

# **Project: The Teaching of Statistics in British Universities**

## **Report 1**

### **Analysis of the data in the Directory of Academic Statisticians**

1. The broad remit of the project is to examine the current extent, levels and emphases in undergraduate and postgraduate statistics teaching, in which university departments it is taught and to what levels and numbers of students. The aim will be to provide a source of information on current and changing university Statistics teaching as a basis for future debate on continuing provision and requirements in the changing climate of the British university scene. The current situation will be placed in context by examining the changes and influences over the last 20 years.

2. The motivation for this project is twofold. The first issue is the perception that the position of Statistics, as a discipline in its own right, is declining. Some well-known departments have been closed, or are being closed, and there is a shortage of UK research students. This perception about the discipline is shared by many other countries including Australia and the USA. The second issue is that the Committee of Professors of Statistics (COPS) has been collecting data for over 20 years but nobody has bothered to analyse the data.

3. The project is proceeding in two phases. In Phase 1 the background data sources for the last 20 years have been examined and the COPS data have been analysed to set the context for Phase 2. In Phase 2 the trends and issues that have been identified in Phase 1 will be used as the basis for a detailed survey of the current provision of Statistics teaching in British universities. It will also help to inform the future structure of the COPS annual data collection exercise. This report concentrates on Phase 1 of the project.

4. There are several possible sources of data for exploring past trends. Universities make annual returns to the Higher Education Statistical Agency (HESA) and to HEFCE on

student and staff numbers. The various Research Assessment Exercises (RAEs) have collected information on staff numbers, in particular on research active staff, and Teaching Quality Assessment (TQA) reports give information on teaching. Finally the COPS data in the Directory of Academic Statisticians (DAS) provide the only accessible information on both named academic statisticians and on clearly identifiable groups of statisticians.

5. Of the administrative data sets the HEFCE and RAE data are incomplete in various ways that make them unsuitable for a consistent analysis of trends. There has been only one set of TQA reports, spread over two years, which makes it unsuitable for establishing trends. The HESA returns are the most complete, but the coding system was changed in 2002/3 and it is impossible to construct a consistent series for Statistics across this change. Prior to 2002/3 students were allocated as whole numbers to disciplines. Since 2002/3 students are apportioned to a variety of disciplines according to the balance of the subjects, and this has had a major impact on subjects such as Statistics and Mathematics. There have also been some other major changes to the coding, especially for Operational Research, which affect Statistics and Mathematics. However, from 2002/3 onwards, if there are no further changes to the coding, it should be possible to construct consistent series for both staff and student numbers subject to certain caveats. The most important caveat is that HESA returns are administrative returns and the coding of the returns depends on the institution and the person doing the coding. For example in 2002/3 there were returns on student numbers for (G3) Statistics from 72 institutions. However, there was no return from Cambridge, even for postgraduate students, despite Cambridge receiving an RAE grade of 5\* for Statistics. Also under postgraduate taught students, of the GB total of 311 in 2002/3 no less than 110 were taught at Abertay Dundee. Does Abertay really account for over one third of the national production of postgraduate taught statisticians? The five institutions recording total numbers of Statistics students (u/g and p/g) greater than 100 were Abertay, City, Heriot-Watt, UCL and Warwick. Are these really the five most important centres for the training of statisticians in Britain? The returns from City and Heriot-Watt clearly include their Actuarial students, while from personal knowledge the return from Southampton under Statistics does not include their

Actuarial students that also number over 100. These inconsistencies make the HESA data difficult to interpret at a national level. Basically any set of data generated by administrators should be treated with caution.

6. The problems of the statistics of Statistics are shared with the statistics of Mathematics. Wydall (2005), in a report to the London Mathematical Society on the numbers of undergraduate Mathematics students, produced six plots of the trend from 1996 to 2002. These plots varied in both the level and the pattern of the trend depending on the source and the definitions used. The HEFCE figures show little change whilst the five plots based on HESA returns vary dramatically; some show a steady increase while others, including Wydall's preferred measures, show an increase from 1996 to 1999 followed by a decline from 1999 to 2002. The definitional problems implicit in the plots will be as bad, and possibly worse, for Statistics. Our conclusion is that the historical data from HEFCE and HESA are too unreliable for the purposes of this study.

