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Policy Study No. 4

THE STRUCTURE OF RESEARCH EXPENDITURE

SCIENCE AND ENGINEERING POLICY STUDIES UNIT

THE ROYAL SOCIETY THE FELLOWSHIP OF ENGINEERING

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FOREWORD

Analysis of the structure of research expenditure leads one directly into some of the key issues in science and engineering policy, even though it may at first sight appear to be a dry, not to say arcane, subject. Particularly topical at the moment is the issue of overheads—expenditure on things other than the salaries of research staff which, if consistently miscalculated, can bankrupt a research group. Other issues include the adequacy of provision for materials and equipment, relative expenditure on support staff, the balance between capital and recurrent expenditure and the extent to which these parameters are affected by the size of the research group.

This report presents detailed data on how 30 leading research centres (from university departments to major research institutes) use their budgets. Our data are unique not only in their level of detail but also in the fact that they cover, on a directly comparable basis, research in universities, research institutes and industry. They also cover four broad disciplinary areas. The complexity of the exercise meant that we had to use a case study approach rather than attempt to construct statistically significant samples.

Our methodology, as well as our findings, will be of interest. The methodology is necessarily experimental, especially in the university sector where it involved allocating central expenditure to individual departments and dividing all expenditure between teaching and research. A simplified version could be developed for more widespread use.

We present our findings as indicative, not prescriptive: they establish ranges for the various parameters, for each sector and discipline covered, rather than laying down statistical norms. These ranges will provide a background against which individual research managers can assess their own use of resources. They will also be of value to those concerned with developing research policy at the national level, for example in connection with the future of the dual support system.

Professor B.K. Follett, Sec RS
Chairman, SEPSU Steering Group

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Vice-Chairman, SEPSU Steering Group

July 1990

SUMMARY

This report presents a quantitative analysis of how research centres in various science and engineering disciplines spend their research budgets. We have collected very detailed data on actual expenditure patterns in a single year (1986/87) from 30 research centres in four disciplines (biochemistry/pharmacology, chemistry, electrical engineering & electronics and plant science). The centres cover a wide range of size, and include university and polytechnic departments, research council and other research institutes, and industrial research centres. Our results are of special interest because they allow direct comparison to be made between the three sectors of research.

We have used the data to examine many facets of research expenditure: the division of expenditure between pay and non-pay, how pay is divided among various categories of staff, how much goes on equipment & consumables, on computers, on travel, on training, how the pattern of expenditure varies by discipline and by sector. The results are presented in relative terms, particular expenditures being expressed as a percentage of total and/or recurrent expenditure and as expenditure per researcher.

Those concerned in any way with the management of science and engineering research will be particularly interested in the following findings.

(i) *Overheads*. In universities, indirect expenditure ('overheads') on research in plant science, biochemistry/pharmacology and chemistry was at the rate of about 80% of the pay costs of departmental research and research support staff; for electrical engineering & electronics, the figure was 140%. In industry, we found rates of 240% in biochemistry/pharmacology, 190% in chemistry and 165% in electrical engineering & electronics. Rates in research institutes were somewhere between those in industry and those in universities.

(ii) *Pay expenditure*. Over all disciplines, universities spent 63% of total recurrent expenditure on pay, while research institutes and industrial research centres spent about 50%.

(iii) *Non-pay expenditure*. In universities, expenditure per researcher on non-pay items (including materials & equipment) averaged £18K for the three science disciplines and £46K for electrical engineering & electronics. In industry it averaged £93K for biochemistry/pharmacology, £75K for chemistry and £29K for electrical engineering & electronics.

(iv) *Scale effect*. We found no correlation between the size of research centres and their expenditure patterns.

(v) *Heterogeneity*. On most parameters, we found considerable variations between research centres, even within the same sector and discipline. Funding formulae based on the 'typical' research centre could therefore be misleading.

In measuring research expenditure in the university sector we had to devise methodologies for attributing central expenditure to individual departments and for allocating both central and departmental expenditure between teaching and research. The way we did this could be developed so as to provide a relatively accurate way of monitoring academic expenditure on research.

