

THE MIGRATION OF SCIENTISTS AND ENGINEERS TO AND FROM THE UK

A report on a study by the Science and Engineering Policy Studies Unit
of the Royal Society and the Fellowship of Engineering

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Foreword

For some years there has been an increasing concern that among factors adversely affecting science, technology and engineering in the UK is a growing loss of talent abroad - the so-called 'brain drain'. In order to secure both a sounder basis of data on this subject and an in-depth review of the perceptions of the scientific community, the Science and Engineering Policy Studies Unit of the Royal Society and the Fellowship of Engineering has undertaken a study of the inward and outward flows of scientists and engineers to and from the UK. Necessarily, to achieve depth, the scope of the study had to be limited, and it was restricted to those working in Biochemistry, Chemistry, Earth Sciences, Electronic Engineering and Physics, who left or came to the UK between 1975 and 1985.

This report describes the results of that study. It is based largely on a questionnaire survey of university departments, research groups and industrial, governmental and research council establishments. The report has been endorsed by the Councils of the Royal Society and the Fellowship of Engineering.

The numerical scale of migrants identified here would not generally be considered large in comparison with the overall size of the groups that migrants left or joined. But, as the survey revealed, the significance of migration, inward or outward, lies not only in counting heads but also in the intellectual capacity of the migrants, their collective and individual experience and the period of time they spend in any one institute or country. The majority of those leaving the UK did so for long-term posts abroad; most foreign scientists and engineers coming to Britain from overseas came for relatively short periods. The assessment of losses and gains in terms of the health of UK research must inevitably combine factual analysis with a more subjective judgement of the impact of individual movements.

Thus, although almost as many 'experienced' scientists and engineers entered the UK as left, our data provide no grounds for complacency. We found that, over the ten year period of our study, many 'recent PhDs' left the UK without having taken up employment in this country. A greater proportion of these young people emigrate permanently, or for long periods, than was the case 25 years ago. The number of Fellows of the Royal Society resident in the USA at the time of their election has risen progressively over the past two decades, illustrating that an increasing proportion of our most talented scientists have been among those who have left the UK.

The report is published in the hope that it will contribute to a sounder framework against which to judge the capacity of the research system in the UK to continue to meet the needs of the nation in its wealth-creating activities.

Sir David Smith, Sec.R.S.
Chairman, SEPSU Steering Group

May 1987

Summary

This report describes a study of the migration of scientists and engineers to and from the UK which was carried out by the Science and Engineering Policy Studies Unit of the Royal Society and the Fellowship of Engineering. It was initiated in the summer of 1985, when there was renewed concern that increasing numbers of experienced scientists and engineers were leaving the UK to work abroad. The study aimed to collect quantitative evidence about such emigration and the extent of any similar flow of foreign scientists and engineers to the UK. It became increasingly evident during the study that a proper assessment of the impact of migration depended as much on the quality of migrants as on their number, although quality is clearly more difficult to measure.

Section I describes the background to the study and its design. Five broad fields of science and engineering were selected - Biochemistry, Chemistry, Earth Sciences, Electronic Engineering and Physics. These were chosen, not because they were thought to be particularly affected by migration, but rather because they covered a broad spectrum of scientists and engineers, both in newer disciplines and in well established ones. The emphasis was on science subjects, so the results may not be typical of all engineering disciplines. Moreover, it cannot be assumed that the results are applicable to scientific disciplines outside the study.

The main method of collecting data was a questionnaire survey of all heads of university departments in the selected disciplines and of leaders of some university research groups. Information was requested on members of departments (most engaged in normal academic teaching and research activities), and on members of research groups (most engaged primarily in research), who had left or entered the UK during the period 1975-85. The questionnaires asked for details about the migration of young research workers (postgraduate and postdoctoral) as well as about more senior staff. Similar questionnaires were sent to appropriate industrial, Government and Research Council establishments. Respondents were asked to give the names of migrants to eliminate double-counting and to increase accuracy by ensuring that the data referred to specific individuals, rather than to vague, and possibly misleading, impressions of the numbers involved.

Almost 750 questionnaires were sent out and 568 (77%) were completed and returned; the response from industry, Government research establishments and Research Council institutes was not as good as that from universities (83%). 82 industrial, Government and Research Council establishments, 301 university research groups and 185 university departments responded (not including heads of departments of Earth Science, who were included in a separate survey by the Institution of Geologists).

Section II presents the main results of the survey. The completed questionnaires named 617 'experienced' British scientists and engineers, and a further 314 British postgraduates, almost all 'recent PhDs', who had left the UK during the years 1975-85. Respondents also named 685 scientists and engineers who had entered the UK from abroad; of these, 183 were British who returned to the UK from overseas, and of the 502 foreigners, about 130 were 'recent PhDs' or equivalent, including 15 who stayed to work in this country after completing postgraduate studies here. Information was not sought on foreign students who came to this country to study for higher degrees and left immediately on completing their courses.

Both emigration from the UK, and to a lesser extent immigration to the UK, increased slightly during the period from 1975 to 1985. However, the number of scientists and engineers who migrated each year would not generally be considered large in comparison with the size of the groups or establishments they left or joined. For postdoctoral research assistants and more senior members of university research groups, the emigration rate averaged about 2% annually; it was much lower for staff (generally more senior) from university departments and from industry, Government and Research Council establishments (0.5% annually, or less). The emigration rate for British 'recent PhDs' from university research groups, although difficult to measure with accuracy, appears to be rather higher. The immigration rate to university research groups (excluding those coming to study for higher degrees) was 2.9% per year, while rates to university departments and the non-university sectors were all less than 0.4% per year. In assessing impact, direct comparisons of emigration and immigration rates would be misleading; other factors such as staff experience and seniority are important, and these are in turn affected by the size of a research group and other inflows and outflows.

Almost three-quarters of those emigrating from universities in the UK previously held short-term posts or equivalent, most in research groups; about one quarter left long-term posts (more than three years), the majority in university departments. Most of those emigrating from industry or from Government and Research Council establishments left long-term posts. It appears that those in long-term posts were least likely to emigrate, those in short-term posts more likely, while those not yet in employment were most likely to do so.

Most emigrants were said to have taken up long-term posts abroad. Half the 'recent PhDs' named as having left university research groups, and an even higher proportion of other university emigrants, were said to be in such long-term posts. This contrasts with twenty-five years ago, when a greater proportion of 'recent PhDs' who went abroad subsequently returned to the UK. The majority of emigrants from British universities went to universities and similar organizations abroad, while those from industrial, Government and Research Council establishments were more likely to be employed by industrial or commercial establishments overseas.

In contrast to emigrants, the great majority of foreign immigrant scientists and engineers came to work in the UK for periods of less than three years and then returned home or moved to other countries. Those foreign immigrants who took up long-term posts in the UK were only a quarter of the number of British emigrants (excluding 'recent PhDs') who went to such posts overseas. However, most British scientists and engineers who returned to the UK took up long-term posts. Few foreign postgraduates remained to work in the UK after obtaining higher degrees.

Most of the immigrants who came to work in universities and Government and Research Council establishments had left university posts overseas or had come directly from studying abroad.

Almost 90% of all those who left the UK during 1975-85 went to North America, Western Europe or Australia, with the majority (about 60%) going to North America, as in previous years. The largest group of immigrants were British returning from abroad. The nationalities of foreign immigrants were fairly evenly distributed: the largest group was from Western Europe.

The reasons most commonly given for emigration were career opportunities abroad and career limitations in the UK, followed by higher rates of pay (particularly by respondents from university departments) and better research facilities abroad. Foreign immigrants to the UK were thought to be attracted largely by a desire to widen their experience. British scientists and engineers returning to the UK were generally said to have done so for personal and family reasons.

There were some differences between disciplines in rates of emigration and immigration. However, where comparisons were possible of other characteristics of migration, we did not find major variations between disciplines.

In addition to these factual conclusions from the questionnaire data, an attempt was made to assess the quality of migrants and the effects of migration on UK research.

Assessing quality is difficult; inevitably, we had to rely on respondents' own assessment of the ability of those leaving or joining their groups or establishments. Generally, both emigrants and immigrants were considered to include many talented scientists and engineers, but because foreigners working for only short periods in the UK could not fully replace those British scientists and engineers who had left for permanent posts abroad, the resulting net loss of talent was regarded as having an adverse effect on British research, particularly in universities. We found evidence to support this view; this included the high level of qualifications of most emigrants, the small, but significant, number who had previously held senior posts in comparison with the much smaller number of foreign scientists and engineers who took up such posts, and the increasing number of Royal Society Fellows, born in the UK, who choose to live and work outside the UK.

Section III reports respondents' views on migration and their suggestions for ways to alleviate the problems caused by emigration from the UK. University respondents stressed how difficult it was to replace both junior and senior researchers who emigrated, and the majority were also concerned about the increasing movement of talented graduates and new PhDs out of science to more financially rewarding employment in this country. Attracting either British or foreign students for postgraduate or postdoctoral research was becoming more difficult. Industrial respondents were less concerned about the effects of emigration, although these may be different in disciplines not covered by this study.

There was widespread concern among respondents from universities and Government and Research Council establishments that emigration would increase in future as other industrialized countries offered greater incentives and opportunities to scientists and engineers, in contrast to the current climate of decreased 'real' spending on civil research in the UK. Among suggestions made to counter what was seen as a significant loss of talented researchers abroad were increased long-term funding for research, a better career structure for university research staff, the revival of schemes to attract past emigrants back to the UK, and an increased number of longer-term, though not necessarily tenured, posts in universities. It was felt these would encourage more young scientists and engineers, both British and foreign, to regard a research career in UK universities as a desirable alternative to employment abroad, or in the UK in industry or outside science. There is some indication that the 'new blood' schemes reduced emigration rates in 1983 and 1984.

Section IV summarizes other information on migration. A quantitative analysis is given of data collected centrally by the Universities' Statistical Record on the numbers and destinations of academic staff leaving UK universities. Statistics collated by the National Science Foundation in the USA on the rate at which scientists and engineers from the UK gain permanent immigrant status are also examined. Some qualitative evidence about emigrants is given by an analysis of the geographical distribution of Fellows of the Royal Society (excluding Foreign Members). Of the total Fellowship, the proportion living in the USA rose from less than 3% in 1960 to about 8% in 1986; the proportion living in the USA at the time of their election rose from almost 4% in 1960-62 to more than 13% in 1984-86.

Section V is a summary of the main findings of the questionnaire survey and related information from other sources.

Section VI discusses these findings and the views expressed by respondents, and considers them in the broader context of the international movement of scientists and engineers.

Section VII contains tables and figures giving details of the results described in section II.

In summary, the study indicated that migration in the disciplines and sectors considered was not numerically large during the decade 1975-85. However, differences in the length of stay and nature of work of British scientists and engineers who left the UK, in comparison with those of foreigners who came to this country, mean that simple counting of heads underestimates the net effect. Moreover, respondents to the questionnaire were concerned about the quality of those leaving and difficulties in replacing them adequately. It was therefore generally believed that the impact of emigration, particularly for universities, was much greater than the numbers involved might suggest.

The evidence we collected about the quality of migrants was necessarily less rigorous than information about their numbers and characteristics. However, when allied with respondents' views on migration, it suggested that the net outflow of talented scientists and engineers, both young researchers and established leaders, was having significant adverse effects on British research.

Within any sector of employment, losses overseas can be made up by new entrants, by lateral movement or by replacements from overseas. The losses through emigration reported in this study will have been offset to some extent, and may be sustainable. However, there must be some cause for concern about the continuing loss of young, qualified and trained scientists and engineers who are not yet in permanent employment in this country and who represent a considerable investment of national resources.

The disciplines that we surveyed are central to scientific research but may not be typical. Different migration patterns might be found in other disciplines, especially those that are relatively new and developing rapidly. Our data on engineers represent too small a sample to allow extrapolation to all engineering. There are also difficulties in extending our data on the four science disciplines studied to obtain migration rates for all science, partly because of uncertainty about what proportion of the total relevant scientific population was covered by our survey.

Short-term emigration from the UK can valuably broaden an individual's experience, but the permanent emigration of significant numbers of well qualified and experienced scientists and engineers was widely regarded as a matter for serious concern, particularly among the university community and in Government and Research Council establishments. It was considered by many respondents as one more symptom of a decline in the health of UK science and engineering, and within the context of a perceived worldwide shortage of qualified professionals, as an additional pressure on an already overstressed system.

Contents

	<u>Page</u>
Foreword	iii
Summary	v
List of Tables	xi
List of Figures	xii
I Background and study design	1
Background	
Previous Studies	
Management, resources and scope of study	
Study design	
Questionnaire sample and response	
II Questionnaire analysis	8
Number of migrants named by respondents	
Population represented by respondents	
Rates of migration	
Quality of migrants	
Effects of migration on British research	
Ease of replacement of emigrants	
Reasons for migration	
Destination of emigrants	
Nationality of immigrants	
Nature of overseas posts of emigrants	
Nature of employment of immigrants	
UK posts left by emigrants	
Qualifications of migrants	
Age of migrants	
Year of migration	
Seniority of migrants	
Employment opportunities for new PhDs	
III Respondents' views	21
Concern about emigration	
Emigration in future	
Possible actions	
IV Other information on migration	27
Royal Society Fellows living overseas	
USR statistics	
NSF data	
V Main findings and related information	34
VI Discussion	40
VII Tables and figures for section II	44
Appendices:	
A Questionnaires	69
B References	75

List of Tables

		<u>Page</u>
Table 1.1	Questionnaire response	7
Table 2.1A & B	Reported migration by category of respondent	44
Table 2.2A	Rate of migration by category of respondent	45
Table 2.2B	Rate of migration by discipline and category of respondent	46
Table 2.3A	Effect of emigration from the UK on British research by category of respondent	47
Table 2.3B	Effect of migration from the UK on British research: university respondents by discipline	47
Table 2.4	Replacement of emigrants from the UK by category of respondent	48
Table 2.5A	Reasons why emigrants left the UK by category of respondent	49
Table 2.5B	Reasons why non-British staff came to UK by category of respondent	50
Table 2.5C	Reasons why British staff returned to UK by category of respondent	51
Table 2.6A	Destination of emigrants from UK by category of respondent	52
Table 2.6B	Destination of emigrants from UK by discipline	53
Table 2.6C	Nationality of immigrant S&E to UK by category of respondent	54
Table 2.7	Nature of overseas employment of emigrants from UK by category of respondent	55
Table 2.8A	Length of overseas post of emigrants from UK by category of respondent	56
Table 2.8B	Length of overseas post of emigrants from UK by discipline	56
Table 2.9A	Number of emigrants who have returned to UK by category of respondent	57
Table 2.9B	Number of emigrants who have returned to UK by discipline	57
Table 2.10	Length of UK post held by immigrants to UK by category of respondent	58

Table 2.11	Number of immigrants to UK who subsequently left UK by category of respondent	59
Table 2.12	Nature of previous overseas employment of immigrants to UK by category of respondent	60
Table 2.13A	Nature of UK post left by emigrants from UK by category of respondent	61
Table 2.13B	Nature of UK post left by emigrants from UK by discipline	61
Table 2.14	Seniority/Grade of emigrants from UK by category of respondent	66
Table 2.15	Seniority/Grade of immigrants to UK by category of respondent	67
Table 2.16	Employment opportunities in research in the UK for new PhDs by discipline	68
Table 4.1	Graduate scientists and engineers given permanent immigrant status in the USA by year of gaining permanent status and country or region of birth	32

List of Figures

Figure 2.1	Age of emigrants from UK by category of respondent	62
Figure 2.2	Age of immigrants to UK by category of respondent	63
Figure 2.3	Year of emigration from UK by category of respondent	64
Figure 2.4	Year of immigration to the UK by category of respondent	65
Figure 4.1	Proportion of Royal Society Fellowship living outside the UK, 1960-86 (excluding Foreign Members)	31
Figure 4.2	Proportion of Royal Society Fellowship living outside the UK at the time of election, 1960-86 (excluding Foreign Members)	31

I Background and Study Design

Background

The migration of scientists and engineers to and from the UK was chosen for investigation by the Science and Engineering Policy Studies Unit (then the Policy Studies Unit (PSU)) because it was widely believed that growing numbers of skilled and experienced scientists and engineers were leaving the UK to work abroad permanently. The study set out to discover whether this impression was accurate. It is also set out to find whether there was a corresponding inflow of scientists and engineers to the UK from other countries, and the extent to which this balanced the outflow in quality and quantity.

Concern about the so-called 'brain drain' of scientists and engineers from the UK, particularly to the United States of America, was much publicized in the sixties. The growth of research areas such as biotechnology and information technology, where world demand for trained specialists is said far to outstrip the current supply, has again focused attention on the number of skilled people who are leaving the UK to work abroad permanently.