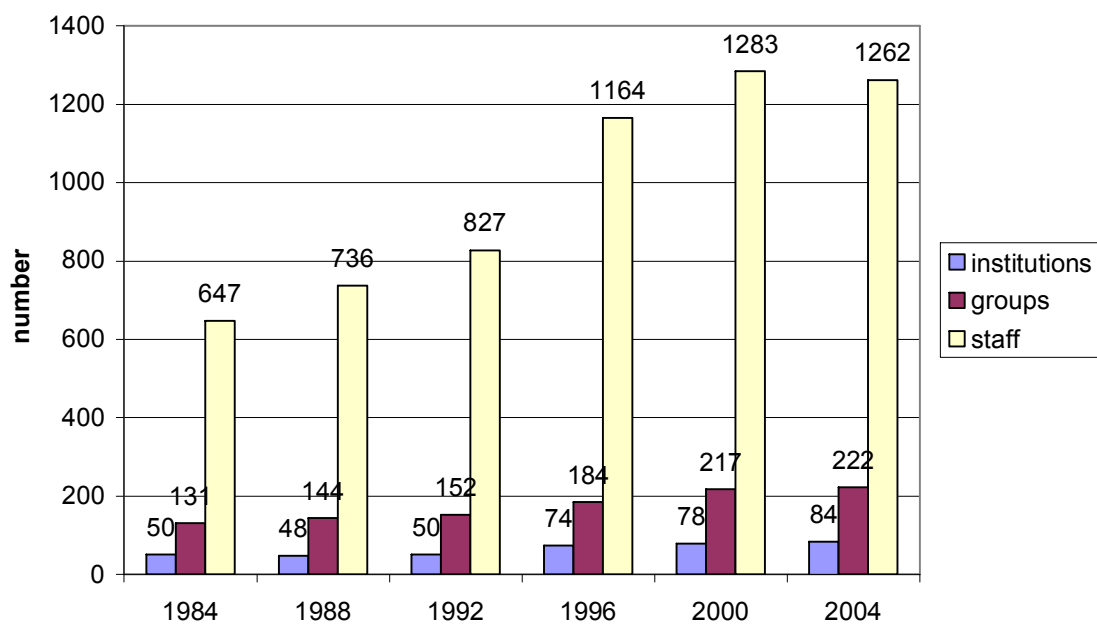
7. This leaves the COPS data set as the only data set collected in a reasonably consistent fashion over a long period. However, as those who have completed returns will know, there are many problems with the COPS data. In the 1980's COPS was a Committee of Professors of Statistics. Only designated Professors of Statistics were admitted to membership and only those professors who were members of COPS made returns. Later heads of identifiable Statistics groups were included in COPS, whether professors or not, and when the Polytechnics attained University status they were also admitted to membership of COPS and hence made returns. Thus the basis of the COPS returns has changed over time. A large part of Phase 1 of this project has been devoted to forming a database of the DAS returns, constructed from the existing database for recent years and from the paper returns for earlier years, and to examining the changes in the structure of the returns.

### **An Overall Picture between 1984 and 2004:**

#### **What the Directory of Academic Statisticians (DAS) does and does not tell.**

8. Counts were performed on the DAS files representing numbers of staff and of groups in Statistics within institutions at the date of the returns in the years 1984, 1988, 1992, 1996, 2000 and 2004. The results of these raw counts are displayed in Figure 1.

**Figure 1. Raw Counts on the DAS, 1984-2004**



Although the numbers reflect the contents of the DAS over the period, they cannot be taken uncritically as indicators of the real trends in the number of groups and of staff engaged in statistical research and in teaching Statistics. This is due to the existence of powerful structural factors, such as those mentioned in paragraph 7, shaping the contents of the DAS. For example:

- 1) Reform of British higher education in 1992 resulting in polytechnics being upgraded to the status of universities.