Some care is needed in interpreting our data. Addressing an issue where there was little previous quantitative work, our methodology was necessarily experimental. The complexity of the data required meant that we were restricted to a statistically small number of case studies. The disciplines we selected may not be typical of all science and engineering disciplines. Nevertheless, we have been able to generate relatively hard data on a series of important policy issues where data have generally been poor. Both our methodology and our findings contribute to an improved understanding of the financing of science and engineering research.

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Tables and figures

CHAPTER 1: INTRODUCTION

(i) Aims

Aims and coverage

This report presents the results of an investigation into the structure of research expenditure at the level of individual research centres. Our aim has been to collect and analyse detailed quantitative data on the way institutional research budgets were used in a single recent year, so as to generate understanding that might be valuable to those in research institutions and in funding agencies who have responsibilities for managing research.

We selected four disciplines with a diverse range of operational requirements (biochemistry/pharmacology, chemistry, electrical engineering & electronics and plant science). Within these disciplines we selected leading research centres in three sectors (industry; research council institutes and comparable research organizations; institutions of higher education). The complexity of the data needed for this exercise—the analysis involved over 100 separate categories of expenditure—limited the number of case studies we could complete to 30.

Our data allow us to address the following issues:

- the structure of research expenditure in each discipline/sector;
- comparisons between disciplines;
- comparisons between sectors;
- the proportion of total expenditure represented by particular items, in particular 'overheads';
- methodology, notably the separation of research from teaching expenditure in the academic sector.

Since the data cover a single year only (1986/87), we cannot address issues, such as the rate of inflation of research costs, that require trend data over a number of years. We have not attempted to relate expenditure on research to outputs (e.g. published papers) from research, since analysis of research performance was outside the remit of this study. For the university sector we collected data on the various sources of income, but we were not able systematically to relate particular sources of income to particular items of expenditure. This is nevertheless of policy interest, since it is likely that sums nominally allocated to teaching or to research are in practice used for the other function.

We have tried to analyse the ways in which different research centres spend their budgets. It has not been our aim to establish norms for any given discipline or sector. One of the main findings from this study is the extent to which expenditure patterns vary even between research centres in the same discipline and sector, so it is not clear how much value the concept of a norm has in this context. We have therefore presented our data as ranges, and interpret them as indicative rather than prescriptive.

Expenditure vs costs

This report deals with the structure of research *expenditure*: the data we collected were on actual expenditure incurred by the respondents, and reflect the particular circumstances of the respondents, including their total available budgets. Our discussion covers the expenditure of research centres rather than the slightly more abstract notion of the costs of research.

(ii) Previous studies

Clayton report

The most detailed recent attempt to examine research expenditure in institutions of higher education is the 1987 report by Professor Keith Clayton, *The measurement of research expenditure in higher education*. Clayton aimed to cover all types of cost centre and constructed a sample in which all universities and polytechnics were represented: the sample covered every cost centre in uncommon and expensive subjects, one in three in high cost areas and one in five in lower cost areas. He developed a set of five succinct questionnaires covering institutional expenditure, central expenditure on research, departmental expenditure on various items including research, sources of departmental income and measures relating to the output of departmental research. He achieved a good response rate: 85% from universities and 40% from polytechnics.

The Clayton study was both more and less ambitious than our own. With responses from 225 university cost centres, he was able to calculate averages and standard deviations for various parameters. His data on outputs allowed him to calculate, for example, average expenditure per published paper. However, the scale of the study was achieved at the cost of detail. Expenditure data were collected at a relatively high level of aggregation: for example, central recurrent expenditure was divided into just five categories. Moreover, Clayton did not attempt to develop detailed methods for separating research from teaching expenditure. Arguing that the study was aimed at developing methodology, he provided some guidelines but generally invited respondents to devise their own approaches.

The Clayton study was criticized for several reasons. The lack of a detailed methodology for separating research from teaching meant that many of his respondents resorted to guesswork, and some emphasized the unreliability of their replies. The lack of clear definitions of key terms such as 'research staff' caused problems. The use of 'pro-rating' techniques at relatively high levels of aggregation begged a number of issues, particularly in respect of the allocation of academic staff time. Clayton's data refer to 1983/84, but most respondents replied during the winter of 1985/86 by which time they had difficulty in tracing how particular items had been divided between research and teaching.

It should be said that Clayton was open about such problems and discussed them frankly in his report. He argued that the consistency of his results justified his general approach. However, given the range of activities to be found in any particular cost centre across different institutions, it is not obvious what degree of variation in expenditure structure one might expect to find even if one had perfect data from each institution.

