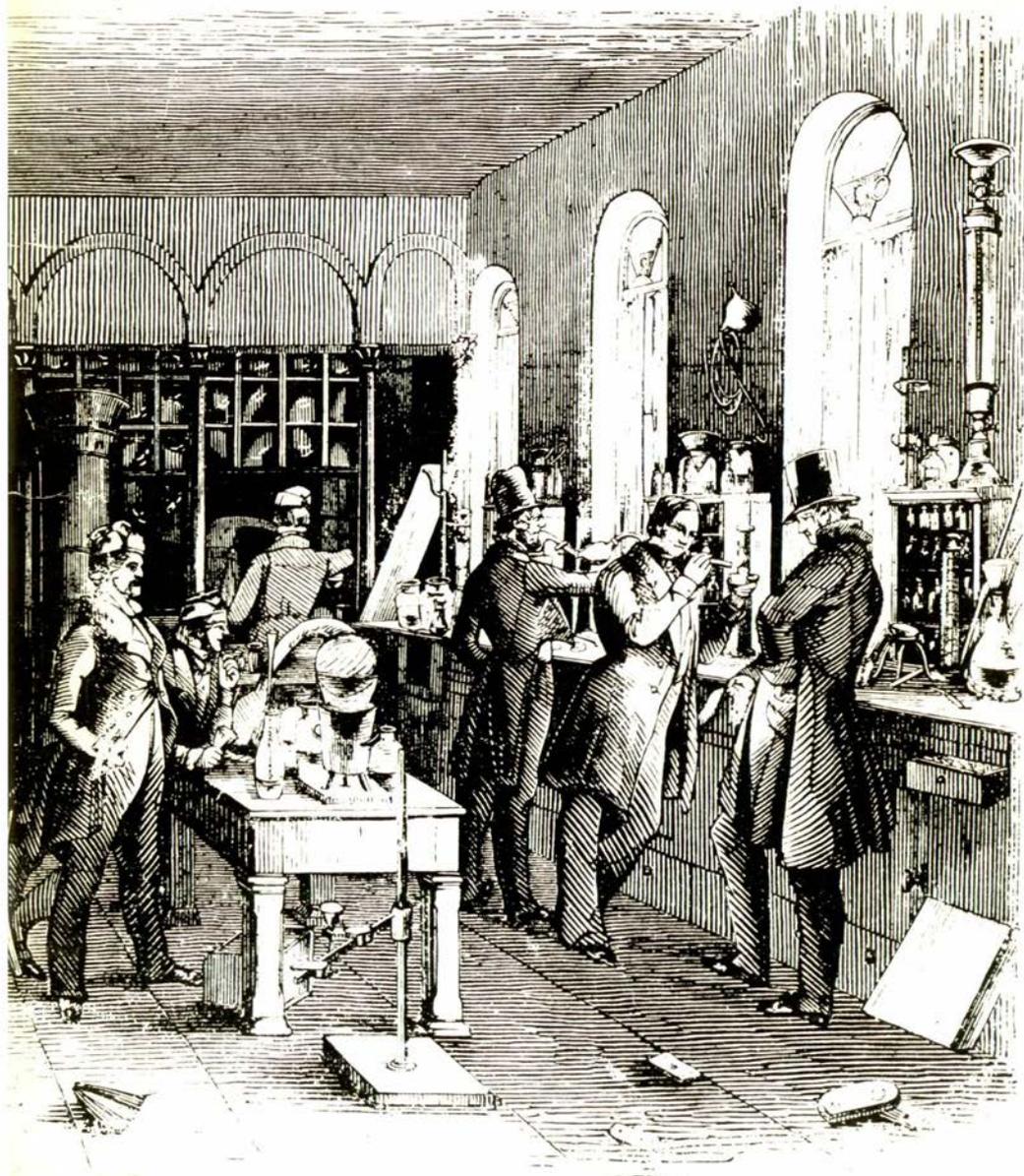


# CRISIS IN RESEARCH



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**Researched and written by Nicholas Wells.**

## **Office of Health Economics**

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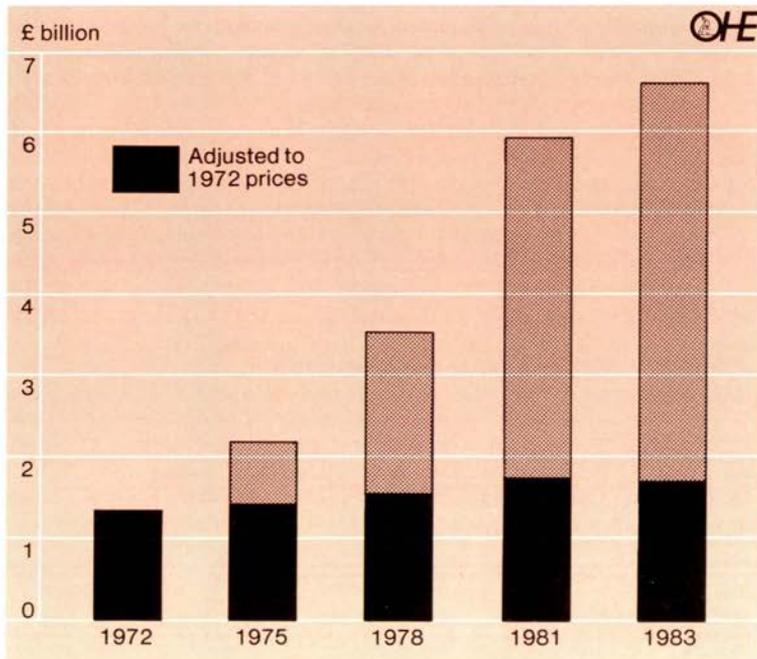
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## Introduction

In 1983, almost £6.6 billion was spent on research and development in the United Kingdom. This sum was five times that recorded in 1972 and even when account is taken of the high levels of inflation experienced over the period, this increase still represents real growth of 28 per cent (Figure 1). The resources channelled into research and development now account for 2.55 per cent of gross domestic product and are approximately equivalent to combined central and local government spending on housing or consumer expenditure on tobacco (1983 data).

Yet despite the scale of investment indicated by these figures, there exists a widely-held view that research in Britain has reached a point of crisis. The scientific journal *Nature*, for example, carried a two-page leading article in one of its 1984 issues examining the reasons for what it described as the 'Dead-end for British research' (*Nature* 1984). Later that year Martin and his colleagues (1984) wrote in an article entitled 'The writing on the wall for British science' that 'international comparisons suggest that Britain's basic science is rapidly declining in quality and quantity'. More recently, the Chairman of ICI, Britain's largest

Figure 1 Expenditure on research and development, UK 1972–83.



Source Annual Abstract of Statistics, 1986 Edition.

manufacturing enterprise and the first company to achieve profits of one billion pounds earned in a single year, is reported to have said that growing concern about the status of British research has 'led us to start increasing our links with overseas universities that we see as centres of excellence' (*Guardian* 1985). And *New Scientist*, in a final editorial for 1985, proclaimed that the preceding 12 months had witnessed 'the final passing of Britain as a leading member of the world of science' (*New Scientist* 1985).