- 2) Professorship no longer required for membership of COPS in the 1990's, thus widening the membership of COPS and hence also the number of groups.
- 3) Changes in the reporting of groups engaged in statistical research and teaching, in particular in public health and medical statistics.
- 4) Dissolution and unification of certain groups over time due to internal university policies, often related to the RAE.

Essentially, each of these factors expressed itself in a *change in reporting practices* to the DAS. It is apparent, for example, that the reform of British higher education in 1992 had a significant impact on the contents of the DAS. During the period 1984-1992 the number of institutions was stable, while between 1992 and 1996 a growth of 48% in the number of institutions was recorded. From 1996-2004, there has been a slow but steady growth in the number of institutions. Most institutions joining the DAS during this latter time were new universities, all former polytechnics; Slough, Thames Valley and Inverness are typical examples.

9. The pattern of the numbers of groups shows a similar dynamic. However, significant growth in the number of groups extends over the entire period of time reflecting *both* addition of former polytechnics *and* addition of groups specializing in areas such as epidemiology/public health and management/business research. In 1984-88 and 1988-92, 10% and 6% growth in the number of groups was observed, while in 1992-96 there was 21% and in 1996-2000 18% growth. Between 2000 and 2004 there was only 2% growth in the number of groups recorded. Looking at the individual returns only about 40 institutions retained the same number of groups at both 1996 and 2004, of which Aberdeen, Birmingham, Durham, Lancaster and Leicester were significant examples. Edinburgh can be presented as an example of a typical change in practice in relation to groups reported. In 1996 Edinburgh reported 3 groups: Biomathematics and Statistics Scotland, Department of Mathematics and Statistics, and a Medical Statistics Unit in the Medical School. In 2004, 4 other (new?) groups were reported in addition to the above-mentioned groups: School of Management, Neurosciences Trials Unit, School of Education and Wellcome Trust Clinical Research Facility. From the returns we cannot tell whether these are newly created groups or not. An issue for Phase 2 of the project is

to try to identify how the changes in the number and reporting of groups are reflected in Statistics teaching across institutions.

10. Although the DAS summarizes the outcome of the reporting process obtaining the real developments in numbers of staff at various points in time is not at all straightforward. Technically changes in reporting practices result in inconsistent data series. Many groups, and certainly nearly all former polytechnics, have made their first appearance in the DAS only since 1992. This is particularly true of groups engaged in statistical research within the area of public health. There is no way of knowing, based on what is presented in the Directory, whether the newly introduced groups are new in reality or whether the described change is purely a change in reporting practice. To understand the state and development of groups engaged in teaching statistics it is necessary to control for the impact of the structural factors. The analysis of the trends presented in the next section attempts to control for some of the effects of the structural factors by focusing on those groups reported to the DAS at every point in time during the period under observation.

### **11. Core and Non-Core Groups**

This section follows developments in staff numbers in those groups consistently reported to the DAS during the period under observation. A distinction is made between two types of groups: core and non-core groups. Core groups are broadly defined as those associated with teaching statistical theory, often in Schools of Mathematics, and responsible for most theoretical statistics research. They correspond closely to the original membership of COPS. Perceptions about trends in the discipline seem to be related to trends in the position of these core groups. Non-core groups are defined as a residual, i.e. the rest of the groups reported to the DAS, often representing disciplines with a strong statistical content. These groups vary in their activities; some provide consulting services, most teach Statistics relevant to their parent discipline, e.g. economics, management, health, medicine, geography, psychology, and many others, and most are engaged in research applied to their discipline. It is the apparent inconsistency in the reporting of these non-core groups that makes the analysis of past trends so difficult.

Identification of core groups was performed retrospectively with the help of the results of RAE 2001. The groups that submitted themselves for research assessment were a *self-selecting* set of the principal research groups since it was regarded as unrealistic that an RAE score below 4 would result in the receipt of financial support for statistical research. Therefore participation in RAE 2001 serves as an objective criterion of quality of research as judged by the institutions themselves. This is not to say that all self-selecting departments obtained the desired score as a result of the exercise. In fact 20% of groups obtained scores equal to or below 3. However, self-selection is an objective criterion in the sense that definition of “a centre of quality research” results from the self-perception of the groups themselves rather than from any arbitrary criterion imposed by others.