Form 3

Extensive data on the income and expenditure of each university are collected annually by the University Grants Committee (UGC—now the Universities Funding Council); some are published by the Universities Statistical Record as volume III of *University Statistics*. The data are valuable for many purposes, and have the advantage of allowing one to track trends over time. However, the data are not close enough to the requirements of our investigation to enable us to use them instead of collecting our own.

Financial data are collected by the UGC via a document known as 'Form 3'. Form 3 is continually being developed to meet the changing needs of the UGC. For the year 1986/87, it comprised a set of seven tables, summarized below:

Table 1: General income (e.g. UGC allocations) and specific income (e.g. research grants and contracts), aggregated for the university as a whole

Table 2: Expenditure, at the level of each of the 39 disciplinary costs centres plus 6 academic services, analysed by salaries and wages costs for various categories of staff and by non-pay expenditure

Table 3: Specific income by source, and related expenditure by pay/non-pay, at cost centre level

Table 4: Catering and residence accounts, at university level

Table 5: Balances, provisions and reserves, at university level

Table 6: Maintenance of premises and capital spend met from income, at university level

Table 7: Equipment and furniture income and expenditure, at cost centre level

From 1987/88, additional tables sought data on fee income for vocational short courses, income from European research grants and contracts and payments to medical authorities for premises used.

Table 1 in Form 3 is similar to the income section of the questionnaire we sent to universities (see Annex A, heads 1–21), except that it omits capital income. Table 2, however, is less useful for our purposes. Our analysis was carried out at departmental level, which is often different from the cost centres used by the UGC. The categories used in table 2 for analysis of pay expenditure are similar to our own (heads 22—33), but neither in table 2 nor in table 3 is non-pay expenditure broken down (cf heads 34—54 of our questionnaire). Table 2 also omits departmental capital expenditure (cf heads 55—58 of our questionnaire). But the most serious difficulty, from our point of view, is that in table 2, as indeed throughout Form 3, there is no attempt to separate expenditure on research from expenditure on teaching. Form 3 was a helpful reference point for the design of our own questionnaire (and we tried to use comparable categories wherever possible), but it was not possible to use Form 3 data in lieu of our own.

Diary exercise

The 'enquiry into the use of academic staff time' was undertaken during 1969/70 and published by the CVCP in 1972. For one week at each of three different times in the year, 8000 UGC-funded academic staff kept a record of how each half hour of each day was spent. Overall, it

was found that 42% of working time went on teaching, 30% on research and 29% on 'unallocable internal time' and 'external professional time'. This is the origin of the assumption, still current, that 30% of staff time—and therefore of staff pay costs—should be ascribed to research. If the unallocable 29% is distributed *pro rata* between teaching and research, then teaching accounts for 58% of total time and research for 42%. There were some differences between disciplines: within the seven science and engineering categories, the highest teaching : research ratio was found in 'engineering' (61 : 39), and the lowest was found in agriculture & forestry (48 : 52).

The survey achieved a fair response rate: 70% completed diaries for at least two of the three weeks. The methodology did, however, attract criticism. Some respondents pointed out that the sample weeks were not typical of their normal activities. More significant was the absence of a category for administrative duties—these were subsumed under teaching, research or unallocable internal time. An exact repeat of the survey now would therefore not show whether, as is often stated, there has been an increase in the amount of time that academic staff spend on administration at the expense of teaching and/or research.

It was expected that the diary exercise would be repeated at five-year intervals, but no repeat has been carried out—because of methodological difficulties and, perhaps, because of the abandonment of quinquennial planning in the mid 1970s.

Hanham Report

In 1988 the CVCP published the Hanham report, *The costing of research and projects in universities*. This followed an interim report issued the previous year. The aim of these two reports was to establish agreed principles that universities should apply when estimating research costs; the interim report also presented some data on what research costs might actually be.