The developments underlying these statements are a source of considerable concern. Apart from their impact on Britain's hitherto unquestioned position among the nations at the forefront of scientific progress, they have profound implications for the future economic prosperity of the nation. Chilver and Merrison (1983) have observed that 'the economy of a modern industrial trading nation depends critically on the efficiency and speed with which it is able to exploit science and technology. And the part played by fundamental research is crucial in underpinning the nation's long-term ability to produce new technological concepts'. These observations, coupled with the highly effective and rapidly growing competition from the newly-industrialising countries in products employing established technologies, emphasise the fundamental importance of a sound research base to economic regeneration in this country.

More specifically, it is hoped that innovative new products could pave the way for a much-needed boost in export earnings. During the early 1980s, the United Kingdom's positive visible trade balance diminished gradually until 1983 when it became a negative entity. The following year an emphatically greater loss was recorded (Table 1). In both years, however, sufficient revenue flowed from trade in invisible items to leave an overall positive balance of payments, on the current account. Yet the prospects for the future are uncertain. Throughout 1981-84, the average annual rate of growth of imports was greater than that for both exports and net visible earnings. Arguably more ominous, however, is the fact that since the second half of the 1970s, the export performance of the United Kingdom has relied heavily on

**Table 1 UK balance of payments, current account, 1981-84, £ millions.**

	<i>Visible Trade</i>			<i>Invisibles</i>			<i>Current Balance</i>
	<i>Exports</i>	<i>Imports</i>	<i>Balance</i>	<i>Credits</i>	<i>Debits</i>	<i>Balance</i>	
1981	50,977	47,617	3,360	29,644	26,071	3,573	6,933
1982	55,565	53,510	2,055	31,396	28,528	2,868	4,923
1983	60,776	61,941	-1,165	35,268	30,857	4,411	3,246
1984	70,377	74,632	-4,255	39,929	35,050	4,879	624

*Note* Figures are on balance of payments basis and are seasonally adjusted.

*Source* Economic Trends, HMSO.

sales of North Sea oil. In 1984 oil accounted for 21 per cent of export income and in its absence, the overall current account balance would have been at least minus £14,200 million instead of plus £624 million. Uncertainty surrounds the exact timing of the ultimate exhaustion of the United Kingdom's oil reserves. There would, however, be little dissent from the view that initiatives are urgently required now to devise means of compensating for the inevitable disappearance of this economic cushion.

Inadequate finance is almost universally considered to be at the root of the present difficulties facing research. Funds are made available by numerous institutions, associations and charitable bodies but the main sources are government and industry. Expenditure by the latter grew from £3.79 billion in 1981 to £4.16 billion in 1983.<sup>1</sup> However, it is estimated that the costs of research increased by more than 16 per cent during this period. Consequently, the volume of expenditure on industrially performed research and development fell by 6 per cent over the two years (Department of Trade and Industry 1985). Inevitably these figures disguise sectors of real growth – the chemical, electronics and motor industries, for example, all raised their research investments by amounts that more than compensated for inflation – but the overall pattern of decline clearly remains a source of major concern.

It has, however, been the financing of research by government that has dominated attention in recent years. Funds from this source support research in academic centres. Consequently, these monies are crucial to advances in basic scientific understanding that in turn provide the platform for industrial innovation. Yet increasing financial stringency in this sector has meant that funds have not been available for growing numbers of highly rated research projects. Furthermore, these developments are occurring at a time of rapid expansion in the opportunities for new research initiatives. As a result, the potential for scientific progress has been inhibited. Linked to this situation there has been an inevitable decline in morale within the research community and in the attractiveness of scientific investigation as a career option.

Against this background, the present paper examines the state of research in Britain today. The analysis is first concerned with scientific research in general and then focuses on the specific issues that confront medicine. In the latter context the problems which beset the Medical Research Council and pharmaceutical research are considered in detail. The important role of the charities in financing medical research – projections indicate that funds from this source could soon overtake those supplied by the Medical Research Council – is also discussed. The final section of the paper raises a series of fundamental questions that need to be addressed – and resolved – if maximum benefit is to be derived from the increasingly scarce resources available for research endeavours.

<sup>1</sup> Government finance in fact accounts for 30 per cent of industrial expenditure on research and development.

## The Funding of Research

The core issue in the present debate concerns the adequacy of the United Kingdom government's contribution to the funding of research and development. The central authorities account for approximately half of the nation's total spending on research. However, as Figure 2 makes clear, a substantial proportion of this expenditure (about 50 per cent) is allocated to defence. This pattern of resource distribution differs markedly from that obtaining among the United Kingdom's major economic competitors (Figure 3). The priority that the UK government attaches to defence research results in a higher proportion of national wealth being channelled into this area than in any of the other major OECD nations shown in Figure 4, with the exception of the United States.

Expenditure by the UK government on civil research in 1983/84 amounted to £1.94 billion. This sum was £46 million less than the amount spent on defence research. Nevertheless international comparisons contained in Figure 5 indicate that the UK government allo-

Figure 2 Government research and development expenditure by broad sector, 1983/84.

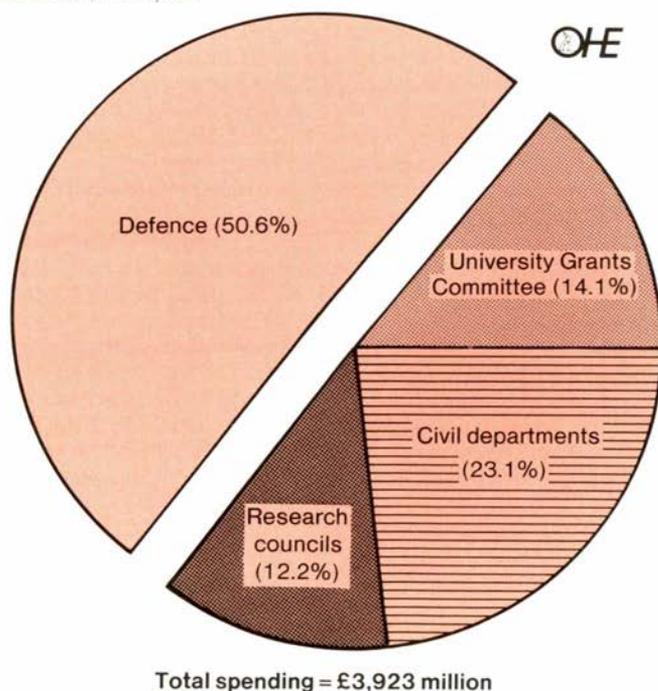
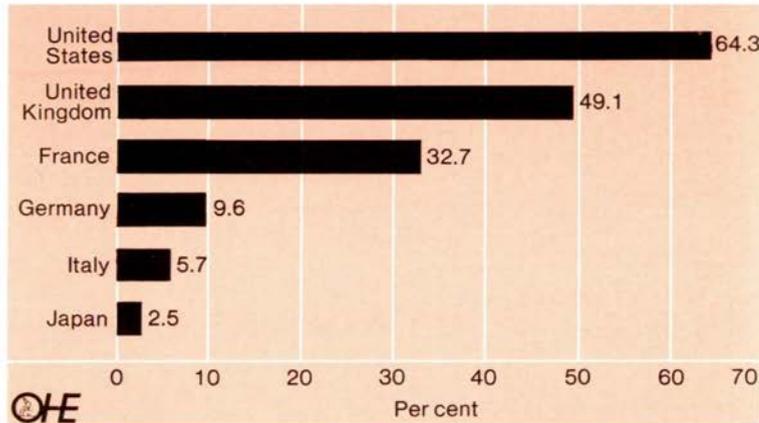