Previous Studies

Two early UK studies of migration were the Royal Society study of emigration of scientists from the UK undertaken by an ad hoc committee chaired by Sir Gordon Sutherland in 1963, and the 1967 report by the Committee on Manpower Resources for Science and Technology. Numerous short articles, general papers and conference proceedings concerning the 'brain drain' have been published since these early studies, but few concentrate on specific scientific areas or provide detailed data.

The pilot study of 'The Biotechnology Brain Drain' (1983) carried out by the Institute of Manpower Studies at Sussex University for the SERC is an exception, but many other recent studies tend to concentrate on the migration of scientists from developing countries, and most studies comment on the difficulty of obtaining complete or reliable data. Some early reports have since been criticized for the suspect methods or assumptions made when collecting figures on migration. Further, an OECD paper published in the early 1970s suggested that many of those who left the UK during the fifties and sixties later returned, and concluded that much of the concern expressed then about emigration was unfounded (Young, 1973).

Few studies have attempted to investigate the pattern of immigration to the UK and much of the recent debate on the so-called 'brain drain' has focused on the outward flow of scientists from the UK, which could well lead to a one-sided view of a complex situation. It would be irresponsible to draw undue attention and create widespread alarm on the basis of such an analysis, if there were in fact a compensating inward flow both of returning British scientists and engineers and immigrants from other countries. The gain from inward migration and the consequent loss of scientists and engineers by other countries, particularly developing countries, ought not to be ignored.

In the early summer of 1985, shortly after this SEPSU study began, the ABRC conducted an enquiry into recent emigration of staff from selected university research groups. Over forty research groups were asked about the number of research staff and postgraduate students leaving them for appointments overseas during the last five years. Although the results were based on a very limited sample, the report pointed to evidence of 'a serious loss of talent'.

Management and resources

The Council of the Royal Society appointed a Task Group to oversee the present study, chaired by Professor G.K. Radda, F.R.S. The other members of the group were Professor W.J. Albery, F.R.S., Professor D.P. McKenzie, F.R.S., and Dr J.C. Walling. The Task Group reported to the SEPSU (formerly PSU) Steering Group.

The study was carried out by Jane Silverleaf, a member of SEPSU, and took the equivalent of about fifteen months during the period June 1985 to May 1987. Dr P.M.D. Collins, the Head of SEPSU, directed the study.

Scope

It was decided that the study should collect data from as wide a population as possible and thus attempt to gain a representative picture of migration in research generally, not just within the university sector.

Five broad areas of science and engineering - Biochemistry, Chemistry, Earth Sciences, Electronic Engineering and Physics - were chosen by the Steering Group for investigation. They were chosen, not because they were thought to be particularly affected by migration, but rather because they covered a broad spectrum of scientists and engineers both in newer disciplines and in well established ones.

Since there were relatively few engineers in the disciplines selected, except for Electronic Engineering, the emphasis was on science subjects. The results therefore may not be typical of engineering generally. Further, the detailed results may not be directly applicable to scientific disciplines outside the study.

We did not attempt to define the five disciplines too closely, but asked respondents to state their particular specialization and that of any migrants they named, so we could analyse our data more narrowly, if necessary.

Study Design

The first few months of the study were spent partly determining the most appropriate methods of collecting reliable data on migration, given the resources of the Unit, and partly discovering whether any data collected for other purposes could provide additional information on migration. However, central statistics, both British and foreign, are rarely detailed enough to measure the movement of scientists and engineers; there are also considerable problems of comparability, and insufficient disaggregation of the available data.

Amongst several possible approaches, we investigated the feasibility of analysing the membership of learned and professional societies to discover the number of British members now working overseas, and the number of foreign members working in the UK. Apart from problems of confidentiality, insufficient detail in records and the sheer size of such a (necessarily manual) analysis, it was decided that the membership of any professional or learned society was unlikely to reflect migration. For instance, emigrants from the UK may let their membership of UK societies lapse and join equivalent foreign societies, and many foreign scientists and engineers join British societies because of their international role, as their UK counterparts join societies abroad.

We eventually decided that a questionnaire survey would be the method most likely to collect representative and reliable data on migration. Some time was spent developing and piloting questionnaires which were to be sent to a wide variety of research organizations, seeking information about the movement of scientists and engineers into and out of the UK during the last ten years. The survey was intended to collect information about the migration of scientists and engineers, both those at the start of their careers and those who had reached a level of seniority where they might be individually head-hunted.

Questionnaire Sample

Between November 1985 and early January 1986 we sent more than 750 questionnaires to selected university research group leaders in the five disciplines chosen for study; to all heads of department in four of the five disciplines and to selected Government, Research Council and industrial research establishments and institutes.

Questionnaires to University Research Group Leaders

The questionnaires to university research groups were designed to elicit information mainly about the movement of postgraduate and postdoctoral researchers. The research group leaders were chosen from lists of holders of SERC awards between £40 000 and £100 000, from NERC award holders and from research groups named in the latest available edition of 'Research in British Universities, Polytechnics and Colleges' (RBUPC) published by the British Library. Where possible, we tried to choose at least one research group in each university for each of the five disciplines, and then added additional groups in proportion to the total number of groups listed in the appropriate discipline in the 'RBUPC'. We hoped in this way that our sample would not be biased to particular universities or locations. We also tried to choose research group leaders at different grades so that both newer and well established groups were represented.

Questionnaires to University Heads of Department

We sent a similar questionnaire to all university heads of department in four of the five subjects asking for information about the movement of more senior university staff (equivalent to assistant lecturer or above).

In both the questionnaires sent to universities, we asked respondents to supply, in confidence, the names and addresses of those who had gone to work overseas or had come from abroad. This allowed us to eliminate any duplication that the two questionnaires produced, and also provided a list of migrants that we could follow up to discover more about individual motives and experiences, if at a later date this was decided to be worthwhile. Asking respondents to name individual migrants also served as a safeguard against exaggeration.

We tried to ensure that the sample of university research group leaders and heads of department was as accurate as possible, and that the sample did not include large numbers of staff who had retired or moved to other posts since the information from which we chose their names had been prepared. We therefore checked all the names chosen against other sources and asked the appropriate professional and learned societies to supply up-to-date lists of heads of department from their central mailing lists. We are most grateful to all the societies which supplied such information and to their staff who gave advice and information during the initial stages of the study, as well as to the NERC and SERC staff who supplied current lists of award holders.

As an additional precaution, we asked the university research group leaders we identified to pass on our questionnaire if they did not consider they were the appropriate respondent for the group. The final response rate (see table 1.1) was over 80% for the university sector; we felt this justified the considerable time we spent choosing and checking the sample.

Questionnaires to Government and Industrial Research Establishments

A similar questionnaire was sent to Government and industrial research establishments which employ scientists and engineers in at least one of the disciplines studied. Industrial companies were initially chosen from a list (supplied by SERC) of companies with a substantial number of CASE studentships. We felt that such companies would have an active interest in research. However, to ensure that we included both large and small companies, this list was supplemented from other sources. The questionnaires were sent to the Director of Research, although in several cases they were passed to the personnel department for completion.

Questionnaires to Research Council Institutes

Questionnaires were also sent to the AFRC, MRC, NERC and SERC asking for information about the migration of staff working in the five disciplines in their research institutes. Two of these Research Councils asked us to contact the Research Institutes directly, and so questionnaires were sent to all Directors of their Research Institutes. The other two Research Councils said they would construct a combined reply for all Institute staff from central records, but only one was able to do so; NERC eventually wrote to say that it had been unable to extract the detailed information requested from records kept centrally or by the Institutes themselves.

Survey by the Institution of Geologists

Questionnaires were not sent to heads of departments of Earth Science since the Institution of Geologists was concurrently conducting its own survey of migration of Earth Scientists and Geologists and had decided to send questionnaires to all university heads of department in these disciplines. To avoid duplication, we therefore agreed that we would not send our own questionnaire to these heads of department or to certain industrial firms also covered by the Institution's survey, but instead exchange information collected about the migration of Earth Scientists with the Institution.

However, it was not possible to include the results of this survey directly in our report because of differences in approach and statistical difficulties in amalgamating their questionnaire data with our own. Our information about Earth Sciences was thus more limited than that for other disciplines. However, we decided to retain the information on the movement of Earth Scientists working in university research groups and in industrial and Government research establishments, since it did not show strong variations from the other disciplines.

Response

Several industrial companies wrote to say that they did not keep records of destinations when staff leave, or if they did, this information was either confidential or would require considerable effort to extract and involve staff time that they could not justify.

The Government Research Establishments to which we sent questionnaires included several Defence establishments, and most of these responded that they could not participate in the study since the information we requested was not kept or was subject to security restrictions.

However, the general response rate was good - the overall rates of reply (after reminder letters had been sent, and inappropriate replies deducted) are given in table 1.1. We are most grateful for all the detailed replies we received and for the time and effort many organizations and individuals spent providing this information.

Table 1.1

Questionnaire Response

	Research Group Leaders	University Heads of Dept	Total	Industry	Govt/ Res. Cncl	Totals
Biochemistry						
Sent	71	46	117			
Returned	64	44	108			
% response	90	96	92			
Chemistry						
Sent	97	66	163			
Returned	81	57	138			
% response	84	86	85			
Earth Sciences						
Sent	45	-	45			
Returned	30	-	30			
% response	67	-	67			
Electronic Engineering						
Sent	57	41	98			
Returned	42	31	73			
% response	74	76	75			
Physics						
Sent	99	63	162			
Returned	84	53	137			
% response	85	84	85			
Totals						
Sent	369	216	585	94	62	741
Returned	301	185	486	41	41	568
% response	82	86	83	44	66	77

Notes:

- Numbers Sent exclude those who replied stating that the questionnaire was inapplicable (29 respondents). These included establishments where no scientists or engineers were employed in the disciplines studied, and replies that had been included in another return from the same university department.
- Numbers Returned exclude those who did not supply sufficiently detailed information to be included in the data analysis.
- Questionnaires were not sent to heads of Earth Science departments since these were included in a survey by the Institution of Geologists.
- Totals for Industry and for Government and Research Council establishments are not divided between disciplines since many of the establishments concerned employ staff in several disciplines.

II Questionnaire analysis

Number of migrants named by respondents

A total of 931 British scientists and engineers who left the UK for overseas posts during the years 1975-85 were named in the 568 completed questionnaires. Of these, 617 were 'experienced' scientists and engineers and 314 were postgraduates, almost all 'recent PhDs'.

Questionnaire respondents also named 685 scientists and engineers who entered the UK from abroad during the same period; of these, 183 were British who returned to the UK from overseas, and of the 502 foreign immigrants, about 130 were 'recent PhDs' or equivalent, including 15 who stayed to work in this country after completing postgraduate studies here.

We deliberately asked respondents to exclude from their replies foreign postgraduate students who stayed in this country for not more than three or four years to study for a higher degree. These foreign students do not represent long-term immigration to the UK, since most leave the country on completion of their degrees. This was confirmed by respondents who, despite our instructions, did name foreign postgraduate students who were in the UK to study for higher degrees. Most were reported to have returned to their home countries and we included in the analysis only those named by these and by other respondents who remained to work in the UK after completing their studies. In contrast, it had been suggested that many of the British graduates who go abroad to take higher degrees fail to return to the UK and thus become permanent emigrants. Since such students would not be members of any university research group in this country they were not covered by our survey. However, we obtained information about those British postgraduates who went abroad shortly after taking a higher degree and these were included in our analysis.

Several respondents named individuals who had left or come to the UK but who were not directly part of the group or institution sampled, but were employed in similar specializations in other institutions. These were not included in the analysis since we wished to compare the numbers migrating with the size of the groups involved, and because they were not collected systematically.

A few respondents could supply only very general statements about staff movements during the past decade, and this limited information was not included in the analysis. We also excluded one establishment which employs both British and foreign scientists on short-term contracts and encourages their movement to and from related organizations abroad. These movements were not of the kind we were investigating.

Several of the industrial firms we contacted were unable to supply details of staff leaving the UK or coming from abroad, explaining that migration had not been a sufficiently important problem to date to warrant keeping such records.

Tables 2.1A and 2.1B (all tables and figures mentioned in this section are given in section VII) show the number of named scientists and engineers leaving or entering the UK by each of the four categories of respondent, and also show what proportion of the respondents reported no migration in either direction. 67% of all university respondents, and 61% of Government and Research Council respondents, reported some migration, whether to or from the UK, during the past decade; by contrast, fewer than 50% of industrial respondents reported any staff movement to or from the UK. However, the number of immigrants from abroad who join Government and Research Council establishments is in some cases restricted by regulations that forbid the employment of foreign nationals in such establishments.

Population represented by respondents

The questionnaire replies necessarily represent a sample of the total British research effort and so cannot give a complete picture of migration in the five disciplines studied. It is difficult to assess what proportion of the total relevant scientific and engineering professional population was covered by our survey: total figures for those employed in individual disciplines in the industrial sector are not readily available, and in the university sector the total number of research workers in particular disciplines is difficult to measure accurately from central sources (which tend to be structured around departments or cost centres rather than disciplines). Varying definitions and demarcation between disciplines also complicate comparison of our survey data with available central statistics.

However, we asked all respondents to give some indication of the size of the professional population to which these migrants relate. In the case of university research groups and departments we asked for the average size of specific grades in the group or department during the last ten years. For industrial, Government and Research Council establishments, we asked for the number of scientists and engineers (graduate or equivalent) currently employed in R&D departments in the five relevant disciplines. Although the figures for the non-university group are not averages, they provide some guide to the total population during the ten year period; it is reasonable to assume that many Government and Research Council Institutes are likely to have contracted in recent years, and so present numbers may underestimate the average population for these establishments over this period and thus overestimate migration rates.

The estimated total populations for each of the above categories (Research group leader, head of department, industry, Government and Research Council establishments) are included in table 2.2A.

Although the total number of respondents from Industry and Government and Research Council establishments was not large, it can be seen that they represented a large population of scientists and engineers.

Rates of migration

a) By category of response

To estimate the rate of migration, we compared the number of migrants in each category with the corresponding estimated population. From table 2.2A it appears that the total number of migrants who left or entered the UK is small in comparison with the total number of scientists and engineers in the research groups, departments and establishments they left or joined. For postdoctoral research assistants (PDRAs) and more senior members of university research groups, the emigration rate was slightly under 2% per year. University heads of department reported an emigration rate of about 0.5% a year, while industry, Government and Research Council establishments indicated lower rates - less than 0.3% per year.

Our estimated rates of emigration from universities of more senior staff agree with those derived from an analysis of data collected by the Universities' Statistical Record. This also shows that the overall number of university scientific and engineering staff leaving the UK for posts overseas, is small in comparison with the total related university population (see section IV).

The rate of emigration from university research groups of British postgraduates who had completed a higher degree is more difficult to measure, since the total postgraduate population (1190) in the groups surveyed included foreign postgraduates and also those at different stages in their courses. However, some estimate can be made using information from the Universities' Statistical Record (USR) for the years and disciplines covered by the survey. This suggests that approximately two-thirds of all the postgraduate students in our survey population were British, with a lower proportion in Electronic Engineering research groups and slightly higher proportion in Biochemistry, Chemistry, Earth Sciences and Physics research groups. USR data also suggest that each year between 40% and 50% of all such postgraduate students complete their higher degree, again with slight variations between disciplines. Using these proportions indicates an average rate of emigration for British 'recent PhDs' of approximately 9% per year for the period 1975-85. This agrees well with figures published by the USR on the first destination of British postgraduates who obtained higher degrees.

Our estimated rate for postgraduate emigration is considerably less than that reported in the 1963 Royal Society study. For the period 1957-61, about 35% of all 'recent PhDs' emigrated each year (more than 20% to the USA alone). Further, the total number of PhDs awarded annually at that time was much smaller than in the period 1975-85. The variation between disciplines was not dissimilar to that found in the present survey.

The USSR data also provide an indication of the rate of emigration of British graduates who left the UK directly after taking a first degree (who were not covered by our survey). Annual rates for the science disciplines covered in our survey averaged less than 3% and were somewhat lower for Electronic Engineering.

Immigration rates for university research groups were 2.9% per year (postgraduate immigrants not remaining in the UK after study were excluded and so the corresponding population excluded all postgraduates). University heads of department reported an annual immigration rate of about 0.4% and industry, Government and Research Council establishments reported annual rates of less than 0.2%.

Direct comparisons of emigration and immigration rates would be misleading; other factors such as staff experience and seniority are important, and these are in turn affected by the size of a research group and other inflows and outflows.

b) By discipline

Table 2.2B shows the rates of migration for each separate discipline. As before, the average number migrating per year was compared with the corresponding estimated total population in the groups or establishments which responded. Postgraduates ('recent PhDs') are shown separately from other more senior members of university research groups; immigration rates are not given for foreign postgraduates, since the number who remained in the UK after studying for a higher degree was too small for meaningful analysis by discipline.