The Hanham report emphasised the importance of knowing the full costs of research projects, as a prerequisite for establishing a proper pricing policy. The price charged for a piece of research might well differ from the actual expenditure on that piece of research; but it should do so as a deliberate matter of policy, which would not be possible if the expenditure were not known to a reasonable degree of accuracy. The practice, dating from 1970, of charging indirect costs as 40% of total direct costs was said by Hanham to be inadequate either as a means of calculating full costs or as a charging policy. Moreover, in 1985/86 the actual recovery of indirect costs on contracts from outside the dual support system averaged just 10%, resulting in a shortfall of over £40M against the 40% target—i.e. a 'subsidy' of this amount from university general funds to external bodies.

In line with general industrial practice, Hanham recommended that the indirect costs of a project be related to the payroll costs of all research and support staff directly engaged on the project. The total costs of a project would then be direct payroll costs, plus a certain percentage for indirect costs, plus other direct costs such as travel, consumables and equipment purchased specially for the project. The interim report suggested that that percentage would be in the range 100%—150% of direct payroll costs; it would vary not only between institutions but also between capital-intensive and manpower-intensive projects. The final

report suggested that indirect costs were likely to be 75%—150% of direct payroll costs.

On pricing, Hanham recognised the need for sufficient flexibility to account for the nature of any given project. Short-term contract research should be charged at full cost, or higher if the university was in a strong bargaining position (e.g. through having unique expertise); it could be charged at less than full cost if the university secured a compensating right to the ensuing intellectual property or some comparable benefit. Projects of a more long-term or basic nature, where the university had greater influence over setting the objectives and timescale of the research, might be charged at less than full cost: the university might deliberately decide that the research was a legitimate object for its own funds. Full-cost pricing carried with it tougher obligations as to delivering results to time and to budget.

Sophistication factor

It is often suggested that the costs of remaining at the forefront of experimental research increase faster than the general rate of inflation. This arises in part from the escalating sophistication of the experimental equipment and techniques needed to compete at the world level—the so-called 'sophistication factor'. Substantive attempts to measure the sophistication factor are relatively rare, not least owing to the difficulty of ensuring that one is comparing like with like over intervals of several years. At one stage, we considered trying to make a quantitative investigation of the sophistication factor, but were dissuaded by the conceptual and methodological difficulties. One attempt to measure it was, however, published by the Council for Scientific Policy in 1967 as *The sophistication factor in science expenditure* (CSP Science Policy Studies No 1).

The study examined the budgets of thirteen government research institutes and three university departments over the period 1955—1965, and focused particularly on the costs of pay, buildings and equipment. Growth rates of 7%—20% above the general rate of inflation were reported for expenditure on equipment per researcher; this was to some extent balanced by lower growth rates in other parts of the budget.

Equipment costs

The Council for Scientific Policy returned to the issue of equipment costs in a report published in 1972, *An analysis of equipment costs in university science and engineering departments* (CSP Science Policy Studies No 5). This report was based on analysis of 69 departments in 14 universities over the period 1957—1968, and covered 13 science and engineering disciplines. Overall, a mean annual growth rate in the cost per scientist of teaching and research equipment of 8%—11% in real terms was reported. It was pointed out this result could reflect not only increasing sophistication per se but also management decisions on the deployment of resources and moves by some departments into new areas of research where initial unit costs were high. Indeed, equipment costs per scientist were determined as much by the amounts of money made available for research as by the inherent demands of the advance of scientific knowledge.

Canadian study

The Canadian Association of University Business Officers published in 1982 an empirical report *On the costs of university research*. This was based on data from 14 universities on expenditures in four groups of

disciplines—education, humanities & social sciences, business & law and physical & applied sciences (health sciences were excluded). The objectives of the study were to establish a methodology for analysing costs and to examine the ratio of indirect to direct costs of research.

The study was conducted at a fairly high level of aggregation. It drew on a previous 'empirical faculty activity analysis' to apportion costs such as faculty time between the three functions of teaching, research and 'community and professional service' (for all disciplines combined, faculty time was apportioned as 69 : 26 : 5 respectively). It argued that indirect costs could most usefully be specified in relation to direct payroll costs rather than total direct costs.

For research in the discipline group physical & applied sciences, the study found that indirect recurrent costs averaged 69% of direct payroll costs. Across all disciplines, capital expenditure averaged a further 36% of direct payroll costs. This gave a total of 105% as the proportion of indirect costs to direct payroll costs in physical & applied sciences. In the other discipline groups, the ratio ranged from 99% to 106%.