The process of self-selection by RAE 2001 resulted in the identification of 44 groups as core groups. The distribution of their RAE 2001 scores is presented in Table 1.

**Table 1.**  
**Distribution of RAE 2001 scores**

RAE 2001 score	Number of groups
2-3	9
4	14
5	15
5*	6
Total	44

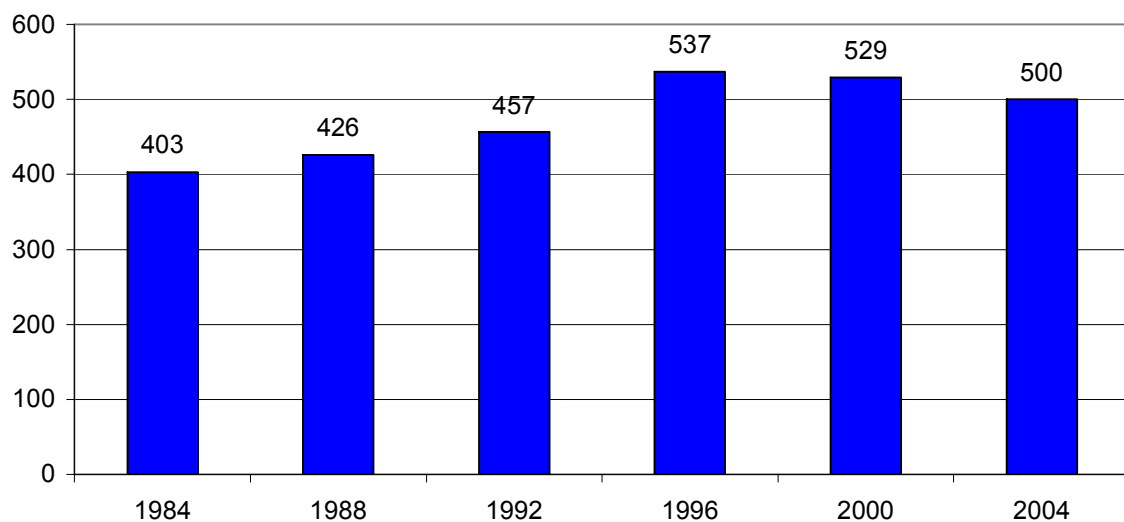
80% of the core groups obtained scores equal to or above 4, and nearly half the groups obtained scores equal to or above 5. The highest score (5\*) was obtained by groups in Bristol, Cambridge, Oxford, Kent, Lancaster and Warwick.

The information in the DAS for these self-selecting core groups is found to be more consistent than for many others. Most of the core groups were in existence in 1984, at the beginning of the period under observation, and thus a full staffing history is available for the whole period 1984-2004. The main exceptions to this rule are groups existing within

the former polytechnics, and for 5 such institutions, due to the lack of data prior to 1992, we made the assumption that the numbers of staff and groups in these institutions remained constant between 1984 and 1996. We are trying to acquire copies of the Polytechnic equivalent of the DAS which should enable us to improve our estimates.

Figure 2 presents overall numbers of staff in the core (self-selecting) groups during the whole period under observation.

