertain because of the close connection with mathematics departments; at some universities, degrees with a substantial statistical content are

not recorded as degrees in statistics and consequently do not appear in tables such as Table 2.)

116. University teaching staff (and research assistants who aspire to become teaching staff) may or may not be content with the prospect held out by a structure such as has been described. The S.S.R.C., however, has to weigh up the consequences for research of a substructure largely composed of young research people which tapers off much more rapidly, a concomitant of which is that research work is a part-time occupation for most senior staff. Under circumstances in which it appears likely that teaching duties will bear more heavily than before on university staff, there seems to be a strong case for improving the pattern of purely research posts (or posts with a minimal amount of teaching) and, in effect, providing a hierarchy parallel to the teaching hierarchy, with, of course, full opportunity for switching from one to another and to non-university posts. At the summit of such a system would be a number of Research Chairs, financed perhaps in part by the S.S.R.C. and in part by the university.

117. There is a need quite separately for Chairs in Social Statistics (or in Statistics as Applied to the Social Sciences) to be set up by universities to promote the teaching of the subject. At present there is, in practice, a barrier to the advancement of a statistician whose interests are methodological, beyond the level of reader in a department orientated to one of the social sciences. This has a deleterious effect on research which can be dependent in more ways than one on the standing that a subject has in a university. Certainly it would improve the entry of people of ability into the field, as the establishment of Chairs of Mathematical Statistics has done. Whether social statistics should be brigaded with mathematical statistics in a mathematics department, or separately in a faculty of social sciences, or independently of mathematics and social sciences in a department of probability and statistics is a matter for local administrative arrangement. Without the existence of some such posts it is vain to lament a lack of progress in the subject. There is an adequate potential of statisticians whose interests lie in the area of the social sciences; one might adapt a celebrated phrase and say, "Give them the jobs and they will provide the tools!"

RESEARCH FELLOWSHIPS

118. A research set-up at universities, headed by research professors as recommended above, would have appropriate numbers of more junior staff in support, either providing a service, or collaborating, although one could envisage the lone researcher depending on a department for the barest office services. The financial support of the research staff, as in the case of professors, could be partially provided by S.S.R.C. This is contrary to the current practice where money is awarded for a definite programme of research; university staff are not normally paid out of the grant, although it may have happened that a university lecturer has been seconded from his usual post for the purpose.

119. If such direct financial support of established university staff is *ultra vires*, the S.S.R.C. would come closer to its orthodox role if it provided funds for research fellows to be attached to university departments on a non-established basis. These would be senior appointments and not to be confused with the "senior research fellowships" of up to £2,000 which are awarded for a period of research training. Prototypes exist in the form of fellowships supported by private bequests (the Simon Research Fellowship at Manchester is an example) though these tend to be one-year appointments. Their procedures for making the appointments could easily be adapted to the conditions attached to S.S.R.C. awards.

120. Lest it be thought that the previous paragraph, with its emphasis on senior appointments, was ruling out the possibility of junior fellowships, it should be stated explicitly that these are not ruled out, that there is room for substantive work at all levels of experience and that the results of a young man's work can be a sufficient reason for engaging him in research, without justifying it as training. The immediate postgraduate years could be the most fruitful as far as mathematical ideas are concerned, even if experience counts for more in developing and applying them.

121. The whole spectrum of possible ages and levels of appointment to research fellowships should therefore be examined by the S.S.R.C. with a view to encouraging a variety of outstanding talent, and this should be treated as a separate issue from the provision of training. It will be realized that such a conclusion, though it arises from a consideration of the special case of statistics, is applicable, in principle, to all the social sciences. But if funds are limited there could be discrimination in favour of one subject, just as privately donated funds are used to support particular topics (e.g. the Hallsworth Research Fellowship on Political Economy and Public Administration).