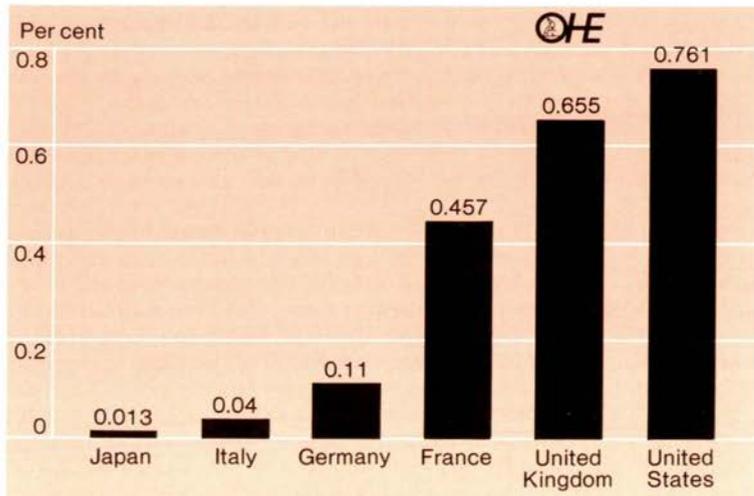
Figure 3 Government funded research and development: proportion of total allocated to defence research in selected OECD countries in 1983.



Note: Japanese figures are for 1981.

Source: Annual Review of Government Funded R & D 1985.

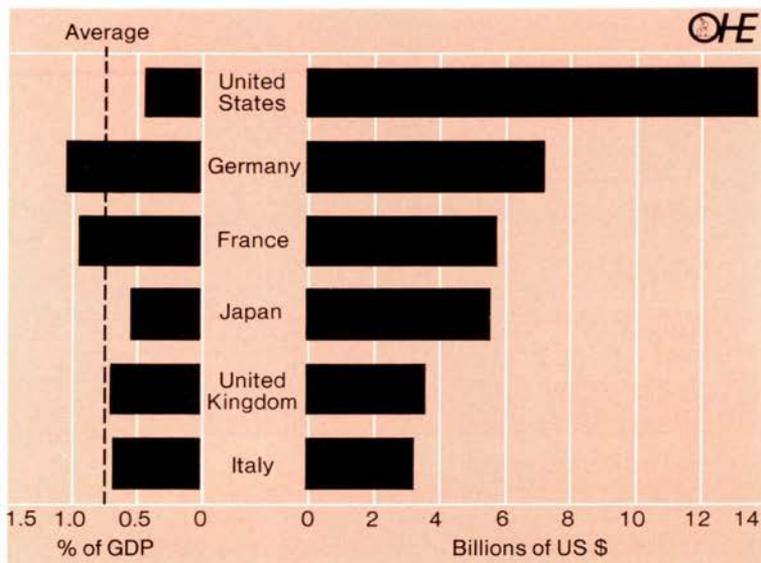
Figure 4 Percentage of gross domestic product allocated by Government to defence research in selected OECD countries in 1983.



Note: Japanese figures are for 1981.

Source: Annual Review of Government Funded R & D 1985.

Figure 5 Government spending on civil research and development in 6 OECD nations in volume terms and as a percentage of gross domestic product, 1983.



Source Annual Review of Government Funded R & D 1985.

icates a proportion of gross domestic product to civil research that is similar to the average for all of the nations shown in the diagram. A sharply different picture emerges, however, when account is taken of international variations in wealth (Figure 5). For example, the percentage of gross domestic product spent by government on civil research in Japan is about three-quarters of that found in the United Kingdom but the cash sum involved is in fact almost half as much again.

International comparisons have of course to be treated with caution for several reasons. Apart from the formidable difficulties of compiling accurate and comparable indicators, account needs to be taken of the fact that governments involve themselves to differing degrees in the financing of research. Thus funding that falls within the domain of the central authorities in one country might be undertaken by private enterprise or the relevant nationalised industry elsewhere.

Nevertheless, available data indicate that public sources account for broadly similar proportions (between 40 and 50 per cent) of national expenditure on research and development in the United Kingdom. France and Germany and spend approximately the same percentages of gross domestic product on the activity as a whole. Yet the volume of government monies spent on civil research in the United Kingdom is

**Table 2 Government expenditure on research and development by department in 1983/84.**

<i>Department</i>	<i>£ millions</i>
<b>Civil Departments</b>	
MAFF	118.6
DES	11.4
DEn	34.0
UKAEA	203.8
DoE	32.4
ODA	20.8
DHSS	27.7
HSC	8.3
Home Office	12.2
DTI	313.1
DTp	27.8
NI Departments	14.3
Scottish Departments	49.5
Other Departments	33.2
<b>Total Civil Departments</b>	<b>907.4</b>
<b>Research Councils</b>	
AFRC	44.4
ESRC	17.5
MRC	113.0
NERC	59.8
SERC	245.1
<b>Total Research Councils</b>	<b>479.8</b>
UGC etc	551.0
<b>Total Civil</b>	<b>1,938.2</b>
<b>Ministry of Defence</b>	
MOD (Research)	357.2
MOD (Development)	1 555.8
MOD (Staff & Superannuation)	71.0
<b>Total Defence</b>	<b>1 984.0</b>
<b>Net Total</b>	<b>3,923.0</b>

Source Annual Review of Government Funded R & D 1985.

approximately two-thirds that in France and half that in Germany. From the perspective of the United Kingdom, these discrepancies are a reflection not just of the lower level of national wealth but of the substantial funding of defence research compared to the other countries.

### The 'Science Base'

Public expenditure on civil research originates from many different sources. The data contained in Table 2 indicate that in 1983/84 government departments together accounted for 47 per cent of spending on this activity although there are of course marked variations in the contribution to this total from individual departments. It is, however, the direct funding by government of research undertaken in universities and by the research councils that is the concern of the present paper. These two sectors constitute the nation's science base which 'provides our national research capability and trains the highly qualified manpower essential for our increasingly science-based society' (Joseph 1985).