The estimated annual emigration rate for 'recent PhDs' from university Earth Science research groups was well above the overall average for all disciplines; this may be partly because many necessarily work overseas, but for multinational organizations with British connections. The emigration rates for 'recent PhDs' from Biochemistry research groups was slightly above the average, and from Electronic Engineering groups considerably below the average. For more senior members of university research groups there was little variation between disciplines, except for Physics, for which there was a higher than average annual rate of emigration. Heads of department reported a higher emigration rate in departments of Electronic Engineering than for other disciplines. Rates for Electronic Engineers were slightly higher in industry than for other disciplines. Biochemistry staff in Government and Research Council establishments showed a higher rate of emigration than other disciplines. However, because of the small numbers in some subcategories and the low response rate from industry, Government and Research Council establishments, such distinctions between disciplines are not very reliable.

Immigration rates also varied slightly between the disciplines studied, with higher rates for postdoctorate and more senior staff in Chemistry university research groups, slightly higher rates for staff in university departments of Biochemistry, and lower rates for departments of Physics. Immigration rates from industry and from Government and Research Council establishments were higher for Biochemistry and Chemistry than for other disciplines. Again, the small numbers in some subgroups affect the reliability of such comparisons.

Other factors made direct comparisons between disciplines difficult. The estimated total population and the number of migrants named for Earth Sciences were smaller than for other disciplines, partly because heads of university departments of Earth Science were not included in our survey and the NERC did not supply details of the movements of its staff. Generally, we did not find major variations between responses according to discipline.

Quality of Migrants

Since overall rates of emigration and immigration are broadly similar for 'experienced' scientists and engineers, the net effect of migration on UK research will depend mostly on the relative quality of migrants, on whether emigration is permanent or short-term, and on the extent to which those leaving the UK are replaced either by other British scientists and engineers or by others from abroad. Lengths of stay of emigrants and immigrants are discussed in a later section. The 1985 ABRC survey of emigration from selected university research groups also recognized the importance of quality. However, assessing the quality of those migrating is difficult; indeed, agreement on what constitutes 'quality' is almost impossible. However, some attempt has been made to assess the quality of migrants through such factors as relative seniority and qualifications. These are discussed in later sections of this report.

The question of whether emigrants from the UK are adequately replaced by newly qualified and other British scientists and engineers is difficult to measure and again will depend on the research experience and 'quality' of those leaving or returning from abroad. Some would argue that, given the acute shortage of scientists and engineers, any outward migration must be damaging to British science and engineering, while others argue that some international movement is necessary to keep science 'healthy'.

We asked all respondents how many of the migrants they named they would regard as 'outstanding'. Although this is a very subjective question and is open to different interpretations (for example, an outstanding research student may not become an outstanding research group leader), we felt that this might provide a further qualitative measure of migration. Generally, respondents appeared to treat this question seriously: few refused to answer it or listed all the migrants they named as outstanding without careful thought. Several qualified their answers, explaining that although those who had left or joined were 'good' they could not be classified as 'outstanding'.

Overall, of all the emigrants from the UK who were still working abroad, more than 40% were said to be 'outstanding'. However, Government and Research Council establishments indicated that fewer of their emigrants were 'outstanding' (20%). We asked university research group leaders to distinguish between senior and junior (postgraduates and postdoctoral research assistants (PDRA)) group members. Nearly 60% of senior and 40% of junior members who had emigrated were regarded as 'outstanding'. We did not ask other respondents to make any distinction between grades when answering this question, since the number of migrants involved was likely to be so small that individuals might have been identified and this might have deterred some respondents from answering.

Over 30% of the immigrant scientists and engineers to the UK who were still in the UK were also regarded as 'outstanding'. Again, fewer working in Government and Research Council establishments were regarded in this way (12%), while 74% of senior and 30% of more junior members (PDRA only) who had joined university research groups from abroad were regarded as 'outstanding'.

Effects of emigration on British research

Over half the respondents commented on the effects of emigration of British scientists and engineers on British research, either generally or in their particular specialization (table 2.3A). Of the respondents who did not reply to this question, most reported no migration to or from the UK and so did not complete the sections of the questionnaire seeking opinions on the effects of migration and the reasons behind it.

Of the 323 who did respond, 73% of university, Government and Research Council respondents thought that emigration from the UK was having an adverse effect, but less than half of industrial respondents thought so. When asked to qualify this effect further, 45% of university, Government and Research Council respondents considered it serious and 22% of minor importance. Of the remaining 6% of these two groups, several stressed in written comments that the effects of emigration would become a more serious problem in the next few years, and believed that this would lead to a worsening of the research base in the UK. A smaller number answered that, in comparison with the current effective reduction in funding for university research and equipment, migration from the UK was less important, although others argued that these issues were connected.

Thus respondents in university and Government research establishments generally regarded emigration as a more serious problem than those in industrial research organizations. Table 2.3B shows how respondents from university research groups or departments responded to the question on the effects of emigration according to their discipline. It appears from this breakdown that there are relatively small differences in attitude within universities between the disciplines studied.

Ease of replacement of emigrants from the UK

Respondents were asked 'How easy has it been to find replacements of equal calibre for those who have gone overseas?' This question was answered by 50% of all respondents. As table 2.4 shows, 68% of university respondents said that, when permitted, it was difficult to find such replacements. A small number said that the difficulty varied with the seniority of the staff who left - it was easier to replace younger, less experienced staff. Answers to this question varied to some extent with the discipline of the emigrants - over 90% of those who responded from departments of Electrical and Electronic Engineering said that it was either fairly or very difficult to replace staff who left to go abroad, while in departments in the other four disciplines, approximately 60% of those who answered said it was difficult to replace losses.

The response from Government and Research Council establishments was similar to the university response, but industrial respondents were equally divided between those who considered it difficult to find replacements and those who thought it was easy.

Reasons for migration

We asked respondents if they could list the most common reasons that persuaded the named scientists and engineers to migrate to or from the UK. Although it is difficult to judge the motives of other people, we thought that many respondents would have some idea of the motives of the migrants.

Tables 2.5A to 2.5C list the reasons given by each group of respondents. Each respondent was asked to choose a maximum of three from a list of motives that are generally thought to be associated with migration and to supplement the list as appropriate.

The most common reasons why scientists and engineers were believed to have left the UK were career opportunities abroad and career limitations in the UK. Rates of pay, the desire to widen experience and research facilities abroad were also thought to be influential. Higher rates of pay abroad were considered particularly attractive to staff leaving university departments.

In contrast, the most common reason given for the immigration of non-British scientists and engineers to the UK was the desire to widen experience, perhaps not surprising since the majority were only in the UK for not more than three years on short-term appointments. The status of science and research facilities in this country relative to immigrants' home countries was also considered to be important.

British staff were most often thought to have returned from periods spent working abroad for personal reasons, usually family ties, or by the desire to educate their children within the British system.

An additional reason given for coming to the UK from abroad for both British and non-British scientists and engineers was the reputation of a particular research group or department or the special nature of its work.

It might have been more revealing to ask the migrants directly, although it is widely recognized that people often 'rationalize' their actions later. The information respondents provided about reasons for migration were in relation to named and known migrants and therefore likely to be more reliable than a general view of why people migrate. It is probable that most university heads of department and research group leaders would have talked, as a matter of course, to those they named, and there was no reason to believe that migrants would not discuss their true reasons for moving.

Further, other studies in which emigrants themselves were questioned directly reported reasons for emigration very similar to the ones we found. For instance, a questionnaire survey of UK Biotechnologists working overseas conducted by the Institute of Manpower Studies in 1983 found that when asked to indicate why they had left the UK 'the dominant reason overall related to career and work opportunities, with 45% saying that these were better overseas and 41% saying that the lack of such opportunities in the UK forced them to look overseas, ... Better salary was only specifically mentioned by 13%' (Pearson & Parsons, 1983, p32). Studies carried out in the 1960s indicated similar attitudes to emigration.

Destination of emigrants from the UK

For many years the United States of America and Canada have been the most popular destinations for scientists and engineers working in all disciplines and in all types of research establishment. As tables 2.6A and 2.6B show, almost 60% of all emigrants during the period 1975-85 went to North America, while other destinations accounted for much smaller proportions.

It is difficult to compare our survey data directly with that collected in earlier years. For instance, the 1963 Royal Society study looked at a wider spectrum of disciplines than the current study but investigated only emigration from the UK, not immigration. The number of scientists and engineers employed in the UK and throughout the world has increased substantially since then, so direct numerical comparisons are misleading. However, it is possible to compare patterns of emigration, and these appear to have changed to some extent in the twenty years between the two studies. North America attracted the majority of British emigrants both in the period of this survey and in 1950s and early 1960s (about two-thirds of all emigrants identified in the 1963 study). However, almost one quarter of all emigrants who left in the period 1975-85 went to countries in Western Europe, compared with very few in the earlier period.

Nationality of immigrants

The nationalities of foreign scientists and engineers who came to the UK were more evenly distributed, overall the largest number being from Western European countries (see table 2.6C). However, the largest group of 'immigrants' were British scientists and engineers returning from abroad; one quarter of all immigrants to universities and one third of those to other sectors.

Nature of overseas posts of emigrants from the UK

Tables 2.7, 2.8A and 2.8B show the type and length of overseas employment of scientists and engineers who had left the UK. The majority from British universities found employment in universities or equivalent organizations abroad, while those from industrial, Government or Research Council establishments were more likely to be employed by industrial or commercial firms overseas.

Of all emigrants from UK universities, 63% were said to have gone to long-term posts overseas of three or more years; indeed, more than three-quarters of such emigrants were known not to have returned to the UK (see tables 2.9A and 2.9B).

The 1963 Royal Society Study found that of the 'recent PhDs' who left between 1957 and 1961 at least 50% returned to the UK, although some of these may have emigrated again later. In comparison, our data suggest that, of the 'recent PhDs' who emigrated during an equivalent five-year period (1980 to 1985), fewer than 20% were known to have returned and nearly 50% were still in long-term posts abroad.

The limited records kept on past employees and the limited contact with such staff by industrial and non-university research establishments are reflected in the large number of these respondents who were unsure of the type and length of overseas employment of emigrants from the UK.

Nature of employment of immigrants to the UK

Of the scientists and engineers entering UK universities from abroad, 75% were non-British (see table 2.10). Of these non-British immigrants, 80% took up short-term posts of less than three years, and 20% took up long-term posts. In contrast, 22% of British staff who entered universities from abroad took up short-term posts and 78% long-term posts (greater than three years). Overall, more than two-thirds of the immigrants who took up long-term posts in universities were British staff returning from periods spent working abroad. The same pattern, though less marked, occurred in Government and Research Council establishments. In industry most immigrants took up long-term posts and the majority of these went to British staff.

The high proportion of foreign scientists and engineers employed in short-term posts in university research groups and Government and Research Council establishments probably reflects a policy of these organizations of encouraging visiting research workers from abroad. This was also reflected by the number who had subsequently left the UK (66%) (see table 2.11).

Table 2.12 shows that the majority of scientists and engineers who came to work in universities and Government and Research Council establishments had left university posts overseas or had come directly from studying abroad.

UK Posts left by emigrants

Of the 740 British scientists and engineers emigrating from UK universities (including 'recent PhDs'), almost three-quarters were previously in short-term posts or equivalent of not more than three years, most within research groups; the remaining quarter previously held long-term posts, the majority in university departments (see table 2.13A). Not surprisingly, the great majority of emigrants form industry or from Government or Research Council establishments left long-term posts. However, electrical and electronic engineers were more likely to have left longer-term posts in the UK than were those working in other disciplines (see table 2.13B).

Qualifications of migrants

Over 90% of emigrants from universities held doctorates or equivalent qualifications while the number of emigrants from industry and from Government and Research Council establishments with this level of qualification was lower - about 30% and 60% respectively. These figures are not surprising since the university questionnaires focused on migration 'post higher degree', while those to the other groups did not stipulate the level of professional qualification. Nearly all emigrants had gained their highest qualification studying in the UK.

Nearly all British staff who returned from abroad to UK universities or Government and Research Council establishments held doctorates or equivalent qualifications, although only about half of those joining UK industry did so. Almost 90% had obtained their highest qualification in the UK. Similarly most foreign immigrants to UK universities or Government and Research Council establishments held doctorates or equivalent qualifications, but less than half of those joining industry. Fewer than 30% of foreign immigrants had studied for their highest qualification in the UK.

Age of migrants

As might be expected, the majority of those leaving university research groups were under 30 years of age when they left the UK, while those leaving more senior academic positions in university departments were most frequently in their thirties and forties. Emigrants from Government and Research Council establishments were also likely to be between 30 and 40 years old, while those from industrial establishments were generally in their thirties or younger when they left the country (see figure 2.1).

The average age of immigrants, whether British or foreign, was between 29 and 33, depending on the type of research group or establishment they joined, with over 80% under 40 (see figure 2.2).

Year of migration

Figures 2.3 and 2.4 show the numbers reported as leaving and entering the UK each year between 1975 and early 1986. In general, there was more migration during the latter five years than in the previous five years.

Almost two-thirds of all emigrants from universities left since 1980, with very similar patterns for industry and for Government and Research Councils. Although the numbers involved are not large, there was a reduction in the numbers emigrating from university departments in 1983 and 1984. This might reflect the introduction of 'new blood' posts which were reported by many respondents to have dissuaded several British scientists and engineers from emigrating and attracted earlier emigrants to return to the UK from overseas.

Again, the majority of immigrants to universities and to industry, Government and Research Council establishments entered the UK since 1980. Indeed, industry did not report any immigrants from 1975-79, although this may reflect their incomplete records. This pattern was also true for returning British staff and for foreign immigrants separately.

It has been suggested that a 'memory effect' (respondents may have forgotten and so not recorded those who migrated several years ago) could affect reported patterns of movement, giving undue emphasis to movements in recent years. Similarly, the year in which a university research group was established could affect the number of migrants named, with more recently established groups obviously reporting migration only in the last few years of the survey. However, although almost 40 of the 301 research groups were not established before 1980, between them they reported only seven emigrants and eight immigrants since then, and thus had little effect on the overall trend of migration over the decade.

Seniority of migrants

We asked respondents to specify the grade of migrants to and from the UK; in universities we asked for their position, while we asked other respondents to group migrants according to their seniority in three categories of 'senior', 'middle' or 'junior'. The proportions in each grade or category are shown in tables 2.14 and 2.15. Emigrants from the UK universities were dominated by postdoctoral research assistants (PDRAs) and postgraduates ('recent PhDs'), and more senior academic staff accounted for only 28%. Emigrants from non-university research organizations were primarily 'junior' or 'middle' grade staff who form the largest groups in such organizations.

Scientists and engineers joining university research groups and departments from abroad were mainly postdoctoral research assistants and junior or visiting research staff (apart from foreign postgraduate students in the UK for short-term study, who were not included in our survey).

If postgraduate and postdoctoral grades are excluded from this analysis, then 32% of 212 other emigrants from universities held middle or senior posts before leaving the UK, while 9% of 275 immigrants who took up staff positions in universities occupied such posts. This disparity obviously reflects the short-term nature of the posts taken by the majority of immigrants.

The majority of those coming from abroad to work in industrial or Government and Research Council establishments were graded as 'junior' or 'middle'.

Employment opportunities for new PhDs

We asked university respondents to indicate how good they thought employment opportunities were in research in the UK for new PhDs in their specialization. Nearly 40% of all university respondents did not venture an opinion on this question - some commented that they did not have the breadth of knowledge to answer such a question or that their specialization was atypical of the discipline as a whole and so their answer could mislead. Others commented that although short-term prospects were good, there were few longer term posts for new PhDs and thus career prospects were poor.

There were differences between disciplines in the replies of those who did answer (see table 2.16), while respondents in the same discipline were not always in agreement on this issue. On the whole, the majority of respondents from chemistry departments reported that UK employment opportunities for new PhDs were fairly good, those from departments of electronic engineering said they were very good, while those from biochemistry and physics departments were almost equally divided between those who said opportunities were good and those who said they were poor. Most respondents from departments of Earth Science said opportunities in the UK were poor.

We also asked university respondents what proportion of the 'best' new PhDs in their specialization, of British nationality, continued in UK research, continued in other UK scientific work, left scientific work altogether or took up scientific work abroad. Again about 40% of respondents did not give any opinions and it was clear from the responses that many found some difficulty answering this question. As with the previous question, there was some disagreement among respondents in each discipline - for instance almost equal numbers of respondents from biochemistry departments indicated that the majority, or the minority, continued in UK research. However, in all disciplines, except Earth Sciences, most respondents suggested that a minority of or very few new PhDs took up scientific work abroad. Yet in Earth Sciences, respondents were almost equally divided as to whether the majority or minority went abroad. It was evident from the responses that employment opportunities in research in the UK or abroad are not clear cut. Much appears to depend on individual circumstances.