PROPOSALS CONCERNING S.S.R.C. SUBJECT COMMITTEES

122. Some consideration has to be given to the role of the S.S.R.C. subject committees in the organization of research. They have a crucial part to play in judging whether an application for a research grant is a worthy one. Yet complaints are made that too much detail is asked for on a project, which it is sometimes impossible to be specific about at an early stage of the work; also that administrative processes are slow (a perennial complaint of the suitor). The latter is not a point which I have investigated, nor do I think it likely that major savings in time can be made through speeding up office procedures, compared with the time it takes to obtain referees' reports, to get applications re-submitted, and so on. Incidentally the whole apparatus can be discouraging to the novice and it is pleasant to report on the general helpfulness of the S.S.R.C. staff to intending applicants.

123. People need advice at an early stage about the difficulties they are likely to encounter. One practical suggestion is for the S.S.R.C. on the basis of its past experience to issue a note on statistical weaknesses in the projects which it has been asked to support. More particular advice should become available on surveys, with the setting up of the Council's own Survey Unit.

124. It would be more satisfactory if projects had the benefit of statistical advice before being submitted. The S.S.R.C. could let it be known that this would be an advantage in getting a project accepted. However, it would be going too far to make it obligatory, because there are insufficient resources at universities to provide such a service universally. If the S.S.R.C. does make it part of its policy to encourage applicants to get prior statistical advice, it must also undertake some responsibility for urging the provision of people competent to give the advice.

125. When, in spite of such advice, or in consequence of its absence, a project has to be re-submitted, the Statistics Committee ought to be in a position to offer constructive advice of its own that goes beyond the usual comments made by referees. To do this properly may necessitate the employment of permanent statistical staff by the S.S.R.C., who are able to give technical not just administrative help to each project.

126. A more positive role for the committee in another direction might involve them in seeking out talent, whereas now their function is rather to screen applications

that come before them. They would work through people of repute in the field who were prepared to give some supervision to an assistant in developing a new line of research. (There is not much chance of overlooking anyone when the field is so small, and the committee membership changes regularly.) The initiative could, in time, come from the directors of research; where they have struck a rich vein it will probably pay to exploit it through the induction of associate workers, not necessarily with a precise research objective but with the aim partly of training a school of novitiates.

127. Finally, some attention should be given to the relationship between the various S.S.R.C subject committees, the structure of which should obviously not be an impediment to research applications; yet there have been requests for advice as to the particular committee an application ought to be directed towards, which may imply that they are too self-contained. At present a project may be passed from one committee to another, thereby collecting another grading (on a scale from A1—first priority award, to R2—reject) and facing a double hazard—perhaps rightly so. Statistics is in a special position as an accessory to so many topics, and this has led to the suggestion being made that a statistician should serve on each of the other subject committees. This would, of course, be a burden to the existing members of the Statistics Committee, as would the suggestion that *all* applications should go to the Statistics Committee. If the first idea meets with approval it could be made less burdensome by introducing more statisticians from outside, who are not necessarily on the Statistics Committee at the time, to serve on subject committees where their knowledge and experience are particularly relevant. There are, admittedly, risks in such a procedure. A subject committee with its own statistician member might assume that this removed any need for applications in its subject with a statistical content to be put to the Statistics Committee—thus progressively depriving that committee of its important "vetting" function. A solitary statistician, moreover, may easily be out-voted and applications recommended for support on other grounds quite irrespective of their statistical adequacy (though this would hardly matter if the applications are considered *as well* by the Statistics Committee). In time, too, such a system is liable to be seen as a duplication of effort and moves might be made to do away with a separate committee of statisticians altogether, which would be singularly unfortunate.

CONSULTANCY

128. Reference has already been made to the increasing pressure that teaching demands are likely to make on the time available for research. Concerned as the S.S.R.C. is with encouraging statistical research, it will doubtless make exceptional efforts to provide finance and persuade universities and the U.G.C. to make sufficient provision for both. But statistics is not the only subject that faces an increase in teaching duties, even if its service load is greater than most, and the allocation of staff will presumably be made on a *per capita* basis as the demand becomes apparent. Provided the staffing ratio carries an adequate allowance for the pursuit of research, an increase in the numbers of students should, through the provision of more staff, result in more research being done. A third call on the statistician's time (that is, apart from teaching and research) is consultancy, and this is probably much greater than is generally appreciated—other than by the statisticians concerned. One must except from this statement outside consultancy, since it is common in some other subjects; it can benefit research in the same way as consultancy inside the university.