**Figure 2. Numbers of staff in core groups defined by RAE 2001, 1984-2004**



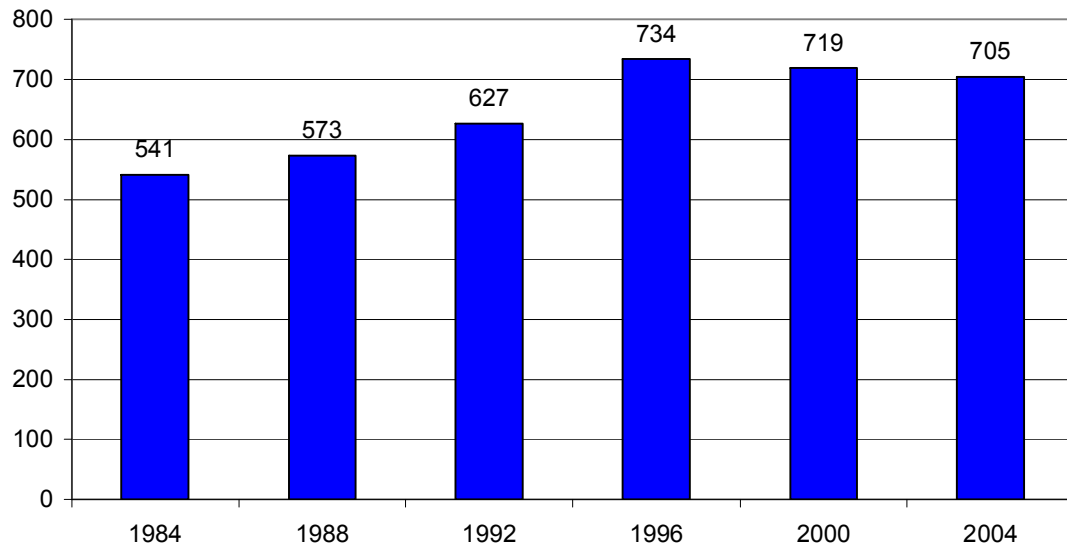
There is a steady growth in numbers up to 1992, followed by an increase of over 17% between 1992 and 1996. This large increase between 1992 and 1996 corresponds to a period of large growth in student numbers. Although this growth was not fully funded there was a general increase in university budgets that appears to have been reflected in an increase in staff numbers. Since 1996 there has been a steady decline in the numbers of staff in these core groups.

An alternative method of defining core groups is prospectively based on the membership of COPS in 1984. These are the key members of COPS and they have consistently reported their data to the DAS over the entire period 1984-2004, regardless of their RAE



score. The results from this prospective view are shown in Figure 3. The trend is very similar to that is presented in Figure 2.

**Figure 3. Numbers of staff for key members of COPS, 1984-2004**



There is a considerable overlap in the groups obtained using both retrospective and prospective definitions and so it is not surprising that they result in the same observed trend: an increase over 1984-1996 and a slight decrease thereafter.

12. We now explore the nature of the decline in numbers since 1996 in more detail. Since 1996 funding for subject groups in most institutions has been strongly affected by the results of the RAE. Figure 4 presents the observed relationship between the RAE 2001 scores and the pattern of staff numbers between 1996 and 2004 in the core groups.