Note: Tables 2.1 - 2.16 and figures 2.1 - 2.4 are given in Section VII.

III Respondents' Views

Many respondents included detailed comments in their questionnaire replies about migration generally, or about particular questions which they felt were unclear or needed explanation.

Concern about emigration

Several comments by respondents which expressed concern about the emigration of scientists and engineers seemed sometimes at odds with the small number of emigrants they named. Some stressed that the quality and seniority of those leaving was of more concern than the absolute numbers involved, and emphasized the damage done by the emigration of a few key senior staff. This was particularly felt by university respondents, where the emigration of a leader of a small research group 'could lead to the entire research group following overseas'. In other cases, respondents were concerned about those who had left the UK whom they knew but who had not worked with them personally and so were not named in their questionnaire responses.

Other respondents stressed that the short-term nature of the posts taken up by foreign scientists and engineers in the UK could not make up for the permanent loss of British staff overseas.

Typical comments included:

- 'the number of non-UK nationals wishing to come here to take up one-year "leave" appointments has increased considerably in the past two years. They provide useful "supernumerary" help but can in no way replace core longer-term members of a research team';
- 'the migration of British research workers to the USA from my research group is matched, at least approximately, by the number of overseas people who come here to obtain their MScs or PhDs and then move to the USA.'

University respondents expressed concern about the decreasing number of young talented students choosing to embark on a research career in the UK. Many said that they found it increasingly difficult to recruit good postgraduate students to undertake higher degrees in competition with posts in UK industry or postgraduate opportunities abroad. Those who did complete UK PhDs were also said to be reluctant to stay within the UK university research system, again reflecting better research opportunities abroad or in UK industry. One respondent commented 'in the present climate it is difficult to understand why any new PhD or PDRA should wish to enter scientific research in this country. Scientists have low status relative to other professional groups and are very poorly paid in comparison with other professionals and with scientists in other Western nations.'

The general lack of career structure in university research was severely criticized by a number of respondents - short fixed-term contracts were said to be unattractive to young scientists, who sought, if not tenured posts, then at least ones lasting substantially longer than three years.

Typical comments from all disciplines included:

- 'There is an adequate number of short-term opportunities for research in UK universities, but they are difficult to fill in some areas because of the almost complete absence of long-term posts.'
- 'There is a tremendous problem in attracting good postdocs for fixed-term research positions in the UK. Subsequent to qualifying for a PhD, many postgraduates within this department leave to take up appointments in the USA, Australia or Europe. There is little incentive for them to return to the UK since to do so involves a great reduction in salary and a low expectancy of a permanent position within academic or research institutes. From my own point of view, attempting to run a competitive research group is now highly frustrating - both from the "alpha" grants rejected, the irrational method of cutting consumables on successful grants and the problems in attracting good scientists to do research that the Councils have agreed should be of high priority.'
- 'The problem in electronics is now how to find anybody willing to work in universities. We used to rely on overseas PhDs, but this supply is drying up as other countries offer more attractive prospects. The total number of British electronic graduates is far too few to satisfy demand. The "brain drain" is only a small influence on the total problem.'

UK industry and commerce, as well as overseas employers, were believed to be attracting scientists and engineers from short-term university posts, and some respondents thought that the number of young scientists and engineers going overseas was less than the total entering UK industry or leaving science or engineering altogether to enter more lucrative employment, such as accountancy or business computing. Analysis of statistics collected by the Universities' Statistical Record on the movement of UK university scientists and engineers abroad and to UK posts outside the UK university system provides some evidence to support this view. Government and Research Council establishments also reported difficulties in recent years in recruiting and retaining well-qualified staff in competition with UK industrial salaries and facilities.

Industrial firms were generally less worried about migration. The international nature of many organizations makes the concept of 'brain drain' less meaningful, and it appears that much of their concern is with filling posts in particular specializations. However, our results may not be representative of all industry or of all scientific disciplines.

Similarly, our results may not be typical of all engineering disciplines. Several respondents believed that many engineers went abroad after completing their first degree; it was said that some North American firms now offer full sponsorship to such students for higher degrees. Respondents working in university departments of electrical and electronic engineering also commented that the emigration of master degree students who had qualified in microelectronics was a serious problem, and few UK graduates would undertake a PhD since industry did not give any significant financial reward for such a qualification. Emigration of this kind would not have been identified by our study since it concentrated on movement from university research groups at 'recent PhD' level and above. Several respondents also suggested that there were more emigrants among staff and students in disciplines outside those covered by our survey.

Emigration in future

Many respondents, including several who reported that no migration had taken place during the ten years to the end of 1985, commented that emigration was likely to increase in the next few years, particularly from universities, since many staff were now seriously considering leaving the UK in the current climate of financial restraint. Several university respondents mentioned the increasing number of approaches made to them and to colleagues from overseas employers, and they said they were now more likely to consider such offers, as research funding and career opportunities in the UK worsened.

In contrast, some senior university research workers were reported to have recently been persuaded to stay in the UK, because they had been successful in obtaining research funding or equipment grants. Whether they remained would depend on the continuing availability of funds for research. Similarly, the 'new blood' lectureships were commonly singled out as having dissuaded younger scientists and engineers from leaving the UK, but it was suggested that movement from the UK might increase now that no further 'new blood' appointments were being funded by the UGC.

Increased spending in the USA on projects linked to the Strategic Defence Initiative and those concerned with biotechnology, as well as the recent emphasis on investment in basic research generally in the USA, were thought likely to increase the number of scientists and engineers leaving the UK in the next few years. In contrast, reduced funding policies in the UK for non-defence research, leading to fewer permanent university posts and increasingly out-of-date facilities, were severely criticized by many respondents, and it was suggested that these policies were likely 'to be seen in years to come as one of the most disastrous examples of this country's post-Victorian reluctance to invest in the future rather than gobbling up the present'.

Government and Research Council establishments as well as universities voiced strong opinions on this - as one Director of a Research Council Institute commented:

'The present research financial climate and major changes occurring in Research Council institutes and apparent lack of University opportunities is resulting in many key staff seeking career development in the private sector within and outside the UK. Unless government shows more commitment and halts the downward spiral, morale will continue to be affected and the loss of scientific staff will increase. A major problem is the lack of recruitment and loss of "seed-corn" to ensure the future of British Science.'

University respondents also pointed to proposed changes in tenure arrangements and the criteria for research funding as likely to persuade more scientific staff to consider offers of posts overseas. A typical comment was:

'Tenure arrangements in British universities and the large measure of freedom to pursue their own research interests have been, and remain, one of the most attractive features of appointments in universities here. These benefits have, until recently, outweighed deficiencies in rates of pay, the status of science, the standard of living and the diminishing provision for equipment and consumables. Increasingly, diminishing career opportunities and funding of research in the UK are influencing decisions by good graduates and good postdoctoral fellows to seek opportunities abroad.'

Only a minority took the view that emigration from the UK was not a matter for anxiety, and that a rethinking of the criteria for research funding was long overdue.

Possible actions

Respondents who thought that migration was a cause for concern made several suggestions about ways of alleviating the problems caused by emigration from the UK. One general suggestion was to encourage those who leave the UK to return, and also to encourage foreign scientists and engineers who come to train in this country to stay longer. It can be argued that those who return to the UK after a period spent working abroad are likely to be enriched by the experience, and rather than try to discourage emigration, the emphasis should be on attracting such 'temporary' emigrants back to the UK.

During the late sixties SERC operated such a 'bring-back' fellowship scheme. In the period 1968 to 1972 this encouraged some 400 scientists and engineers to return to the UK from North America. However, in 1972 the scheme was subsumed into the general SERC Fellowship provisions. Some respondents suggested that similar schemes should once again be introduced.

There are some current initiatives in this direction. During the study we talked to one British recruitment firm which was acting for several UK companies in attempting to attract emigrant British electronic engineers back to the UK by advertising in North America and holding interviews there, as well as by offering to pay removal expenses and giving assistance with house purchase in the UK.

However, our survey suggests that it is not merely the lack of such contacts and help that dissuades scientists and engineers from returning, but rather the inferior research facilities and funding here. Although salaries are generally well below overseas equivalents, several respondents suggested that they might succeed in attracting scientists and engineers back to the UK provided they could guarantee continuity of research funding, facilities and long-term (not necessarily tenured) positions, particularly for younger scientists and engineers. Obviously this would not persuade all past emigrants to return, but it might be sufficient incentive to tempt some.

Similarly, improving facilities, funding and the number of longer-term posts, particularly in UK universities, was suggested as one way of encouraging more UK scientists and engineers to seek research positions in this country, and might also encourage overseas scientists to stay here longer once they had completed their training. Temporary posts were regarded as unlikely to attract young researchers who had similar aspirations to permanent careers as other young people.

As already mentioned, the 'new blood' posts in universities were cited by several respondents as having successfully dissuaded several UK researchers from leaving the UK or as attracting British scientists and engineers back to the UK. The termination of UGC support for this scheme was therefore regretted.

Another approach suggested to the problems currently encountered by universities and Government and Research Council institutes is the differential payment of researchers working in areas of shortage and innovation. This has been severely criticized in the scientific press as being divisive and unlikely to encourage the type of interdisciplinary cooperation that is now increasingly necessary. It has also been suggested that administering such a system to take account of changing priorities would also cause considerable difficulties.

Increasing cooperation and movement between industrial companies and university research groups was also put forward as one way of enriching British research, and perhaps encouraging more people to stay in both sectors. University respondents who reported that they had developed, with industrial funding, research programmes closely allied to industry with 'high levels of cross-fertilization' between industry and universities, believed that this was 'a key factor in maintaining good morale and facilities'.

Increasing the number of foreign scientists and engineers working in British research groups or establishments was also suggested as promoting an international spirit which might dissuade potential emigrants leaving the UK to seek a wider perspective. To do so might involve implementing many of the other suggestions and increasing funding for such posts, if more foreign scientists and engineers are to be attracted to work and to remain in the UK. Other respondents reported that they or colleagues were able to work abroad for short periods each year (often the Summer break for university researchers), and this dissuaded them from seeking permanent positions overseas. Encouraging this international approach was felt to be worthwhile.

More generally, respondents frequently suggested that there is a need to raise the standing of science and engineering in this country and to counter the feeling that it is only in other countries that 'science matters'.

IV Other information on migration

Royal Society Fellows living overseas

Election to the Fellowship of the Royal Society is widely regarded as recognition of very high achievement in research. Eligibility for election is restricted to citizens of British Commonwealth countries or the Irish Republic, or those 'ordinarily resident' in a British Commonwealth country or the Irish Republic. Most Fellows have always been British citizens living in the UK. An analysis of the Fellowship therefore provides some measure of how migration affects some of the outstanding members of the UK scientific community. Such an analysis, covering all scientific disciplines for the period 1960-1986, was conducted as part of the Royal Society evaluation of national performance in basic research sponsored by the ABRC/ESRC (ABRC, 1986). This showed that as the Fellowship (excluding Foreign Members) grew from 603 in 1960 to 1022 in 1986, both the number and proportion of those living outside the UK had grown, most markedly since 1976 (see figure 4.1). In particular, the proportion of those resident in the USA had grown from 2.8% in 1960 to 8.1% in 1986. Similarly, the proportion of new Fellows elected to the Society each year (again excluding Foreign Members) living overseas at the time of their election had increased from 15.8% in 1960-62 to 24.0% in 1984-86 (see figure 4.2) and the proportion living in the USA when elected had tripled in this time. (In 1976 the number of Fellows elected annually was increased to 40 compared with 32 per year in the period 1965-75 and 20 per year before 1965.)

Although the total Fellowship is small in relation to the UK scientific population and covers a broader range of disciplines than the present study, the increasing number of Fellows working outside the UK does support the view of several respondents that many 'outstanding' scientists and engineers have left the UK. In contrast, very few Members of the US National Academy of Sciences work in the UK - in September 1984 only two of 1484 such Members were reported to do so. Further, the Royal Society has elected progressively fewer Fellows who are foreigners but 'ordinarily' resident in the UK. This may also reflect the decreasing number of leading foreign scientists who choose to work permanently in the UK.

USR statistics

The Universities' Statistical Record (USR) annually collects information on the number of staff who leave university posts. Much of this is published in the USR annual volumes, but the USR staff supplied us with many additional tables from which we extracted information on the number of those leaving universities in various categories and disciplines since 1974. We were very grateful for this information and for the time USR staff spent explaining their definitions and analysis.

The main findings of our analysis of this USSR data are:

- (i) The total number of full-time academic staff in relevant, but broader, USSR groups (III to V: engineering and technology, agriculture, biological and physical sciences) who were known to have left for overseas posts has fallen from 350 in 1974 to 290 in 1984, with an 'isolated' increase to 447 in 1977. Numbers of 'wholly university financed' staff in these subject groups who went overseas decreased from 165 in 1974 to 47 in 1984; on the other hand, numbers of staff emigrating, who were on short-term contracts not financed by the UGC, increased from 185 in 1974 to 243 in 1984. (A substantial proportion of university leavers did not indicate their future employment, perhaps because they did not know at the time. The proportion of leavers to unknown or temporary destinations increased from 20% in 1974 to 38% in 1984, and some of these may have eventually emigrated. Thus the real annual totals of those who went abroad may be higher.)
- (ii) If the number of those who went overseas is compared with either the total number of university scientists and engineers leaving the university system and available for work, or the total number in post, the proportion has also decreased during the period 1974-84. In 1984 approximately 1.5% of full-time scientists and engineers in USSR groups III to V left university posts to go overseas, compared with 2.1% in 1974. The rates differed between 'wholly university financed' full-time staff (0.4% in 1984 and 1.2% in 1974) and 'not university financed' full-time staff (3.7% in 1984 and 7.0% in 1974).
- (iii) There is some indication that the number of full-time staff leaving university to enter UK industry and commerce increased, and in engineering became greater than the number going overseas.
- (iv) Scientists and engineers were more likely than staff from other disciplines to go overseas; scientists were more likely than engineers to leave university for posts overseas.
- (v) Most of the scientists and engineers who went overseas were aged between 30 and 39.

There are necessarily differences in definition of staff grades and disciplines between the USSR analysis and our study. However, both analyses show that the number of university full-time staff going overseas is small in relation to the total number in post.

The Committee of Vice-Chancellors and Principals (CVCP) has also carried out its own analysis of staff leaving university posts. Their survey identified 173 leavers in 1984/5 in all disciplines; of these 7% went overseas compared with 45% who left to join other UK universities.

NSF data

For some years the National Science Foundation (NSF) in the USA has collated statistics on foreign scientists and engineers given permanent residence status in the United States. These statistics do not include the many foreigners who work in the USA on a temporary basis, but they do provide some measure of the attraction of the USA as a permanent workplace.

Changing American immigration laws have affected the number of scientists and engineers allowed to gain permanent residence - quotas for different areas of the world have been introduced and amended, and for certain occupations potential immigrants must obtain a certificate which declares that their employment will not disadvantage similarly employed American workers.

Despite these restrictions, NSF statistics suggest that, by 1985, the number of graduate scientists and engineers from the UK taking up permanent immigrant status had almost doubled since 1975, and had returned to levels of the early 1960s of nearly 1000 per year. Such figures must be treated with some caution; they include over 100 non-British scientists and engineers whose last place of residence was the UK, and many of the 1000 would have left the UK some time ago and only applied for permanent immigrant status later and so do not represent emigration from the UK in 1985. Of the 852 UK citizens in this 1000, 134 were classed as natural scientists, a further 121 as mathematics and computing professionals, and 597 as engineers (see table 4.1).

The number of British immigrants taking up permanent residence in the USA in 1985 with a background in engineering, mathematics or computing was about double that in 1975, but the number in other scientific disciplines was almost unchanged. In 1985 the number from the UK granted this status in all disciplines was about 8% of the total coming from all countries, but was 56% of those from Western Europe. In the late sixties these proportions were about 20% and 50% respectively, while in the early seventies British immigrants dropped to less than 4% of those from all countries and to about 35% of those from Western Europe.

These figures support the view that, for engineers and for mathematics or computing professionals, the USA became increasingly attractive in the period 1975-85, but for other disciplines the number who sought permanent residence status changed little, continuing at about 130 a year. However, the number of British scientists and engineers applying for and obtaining permanent immigrant status in the seventies and early eighties was considerably lower than the number in the late sixties, perhaps because it then became known that immigration quotas would be introduced.

NSF studies have also shown that the proportion of scientists and engineers working in America who are foreigners or naturalized US citizens increased from 10% to 17% between 1972 and 1982. Half the 300 large industrial firms which took part in a 1985 NSF survey employed foreign scientists and engineers, and these staff accounted for 9% of the 400 000 workforce in these firms, with an additional 11% who were naturalized US citizens. It is clear that the demand for scientists and engineers in the USA continues to outstrip the supply of qualified American staff, and so the USA will continue to try to recruit foreign, including British, professionals.