Moreover, the equation can be balanced to some extent by bringing people in from outside the university, provided their employers will agree to it, to teach and research, and as consultants (the "visiting professor" arrangement). The S.S.R.C. could find a role here, supplementary to the provision of funds for research fellowships already proposed, namely to seek, to find and to persuade.

129. Inside the university the traffic is one-way and it seems inevitable that it will grow as the social sciences allow more scope for statistical methods and social scientists become familiar with them. One thing that does seem certain is that the widespread inculcation of statistical ideas among social scientists will increase rather than diminish their call upon professional statisticians for advice. The problems of statistical consultancy were thoroughly discussed at a recent meeting of the Royal Statistical Society (Sprent, 1970) and there is no need to go over the whole ground again; a perusal of the proceedings at that meeting is recommended as part of the background to the present report. Three of the points made by the various contributors are selected for their relevance to the issues considered here. P. Armitage made a clear distinction between the full collaboration of a statistician in a scientific investigation, leading to joint publication, secondly advisory work on particular aspects of design or analysis, and thirdly a routine servicing function that could be performed by any research worker taught to use standard methods. He submitted that the latter resort was made necessary by a shortage of statisticians. E. Jowett and A.S.C. Ehrenberg discussed locating a statistician in an experimental team rather than treating him as a "general practitioner" to whom all data problems are shorn of their subject matter. A similar point was made during the course of the university visits by those social scientists who expressly wanted help from *social* statisticians. The implication in a university context is the placing of a statistician in a social science department, or having very special links with one. Finally D. J. Finney, as well as P. Sprent in the opening contribution, referred to the need for resources, one in terms of staff in excess of the normal teaching requirements, the other in terms of finance. The logic is unimpeachable, if the provision of a consultancy service is to be taken seriously by the universities.

130. The beneficiaries of a consultancy service have to learn the best way to take advantage of it. Of the categories outlined by Armitage, full collaboration leading to joint publication is most attractive to the statistician and advances his own research. Anything less is unlikely to compete with the attractions, for instance, of outside consultancy. To put it bluntly, the acknowledgment in a footnote to an article is not an adequate reward for the considerable effort often put into the giving of advice.

131. It is fairly evident that the quality of consultancy is improved if the recipients are statistically educated. But some, whilst appreciating the value of statistical techniques, do not realize the time it takes to develop them, or adapt them to new situations. Unfortunately, the research worker often wants a fairly immediate answer, at any rate in the advisory situation (Armitage's second category), whereas mathematical statistical research prompted by it is liable to be long term. The consultant has to tread a delicate path in meeting the needs of the moment as well as pursuing his further aims.

132. For these reasons the mathematical research worker is better safeguarded in a university mathematics or statistics department, although one acknowledges the strength of the Jowett/Ehrenberg case for integration; the answer may be to provide for both categories of statistical staff. The question of departmental structure is discussed elsewhere, since it has obvious relevance to teaching as well as research.

133. The provision of staff for consultancy work is presumably a university responsibility; moreover, it seems an entirely proper disbursement of its funds to pay on an exceptional scale for such a service just as it may do for special contributions to teaching. The S.S.R.C. may not appear at first sight to have a direct part to play in this situation, unless it can provide some finance initially, though certainly it should give its full support to the appointment of statisticians in the role of consultants, or the allocation of teachers' and research workers' time, reflected in staffing ratios. Its motive for so doing should be the overall gain to research, in spite of the calls on the consultants' time. The value to other people's research is unbounded. But more directly, when the S.S.R.C. gives money for research projects it can see that some is allocated specifically for consultancy purposes. This is no more than providing the sinews for its laudable intentions to improve the statistical quality of research. The S.S.R.C. has, in fact, a particular responsibility in this regard, because the research personnel it subsidizes on full-time projects can make very substantial demands on consultants, in contrast to the latter's university colleagues whose demands are more intermittent because of their teaching duties.