In 1983/84, the universities and the research councils received a total of £1,031 million. This sum represented 26 per cent of all government spending on research and development during the financial year in question. However, both parts of the system have been experiencing severe financial pressures and it is the difficulties to which the latter have given rise that underlie the current concerns of the research community.

Within the university system, one of the major sources of financial support for research is the University Grants Committee (UGC).<sup>2</sup> This body distributes resources to the universities in the form of block grants to cover teaching and research. The precise allocation of UGC funds between these two activities is unknown<sup>3</sup> but research is now estimated to account for around £600 million of the total each year (Education, Science and Arts Committee 1985). In the science fields, the UGC's input into research is designed 'to provide the basic floor of research capability in university departments which is necessary if speculative ideas are to be generated and developed to the stage where they may attract support from external sponsors', such as the research councils (Cabinet Office 1984).<sup>4</sup> However, the UGC has experienced cuts in its budget since the start of the decade. Overall, university funding has declined by about 8 per cent since 1981-82 and there is evidence to suggest that cuts have fallen disproportionately on research (ABRC

2 Funds also come from research councils, government commissions, industrial sponsorship and charitable bodies.

3 Estimates of the volume of UGC resources channelled into research are based on a long-standing formula which allocates about one third of university workers' time to this activity. This division originates from an exercise undertaken in the 1960s in which university staff maintained a record of their activities for a period of one week (Lamb 1985). However, apportionment in this way may be less relevant today and a study is currently in progress which it is hoped will provide better information on the volume and distribution of university research (Walden 1985).

4 The combination of these two types of money constitutes the 'dual support system'.

1985). Furthermore, it is estimated that the universities' budget is continuing to shrink at between one and a half and two per cent per annum after allowing for increased costs and the problems of setting salary increases within the government's national allowance (*Nature* 1985a).

Reductions in available resources on this scale have inevitably had a deleterious impact on the provision of basic equipment, technician assistance and other elements of infrastructure. In turn, this development has resulted in some research council funds intended for use as research grants being diverted to supply basic support facilities. Furthermore, it has meant that 'able research groups are frequently ill-provided with research support, even in competitive fields where being second counts for very little' (*Nature* 1985).

With regard to the research councils, available data indicate that Government pledges<sup>5</sup> to protect the total combined income of these bodies appear to have been fulfilled. Table 3 shows that over the period 1981/82 to 1984/85 the growth in the Science Budget exceeded increases in price inflation by four percentage points. However, this apparent 'surplus' should not be interpreted as real growth in the capacity to support research for two principal reasons.

First, resources available to the research councils are increasingly being deflected from 'investigative' uses to meet other non-scientific costs. In addition to the demands arising from the cut-back in UGC

Table 3 Science budget 1981/82 to 1988/89.

	<i>Cash terms</i>		<i>Real terms</i>
	<i>£ millions</i>	<i>Index</i>	<i>Index</i>
1981/82	450.7	100	100
1982/83	481.6	107	100
1983/84	516.3	115	102
1984/85	549.9	122	104
1985/86 (Est)	583.9	130	106
1986/87 (Prov)	598.8	133	104
1987/88 (Prov)	613.5	136	103
1988/89 (Prov)	628.7	139	102

*Note* Figures do not include additions to the Science Budget announced in November 1985.

*Source* Cmnd 9428.

5 For example, the March 1981 Public Expenditure plans stated that: 'The Government wish to give protection to the support of basic science, an activity which underpins further development and is a particular strength of the United Kingdom. Within the declining level of the total programme for education and science, the plans allow for provision of science to be held broadly at the current level throughout that period. It should thus be possible for the Research Councils, along with other activities, to maintain their selective support for research in universities and polytechnics at broadly the current level at a time when provision generally for higher education is planned to decrease.'

monies noted above, a growing proportion of funds is being absorbed by superannuation and restructuring expenses. Unlike government departments, the research councils are required to meet both of these costs. Expenditure on superannuation is a major commitment – for the Medical Research Council, for example, these costs absorbed 8.5 per cent of its parliamentary grant-in-aid in 1984/85 – and one that will become increasingly significant for some of the research councils as they age with the passage of time (Brooke 1985). Restructuring costs are generated by programmes of early retirement, redundancy<sup>6</sup> and institute rationalisation. These measures are themselves a response to real reductions in income. An estimated £9 million of the Agricultural, Environmental and Economic and Social research councils' funds will be absorbed in this manner in the current financial year. The volume of resources available to the research councils for scientific investigation has also diminished as a result of annual pay awards in excess of the official allowance for increases in remuneration and because of reductions in the exchange value of sterling which have raised the costs of the international subscriptions paid by these bodies.<sup>7</sup>

Second, the costs of modern research have been, and are set to continue, increasing at a considerably faster pace than the costs of those items comprising the retail price index. The electron microscope, for example, is of central importance to research in many different fields including metallurgy, materials science, solid state physics and biology, but the cost of the best machines has risen from £12,000 in 1968 to between £250,000 and £1.5 million today (Bray 1985). Without access to the most advanced equipment, it would be impossible to maintain a position at the forefront of scientific progress.

The operation of these cost factors has meant that even though the pledge to maintain level funding has been more than fulfilled, the volume of research has not in fact been protected. Furthermore, this development has taken place at a time of expanding opportunities for research. Thus, whilst existing project commitments have come under increasing financial pressure, many of the growing number of new research proposals have failed to attract any funding at all. In 1978/79, the research councils as a whole were rejecting about 300 project grant applications of the highest quality (alpha-rated proposals) per annum. By 1984/85 this figure had risen to more than 650 (Table 4).<sup>8</sup>

6 By 1987/88, the shedding of posts since 1981/82 will have reduced the number of staff directly employed by the research councils by over 2,000 (ABRC 1985).

7 The cost of subscriptions for participation in international collaborative endeavours accounts for about 10 per cent of the research councils' total income. A large proportion of the sum involved stems from the Science and Engineering Research Council's membership of the European Centre for Nuclear Research (CERN).

8 In the specific instance of the Science and Engineering Boards of the SERC, a special steering group analysis of research grants awarded during 1982/83 revealed that more than 20 per cent of alpha applications in most subject areas were left without support. In physics, chemistry and materials science, the proportions of unfunded alpha applications were much greater at 28, 29 and 43 per cent respectively (Campbell 1984).

Table 4 Grant funding by four research councils 1980–81 to 1984–85.

Research Council	1980–81		1981–82		1982–83		1983–84		1984–85	
	Funded research grants	Unfunded alpha-rated grant applications	Funded research grants	Unfunded alpha-rated grant applications	Funded research grants	Unfunded alpha-rated grant applications	Funded research grants	Unfunded alpha-rated grant applications	Funded research grants	Unfunded alpha-rated grant applications
AFRC	107	—	134	—	105	47	142	39	103	93
MRC <sup>1</sup>	472	59	495	66	516	25	473	199	440	87
NERC	176	50	160	153	180	60	120	185	128	43
SERC	2,047	148	1,980	451	2,141	452	2,151	490	2,269 <sup>2</sup>	437

1 The MRC figures for funded grants relate to short term support only.

2 Provisional figure.

Source Hansard 20th January 1986. Cols. 79–80.