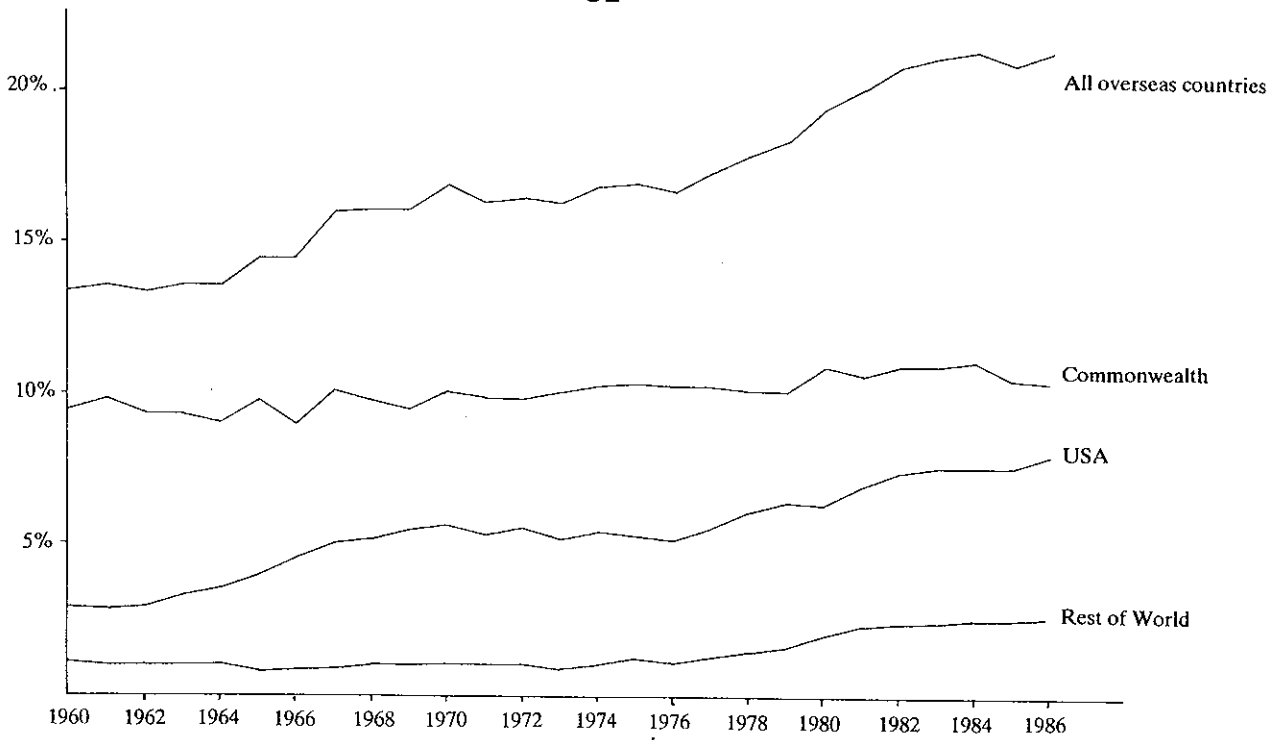


Figure 4.1

Proportion of Royal Society Fellowship living outside the UK, 1960-86
(excluding Foreign Members)

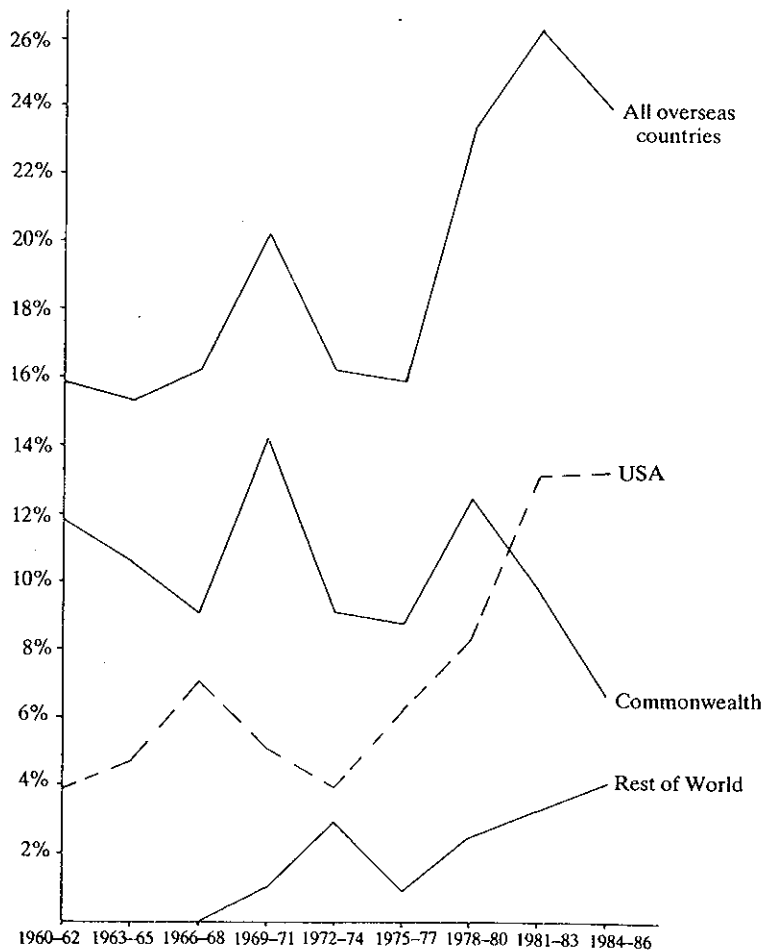


Figure 4.2

Proportion of Royal Society Fellowship living outside the UK
at the time of election, 1960-86 (excluding Foreign Members)

Table 4.1

Graduate scientists and engineers given permanent immigrant status in the USA,
by year of gaining permanent status and country or region of birth

	<u>Natural scientists</u>	<u>Engineers</u>	<u>Mathematicians and computer specialists</u>	<u>Total S&E</u>
<u>1966</u>				
UK	312	1095	36	1443
W Europe	717	2061	66	2844
All countries	1773	4915	176	6864
<u>1967</u>				
UK	373	1842	39	2254
W Europe	868	3292	90	4250
All countries	2763	8821	395	11979
<u>1968</u>				
UK	440	1908	51	2399
W Europe	947	3661	106	4714
All countries	2757	9304	351	12412
<u>1969</u>				
	n/a	n/a	n/a	n/a
<u>1970</u>				
UK	166	578	18	762
W Europe	460	1500	56	2016
All countries	2916	9305	348	12569
<u>1971</u>				
UK	105	322	10	437
W Europe	296	914	32	1242
All countries	3073	9015	383	12471
<u>1972</u>				
UK	127	231	16	374
W Europe	339	690	38	1067
All countries	2946	7436	325	10707
<u>1973</u>				
UK	81	232	9	322
W Europe	203	541	16	760
All countries	1642	4422	147	6211
<u>1974</u>				
UK	97	242	40	379
W Europe	241	575	87	903
All countries	1347	3866	471	5684
<u>1975</u>				
UK	105	299	56	460
W Europe	260	603	107	970
All countries	1525	4648	569	6742

Table 4.1 continued

	<u>Natural scientists</u>	<u>Engineers</u>	<u>Mathematicians and computer specialists</u>	<u>Total S&E</u>
<u>1976</u>				
UK	126	316	58	500
W Europe	299	657	106	1062
All countries	2179	5146	611	7936
<u>1977</u>				
UK	150	323	76	549
W Europe	310	699	140	1149
All countries	1806	5191	749	7746
<u>1978</u>				
UK	165	443	89	697
W Europe	318	866	156	1340
All countries	2109	6762	1169	10040
<u>1979)</u>				
<u>1980)</u>				
<u>1981)</u>				
	n/a	n/a	n/a	n/a
<u>1982</u>				
UK	137	581	166	884
W Europe	261	1013	255	1529
All countries	1756	7880	1805	11441
<u>1983</u>				
UK	127	688	130	945
W Europe	261	1168	186	1615
All countries	1451	7803	975	10229
<u>1984</u>				
UK	114	628	105	847
W Europe	225	1121	160	1506
All countries	1173	7281	732	9186
<u>1985</u>				
UK	134	597	121	852
W Europe	252	1097	173	1522
All countries	1342	8133	999	10474

Notes:

- computer specialists were first separately identified in 1974;
 - changes in American immigration laws have affected the number of British scientists and engineers given permanent residence status.
- n/a not available.

Source : NSF surveys of science resources series 1966-85.

V Main findings and related information

(i) Rates of migration

A significant number of scientists and engineers in the establishments surveyed left or came to the UK during the decade to the end of 1985, but they represent only a small proportion of the relevant professional population within these establishments.

For postdoctoral research assistants (PDRAs) and more senior members of university research groups, the emigration rate was approximately 2% per year. Emigration rates were much lower for university departments and for industrial and Government and Research Council establishments. The emigration rate for postgraduates ('recent PhDs') leaving university research groups appeared to be appreciably higher - approximately 9% per year. The emigration rate estimated using USR data for graduates leaving directly after a first degree was on average less than 3% per year.

The immigration rate to university research groups (excluding those who came to study for higher degrees) was 2.9% per year, while rates for university departments, industry and Government and Research Council establishments were much lower - less than 0.4% per year. However, while most emigrants took up long-term posts overseas, immigrants tended to take only short-term posts in the UK and then moved to another country.

Both emigration from the UK, and to a lesser extent immigration to the UK, increased slightly during the period 1975-85. There was some general indication that emigration increased more rapidly than immigration during this period and it was suggested that this trend might continue. For universities almost two-thirds of all emigrants in our sample left since 1980, while about the same proportion of immigrants entered the UK in this period. Industrial, Government and Research Council establishments showed very similar patterns. A reduction in the numbers emigrating in 1983 and 1984 from universities might reflect the introduction of 'new blood' posts.

(ii) Disciplines of migrants

Earth Science and Biochemistry university research groups reported rather more postgraduate ('recent PhDs') emigrants than other disciplines, and Electronic Engineering considerably fewer. Physics groups reported higher emigration rates for more senior staff. University departments of Electronic Engineering reported slightly higher rates of emigration than other disciplines, while Biochemists were more likely to leave Government and Research Council establishments for posts abroad than other scientists.

Immigration rates for Chemistry research groups were slightly higher than for other disciplines. University departments of Biochemistry also reported slightly higher immigration rates than other disciplines.

In this analysis the numbers in subgroups were often small, so such distinctions between disciplines are not very reliable. Similarly, in other analyses by discipline, subgroups were also generally too small for reliable distinctions to be made. In those cases where reasonable comparisons were possible, there were few significant differences between disciplines.

(iii) **Quality of migrants**

The quality of migrants is a crucial factor in assessing the effect of emigration, but is difficult to measure. We attempted to assess quality mainly in terms of migrants' relative seniority and qualifications (see below).

We also asked respondents for their subjective views on the ability of the migrants they named. Over 40% of the emigrants named in the study who were still working abroad were said to be 'outstanding', although Government and Research Council establishments considered fewer of their emigrants to be in this category.

Over 30% of the scientists and engineers who entered this country from abroad and were still in the UK were also regarded as 'outstanding', although, again, Government and Research Council establishments thought fewer of their immigrant staff could be considered as such.

(iv) **Effect of emigration on British research**

Over 70% of respondents from universities and Government and Research Council establishments who answered a question on the effect of emigration from the UK on British research, felt that it was having an adverse effect, and 45% felt that the effect was serious. Written comments from several respondents, particularly in universities, supported this view and many stressed that if funding for research were further restricted, the numbers of both senior and junior research staff leaving the country would increase. Less than half the industrial respondents answering this question thought that emigration was having an adverse effect on research in this country. It is not clear whether these findings would be typical for disciplines other than those we surveyed.

(v) **Posts left by emigrants from the UK**

Almost three-quarters of those emigrating from universities in the UK previously held short-term posts or equivalent (i.e. up to 3 years), most in research groups; about one quarter left long-term posts, the majority in university departments. Most of those emigrating from industry or Government and Research Councils left long-term posts.

(vi) Destination of emigrants

North America continued to be the most popular destination for those leaving the UK, but Western Europe now appears to attract more scientists and engineers than in the early 1960s.

(vii) Overseas employment of emigrants from UK

The majority of emigrants from British universities found employment in universities and similar organizations abroad, while those from industrial, Government and Research Council establishments were more likely to be employed by industrial or commercial establishments overseas. Almost 60% of all emigrants were said to have gone to long-term posts overseas of more than three years.

(viii) Replacement of emigrants

When permitted, it has generally been difficult to replace scientists and engineers who have left UK universities and Government and Research Council establishments, although this depends on their seniority, ability, experience and, to some extent, their specialization. Industrial respondents were divided almost equally between those who found it difficult to find replacements and those who found it easy.

(ix) Nationality of immigrants

Returning British scientists and engineers formed the largest group of those who entered the UK (one quarter of all immigrants to universities and one third of those to other sectors), with the largest group of foreign scientists and engineers coming from Western Europe.

(x) Nature of UK employment of immigrants

Nearly 80% of all non-British immigrant scientists and engineers took up short-term posts in the UK of less than three years, and most of those named had already left the UK to return to their home or to other countries. British staff returning to the UK from abroad were more likely to take up longer-term posts, particularly in university departments. Non-British staff who came to work for periods of more than three years in the UK were only a quarter of the number of British staff (excluding 'recent PhDs') who left for similar overseas posts in this period. Very few foreign postgraduates were reported to have remained in the UK after studying, while half of the British 'recent PhDs' who left were said to be in long-term posts abroad.

(xi) Reasons for migration

The majority of emigrants from the UK were thought to have left primarily because of career opportunities abroad and career limitations in the UK. Except for staff from university departments, rates of pay overseas were regarded as of less importance, although still relevant.

In contrast most of the scientists and engineers coming to this country from abroad were thought to be motivated by the desire to widen their experience. British scientists and engineers who returned to the UK from abroad were generally thought to have returned for personal reasons, such as the wish to educate their children in this country.

Although the reasons given were not reported by migrants themselves, previous studies which have questioned migrants directly reported similar motivations.

(xii) **Qualifications of migrants**

Most emigrants from UK universities held doctorates or equivalent qualifications. Fewer from industry (30%) and from Government and Research Council establishments (60%) held such qualifications. Nearly all emigrants obtained their highest qualifications in the UK.

Similarly nearly all British staff who returned to UK universities or to Government or Research Council establishments from abroad held doctorates, while fewer who joined UK industry did so. Again, most had gained their highest qualification in the UK before going abroad. This pattern was repeated for foreign immigrants to the UK, but less than 30% of them had studied in the UK for their highest qualification.

(xiii) **Age of migrants**

The majority of scientists and engineers were under thirty years of age when they left the UK, although staff from university departments and from Government or Research Council institutes were slightly older, between thirty and forty, when they left. Most of the scientists and engineers who came to the UK from abroad were under 40 years of age.

(xiv) **Seniority of migrants**

Postgraduates ('recent PhDs') and postdoctoral research assistants formed the majority of those emigrating from universities, more senior staff accounting for 28% of university emigrants. 'Junior' and 'middle' grade staff formed the majority of emigrants from the non-university sector, and also formed the majority of those coming from abroad to work in this sector.

If postgraduates ('recent PhDs') and postdoctoral research assistants are excluded, almost one third of emigrants from universities held middle or senior posts in the UK before leaving, while considerably fewer immigrants to universities took up such posts in the UK.

(xv) **Employment opportunities for new PhDs**

University respondents were divided about employment opportunities in UK research for new PhDs in their specializations. In all disciplines, except Earth Sciences, the majority of respondents said that a minority of or very few of the 'best' new PhDs went abroad. Respondents from departments of Earth Science were almost equally divided as to whether the majority or minority went abroad.

However, many university respondents expressed concern about the increasing difficulty of recruiting 'good' graduate students to undertake higher degrees in the UK. Both graduates and new PhDs were said to be attracted by posts in UK industry or commerce, often outside science, or by further training or permanent employment opportunities abroad.

The dearth of long-term posts for young university research workers and the lack of an adequate career structure were criticized by many respondents, and it was suggested that this could lead to increased movement of good researchers to other employment in the UK and abroad. 'New blood' posts were said to have dissuaded several young scientists and engineers from emigrating and to have succeeded in attracting others back from overseas. The discontinuation of UGC support for this scheme was regretted.