FURTHER DISCUSSION AND RECOMMENDATIONS

134. Some of the questions raised in the report have not been treated as adequately as they deserve; for example, the problem mentioned in the Introduction, of non-numeracy originating in schools. One would hope that the Educational Study Group referred to in paragraph 59 will have an effect in the long run; its activities certainly deserve support.

135. Another is the assessment and comparison of syllabuses and examination papers, both in mathematical statistics and applied statistics; and also of the statistics content of social science courses. This should properly be done on a regular and comprehensive basis—if indeed criteria can be established for making such comparisons. The Committee of Professors of Statistics was invited to consider whether it could undertake this task, but felt unable to do so. There is not even a central collection of examination papers and syllabuses (apart from what appears in university prospectuses) although the S.S.R.C. has information on postgraduate courses, obtained for the purpose of its grant scheme. It has already been said (paragraphs 63–64) that the objective is not completely to standardize the content of papers nor what is taught. Principally it is to keep each other informed, and the suggestion has been made to hold regular colloquia (paragraph 62).

136. The geographers (Robson, 1970) have made another suggestion, for circulating duplicated exercises between departments, which indicates a similar need for information. The different social sciences can also draw upon one another for inspiration, and statisticians in general can be made aware of what is going on in the social sciences to good purpose. For instance, reviews by statisticians of such influential books, among geographers, as P. Haggett's *Locational Analysis in Human Geography* could be commissioned by the S.S.R.C. and subsequently published in the *Journal of the Royal Statistical Society*, as well as the S.S.R.C.'s Newsletter.

137. The Committee of Professors of Statistics has been mentioned once or twice already in this report and it may be useful to summarize the rest of the advice they gave in response to the questions that were put to them. They agreed, first of all, that the S.S.R.C.'s concern about statistics in the social sciences was justified, as regards both research and teaching. In their opinion mathematical statistics teaching is relevant to applications in the social sciences. As to whether the direction of

their own research had any relevance to the social sciences, or was likely to lead to applications for S.S.R.C. grants, the answer was "sometimes". They considered that research units were not such good places for research as university departments, despite the heavy teaching responsibilities of the latter. (See paragraphs 93–98 for some arguments to the contrary.) Specifically with regard to students in social science departments, the load of service teaching can sometimes be very heavy. Finally, on the respective merits of central statistics departments and individual statisticians attached to social science departments, their comment was that individual statisticians should collaborate closely with central departments.

138. There is no doubt that there is room for more collaboration between mathematical and social statisticians—the latter term being used here to denote an occupation, irrespective of a person's training, which may have been as a mathematician. There is even more to be done in achieving collaboration between statisticians and social scientists. One useful product of the visits, at any rate to some universities, seems to have been a renewed interest of these groups in each other's work, although in the long run it will require more permanent organizational changes to draw the different faculties together. A word of explanation is perhaps called for about an apparent change in the purpose of the visits, which started as an enquiry about statistical research in the social sciences but became, to some extent, what one professor called missionary work. There seemed to be no merit in preserving a strict impartiality, with the aim of producing a report on the current position, when some immediate good could be done through the machinery of the visits themselves. Hence, in addition to advocating closer ties between statisticians and social scientists, I did not conceal a conviction that financial support for projects involving statistics, including methodological and mathematical developments, should be forthcoming. If this has influenced competent people to apply to the S.S.R.C. for research grants, one of its objectives will have been achieved.

139. The establishment of departments of social statistics has been advocated (paragraphs 72–74), but this is not a unique solution and depends on the relative strength of interests at a particular university. If one considers the relevant disciplines arranged serially:

mathematics—mathematical statistics—applied statistics
(social statistics)—social sciences,

where social statistics is shown as a sub-class of applied statistics, it is not obvious where to draw boundaries for organizational purposes, and some mathematical statisticians may fairly claim to be as interested in retaining links with mathematics as with social statistics. All the possible neighbour-pairs have been encountered, as well as singletons, and it would be invidious to suggest that any are superior, because universities have different aims and cannot be expected to follow a set pattern. The S.S.R.C., however, is entitled to pursue its own aims, and hence to promote the formation of departments of social statistics. An obvious way of doing so is to provide funds for an initial period in order to establish Chairs of Social Statistics for which the universities will eventually take financial responsibility. A parallel provision is wanted for a number of Research Chairs (paragraph 116).