In addition to causing the abandonment of many potentially valuable research projects or at least delaying their start, the scarcity of finance may be having an undesirable impact on the distribution of those monies that are available. Williams (1985), for example, has suggested that under present circumstances, well-established research teams may be more likely to attract financial support than less well-known groups pursuing perhaps more innovative endeavours. Uncertainty surrounding future supplies of funds may in addition be fostering a situation in which 'short-term projects with easily attainable results are favoured and long-term more fundamental research is neglected' (Wellcome Trust 1985).

Debate has also focused on what is seen by some commentators as an increasing preference for economically relevant applied projects at the expense of basic pure research. In particular, concern has been expressed that the United Kingdom now spends a smaller fraction of its research and development budget on basic research, the seedcorn of tomorrow's technologies, than any of its major competitors (Irvine 1984). Further reductions could be highly damaging because progress in strategic<sup>9</sup> and applied fields depends on new insights in the related basic sciences. Consequently, adequate resources must be available to the latter in order to foster technological advance. Such support is also required to facilitate understanding of the developments emanating from research centres in other countries and to train the scientists and technologists who are responsible for transferring new knowledge from the laboratory to industry.

Thus science, as the Advisory Board for the Research Councils (1985) has observed, 'is now so pervasive and the application so widespread that most basic science is relevant to the practical needs of society'. More specifically, 'industrial innovation without an underpinning research capability is not a realistic option' as the Secretary of State for Education and Science stated in the House of Commons debate on the government's policy for science last summer (Joseph 1985). Yet evidence based on citations in scientific papers and patents, patent registrations, papers produced and Nobel prizes awarded suggests that basic science in the United Kingdom is now in a state of decline (Bray 1985).

The developments described above have been associated with a number of costs. In particular, morale within the research community has been damaged and as a consequence, able young people are rejecting careers in research (*Nature* 1984) whilst others, trained at high

9 Strategic research embraces investigations 'with clear potential for wide-ranging applications in industry, medicine and so on, but where it is too early in the development of the work for specific applications and products to have been clearly specified' (Joseph 1985). This type of research absorbs 40 per cent of the support provided by the research councils whilst applied and pure account for 20 and 40 per cent respectively.

expense to the nation, are seeking opportunities abroad.<sup>10</sup> The undesirable implications of these trends for the future of the United Kingdom's research capability are compounded by the direct impact of present and foreseeable resource constraints. The Advisory Board for the Research Councils, in its 1985 report to the Secretary of State for Education and Science, argued that although recent year-on-year reductions in the real resources available to the councils may appear to be modest, 'the cumulative effect may well be that by the end of this decade the UK's science base could be 10 per cent smaller than at the beginning'. Furthermore, 'if account is taken of pressures on the funding of university research through the UGC, the overall reduction in our basic science capability may be greater than this'.

## The Case of Medical Research

In some respects, medical research may be seen as a microcosm of the current state of general scientific research. In the publicly-funded sector, morale is declining as increasing numbers of highly-regarded research projects cannot be funded at a time when new knowledge is rapidly opening up promising areas for investigation. Yet available data suggest that the Medical Research Council (MRC) has in fact fared worse than some other research councils in recent times. Thus between 1981-82 and 1985-86 the MRC's grant-in-aid decreased by one per cent in constant price terms whereas corresponding funding for the Science and Engineering Research Council increased by 12 per cent (MRC 1986). In addition, the MRC's share of the Science Budget was 0.7 per cent less in 1984/85 than it had been in the previous year. This drop represented a loss of potential income in 1984/85 of £4 million.

Concurrently, research into new and better treatments for disease is also being threatened by new constraints imposed upon the pharmaceutical industry in the United Kingdom. The latter channels approximately four times as much finance into research and development as the Medical Research Council. However, the availability of resources in the ever-increasing volumes necessary to generate new medicines is now more than ever in question with the advent of prescribing restrictions and a series of cuts in the industry's permitted level of profitability.

There can be no doubt that medical research has had a substantial impact on man's health and well-being. Setting aside the now somewhat sterile debate over the relative contributions of environmental improvements and medicine to the decline in mortality from infectious disease, the major influence of medicine today is on the quality of life. Thus chemotherapy provides effective control of symptoms for indivi-

<sup>10</sup> One of the impacts of this trend has been an 'ageing of Britain's science'. A survey conducted by *New Scientist* found that the number of people under 35 years of age in teaching and research in the major scientific disciplines has declined steadily since 1980 by about 2 per cent per annum (Connor 1985).

duals suffering from complaints as diverse as asthma, arthritis, epilepsy, glaucoma, anxiety, depression, angina, hypertension and Parkinsonism. Equally, surgical intervention can, where appropriate, greatly enhance the quality of life for patients with, for example, severe angina, painful hip joints, intervertebral disc disorders and visual deficits caused by cataracts.

At the same time, it has of course to be acknowledged that pharmaceuticals and surgery, either alone or in combination, do in many instances promote extended survival. In this context, cardiac and renal transplantation provide dramatic examples of success and it is also noteworthy, although perhaps less widely appreciated, that cancer life-expectancy rates are now improving. Table 5 shows crude three-year survival rates for cancer cases registered in 1980 in England and Wales and the improvements (or otherwise) in survival experienced by these individuals compared with members of the 1977 cohort. Data from the Office of Population Censuses and Surveys also show that the crude five-year survival rates for cancer cases registered in 1978 were almost universally higher than those of the 1977 cohort.

### Medical Research Council

It is nevertheless clear that there is a need for more accurate understanding of causal mechanisms as well as improved means of treatment (Table 6) in practically all of the diseases to which man is susceptible, and not just in such major contemporary burdens as senile dementia, rheumatoid arthritis and multiple sclerosis. A degree of optimism may

**Table 5 Three-year survival of cancer cases registered in 1980 in England and Wales and percentage change on the survival experience of the 1977 cohort.**

<i>Age group</i>	<i>Males</i>		<i>Females</i>	
	<i>Crude 3-year survival rate (%)</i>	<i>% change on 1977</i>	<i>Crude 3-year survival rate (%)</i>	<i>% change on 1977</i>
0-4	63.2	11.5	55.6	-2.5
5-14	61.7	16.0	66.0	27.7
15-24	66.8	16.6	71.4	3.6
25-34	73.1	19.1	74.0	5.4
35-44	57.5	9.3	70.5	5.5
45-54	45.0	13.1	62.0	8.2
55-64	37.6	14.6	52.0	9.0
65-74	31.9	22.7	43.7	9.3
75-84	24.7	24.7	32.6	12.4
85 and over	18.3	22.0	21.5	19.4

therefore be drawn from the 1984/85 annual report of the Medical Research Council which highlighted many current projects with potential for realising significant advances in fundamental knowledge and treatment. The same document expressed concern, however, at the severe financial difficulties besetting the council and their potential impact on the experimental work required to improve the health of the community.