(xvi) **Royal Society Fellows living overseas**

Further evidence about quality comes from an analysis of the country of residence of Fellows of the Royal Society (excluding Foreign Members) which was conducted as part of a recent SEPSU study on performance in basic research. This showed that the proportion of Fellows living overseas at the time of their election increased from under 16% in 1960-62 to 24% in 1984-86, and the proportion living in the USA when elected had tripled in this time. This analysis covers all branches of science, not just the five disciplines surveyed in this report. However, evidence of this kind supports the view of several respondents that many 'outstanding' scientists and engineers have left the UK.

(xvii) **USR statistics**

Information collected annually by the Universities' Statistical Record (USR) on the number of staff leaving university full-time posts suggests that between 1974 and 1984 the number of scientists and engineers in the relevant USR categories leaving for posts abroad has declined to approximately 300 a year - about 1.5% of the total population in these categories. There is some indication that, particularly in engineering, the number of university staff leaving for posts in UK industry and commerce is increasing, and has overtaken the number going overseas.

(xviii) NSF data

Figures collated by the National Science Foundation (NSF) in the USA point to an increased number of UK scientists and engineers given permanent immigrant status between 1975 and 1985. The number of engineers, and of mathematics and computing professionals, granted this status almost doubled since 1975 to about 700 a year in 1985. However, the number of scientists has remained more stable with about 130 a year granted permanent residence in the USA.

VI Discussion

Our findings suggest that the movement of scientists and engineers to and from the UK has increased slightly during the last ten years. The numbers involved are not large in relation to the total population of the research groups, departments or establishments they left or joined. However, in addition to the overall numbers, the relative periods of time that emigrants spend overseas and immigrants spend in the UK, and the relative quality and seniority of emigrants and immigrants, are important factors in assessing the impact of migration on UK research.

The number of scientists and engineers who left posts in the UK (617) was more than off-set by the total number of foreign scientists and engineers who came from abroad (502) and British emigrants who returned (183) to take up such posts. Alternatively, the 617 'experienced' British emigrants can be compared with about 555 similar immigrants, of whom 372 were foreigners and 183 were returning British; the remaining 130 foreign immigrants were almost all 'recent PhDs' who can be compared with 314 emigrant British 'recent PhDs'. However, these figures disguise an imbalance in the length of stay and nature of the work migrants undertake. Most foreign scientists and engineers came to this country for only short periods (generally less than three years), and then either returned to their home countries or moved to other countries. In contrast, the majority of the 'experienced' scientists and engineers named as having left the UK had not returned after three years and most were thought to have taken up permanent employment abroad. Although the majority of British emigrants who returned took up similar long-term posts in the UK, more than twice as many emigrants left such posts during the same period.

Further, many British postgraduates who went overseas after completing higher degrees did not return to the UK and about 50% of the 314 such 'recent PhDs' were known to have taken up long-term posts abroad (longer than three years).

Many respondents stressed that it was often the 'best' researchers who went abroad, and replacing such staff was difficult, particularly if they were senior, experienced, or worked in new areas for which the pool of suitably qualified replacements was small. The emigration of a few key staff could thus have a 'debilitating effect' on UK research.

It is difficult to agree on what constitutes quality or to measure it; we were able only to collect data on the qualifications and seniority of migrants, and to report respondents' views on the effect they felt emigration was having on UK research and their opinions on the ability of migrants. Such opinions are necessarily subjective, yet it does not seem unreasonable to accept the views of university research leaders, heads of departments and directors of research in industry, Government and Research Council establishments on the quality of those migrating to and from their groups or establishments. Generally, respondents were concerned about the loss of talented staff overseas, and while many of those coming to posts here from abroad were also considered talented, the short-term nature of their work in this country meant that they could not fully replace permanent staff. Thus it was felt that emigration was having an adverse effect on British research, particularly within the university system.

There is some other evidence to support this view, including the increasing number of Fellows of the Royal Society who choose to live and work abroad, and the fact that foreign companies feel that it is worthwhile 'head-hunting' scientific staff in the UK. Other industrialized countries have experienced unemployment problems in recent years and so emigration from the UK is no longer as easy as in the past. Potential immigrants to North America must fulfil stringent entry conditions. It is therefore likely that most British scientists and engineers who emigrated in recent years to North America were talented individuals with skills that are probably as in short supply in the UK as abroad.

The majority of those emigrating from universities and Government and Research Council establishments held doctorates or equivalent qualifications, and had obtained these in the UK. They included a significant proportion of British postgraduates who left this country directly after completing a higher degree. The education and training of these scientists and engineers represents a considerable investment by this country: their permanent emigration is thus an appreciable loss. In addition, the high proportion of foreign postgraduates who, after studying in the UK for a higher degree, leave to return home or move to other countries means that a considerable part of the UK output of PhDs does not work for long in this country. Their numbers may not be large in terms of the overall scientific population, but they are among the most highly educated scientists and engineers and may have more up-to-date training than many others working in the UK. It is therefore not surprising that university respondents were particularly concerned about the continuing movement from this country of such researchers, especially when this was coupled with the difficulty in recruiting others from Britain to replace them.

A small, but significant, number of university emigrants previously held senior posts, while considerably fewer immigrants took up such posts, reflecting the short-term nature of the work of the majority of immigrants. The net emigration of senior university staff thus constitutes a loss of experience and leadership.

Generally, migration must be considered in the context of a perceived worldwide shortage of qualified scientists and engineers. Although it has increased, the pool of qualified scientists and engineers is still widely regarded as too small to supply adequate numbers to fill all current and potential posts in both UK universities and industry. Several respondents commented that the UK is not alone in having this problem: other industrialized countries with similar manpower shortages have increased their research funding, and have offered substantially higher salaries than the UK, and so will continue to attract not only UK scientists and engineers, but also foreign professionals who receive their initial research training in this country. This is indicated by the destinations of British emigrants; almost 90% of all who left the UK went to North America, Western Europe or Australia.

Other UK professions, outside science, suffer from similar shortages of potential skilled recruits, but many have been able to offer salary incentives and improved facilities and conditions of work to attract qualified staff or persuade others to retrain. Most universities have been unable to do this and have recently suffered from financial cuts in core funding and support for specific research programmes, and so a scientific research career in the university sector has become less attractive in comparison with industrial research or professions outside science in the UK or abroad.

The main reasons given for emigration were career limitations in the UK compared with better career opportunities, salaries and research facilities overseas. University respondents argued that an improved career structure, with more permanent, though not necessarily tenured, posts and increased longer-term funding would enable UK universities to compete more successfully for the small pool of highly talented, qualified scientists and engineers. Government and Research Council establishments also considered that the current salary structures and research funding arrangements were too constrained and offered too few incentives to persuade talented scientists and engineers to remain in research work. Industrial respondents generally were less concerned about the impact of emigration on their research effort, perhaps reflecting the more flexible approach they have been able to adopt to attract 'shortage' staff. However, it is not clear whether this would be true for disciplines not covered by our study.

Our study did not attempt to record emigration of engineers, apart from Electronic Engineers. However, the emigration of engineers in other disciplines may be a more serious problem for industry, as well as for university and Government and Research Council establishments. This was apparent from respondents' comments and from statistics produced by the National Science Foundation in the USA which show that increasing numbers of engineers have obtained permanent immigrant status in the USA since the early seventies.

The movement of scientists and engineers from university research groups, both to posts abroad and to industry in the UK, could be regarded as desirable and welcome; a period spent abroad may encourage a broadening of outlook, and more professionals with research experience entering industry may counter past criticism that the number doing so was insufficient to keep British industry competitive. Equally, the need to maintain links with other countries and share new scientific developments is partly met by a steady flow of foreign scientists and engineers working for short or extended periods in UK research establishments. Some respondents argued that migration to and from developing countries is one way of partly 'repaying the debt' owed to them by industrialized countries, which also benefit by maintaining or establishing worldwide links. Indeed, encouraging more scientists and engineers from developing countries to stay for longer periods in the UK rather than return home, might have serious consequences for these countries. Migration has also been dismissed as unimportant in the long-term development of science, since basic research in civil science and engineering benefits the whole international scientific community, no matter where the research is undertaken.

The majority of respondents were no doubt aware of the arguments about the benefits of international movement and cooperation. However, it is apparent from our survey that emigration on the current scale is generally regarded as a matter for serious concern, particularly among the university community and in Government and Research Council establishments. Most immigrant scientists and engineers did not stay in this country for many years. Thus there is a net loss of skill and experience. This, when combined with the effects of reduced research funding, widening differentials between UK industry and university salaries, and the overall shortage of qualified scientists and engineers means that respondents considered the negative aspects of migration to outweigh the positive gains from international exchange.

VII TABLES for SECTION II

Table 2.1A
Reported Migration
by category of respondent

	Research Group Leaders (RGL)		University Heads of Dept (HoD)		Total		Industry		Govt/ Res. Cncl		Totals	
	N	%	N	%	N	%	N	%	N	%	N	%
Total Respondents - all disciplines	301	100	185	100	486	100	41	100	41	100	568	
No migration	95	32	66	35	161	33	23	56	16	39	200	
Migration to UK only	21	7	44	24	65	13	0	0	4	10	69	
Migration from UK only	77	25	33	18	110	23	9	22	10	24	129	
Migration to and from UK	108	36	42	23	150	31	9	22	11	27	170	

Table 2.1B

Individuals leaving UK 1975-85	570	170	740	77	114	931
Total						
including Postgraduates	314	-	314	-	-	314
PDRA	214	-	214	-	-	214
Individuals coming to UK 1975-85	403	153	556	28	101	685
Total						
of which British returning to UK	42	98	140	15	28	183
including Postgraduates	-	-	-	-	-	-
PDRA	28	-	28	-	-	28
of which non-British	361	55	416	13	73	502
including Postgraduates	15	-	15	-	-	15
PDRA	238	-	238	-	-	238

* Non-British postgraduates included only if remaining to work in UK after studying for 3 or 4 years.

Table 2.2A
Rate of Migration by category of respondent

	RGL		University		HoD	Industry	Govt/ Res. Cncl
	PG only		RGL	PDR & Sen. Total			
Total respondents	301	301	301	301	185	41	41
Estimated number of S&E in relevant disciplines in sample	British 820 *	Foreign 370 *	1350	2540	3810	4970	3480
Average size of research group/establishment	N/A	N/A	5	8	21	114	85
Average leaving UK per year 1975-85	31	N/A	26	57	17	8	11
% of estimated population leaving UK per year	9 **	N/A	1.9	N/A	0.5	0.2	0.3
Average entering UK per year 1975-85							
Total	N/A	1	N/A	39	15	3	10
of which British	N/A	-	N/A	4	10	2	3
of which non-British	N/A	1	N/A	35	5	1	7
% of estimated population entering UK per year							
Total	N/A	N/A	N/A	2.9	0.4	0.1	0.3
of which British	N/A	N/A	N/A	0.3	0.3	0.04	0.1
of which non-British	N/A	N/A	N/A	2.6	0.1	0.02	0.2

* Total postgraduate survey population (1190) split into British and Foreign as estimated from USR data.

** Rate related to estimated number of postgraduates gaining higher degrees each year (see text).

Notes: - Period 1975-85 treated as ten academic or equivalent years for this analysis.

- N/A : not applicable

Table 2.2B

Rate of Migration by discipline and category of respondent

	Biochemistry	Chemistry	Earth Sciences	Electronic Engineering	Physics	All disciplines
<u>University research groups (RGL)</u>	64	81	30	42	84	301
<u>Postgraduates:</u>						
Total population (estimated)	235	273	99	223	360	1190
British PGs gaining higher degrees						
Annual Total (estimated)	75 *	75 *	34 *	42 *	98 *	324 *
Annual emigrants	9	7	5	2	8	31
Annual rate of emigration (%)	12 *	9 *	15 *	5 *	8 *	9 *
Immigrants per year (working in UK)	0.5	0.3	0.1	0.5	0.1	1.5
Annual rate of immigration	N/A	N/A	N/A	N/A	N/A	N/A
<u>More senior staff:</u>						
Total population (estimated)	263	251	93	250	493	1350
Emigrants per year	5	4	1	3	13	26
Annual rate of emigration (%)	1.9	1.6	1.1	1.2	2.6	1.9
Immigrants per year	6	14	1	3	15	39
Annual rate of immigration (%)	2.3	5.6	1.1	1.2	3.0	2.9
<u>University heads of department (HoD)</u>	44	57	-	31	53	185
Total population (estimated)	649	1301	-	655	1205	3810
Emigrants per year	2	5	-	5	5	17
Annual rate of emigration (%)	0.3	0.4	-	0.8	0.4	0.5
Immigrants per year	5	4	-	3	3	15
Annual rate of immigration (%)	0.8	0.3	-	0.5	0.2	0.4
<u>Industry</u>						41
Total population (estimated)	420	1792	466	1288	1004	4970
Emigrants per year	1	2	0.1	4	1	8
Annual rate of emigration (%)	0.2	0.1	<0.1	0.3	0.1	0.2
Immigrants per year	0.3	2	0.3	0.3	0.3	3
Annual rate of immigration (%)	0.1	0.1	<0.1	<0.1	<0.1	0.1
<u>Government & R.C. establishments</u>						41
Total population (estimated)	460	1019	228	743	1030	3480
Emigrants per year	6	1	1	1	2	11
Annual rate of emigration (%)	1.3	0.1	0.4	0.1	0.2	0.3
Immigrants per year	5	4	0.1	0	1	10
Annual rate of immigration (%)	1.1	0.4	<0.1	0	0.1	0.3

* Estimated using USR data for each discipline for population of postgraduates gaining higher degrees each year.
N/A : not applicable

Table 2.3A

Effect of emigration from the UK on British research by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl		Overall totals
	N	%	N	%	N	%	N	%	N	%	
Effect:											
Adverse:											
Serious	87	47	40	39	127	44	3	17	10	59	
Minor	39	21	25	24	64	22	3	17	3	18	
Other	13	7	7	7	20	7	2	11	-	-	
Not adverse	46	25	31	30	77	27	10	55	4	23	
Total response	185	100	103	100	288	100	18	100	17	100	323
No response	116		82		198		23		24		245
Totals	301		185		486		41		41		568

Table 2.3B

Effect of emigration from the UK on British research: university respondents by discipline

	Biochemistry		Chemistry		Earth Sciences		Electronic Engineering		Physics		Overall totals
	N	%	N	%	N	%	N	%	N	%	
Effect:											
Adverse:											
Serious	36	55	31	39	8	47	25	51	27	35	
Minor	14	22	22	28	3	18	8	16	17	22	
Other	4	6	5	6	1	6	3	6	7	9	
Not adverse	11	17	21	27	5	29	13	27	27	35	
Total response	65	100	79	100	17	100	49	100	78	100	288
No response	43		59		13		24		59		198
Totals	108		138		30		73		137		486

Table 2.5A

Reasons why emigrants left the UK by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Rates of Pay	54	11	41	20	95	14	6	13	6	15
Status of science	24	5	9	4	33	5	1	2	3	7
Scientific vigour	34	7	10	5	44	6	-	-	2	5
Standard of living	22	5	19	9	41	6	7	15	1	3
Political climate	-	-	2	1	2	<1	-	-	-	-
Level of equipment/ research facilities	60	12	32	15	92	13	3	7	2	5
Personal reasons	16	3	14	7	30	4	8	18	1	3
Career opportunities abroad	90	19	35	17	125	18	12	27	8	20
Career limitations in UK	90	19	32	15	122	18	1	2	9	22
Working conditions	11	2	3	1	14	2	-	-	-	-
Desire to widen experience	78	16	8	4	86	12	7	15	7	17
Other	4	1	3	1	7	1	-	-	1	3
Totals	483	100	208	100	691	100	45	100	40	100

Overall
total
776

(Totals are greater than the number of respondents answering this question since each could choose a maximum of 3 reasons)

Table 2.5B

Reasons why non-British staff came to UK by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Rates of Pay	1	<1	2	2	3	<1	1	6	-	-
Status of science	45	17	9	11	54	15	2	12	3	19
Scientific vigour	34	13	7	9	41	12	-	-	1	6
Standard of living	4	1	1	1	5	1	-	-	-	-
Political climate	11	4	7	9	18	5	2	12	-	-
Level of equipment/ research facilities	42	15	9	11	51	14	-	-	1	6
Personal reasons	13	5	10	12	23	7	2	12	2	13
Career opportunities in UK	1	<1	8	10	9	3	2	12	2	13
Career limitations abroad	8	3	4	5	12	3	2	12	2	12
Working conditions	5	2	4	5	9	3	2	12	-	-
Desire to widen experience	83	30	13	16	96	27	2	12	3	19
British educational system	13	5	3	4	16	5	1	5	1	6
Other	12	4	4	5	16	5	1	5	1	6
Totals	272	100	81	100	353	100	17	100	16	100

Overall total
386

(Totals are greater than the number of respondents answering this question since each could choose a maximum of 3 reasons)