140. The other major expenditure recommended is the funding of statistical research units, discussed from paragraph 89 onwards. The precise type of unit cannot be laid down, whether it should be large or small, inside a university department or altogether outside the university, specializing in particular topics or having catholic

interests. The sensible thing would be to let potential directors bid for what they want. Some will want only a small staff of two or three people to develop the work they are doing at present in a special field. Others may have grander plans, and the Statistics Committee itself could initiate proposals. What is required in the first place is a public statement to the effect that the S.S.R.C. wishes to encourage, and will pay for, or, where more appropriate, pay towards, the establishment of such research units.

141. It has been stressed that in the university scene consultancy is an inevitable part of the statistician's duties, to be considered along with teaching and research when making provision for staff. A different form of consultancy operates to the benefit of the S.S.R.C. in supplying members for its committees and furnishing advice in other ways—indeed, a Research Council could not function otherwise. Where other kinds of research unit exist (whether or not sponsored by the S.S.R.C.) whose purpose is research in one of the social sciences, and which are possibly too small to employ resident statisticians, the S.S.R.C. should go on supporting the use of outside consultants as an alternative to the device of funding fellowships suggested in paragraph 96.

142. One further call on many statisticians' time deserves mention, namely, as with other scientists, the service given to learned societies—to be specific the Royal Statistical Society. Universities are probably more generous in making allowance for this than most employers, and they are quite justified in view of the essential role of the Society in furthering research, through its meetings and publications, and at the same time spreading knowledge to a large audience of students and professional workers. It has already been suggested in paragraph 92 that meetings of the Royal Statistical Society provide a good opportunity for the lone statistician in a social science department to escape from his isolation. Local groups of the Society are especially well suited to the purpose and frequently draw their strength from a university connection; they act in a sense as extra-mural departments, with a distinguished stream of visiting speakers. Within this setting the application of statistics in the social sciences could gain a greater coherence; it could lead to the formation of another Section in the Society, or, since the General Applications Section, by and large, covers the ground, its renaming with greater self-consciousness as the Social and Economic Statistics Section. A useful concession for students on approved S.S.R.C. grants would be to allow them expenses for attending meetings and conferences of the Royal Statistical Society.

143. A number of the papers presented at meetings of the Society organized by the Research Section are given by visitors from abroad who are staying in this country for periods up to a year, often as guests of university departments. Very few are concerned with social statistics, indicating probably the small number of departments able to attract them. This will be remedied to some extent by the growth in number and reputation of departments of social statistics, but can also be encouraged by the provision of funds to defray the costs of visitors from abroad. A precedent already exists in the shape of senior visiting fellowships awarded by the Science Research Council.

144. The recommendations in this report are summarized below. Many of the ideas are not new; they have emerged from the scores of discussions with social scientists and statisticians during the course of the visits. But their assemblage in the form of a report will at least provide a checklist for putting into effect the recommendations that are accepted. The procedures for doing this are of the greatest importance. As Florence Nightingale said after a Royal Commission had reported

on the disastrous state of health of the army in the Crimean war, reports are not self-executive. There will need to be staff charged with the responsibility for examining each proposal in detail under the guidance of an expert committee, and negotiating if need be with universities and other departments. Only if these necessary steps are taken by the S.S.R.C. will substantial progress be made towards achieving their aims, namely (a) improving the quality of social science research through the use of statistical techniques and (b) advancing statistical methodology itself, which will lead to better solutions in the long run.

145. SUMMARY OF RECOMMENDATIONS

1. Meetings of university teachers of statistics should be arranged to discuss courses and methods of instruction. (Paragraph 62.) The activities of the Educational Study Group deserve support. (Paragraphs 59 and 134.)