In 1984/85, the income of the Medical Research Council amounted to £123.7 million, most of which, £117.2 million or 95 per cent, was provided by the government via the grant-in-aid. The latter sum represented an increase of 15.2 per cent over the figure for 1981/82 (the year when the full rigours of cash-limits began to be applied). When inflation is taken into account, however, it emerges that the period witnessed a real decline in the MRC's funds from the government of 1.4 per cent (Table 7). Coupled with pay awards in excess of the allowance within the cash limit, increased pension contributions and raised international subscription costs, this reduction meant in fact that the MRC experienced a fall in its purchasing power of 4 per cent in 1984/85 compared with the previous year (MRC 1985). Against this background, Noble (1985) has observed that the MRC has 'passed from growth to level funding to decline in the space of about seven years'.

These deteriorating financial circumstances have severely inhibited the capacity to undertake medical research. During 1984/85 most MRC establishments had their laboratory supplies cut by 16 per cent and received no funds for capital equipment. As a result, there has been a restriction on work programmes and the rate of progress on several major initiatives has been less than the council would have wished (*British Medical Journal* 1985).

An additional effect of the financial constraints has been a reduction in the number of research grants awarded. The MRC's latest annual report estimated that the council was able to provide funding for only about 55 per cent of alpha-quality grant applications in 1984/85 (the remainder were categorised as 'approved but not funded'). Out-turn data are available for earlier years and show that 455 new project grants (usually up to three years' duration) were awarded in 1983/84 compared with 549 during the preceding year. Setting these figures in context, 52 per cent of applications were funded in the earlier year but this fell to 38 per cent in 1983/84.

Focusing on programme grants (support for research designed to achieve broad objectives with a normal tenure of five years) the MRC's statistics indicate that in 1982/83, 15 new awards were approved and 17 grants were extended for further periods of five years. In 1983/84, however, only 10 new awards were approved and nine programme grants were renewed for further periods of five years and three for shorter periods. The number of programme grants in existence has in fact shown a steady decline since the beginning of the present decade: on 1st January 1985, the number of such grants in being (123) was approximately three-quarters the total recorded four years earlier.

**Table 6 Progress in drug research during the past 50 years. Scale: None, poor, moderate, good, excellent.**

<i>Disease or condition</i>	<i>Progress</i>	<i>Examples of drugs discovered</i>
<b>Infection</b>		
Bacteria	Excellent	Antibacterials such as ampicillin, ceftazidime, cephalexin and trimethoprim
Fungi	Good	Griseofulvin, ketoconazole
Animal parasites	Excellent	Ivermectin
Viruses	Good–excellent (vaccines)	Poliomyelitis, smallpox, rubella and others
<b>Cardiovascular disease</b>		
Hypertension	Moderate–good	Methyldopa, propranolol, captopril
Thrombosis	Poor	
Atheromatous vascular disease	Poor	
Ischaemic heart disease	Moderate (drugs–surgery) Poor–moderate (infarction)	Propranolol, atenolol Timolol
Heart failure	Poor (selective inotropy) Good	Thiazides, captopril
<b>Alimentary tract</b>		
Peptic ulcer	Good	Cimetidine, ranitidine
<b>Skin diseases</b>		
	Moderate	Betamethasone valerate, fluocinolone acetonide, Retinoids
<b>Immune diseases</b>		
Allergy including bronchial asthma	Good	Glucocorticoid steroids, oral (prednisone) and inhaled (beclomethasone dipropionate). Selective bronchodilators (salbutamol). Disodium cromoglycate. Histamine H <sub>1</sub> -antagonists
Others including rheumatoid arthritis	Moderate	Glucocorticoid steroids, non-steroidal anti-inflammatory drugs

<i>Disease or condition</i>	<i>Progress</i>	<i>Examples of drugs discovered</i>
<b>Conditions involving the CNS</b>		
Mental illness	Moderate	Neuroleptic and anti-depressant agents.
Pain	Moderate	Pentazocine, buprenorphine
Anaesthesia (and associated surgical practice)	Good	Halothane
Parkinson's disease	Moderate	Levodopa
Epilepsy	Good	Phenytoin and others
<b>Cancers</b>	Poor-moderate	Methotrexate, tamoxifen
<b>Hormone and vitamin deficiencies</b>	Good to excellent	Vitamins, steroid hormones, synacthen

Source Jack 1985.

**Table 7 Grant-in-aid received by the Medical Research Council 1981/82 to 1987/88, £ millions.**

	<i>Cash prices</i>	<i>1981/82 prices</i>
1981/82	101.7	101.7
1982/83	107.5	100.4
1983/84	113.7	101.7
1984/85	117.2	100.3
1985/86	122.3	99.7
1986/87	128.3	
1987/88	130.8	

Source Medical Research Council 1986.

The Medical Research Council is thus facing acute difficulties in funding new work and in meeting existing commitments. The impact of these pressures is being experienced not only in the MRC's own research establishments (which account for approximately 60 per cent of total spending) but in university based medical research as well. The latter is also suffering directly from the University Grants Committee cutbacks. Reduced university incomes have diminished the capacity to cover the overhead costs of research. In addition, medical academic staff have been reduced – numbers are now 21 per cent fewer than they were five years ago (*The Times* 1985a) – and 'those still left in academic posts inevitably have less time for research since clinical service work and teaching must have priority' (Dickinson 1985). It has in fact been reported that in order to maintain patient services with fewer staff, many academics are spending three-quarters of their time treating patients when it is intended that they should devote only just over half their time to NHS work (*The Times* 1985a).