Table 2.5C

Reasons why British staff returned to UK by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Rates of Pay	-	-	-	-	-	-	-	-	-	-
Status of science	3	5	5	4	8	4	1	8	-	-
Scientific vigour	1	1	6	5	7	4	-	-	2	11
Standard of living	-	-	-	-	-	-	1	8	-	-
Political climate	4	6	10	9	14	8	2	17	2	11
Level of equipment/ research facilities	2	3	1	1	3	2	-	-	2	11
Personal reasons	27	41	38	35	65	37	5	42	6	33
Career opportunities in UK	6	9	6	6	12	7	2	17	3	16
Career limitations abroad	4	6	3	3	7	4	-	-	1	6
Working conditions	4	6	3	3	7	4	1	8	-	-
Desire to widen experience	1	1	6	6	7	4	-	-	-	-
British educational system	9	14	20	18	29	17	-	-	1	6
Other	5	8	11	10	16	9	-	-	1	6
Totals	66	100	109	100	175	100	12	100	18	100
										Overall total 205

(Totals are greater than the number of respondents answering this question since each could choose a maximum of 3 reasons)

Table 2.6A
 Destination of emigrants from UK
 by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Africa (incl. South Africa)	19	3	5	3	24	3	6	8	9	8
Oceania	23	4	26	15	49	7	5	7	17	15
Eastern Europe	-	-	-	-	-	-	-	-	-	-
Western Europe	139	24	23	14	162	22	20	26	21	18
Far East	16	3	4	2	20	3	1	1	3	3
Indian subcontinent	3	<1	-	-	3	<1	-	-	-	-
Middle East	7	1	4	2	11	1	1	1	2	2
South/Central America	1	<1	1	<1	2	<1	1	1	5	4
North America	359	63	105	62	464	63	38	49	50	44
West Indies	2	<1	2	1	4	<1	1	1	-	-
Not Given	1	<1	-	-	1	<1	4	5	7	5
Totals	570	100	170	100	740	100	77	100	114	100
									Overall total	931

Table 2.6B
 Destination of emigrants from UK
 by discipline

	Biochemistry		Chemistry		Earth Sciences		Electronic Engineering		Physics	
	N	%	N	%	N	%	N	%	N	%
Africa (incl. South Africa)	7	3	10	5	9	12	4	3	9	3
Oceania	12	5	18	9	12	15	9	6	20	7
Eastern Europe	-	-	-	-	-	-	-	-	-	-
Western Europe	50	22	41	20	18	23	24	16	70	25
Far East	-	-	6	3	7	9	1	1	10	4
Indian subcontinent	-	-	-	-	-	-	-	-	3	1
Middle East	3	1	6	3	-	-	-	-	5	2
South/Central America	5	2	1	<1	-	-	-	-	2	1
North America	140	63	116	58	29	37	104	71	163	57
West Indies	1	<1	1	<1	1	1	1	1	1	<1
Not Given	5	2	1	<1	2	3	3	2	1	<1
Totals	223	100	200	100	78	100	146	100	284	100
Overall total	931									

Table 2.6C

Nationality of immigrant S&E to UK
by category of respondent

Country of origin - based on nationality	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Africa (incl. South Africa)	11	3	2	1	13	2	-	-	2	2
Oceania	37	9	13	9	50	9	3	11	15	15
Eastern Europe	17	4	1	<1	18	3	-	-	2	2
Western Europe	99	25	11	7	110	20	3	11	20	20
Far East	47	12	-	-	47	9	-	-	9	9
Indian subcontinent	52	13	5	3	57	10	1	3	1	<1
Middle East	37	9	5	3	42	8	-	-	7	7
South/Central America	8	2	-	-	8	1	-	-	3	3
North America	48	12	14	9	62	11	1	3	13	13
West Indies	1	<1	-	-	1	<1	-	-	-	-
Other (incl. naturalized & not given)	4	1	4	3	8	1	5	18	1	<1
UK (British returning from overseas)	42	10	98	64	140	25	15	54	28	28
Totals	403	100	153	100	556	100	28	100	101	100
										Overall total 685

Table 2.7

Nature of overseas employment of emigrants from UK by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
University/equivalent	300	53	103	61	403	55	7	9	30	26
Student	9	2	-	-	9	1	1	1	-	-
Industry/commerce	125	22	47	28	172	23	48	63	33	29
Independent res. institute	55	10	7	4	62	8	4	5	10	9
Govt/public service	47	8	9	5	56	8	4	5	15	13
Non-scientific employment	1	<1	1	<1	2	<1	1	1	-	-
Other	6	1	-	-	6	1	1	1	1	1
Not given	27	5	3	2	30	4	11	14	25	22
Totals	570	100	170	100	740	100	77	100	114	100
										Overall total 931

Table 2.8A

Length of overseas post of emigrants from UK by category of respondent

<u>Short/long-term Post overseas</u>	RGL		University HoD		Total		Industry		Govt/ Res. Cncl		Overall total 931
	N	%	N	%	N	%	N	%	N	%	
Short-term	231	41	16	9	247	33	10	13	27	27	24
Long-term (>3 years)	327	57	142	84	469	63	28	36	56	56	49
Not known	12	2	12	7	24	3	39	51	31	31	27
Totals	570	100	170	100	740	100	77	100	114	114	100

Table 2.8B

Length of overseas post of emigrants from UK by discipline

<u>Short/Long-term Post overseas</u>	Biochemistry		Chemistry		Earth Sciences		Electronic Engineering		Physics		Overall total 931
	N	%	N	%	N	%	N	%	N	%	
Short-term	86	39	72	36	20	26	15	10	91	32	32
Long-term (>3 years)	108	48	120	60	54	69	89	61	182	64	64
Not known	29	13	8	4	4	5	42	29	11	4	4
Totals	223	100	200	100	78	100	146	100	284	100	100

Table 2.9A

Number of Emigrants who have returned to UK by category of respondent

<u>Returned to UK</u>	RGL		University HoD		Total		Industry		Govt/ Res. Cncl.	
	N	%	N	%	N	%	N	%	N	%
Yes	115	20	11	6	126	17	7	9	15	13
No	429	75	147	87	576	78	30	39	63	55
Not known	26	5	12	7	38	5	40	51	36	32
Totals	570	100	170	100	740	100	77	100	114	100

Overall total 931

Table 2.9B

Number of Emigrants who have returned to UK by discipline

<u>Returned to UK</u>	Biochemistry		Chemistry		Earth Sciences		Electronic Engineering		Physics	
	N	%	N	%	N	%	N	%	N	%
Yes	41	18	29	15	9	12	12	8	57	20
No	153	69	155	77	62	79	95	65	204	72
Not known	29	13	16	8	7	9	39	27	23	8
Totals	223	100	200	100	78	100	146	100	284	100

Overall total 931

Table 2.10

Length of UK post held by immigrants to UK by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Post in UK										
Short-term:	342	85	20	13	362	65	1	4	67	66
of which British:	26		5		31		-		7	
of which non-British:	316		15		331		1		60	
Long-term: (>3 years):	61	15	132	86	193	35	18	64	34	34
of which British:	16		92		108		11		21	
of which non-British:	45		40		85		7		13	
Not given:	-		1		1	<1	9	32	-	-
of which British:	-		1		1		4		-	
of which non-British:	-		-		-		5		-	
Totals	403	100	153	100	556	100	28	100	101	685
of which British:	42	10	98	66	140	25	15	54	28	183
of which non-British:	361	90	55	34	416	75	13	46	73	502
Overall totals										

Table 2.11

Number of immigrants to UK who subsequently left UK by category of respondent

	RGL		University HoD		Total		Industry		Govt./ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Left UK:	242	60	12	8	254	46	1	4	41	40
of which British:	4		3		7		-		2	
of which non-British:	238		9		247		1		39	
Still in UK:	145	36	141	92	286	51	27	96	60	60
of which British:	38		95		133		15		26	
of which non-British:	107		46		153		12		34	
Not given:	16	4	-	-	16	3	-	-	-	-
of which British:	-		-		-		-		-	
of which non-British:	16		-		16		-		-	
Totals:	403	100	153	100	556	100	28	100	101	100
of which British:	42	10	98	66	140	25	15	54	28	28
of which non-British:	361	90	55	34	416	75	13	46	73	72
Overall totals										685
										183
										502

Table 2.12

Nature of previous overseas employment of immigrants to UK by category of respondent

	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
University/ equivalent	228	57	103	67	331	60	6	21	51	50
Student	106	26	14	9	120	22	5	18	15	15
Industry/ Commerce	18	5	9	6	27	5	5	18	3	3
Indep. res. institute	21	5	15	10	36	6	3	11	12	12
Govt/Public service	24	6	2	1	26	5	-	-	5	5
Non-scientific employment	-	-	1	<1	1	<1	-	-	1	1
Other	1	<1	1	<1	2	<1	-	-	-	-
Not given	5	1	8	5	13	2	9	32	14	14
Totals	403	100	153	100	556	100	28	100	101	100
										Overall total 685

Table 2.13A

Nature of UK post left by emigrants from UK by category of respondent

Post left in UK	RGL		University HoD		Total		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%	N	%	N	%
Short-term	491	86	39	23	530	72	10	13	36	32
Long-term (>3 years)	79	14	128	75	207	28	67	87	78	68
Not known	-	-	3	2	3	<1	-	-	-	-
Totals	570	100	170	100	740	100	77	100	114	100

Overall total 931

Table 2.13B

Nature of UK post left by emigrants from UK by discipline

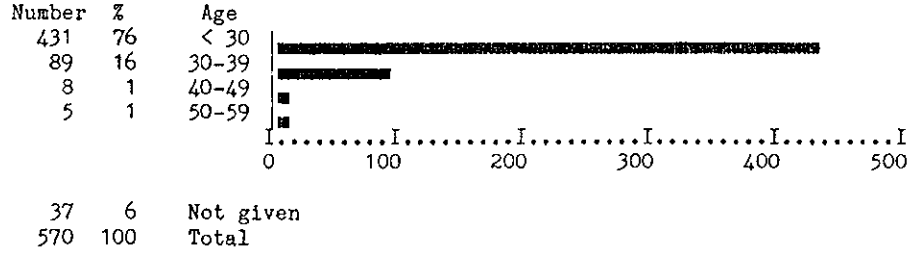
Post left in UK	Biochemistry		Chemistry		Earth Sciences		Electronic Engineering		Physics	
	N	%	N	%	N	%	N	%	N	%
Short-term	149	67	116	58	63	81	43	29	205	72
Long-term (>3 years)	74	33	84	42	15	19	102	70	77	27
Not known	-	-	-	-	-	-	1	1	2	1
Totals	223	100	200	100	78	100	146	100	284	100

Overall total 931

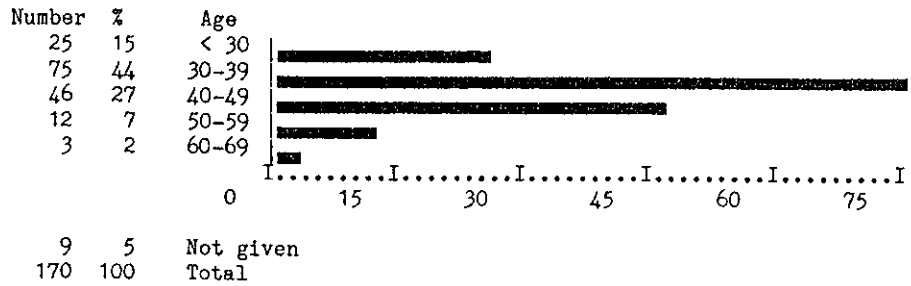
Figure 2.1

Age of Emigrants from UK by category of respondent

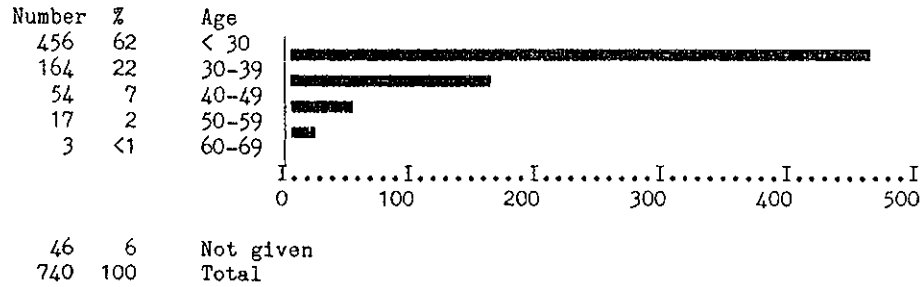
a) University research group leaders



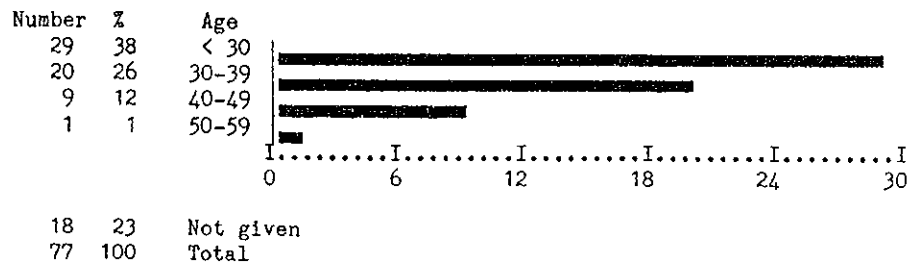
b) University heads of department



c) Total university response ((a) + (b))



d) Industry



e) Government/Research Council establishments

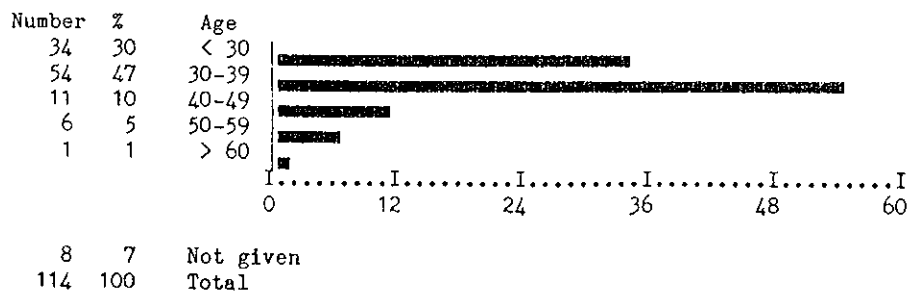
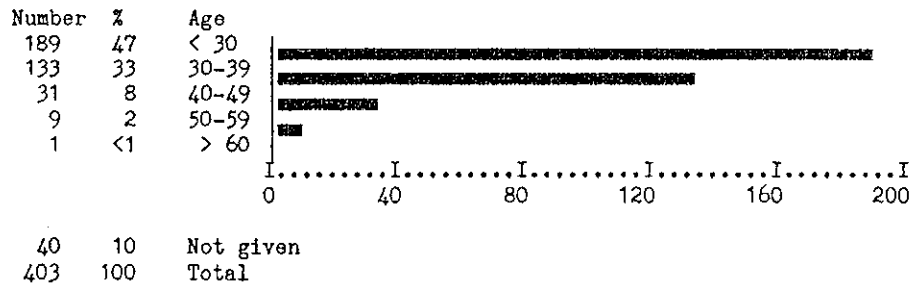