2. It is desirable for social scientists to have attained a certain standard of mathematics at school, though the present O-level syllabuses are not necessarily endorsed. (Paragraph 66.)

3. There is a strong case for having separate departments of social statistics on the grounds of teaching, of research and of the career offered to social statisticians. Their relationship to departments of mathematical statistics should be close. (Paragraphs 72–74 and 117.) The S.S.R.C. should provide funds to establish Chairs of Social Statistics for an initial period. (Paragraph 139.)

4. The S.S.R.C. should give precedence in the allocation of studentships, to courses enabling mathematical statisticians to study the social sciences. They should also be employed as research workers on S.S.R.C. grant-supported projects, to enable them to learn on the job. (Paragraphs 75 and 88.)

5. The S.S.R.C. should discuss with universities whether it can be made a condition of holding one of its studentships that a dissertation in an applied field, when required as part of an M.Sc. course in statistics, should be on a social science topic. (Paragraph 76.)

6. The upper age limit for conversion fellowships should be reconsidered. (Paragraph 77.)

7. The S.S.R.C. has a role in obtaining access to data for researchers. (Paragraph 78.) It could take the initiative in commissioning work, and inviting the participation of statisticians through its publications. The Statistics Committee could also seek out talent in other ways. (Paragraphs 83, 126, 128 and 136.)

8. Where its terms of reference prevent it from supporting research, the S.S.R.C. should give advice about other sources of finance. It could, with agreement, undertake to become a clearing house for applications. (Paragraphs 78–79.)

9. The provisions for carrying out research and for adequate staffing are the concern of the S.S.R.C. even if another body (the U.G.C.) supplies the means. (Paragraphs 81–82, 101, 124 and 133.)

10. Research projects need to be followed up: there is a gap between research and practice; there are up-dating problems: there are problems of disseminating computer programs. (Paragraph 84.)

11. The S.S.R.C. should support theoretical work in statistics as being essential to the social sciences. (Paragraph 85.)

12. Methodological work in statistics may arise out of a normal S.S.R.C. project and need a continuation grant, or it may have originated in some other way; it may be appropriate to share this support. (Paragraph 86.)

13. One or more research units should be established to promote statistical excellence and advances in methodology in the social sciences. (Paragraphs 89–99 and 140–141.)

14. The rules on part-time paid work for graduate students, and higher degrees awarded for work as a research assistant, need to be reviewed. (Paragraph 102.)

15. The study of trends in the number of graduates and their employment would be improved if the U.G.C. could obtain more precise data on the statistical content of degree courses. (Paragraphs 104–115.) A comparison of syllabuses and examination papers should be carried out on a regular basis. (Paragraph 135.)

16. A hierarchy of purely research posts should be established parallel to the teaching hierarchy, with junior staff in support, and financed in part by the S.S.R.C. (Paragraphs 116 and 118.)

17. The S.S.R.C. should encourage a variety of outstanding talent by providing funds for research fellowships at both senior and junior levels (paragraphs 119–121) and in other ways (paragraph 128). It could also fund fellowships in statistics for units which have limited sources of finance from elsewhere (paragraph 96), or support the use of consultants (paragraph 141).

18. The S.S.R.C. might issue a note on the statistical weaknesses in the projects which it has been asked to support, and let it be known that it would be an advantage to obtain prior statistical advice. (Paragraphs 123–124.)

19. The S.S.R.C. should consider employing statistical staff able to give technical advice. (Paragraph 125.)

20. The suggestion that statisticians should serve on other subject committees of the S.S.R.C. should be looked at. (Paragraph 127.)

21. Resources both in staff and money are required to provide for statistical consultancy at universities. (Paragraph 129.) The S.S.R.C. in giving money for research projects can see that some is allocated for this purpose. (Paragraph 133.)

22. Contacts with the Royal Statistical Society should be developed and made more positive. (Paragraph 142.)

23. Funds to defray the costs of visitors from abroad should be provided in the form of senior visiting fellowships. (Paragraph 143.)

24. The procedures for putting the recommendations that are accepted into effect are of the greatest importance. There must be staff at the S.S.R.C. charged with this responsibility. (Paragraph 144.)