**Figure 4. Association between RAE 2001 score and average numbers of staff for core groups, 1996-2004**

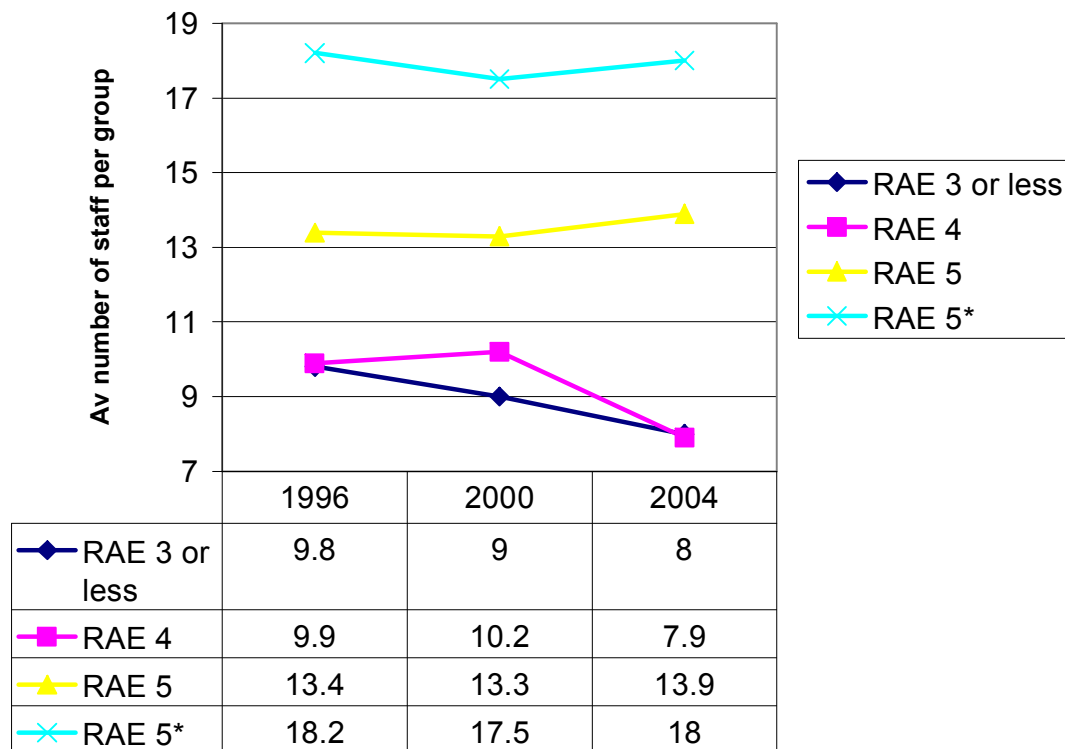
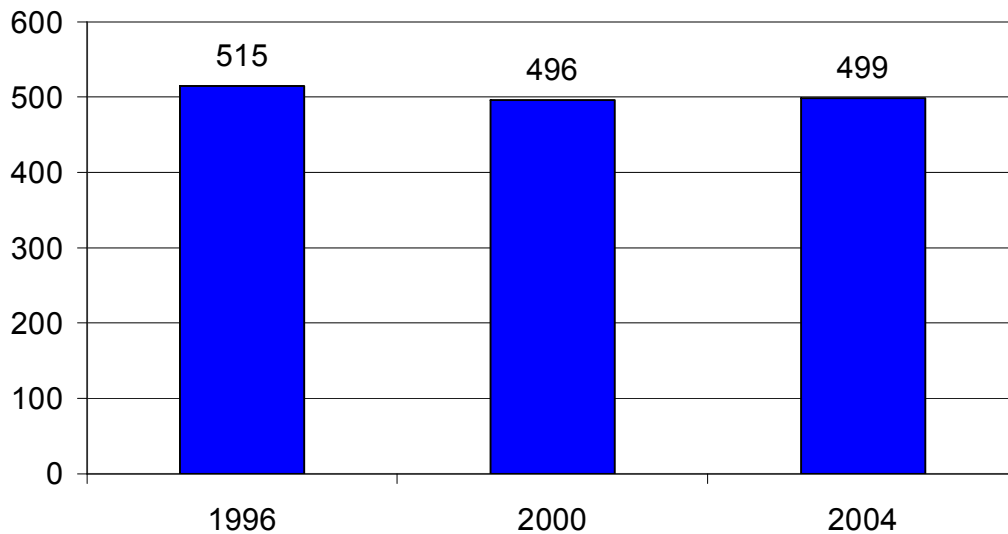


Figure 4 shows two patterns. The first is that the higher the score the larger the average size of groups. As groups are self-selecting it appears that past success in research may have been rewarded by institutions resulting in larger groups. The second pattern shows that this historical trend is continuing. Those groups scoring 4 or less have seen a decline in numbers between 1996 and 2004, while for the high scoring groups the numbers have remained roughly constant. Despite their high RAE scores there is no evidence of any recent growth on the average in these core groups.

13. Figure 5 presents developments in the non-core groups during 1996-2004. Only non-core groups appearing in the DAS at all three points in time are represented.

**Figure 5. Numbers of staff in non-core groups, 1996-2004**



It can be seen that when the same non-core groups are followed over time only a very small decline (less than 3%) is observed. The trend for the core groups over the same period was a decline of 7% (Figure 2). Thus the number of staff in applied statistical disciplines appears to have declined less than the corresponding number in mainstream theoretical Statistics. It is important to remember that the overall number of staff in non-core groups grew during this period from 627 in 1996 to 754 in 2000 to 762 in 2004, due partly to the addition of new non-core groups to the DAS.