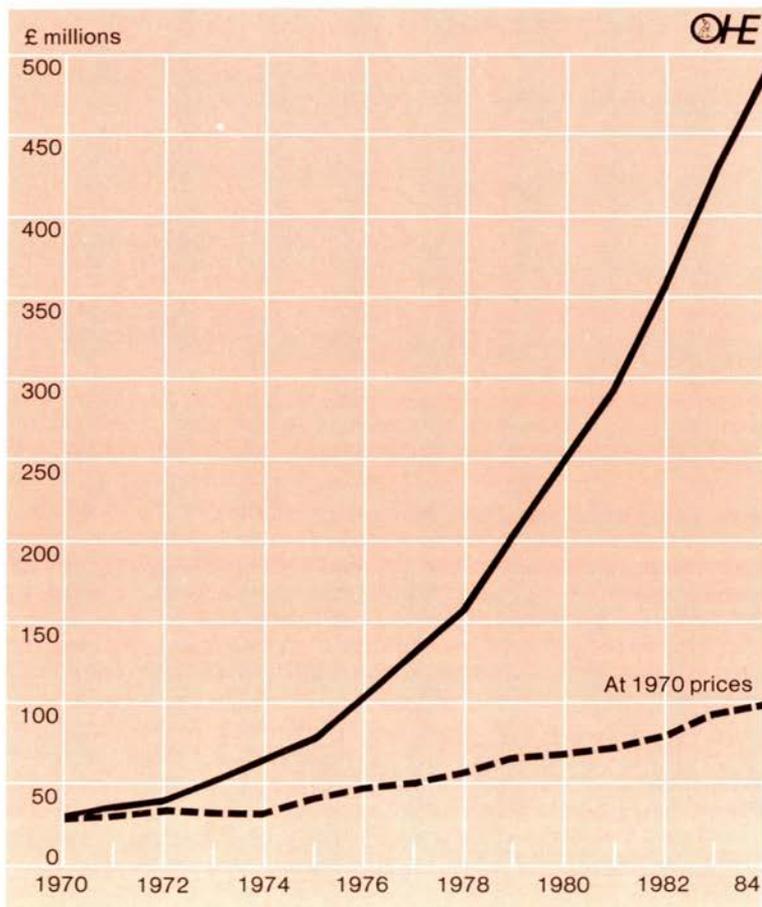
In addition to these more immediate costs, the current financial problems pose a threat to the future supply of personnel trained to undertake medical research. The Medical Research Council, for example, has cut the number of awards made to medical students reading for Master of Science degrees – from 109 three years ago to 75 this year – and is considering a complete withdrawal of financial support for this purpose. In addition, the number of PhD research students supported by the MRC has fallen from 273 three years ago to a current figure of 160 (Gowans 1985). At the same time, potential new recruits to the research community – already concerned at the risks of interrupting their clinical career paths within the NHS – are being discouraged from embarking on research by the poor promotion prospects and other disincentives that have been exacerbated by the present financial difficulties.

Apart from the obvious costs in terms of research opportunities foregone, the developments described in this section have had a damaging effect on morale. Evidence in this connection derives from many anecdotal and other more quantitative sources. For example, declining morale may be an important factor in the 21 per cent reduction in the number of grant requests submitted by university based researchers to the MRC between 1982/83 and 1985/86 (*Nature* 1985b). Other research workers have considered that the situation has deteriorated to such an extent that they have left the United Kingdom to seek opportunities abroad. In this regard it has been reported from the Department of Virology at Glasgow University that only three of the 15 British PhD's to graduate since 1981 are working in science within the United Kingdom – 10 of the group have gone to the United States (Subak-Sharpe and Marsden 1986). It is against this background that the Medical Research Council observed in its 1983/84 annual report that 'in medical research, the science base of the United Kingdom is in danger of being severely damaged'.

### Pharmaceutical Industry Research

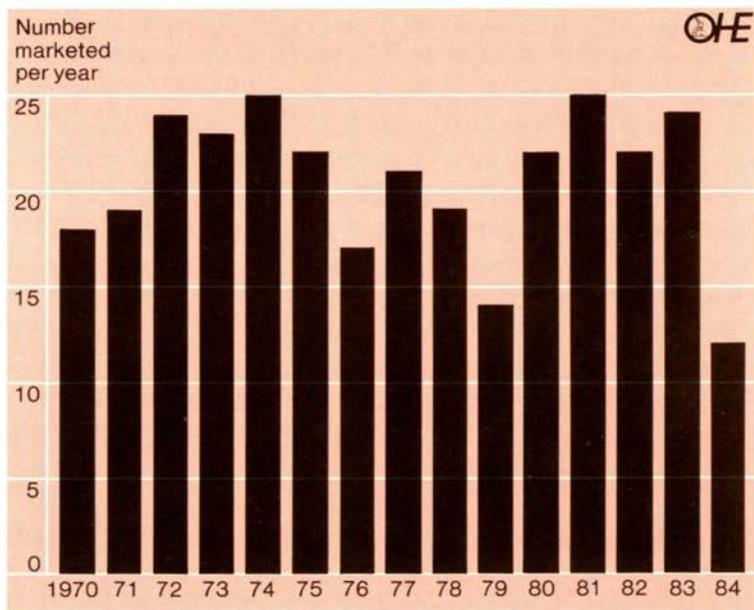
It is estimated by the Association of the British Pharmaceutical Industry that the United Kingdom-based industry spent about £490 million on research and development in 1984. The United Kingdom is in fact a major centre for commercial research and development in this field, attracting around 8 per cent of worldwide industry funds allocated to such endeavours. This position has been achieved because of the excellence of the academic medical research infrastructure in this

Figure 6 Pharmaceutical industry expenditure on research and development, 1970-84, £ millions.



Source ABPI Annual Reports.

Figure 7 Number of new chemical entities marketed in the UK, 1970-84.



Source Centre for Medicines Research, Private Communication.

country and the recognition by government of the benefits of a thriving pharmaceutical industry for the health of both the community and the nation's economic accounts. Yet the financial implications of recent government initiatives involving the industry, motivated by the general desire to contain public expenditure, pose a threat to future investment by pharmaceutical companies in the search for and development of new medicines.

Figure 6 shows that spending on research and development increased more than sixteen times between 1970 and 1984. In constant price terms this trend still represents expenditure growth of almost three and a half fold. However, these rising levels of investment have not been associated with increasing numbers of new medicines becoming available for use each year. Data collected by the Centre for Medicines Research indicate that the number of new chemical entities marketed in the United Kingdom over this period has remained relatively constant at approximately 20 per annum (Figure 7). The explan-

ation for this apparent anomaly lies primarily in the rapid escalation of development costs. The nature of pharmaceutical research is such that it is impossible to isolate the costs attributable to a specific new medicine but it is clear that they are now substantially greater than the £2 to £3 million estimated for the first half of the 1960s. In a consultative document published in 1981, the Pharmaceutical Sector Committee (1981) of the Chemical Economic Development Council reported that the 'cost of developing a successful major drug can now be £50 million or more'.

There is no single reason for this cost explosion. Explanations have been sought in terms of the need to employ increasingly sophisticated and correspondingly expensive research equipment and the possibility that as the relatively more straightforward chemotherapeutic needs have been met, attention has transferred to problems of greater complexity that are considerably more costly to resolve. However, analyses of the causes of the sharply rising expense of developing new medicines have focused largely on the lengthening of the period of time between initial discovery in the laboratory and eventual release onto the market. In the early 1960s, it was not unusual for this transition to be completed within about three years; today this phase may last between 12 and 14 years.

The trend towards lengthening development times is a function of several factors concerned with the testing of new medicines. In the first instance, it reflects progressive changes in the nature of chemotherapy. Many of today's medicines are complex substances which require prolonged administration to control chronic disease. The periods of testing associated with such preparations inevitably exceed those undergone by the early, relatively straightforward anti-infectives of the 'first pharmacological revolution'. In addition, the testing procedures themselves have become increasingly complex over time.

Another major influence has been the proliferation of official regulatory demands following the thalidomide tragedy of the early 1960s. As knowledge has advanced, new safety tests have been devised and these have been added to those requirements already facing potential new medicines. The direct impact of this trend on testing horizons has been compounded by delays within the regulatory authorities caused by the significantly increased volume of information that has to be analysed. Debate has been expressed about the need for some of the procedures that have been incorporated into the safety assessment system but the key point, in the context of the present paper, is that pre-marketing investigation has become greatly prolonged and this has added substantially to the cost of developing new medicines.