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Note: A report has recently been published in connection with the Survey of the Behavioural and Social Sciences 1967–69 in the U.S.A. by its Mathematical Sciences Panel. From this it appears that the two countries have a number of problems in common, and some of the recommendations made are similar. (KRUSKAL, W. (ed.) (1970). *Mathematical Sciences and Social Sciences.* New York: Prentice-Hall.)

ANNEX 1

Letter to Vice-Chancellors

SOCIAL SCIENCE RESEARCH COUNCIL

State House, High Holborn, London WC1

Telephone: 01–405 6491

10 October 1969

Dear Vice-Chancellor

The Council has felt for some time that it has insufficient knowledge of the work currently going forward in the universities in the field of social statistics and in the application of statistical techniques to social science problems. We are also concerned generally with the efforts that are being made to foster a higher level of numeracy among social scientists. The Council attaches very great importance to the latter point. Meanwhile we have been struck by how few applications for research grants we have received in the field of social statistics.

We have accordingly decided that it would be useful to conduct a systematic review of the existing situation in this field, aimed at formulating recommendations to the Council about ways in which we might usefully make a contribution to any

improvements that seem feasible. To that end we have obtained the services of Dr S. Rosenbaum, at present Honorary Secretary of the Royal Statistical Society, who will during the next two years carry out a series of visits on our behalf to university departments, institutes and research units whose work has some relevance to this problem.

These visits are intended to be of an informal character, resembling those made for some years now by representatives of HM Treasury in the field of economics (for which reason econometrics will be covered in the present visits only cursorily). It is hoped that as far as possible they can be arranged in the first instance through particular members of the university's staff with whom Dr Rosenbaum happens to be already personally acquainted or else who may be on one or other of the Council's committees. On some of these visits he is likely to be accompanied by a member either of the Council's scientific staff or of its Statistics Committee.

I hope that your colleagues in the departments concerned will bear with this further demand on their time. Our feeling is that only by conducting a systematic investigation of this kind will we be able to arrive at useful proposals about the kind of contribution that the S.S.R.C. can make towards academic work in the field of social statistics.

Yours sincerely

Signed ANDREW SHONFIELD
Chairman

ANNEX 2

Places Visited

Inside London

Bedford College
Higher Education Research Unit
Imperial College
Institute of Community Studies
Institute of Manpower Studies
Institute of Psychiatry
London Business School
London School of Economics
London School of Hygiene
MRC Social Medicine Research Unit
Richardson Institute for Conflict and Peace Research
Tavistock Institute
University College

Outside London

Aberdeen
Bath
Birmingham
Bradford
Bristol
Cambridge
Cardiff
Dundee
Edinburgh
Essex
Exeter
Hull
Kent
Leeds
Liverpool
Manchester
Newcastle
Oxford
Reading
St Andrews
Salford
Sheffield
Strathclyde
Sunningdale
Sussex
York

ANNEX 3

QUESTIONS PUT

Q1. *Research in progress—or just completed—in the social sciences:*
a. Brief description of each project, with names of investigators and references to publications.
b. *Use of statistics in research:* please give a brief account of the statistical aspects of each project, noting the nature of the data and the techniques used. (A list of techniques is attached to which reference could be made.)
c. *Collaboration with statisticians:* describe the degree of collaboration with statisticians and mathematicians, in the mathematics department or elsewhere, in each project.
d. *Statistical background of researchers:* state any relevant experience and qualifications (including dates) both of investigators and collaborators.

Q2. *Teaching of statistics to social scientists:*
a. Stated aims of the course; statistics syllabuses; reading lists; and examination papers; over the past three years and planned for the future.
b. Numbers of (i) undergraduate and (ii) postgraduate social science students—full-time and part-time separately—over the same period and:
the numbers taking statistics compulsorily or as an option when offered:
if known, the mathematical level at school (O-level, O-level additional, A-level) in each category, both of those taking and of those not taking statistics:
the numbers taking a mathematics course in their first or second year, preparatory to taking a statistics course in their final year.
(If preferred, the data on each student may be entered on the attached form.)
c. The proportion of statistical papers in the final examination, or some other measurement of the statistical content of the course (e.g. hours taught relative to other subjects taught). Also the type of paper (e.g. applied/theoretical).
d. Social scientists taking a full course (e.g. diploma) in statistics: also any mathematicians taking such a course, with social science providing the field of application.