NSF study

A report published in 1987 by the National Science Foundation, *Future costs of research,* presented some aggregated data on likely trends in the financial requirements of research. It concluded that the USA 'will have to more than double its annual expenditures on academic R&D merely to maintain its base level'. A substantial part of this figure arose from inflation: in constant dollar terms, a person-year of senior academic R&D effort was estimated to increase from $155K in 1986 to $180K—$205K in 1996. Expenditure on equipment, facilities and overheads, all of which had been growing in real terms, were expected to continue growing though more slowly, while increasing competition for the services of the decreasing numbers of skilled scientists and engineers was expected to drive up pay costs.

CHAPTER 2: METHODOLOGY

(i) Design of the study

Scope

This study analyses the structure of research expenditure in four disciplines and three sectors. The disciplines were biochemistry/pharmacology, chemistry, electrical engineering & electronics and plant science, chosen to represent a diverse set of operational requirements. The three sectors we covered were industry, Research Council and similar institutes, and academe.

Case studies

In view of the complexity of the data required, we decided to adopt a case study approach. We invited 53 research centres to participate in the study, and 42 initially agreed to do so. The distribution of these 42 within the discipline/sector matrix is shown below.

Figure 1. Initial participants in case studies

	Biochemistry/ pharmacology	Chemistry	Electrical engineering & electronics	Plant science
Industry	3	5	4	2
Research institutes	4	–	2	3
Universities	3	4	4	3
Polytechnics	–	2	3	–

In the event, only 30 centres were able to provide useful data, though in one or two cases the data were incomplete. The final sample gave us up to four data sets in each cell of the discipline by sector matrix. We had no examples of research institutes in chemistry (none were sought) or of industrial research centres in plant science. We had only a single representative of university chemistry, and only two polytechnic respondents (both in chemistry).

Two criteria were used to select the research centres. One was that they should be recognized as among the stronger centres in their disciplines in the UK. This added a degree of coherence to the sample and ensured that our results would be of interest to those concerned with examining 'best practice' in the management of research. The second criterion was that they should be large enough to have discrete financial records and the administrative capacity to analyse them for us.

All the research centres included in the study were located in the UK. Although international comparisons would have been interesting, we thought it preferable to establish the methodology at the purely national level first.

Pragmatism

An investigation of this sort must be approached pragmatically. For example, in devising methods of separating teaching from research expenditure in universities, we had to be sensitive both to the limits of what was meaningful (in view of the sometimes close relation between the two) and to the administrative burden that our respondents might be willing and able to shoulder; but, because the separation was

carried out at the greatest feasible level of disaggregation, by methods appropriate to each individual category of expenditure, we believe the overall result is likely to be reasonably accurate.

Again, we did not attempt to develop precise definitions of the disciplines we covered: since administrative exigencies required that we operate at the level of, for example, a university department, we simply defined disciplines as co-terminous with the departments named after them.

Our necessarily small sample precludes sophisticated statistical analysis of the data. Our results must therefore be regarded as indicative of the characteristics of each discipline/sector rather than as establishing definitive norms.

(ii) General methodology

The study started, at the beginning of 1987, with a literature survey and discussions with research managers and finance officers. This enabled us to identify the components of research expenditure and to gauge what data might reasonably be expected to be available. We developed questionnaires accordingly and tested them with those whom we had consulted.

Once institutions had agreed in principle to participate in the study, we held extended discussions with the individuals who would be responsible for completing the questionnaires, to clarify what was being requested and to ensure that the questionnaires would be suited to the circumstances of each institution. Further meetings were held with respondents after they had received the questionnaires; sometimes additional consultations proved necessary to clarify particular aspects of the completed returns.

The reference year for the study was the financial year 1986/87. The questionnaires, together with the detailed guidelines, were sent out as soon as possible after the year end: the mailing was completed by the end of summer 1987. In not a few cases, respondents proved to have greater difficulty in producing the data than they had originally anticipated. Delays therefore occurred at this stage. Considerable effort was required both in liaising with respondents and in verifying the internal consistency of the completed questionnaires. It was early summer 1988 before we were able to begin analysing the aggregate data; further unavoidable delays occurred before the project could be brought to completion.