14. Our preliminary conclusion from the study of the DAS data is that there is evidence of a decline in the number of Statistics staff in the core theoretical Statistics groups since 1996. This decline is related to the RAE score. It is this decline that probably causes the perception that Statistics as a discipline is in decline. For groups in Applied Statistics, the so-called non-core groups, the decline appears to be smaller. If new groups are being created then there may well be no decline in overall numbers, but we cannot determine this from the existing data.

15. A by-product of Phase I of the project is that it forms the basis for an electronic DAS database. Since 1996 the data supplied by the universities to the DAS have been stored in

electronic text files. For the years 1984-1995 the data are not available electronically. However, hardcopies of the DAS from this period have been preserved. For the purpose of this project, data pertaining to years 1984, 1988, 1992, 1996, 2000, 2004 have been put into an Excel file. Groups, corresponding to departments in formal academic terms, are treated as observations, whilst the numbers of staff in them are treated as variables. Accordingly, the unit of analysis employed in the present report is a group/department.

16. In the process of Phase I a significant effort was put into constructing the working file (referred to in §15) in which the data in the DAS were reliably documented. Treating groups as observations meant in practical terms that either retrospectively or prospectively each group had to be identified uniquely through time even if the name changes. This task proved not at all easy due to the fact that many groups underwent organizational changes resulting either in unification with or splitting apart from other groups, changing names, affiliations etc. Of all the changes of an organizational nature changing names was probably the most dominant feature, reflecting changes within institutions in the understanding of disciplinary boundaries, objectives and contents. In the process of the identification of consistent groups the lists of the names of the members of staff in the DAS were vital. No other data source has names. In many cases, since the actual names of the departments changed, the conclusion regarding the continuing functioning of certain departments could only be drawn on the basis of a detailed examination of the names of members of staff at two periods. In most cases there was a significant measure of continuity in the names of staff between two points separated by 4 years, and therefore the probability of the attribution of a “false identity” is low.

17. What of the future? There are three major courses of action presently open for the COPS in relation to the collection and management of data on staff in Statistics.

(A). To leave the present method of data collection and management unchanged. Presently, data on teaching/research undertaking staff, including names, areas of interest and contact details, by institution, are collected with the help of contact people in

institutions. These data are stored electronically in text and HTML files, with separate files for each year. This situation is not conducive to production of reliable data for statistical analysis, as we have shown above. Adopting this course of action would mean that the future monitoring of numbers of staff would be very difficult.

B. A second option would be to leave the method of data collection essentially unchanged but to modify the data management. In practical terms this would mean maintaining the existing database in its present format, with data returned by institutions stored in text and HTML files and presented online. However, it will also be added to the existing EXCEL file. If this course of action is adopted then COPS will possess data on the numbers of staff on an ongoing basis. The quality of data and the amount of interpretational effort required in order to assess trends will be similar to that presented in this report.

C. Another option would be to expand the coverage of the database in future years. This is in addition to systematic updating as specified in B. For the purposes of analysis of trends in staff numbers the ideal would be to create the equivalent of a population register. In this database individuals, rather than groups, would be treated as observations. This would enable births, deaths and migration to be measured, where a death corresponds to somebody leaving the register, for example, by retiring, by joining industry or commerce, by changing discipline, or by moving to another Statistics group. For Statistics the impact of changing discipline is the most difficult to assess. If a statistician leaves a Statistics department to join a Medical department as a geneticist is this a loss to Statistics? If the leaver is replaced is this a growth? If a person retires but continues teaching and researching how should they be recorded? For a register to be useful COPS would have to collect far more data on individuals and this would place a considerable burden on the contact people in institutions. The questions should relate, for example, to demographic characteristics of the teaching staff, administrative status, details of research and teaching etc. On this basis, reliable projections of trends in the future could be developed. The definitional and other problems of creating a register are

manifold, but this is probably the only way of answering fully the questions posed at the outset of this study.

Maintenance of such a database would be guided by the same principles as maintenance of a population register. Technically speaking, such a resource should be managed with the help of standard software for database maintenance (for example Access), however the data could be organized initially with the help of Excel. The third option, with or without the modification of data contents, is certainly the most demanding in terms of time, finances and human effort, but it could be also the most rewarding for COPS.

TMF Smith

L Staetsky

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