Q3. *Teaching staff in social science departments:* is statistics teaching done within the department, or by the mathematics or some other department, or jointly?
Please give the statistical background of all the teaching staff—whether or not they teach statistics—as in Q1(d).

Q4. To what extent does the teaching in the mathematics and/or statistics departments make use of applications from the social sciences rather than the physical sciences? What facilities are there for a mathematics or statistics graduate without a social science qualification to enter upon a social science course (e.g. is a conversion course necessary, or offered)? Other ways of encouraging mathematics graduates to enter the social sciences field?

Q5. Inventory of equipment (e.g. calculating machines; computers; teaching aids): whether it is considered adequate: whether it is serviced satisfactorily: and whether necessary technical staff (e.g. programmers) are available.

For use with Question 1(b):

List of Techniques

Classification and tabulation of data
Measures of location: averages, percentages, etc.
Measures of dispersion: standard errors, confidence limits
Tests of significance:

- based on standard error
- t
- F
- χ^2(goodness of fit)
- χ^2(independence)
- non-parametric (sign test, Wilcoxon test, etc.)

Analysis of variance and covariance
Sampling design
Design of experiments
Ranking methods
Correlation (between two variables)
Regression (on one variable)
Multivariate analysis:

- multiple correlation and regression
- factor analysis
- component analysis
- discriminant analysis
- cluster analysis

Curve fitting (non-graphic)
Graphical methods
Index numbers
Time series analysis:

- moving averages
- seasonal variation
- spectral analysis, correlograms

Probit analysis
Sequential methods
Queueing theory
Stochastic processes
Monte Carlo methods
Demographic and actuarial techniques
Linear programming
Model building
Other—please specify

For use with Question 2(b):

Please complete a line for each social science student in each year, using code-numbers or ticks as indicated. The name is asked for to enable successive years to be linked; if preferred, a code can be used.

Academic year: 19..... Department: .....

NAME						
Code Full time 1 Part time 2						
Code Undergraduate 1 Postgraduate 2						
Year of course Code: 1, 2, 3, 4						
√ if final year						
MATHS: Qualifications obtained before university. √ as appropriate	Elem. O-Level					
	Addl. O-Level					
	A-Level					
Courses being taken this year. √ as appropriate	Compulsory Stats.					
	Optional Stats.					
	Maths. preparatory to Stats.					

DISCUSSION ON DR ROSENBAUM'S PAPER

Professor G. BARNARD (University of Essex): It is impossible, even in the augmented time allowed to the proposer of a vote of thanks, to do justice to a report so wide in scope and so deep in the treatment it gives. May I say therefore that the S.S.R.C. Statistics Committee and Council, and I expect the Council of our own Society, will be returning again and again to Dr Rosenbaum's report for detailed discussion and implementation of the proposals as the situation develops, at any rate so far as funds permit. One might say in that connection that the limiting factor at the present time is people rather than finance, though how long that situation will remain so it is difficult to say.

One has to exercise restraint in commenting on so many of the points raised. I cannot resist the temptation to refer to Paragraph 36 with the examination questions, where after presentation of the table which shows that university people move house more often than people from technical colleges, the candidates are asked: "Is there evidence here of association between education and the number of changes in address?" I am reminded of a question which used to be asked of Ph.D. candidates—"Would you like to tell me what is a random sequence?" and the correct answer was "No". Presumably the correct answer here is "Yes". But that is not presumably what this means, and rather one was expected to give some measure of the weight of the evidence. Having made that criticism I only hope it does not turn out that this is a question which I set! I do not think I ever took part in a paper under that title, so feel fairly safe.

Well, mainly one feels simply like underlining and elaborating on most of the points with which one is certainly in broad agreement, but there is one point on which I think