(iii) The questionnaire

Content

Two questionnaires were developed, one for the university sector and one for industry, research institutes and polytechnics. The university questionnaire had 117 main headings divided into three sections:

(a) Total income
- general recurrent income
- specific recurrent income
- capital income

(b) Departmental expenditure
- salaries and wages
- non-pay recurrent expenditure (facilities, materials, travel, buildings, other)
- capital expenditure

(c) Central expenditure

The second questionnaire was similar, but omitted central expenditure. Details of both questionnaires are given in Annex A. All respondents agreed that the questionnaires covered all relevant forms of expenditure.

Many of the headings in the questionnaires were divided into fine detail. Respondents sometimes proved unable to supply data at that level of detail, though the main headings were usually completed. The analysis in chapter 3 is therefore confined to the main headings. However, by including the fine detail in the questionnaire we ensured that respondents took account of all relevant factors when assessing total expenditure under any given heading.

Definitions

For ease of reference, definitions of some of the key terms in the questionnaire are given below. Further definitions are given in Annex C.

Researcher

In the university sector, 'researcher' meant both UGC-funded and other staff on academic or related scales; *but in this study postgraduate research assistants (PGRAs) were treated as technical support staff rather than researchers.* In the other sectors, corresponding definitions were used.

The reason for not classifying PGRAs as researchers is that many of them are, in practice, research students registered for higher degrees; as such they are formally regarded as undergoing research training. They do, however, provide valuable support to the research staff, and therefore may properly be included as support staff. On the other hand, *postgraduate students in receipt of grants are neither support staff nor researchers in the sense used here,* and their grants (unlike PGRAs' salaries) do not form part of the department's income or expenditure; we have therefore omitted them from all staff categories. This may distort our analysis of resources per member of staff in departments that have atypical concentrations of research students.

Senior administrative staff within research centres (but not those working in central university administrations) were included as 'researchers'. Such staff were often involved closely in research work.

In the university sector, the number of researchers was given in terms of full-time equivalents (FTE). Academic and academic-related staff paid from general university funds were counted in proportion to time spent on research: for example, ten staff spending on average half their time on research would count as five FTE researchers. We made the simplifying assumption that academic staff paid from other sources would generally devote all their time to research, though of course they do also take part to a certain extent in other departmental activities. In the industrial and research institute sectors, research staff were assumed to devote all their time to research; *in practice, this probably overestimates the effective numbers of researchers in those sectors.*

Support staff — Technicians, scientific officers, experimental officers, secretaries, clerical staff etc and, in the university sector, postgraduate research assistants.

Salaries and wages — Includes full costs, i.e. employer's contributions to National Insurance, pensions etc.

Materials — Includes all recurrent or revenue expenditure on equipment, clothing and other consumables, provided it was not capitalized.

Capital — Covers major and minor building works, equipment, furniture and computers. Academic respondents were not able to provide data on depreciation, *so capital expenditure in all sectors was assessed in terms of actual expenditure during the year.*

Indirect expenditure — All expenditure on research except the salary costs of those categories of departmental staff directly involved in research (i.e. researchers and support staff).

(iv) Allocation of academic expenditure between teaching and research

Research institutes and industrial research groups were assumed to be concerned solely with research, and all expenditure incurred by them was regarded as expenditure on research. Universities, however, have two functions, so it was necessary to devise ways of separating their expenditure into teaching on the one hand and research on the other. Moreover, in universities research expenditure is incurred both by the departments and, indirectly, by the central administration, so central expenditure had to be taken into account in calculating the total cost of departmental research. Our approach to dividing departmental expenditure between teaching and research is described below. Central expenditure is dealt with in Annex B.

Salary costs — Respondents were asked to apportion staff time between teaching and research. Two methods were suggested. One was that the assigning should be done by the head of department and the departmental administrator, and then passed to the staff concerned for comment. The other was that individual members of staff should be asked to identify the tasks they undertook during the year, categorize them as teaching or research, note the number of hours spent on each task and aggregate the results. Individual salary costs were then apportioned pro rata. Total staff numbers, split between teaching and research, were then calculated to the nearest tenth of a unit.

Departmental non-pay expenditure — Unless particular items of expenditure had been incurred specifically for teaching or for research, all facilities and equipment bought solely for the use of undergraduates and postgraduates on taught courses (with the exception of final year undergraduate project equipment) were allocated to teaching, along with any expenditure on teaching aids. All other expenditure was allocated to research. If there was insufficient information available to use this allocation procedure, participants were asked to estimate the amount on teaching and research as accurately as possible, and provide details of how the estimate was derived.