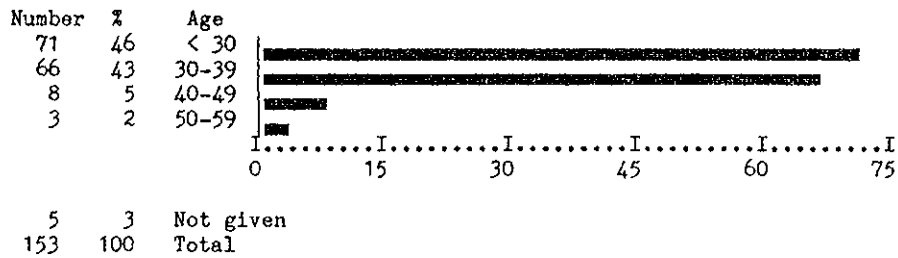
Figure 2.2

Age of immigrants to UK by category of respondent

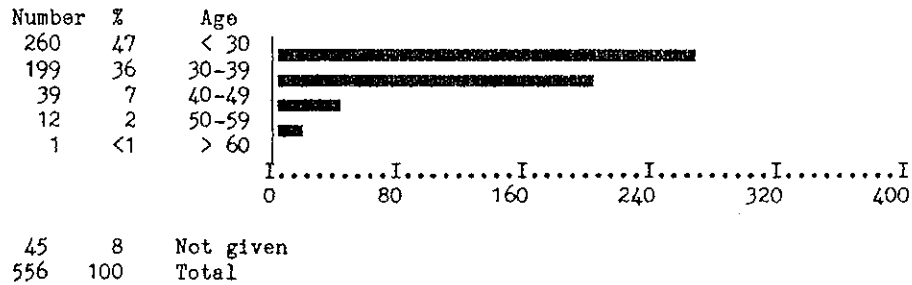
a) University research group leaders



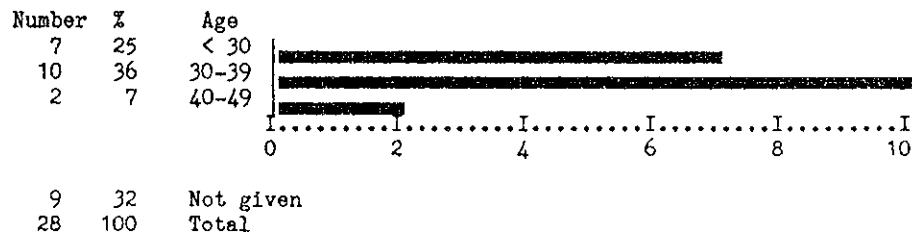
b) University heads of department



c) Total university response ((a) + (b))



d) Industry



e) Government/Research Council establishments

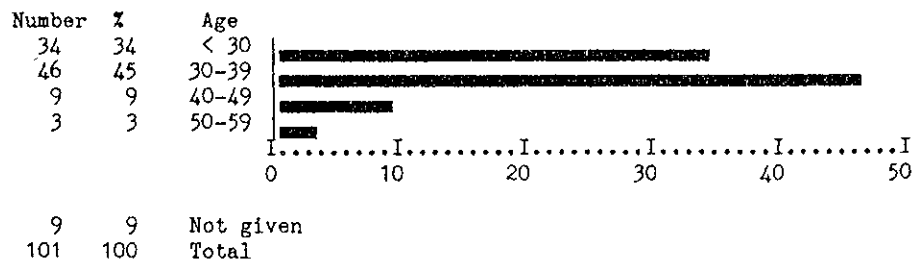


Figure 2.3 Year of emigration from UK by category of respondent

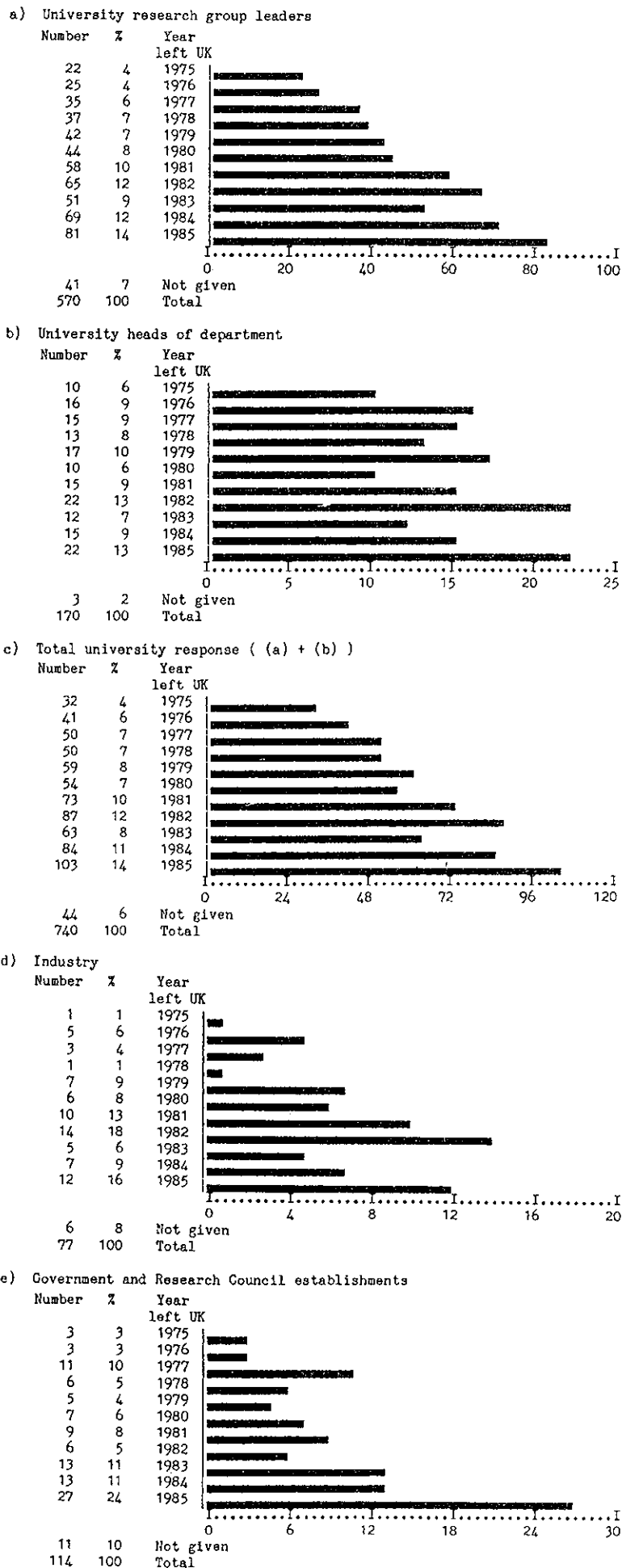


Figure 2.4 Year of immigration to UK by category of respondent

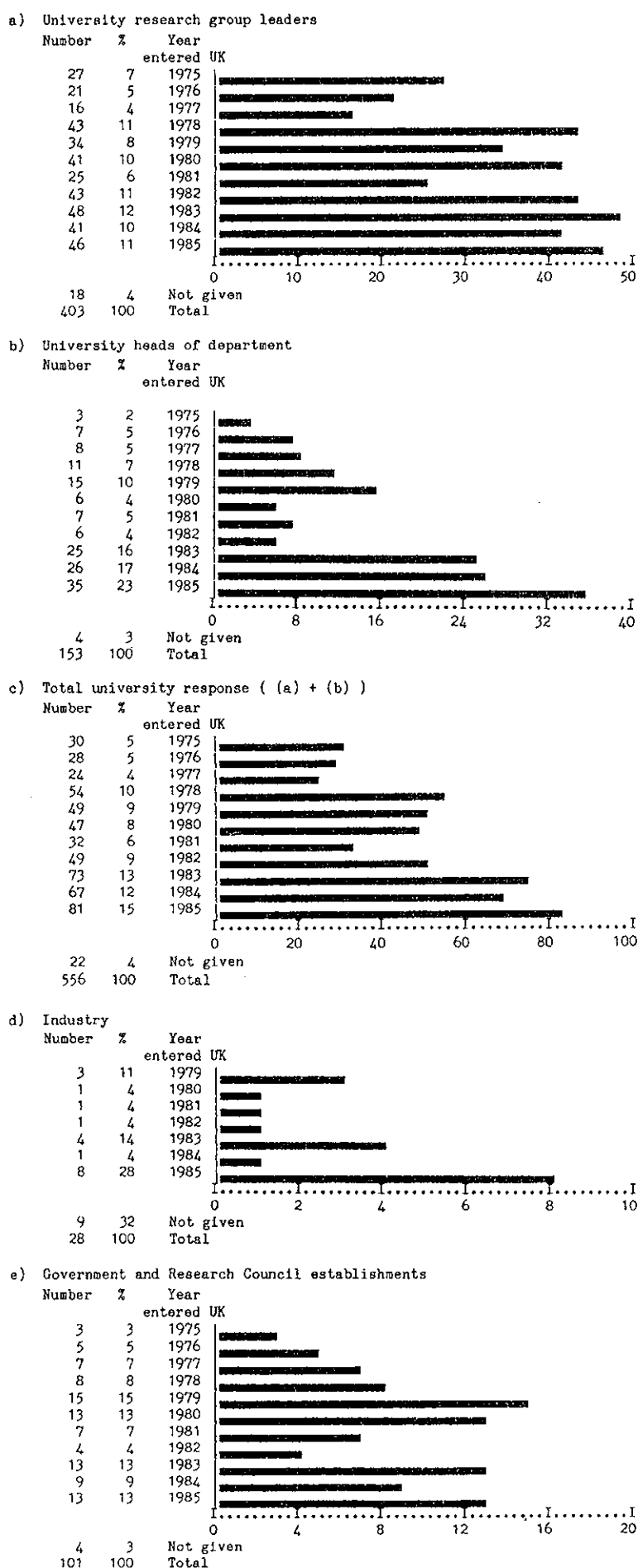


Table 2.14

Seniority/Grade of emigrants from UK by category of respondent

Seniority	University (RGL & HoD)		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%
Senior (incl. Profs/ Readers)	40	5	13	17	22	19
Middle (incl. Senior Lecturers)	27	4	37	48	40	35
Junior (incl. Lects/ Assist. Lects)	91	12	23	30	45	39
Other (incl. Research Fellows)	54	7	4	5	7	6
PDRA	214	29	-	-	-	-
PG	314	42	-	-	-	-
Totals	740	100	77	100	114	100
						Overall total 931

Table 2.15

Seniority/Grade of immigrants to UK by category of respondent

Seniority	University (RGL & HOD)		Industry		Govt/ Res. Cncl	
	N	%	N	%	N	%
Senior (incl. Profs/ Readers)	16	3	1	4	14	14
Middle (incl. Senior Lecturers)	9	2	12	43	45	44
Junior (incl. Lects/ Assist. Lects)	126	23	6	21	38	38
Other (incl. Research Fellows)	124	22	9	32	4	4
PDRA	266	48	-	-	-	-
PG (those remaining after study)	15	2	-	-	-	-
Totals	556	100	28	100	101	100
						Overall total 685

Table 2.16
Employment opportunities in research in the UK for new PhDs by discipline

	(University response)												Overall totals 294			
	Biochemistry	Chemistry	Earth Sciences	Electronic Engineering	Physics	Biochemistry		Chemistry		Earth Sciences		Electronic Engineering		Physics		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Very good	4	6	11	14	-	-	28	57	20	24						
Fairly good	23	33	49	62	5	28	13	27	26	31						
Fairly poor	26	38	10	13	5	28	6	12	20	24						
Very poor	9	13	2	2	6	33	1	2	13	15						
Other	7	10	7	9	2	11	1	2	5	6						
Totals	69	100	79	100	18	100	49	100	84	100						
No response	39		59		14		42		33							

Appendix A

QUESTIONNAIRES

The questionnaire sent to university research group leaders follows.

Similar questionnaires were sent to university heads of department, and to Government, industrial and Research Council establishments.

THE ROYAL SOCIETY

POLICY STUDIES UNIT

MIGRATION OF SCIENTISTS & ENGINEERS TO AND FROM THE UK

Questionnaire

A. PERSONAL BACKGROUND OF RESPONDENT

1. Name:

Position:

2. Institutional address:

3. (a) General discipline (ring as appropriate)

Biochemistry Chemistry Earth sciences Electronic engineering

Physics Other (please specify)

(b) Main specialization:

(e.g. genetics; surface chemistry; geology; circuit theory;
nuclear physics)

4. (a) Average size of your research group(s) over the past 10 years
(or since establishment, if more recent):

Average number of :

post-graduate students
post-doctoral research assistants (PDRA)
more senior academic staff
other

(b) When was your research group(s) established?

B. MIGRATION OF SCIENTISTS & ENGINEERS FROM YOUR RESEARCH GROUP(S)

On the next sheet, please list details of all members of your research group(s), of British nationality, **who have left to work overseas** during the past 10 years.

Separate columns are provided for each individual who has migrated. Please continue on a separate sheet, if necessary - one additional sheet is enclosed for this purpose.

[If no members of your group have migrated to or from the UK, please ignore the rest of the questionnaire but return it, having completed section A, in the envelope provided. This will avoid sending you a reminder and help us to calculate the response rate.]

5. Members of your research group(s) (of British nationality) who have left to work overseas during the past 10 years

	(i) Name				
B	(ii) Last known address overseas				
A					
C					
K	(iii) Main field of specialization (e.g. genetics; nuclear physics)				
G					
R	(iv) Highest qualification (PhD, BSc,...)				
O					
U	(v) Year highest qualification obtained (approx.)				
N					
D	(vi) Country where highest qualification obtained				
	(vii) Country of destination				
	(viii) Nature of overseas employment (put appropriate letter as * below)				
E					
M					
V	(ix) Short (S) or Long-term (L) (>3 yrs) appointment overseas				
P					
L					
O					
R					
S					
Y					
E	(x) Year left UK				
M					
A					
E	(xi) Approximate age when left UK				
S					
N					
T					
	(xii) Returned to UK? [Yes(Y): No(N): Not Known(NK)]				
	(xiii) Position in research gp. when left UK [eg PG student, PDRA,...]				
L					
A					
S					
P					
T					
O					
S	(xiv) Short(S) or Long-term (L) (>3 yrs) appointment in UK research gp.				
U					
T					
K					

* See (viii) above
 (a) university/equivalent
 (b) industry/commerce
 (c) independent research institute
 (d) government/public service
 (e) non-scientific employment
 (f) student
 (g) other (specify in table above)

If necessary, please continue on the next sheet.

6. Of those listed in question 5, who have migrated from the UK and are now working overseas, how many do you regard as outstanding?

PG students PDRA More senior academic staff

7. What, in your opinion, were the most common reasons that persuaded British staff to take up overseas posts? (Ring up to 3 appropriate letters below)

- | | |
|--|---|
| (a) rates of pay | (g) personal reasons (e.g. family connexions) |
| (b) status of science | (h) career opportunities abroad |
| (c) scientific vigour | (i) career limitations in the UK |
| (d) standard of living | (j) working conditions |
| (e) political climate | (k) desire to widen experience |
| (f) level of equipment/research facilities | (l) other
(please specify briefly) |

8. How easy has it been to find replacements of equal calibre for those who have gone overseas? (delete as appropriate)

Very easy / Fairly easy / Fairly difficult / Very difficult

9. What, in your view, are the present employment opportunities in research in the UK for new PhDs in your specialization? (delete as appropriate)

Very good / Fairly good / Fairly poor / Very poor

10. What proportion of the best new PhDs in your specialization (of British nationality) :- (please ring appropriate asterisks)

	Majority	Minority	Very Few	None
(a) continue in UK research?	*	*	*	*
(b) continue in other UK scientific work?	*	*	*	*
(c) leave scientific work altogether?	*	*	*	*
(d) take up scientific work abroad?	*	*	*	*

11. Do you consider that the migration of British scientists to overseas posts is having an adverse effect on British research in your specialization?

Yes / No (delete as appropriate)

If Yes, is this effect :- Serious / Minor (delete as appropriate)

C. MIGRATION OF SCIENTISTS & ENGINEERS TO YOUR RESEARCH GROUP(S)

On the next sheet, please list details of all those **who have joined your research group(s) from abroad** during the past 10 years, excluding post-graduate students on short-term (up to 3 years) attachment.

Separate columns are provided for each individual. Please continue on a separate sheet, if necessary - one additional sheet is enclosed for this purpose.

12. Members of your research group(s) who have joined from abroad during the past 10 years

	(i) Name				
B	(ii) Current address (if no longer in your department)				
A	(iii) Main field of specialization (e.g. Genetics; nuclear physics)				
C	(iv) Nationality (if naturalized British put N)				
K	(v) Highest qualification (PhD, BSc,...)				
G	(vi) Year highest qualification obtained (approx.)				
R	(vii) Country where highest qualification obtained				
O	(viii) Nature of previous overseas employment (put appropriate letter as # below)				
U	(ix) Country of previous overseas employment				
N	(x) Year appointed to UK research group				
D	(xi) Approximate age when appointed				
	(xii) If subsequently left UK, year of departure				
	(xiii) Position in UK research group [eg PG student, PDRA,...]				
	(xiv) Short(S) or Long-term (L) (>3 yrs) appointment in UK research gp.				

* See (viii) above
 (a) university/equivalent (e) non-scientific employment
 (b) industry/commerce (f) student
 (c) independent research institute (g) other (specify in table above)
 (d) government/public service

If necessary, please continue on the next sheet.

13. Of those listed in question 12, now working in the UK, how many do you regard as outstanding?

PDRA More senior academic staff

14. What, in your opinion, were the most common reasons that persuaded non-British staff to work in the UK?
(Ring up to 3 appropriate letters below)

- | | |
|--|---|
| (a) rates of pay | (g) personal reasons (e.g. family connexions) |
| (b) status of science | (h) career opportunities in the UK |
| (c) scientific vigour | (i) career limitations abroad |
| (d) standard of living | (j) working conditions |
| (e) political climate | (k) desire to widen experience |
| (f) level of equipment/research facilities | (l) British educational system |
| | (m) other
(please specify briefly) |

15. What were the most common reasons that persuaded British staff to return to work in the UK (if applicable)? Please list up to 3 appropriate letters as in question 14 above.
.....

D. GENERAL COMMENTS

16. Have you any other comments in connexion with this study?

Thank you for your help.

Signature:

Date:

Appendix B

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