Buildings and premises expenditure

For buildings and premises expenditure incurred by departments, participants were asked to provide a teaching/research split on the basis of floorspace assigned to one or other function.

For both departmental and central expenditure, the approach to separating the teaching and research elements was, inevitably, approximate. In balancing the need for accuracy against the demands we were placing on respondents, we had to rely on pro-rating techniques as well as direct measurement. The method we used was developed in close consultation with university finance officers and other relevant experts. Respondents commented that our approach was 'acceptable', 'better than leaving it up to each university to design its own'. To seek absolute accuracy in these measurements under existing financial arrangements is futile: the aim must be to obtain sufficient accuracy to serve the policy purposes for which the data are collected. We believe that our approach met this latter criterion.

CHAPTER 3: RESULTS

(i) Introduction

Coverage

This chapter presents the core of our quantitative results, grouped together into sections on general income and expenditure, pay expenditure and nonpay expenditure. All data in this chapter refer to research only; other activities such as teaching have been excluded from the calculations.

Our results cover only certain disciplines within science and engineering. How far one can extrapolate from these results to the whole of science and engineering is open to discussion. It would certainly be unwise to extrapolate to social sciences and humanities, with their very different demands for expenditure on nonpay items. Where we refer to average results for the university sector, for example, we mean of course in relation only to the disciplines under discussion; and it may be that in some respects our sample is not representative even of the particular disciplines concerned.

In the figures, cells containing only one respondent are identified as such; other cells have 2 – 4 respondents. With a single respondent it is, of course impossible to know how typical a particular result might be. There were no respondents in the industry/plant science or research institute/chemistry cells. The number of respondents per cell occasionally varies from one parameter to another: respondents were not always able to provide usable data for each section of the questionnaire.

Presentation

The data are presented as ranges showing the maximum and minimum values for each parameter. The text sometimes discusses average values (i.e. total for all respondents of a particular type, divided by the number of responses), but for the most part we have restricted ourselves to describing the broad ranges found for each cell of the discipline/sector matrix. More rigorous statistical analysis would not be appropriate, because of the variable precision of the data we received and because of the small number of respondents in each cell of the matrix. It is not clear how typical our respondents are: they were selected because of their strong research reputation rather than as a representative sample from which one might extrapolate to the whole of the UK. Within the relatively homogenous university sector, our results should be of value in identifying typical ranges for certain parameters; in the other sectors, the concept of 'typical' is less useful.

All results have been normalized, according to total expenditure, total recurrent expenditure or the number of researchers as appropriate.

NOTE ON PRESENTATION OF RESULTS. Data have been presented mostly in the form of horizontal bar charts (from figure 2 onwards). In these charts, the shaded bars indicate the range of results obtained, with maximum and minimum values as marked. Each bar represents up to four results. When only one usable result was obtained, a single value is shown.

Polytechnics

We had hoped to include polytechnics in the study, on a comparable footing to universities. In the event, we obtained usable data from only two polytechnic departments. In both cases, however, the respondents reported that no academic staff time could be apportioned to research: all research was carried out by postgraduate or postdoctoral staff. While this may be formally correct, since polytechnics are funded essentially as teaching institutions, it probably does not accurately represent departmental experience. It also makes it difficult meaningfully to compare the polytechnic data with data from the other respondents. A major review of polytechnic research now being carried out by the Polytechnics and Colleges Funding Council is likely to provide a much more complete picture of polytechnic research. In order to avoid misleading comparisons, we have therefore presented our polytechnic data separately from our other data; see Annex D.

(ii) Income and expenditure: general

Income

The data we received on income (heads 1–21 of the university questionnaire, heads 1–7 for other respondents) were of mixed quality. Four of the industrial respondents, in otherwise complete returns, left the income section blank. Few of the university respondents could provide data on departmental income – especially on the amount allocated to the department from the UGC block grant – though data on income for the university as a whole were available. We did, however, obtain data on external income.

'External income' is income from sources other than the parent body (e.g. the relevant research council for research council institutes, the parent company for industrial research groups, the UGC for university departments). Some respondents had little or no external income, mainly as a matter of policy. The research institutes in plant science secured significant external funding: 12% – 22% of their total income. The highest proportion, however, occurred in electrical engineering and electronics; the industrial respondents in this field derived 21% – 51% of their total income from external sources, and one research institute derived 77%. The Alvey programme accounted for part of these sums, but overseas sources also contributed significantly to external income.

Figure 2 shows the ranges in each discipline/sector of external income per researcher. This, again, shows the relatively high external income in electrical engineering & electronics and in university departments of plant science.

Total expenditure

Our 30 respondents varied considerably in size. In the university sector, total expenditure per respondent ranged from £0.7M to £2.5M; in the research institute sector it ranged from £1M to £130M; and in industry it ranged from £3M to £130M. The university respondents had a combined total expenditure of £12M; for research institutes this figure was £210M; and for industrial respondents it was £280M.

In the academic sector, the highest *per capita* expenditure in our sample is found in electrical engineering and electronics (at an average of £90K per researcher), with plant science in second position at £50K and biochemistry/pharmacology and chemistry at a little over £40K (figure 3). Electrical engineering and electronics would appear also to be the

Figure 2. External income per researcher (£K)

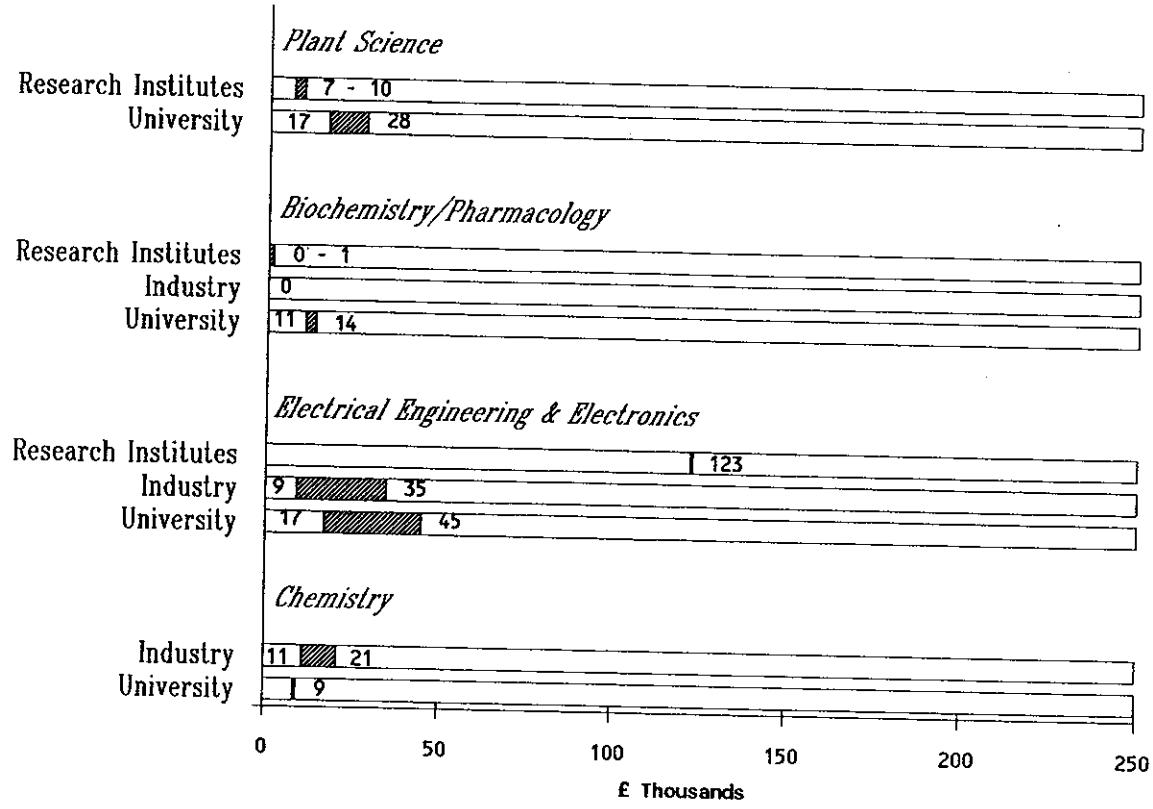

Figure 3. Total expenditure per researcher (£K)