It is not possible to predict with accuracy what might happen to these trends in the future. Development times for a new medicine could, for example, level off as a result of measures introduced at the start of the present decade by the Committee on Safety of Medicines and the licensing authority to promote greater flexibility in pre-clinical testing and

to establish a clinical trial certificate exemption scheme respectively.<sup>11</sup>

Yet it might be speculated that any savings achieved in this respect would be counterbalanced by the additional expense generated by the increasing complexity of modern research projects. In spite of these uncertainties, it is highly unlikely that the financial burden of developing a new medicine will decline and that most probably, in view of the labour intensive nature of research and the ever-increasing costs of equipment and materials, it will continue to show year-on-year growth.

11 In 1984, the mean time taken by the Medicines Division of DHSS to approve product licence submissions reached a new high level (Table 8). This development represented a complete reversal of the steadily declining trend recorded since the beginning of the decade and may be attributed, *inter alia*, to staff shortages, the diversion of resources in order to complete the review of medicines by 1990 and the extra workload generated by licence applications for parallel imported products.

**Table 8 New chemical entity approvals and product licence determination times, United Kingdom, 1971–84.**

Year (Jan–Dec)	NCEs approved	Determination time in months			
	(actual No of PL applications)†	Mean	Median	Min	Max
1971	38 (NA)	8.4	NA	NA	NA
1972	31 (NA)	7.3	NA	NA	NA
1973	No information available.				
1974	19 (49)	9.6	7.8	1.9	35.0
1975	19 (26)	6.9	6.9	3.0	9.2
1976	19 (22)	7.9	8.0	2.0	18.8
1977	19 (37)	12.1	10.3	1.4	29.1
1978	20 (53)	13.8	11.3	0.7	34.2
1979	14 (47)	16.8	14.3	6.0	50.6
1980	23 (53)	17.4	12.7	2.0	50.5
1981	32 (57)	15.0	12.0	5.0	35.0
1982*	NA (49)	14.0	10.0	2.0	41.0
1983**	NA (29)	10.0	9.0	1.0	28.0
1984***	NA (9)	23.0	12.0	6.0	46.0

†Number of PL applications may exceed number of NCEs due to each formulation of the NCE requiring a separate PL.

Sources 1971–72 ABPI data quoted in Diggle and Griffin (1982) *Pharmacy International*, 3, 230–236.

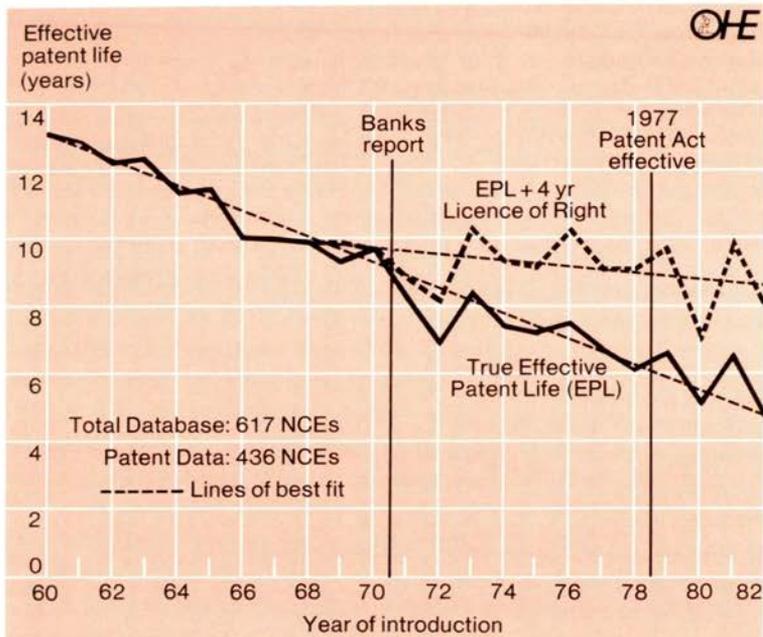
1974–81 from DHSS Data (*ibid*).

\* 1982 *MAIL* 37, May 1983.

\*\* 1983 *MAIL* 39, year Sept 1982–Sept 1983. All other years 1 Jan–31 Dec.

\*\*\* 1984 *MAIL* 43, June 1985.

Figure 8 The erosion of effective patent life, 1960–82.



Source Walker and Prentis, 1985.

If this analysis is correct, it follows that a key determinant of future success in utilising new knowledge of disease processes to produce novel and more effective medicines will be the availability of sufficient funds to finance research and development initiatives. However, this requirement is already under threat from two different sources. First, the lengthening of development times has significantly eroded the patent protection available to new medicines entering the market. Figure 8 shows that medicines first introduced in 1960 had an average of over 13 years of their patent lives still to run but by the early 1980s true effective patent life had fallen to five or six years. Even if account is taken of the licence of right period granted for new existing patents,<sup>12</sup> the protection afforded to recently introduced products is extended only to around nine years. With such a sharp reduction in the period of time during which marketing can take place without the presence of

<sup>12</sup> In June 1978, the UK followed the ruling of the European Patent Convention and raised patent terms to 20 years (previously 16 years) from the date of filing. Existing patents at this time were not granted an extension of their terms with the exception of those filed after 1967 (the 'new' existing patents). However, the latter had imposed upon them a licence of right endorsement which means that other companies can apply as of right to manufacture and/or sell the product concerned after the first 16 years of patent life.

price-lowering generic competition, manufacturers have found it increasingly difficult to obtain the volume of sales receipts required to cover research and development costs. These revenues are in fact employed to finance current research projects so that the erosion of patent life is effectively jeopardising future innovation.

A similar threat stems from recent government initiatives designed to contain the NHS medicines bill. The revenues that pharmaceutical manufacturers received from sales of medicines to the NHS totalled £1,702 million in 1984. However, this sum accounted in fact for only 9.8 per cent of overall NHS expenditure. Furthermore, international comparisons reveal that less is spent on pharmaceuticals in the United Kingdom than in many other nations. The data contained in Table 9 indicate that pharmaceutical consumption per capita in the United Kingdom is about half that of Switzerland, West Germany and the United States – the other three members of the group of four nations with a pharmaceutical industry that has, to date, been highly successful (Chew *et al* 1985).

In spite of these observations, the government of the United Kingdom, in pursuit of its general objective of containing public expenditure growth, recently introduced a number of measures which have cut the pharmaceutical industry's sales revenues from the NHS.<sup>13</sup> In 1983 the DHSS announced a 2.5 per cent overall price reduction on NHS medicines and a price freeze which took effect from the beginning of August with the goal of cutting the cost of the pharmaceutical bill by £25 million in 1983/84 and by £65 million in 1984/85. In December 1983, the target rate of return on capital for pharmaceutical companies supplying the NHS was lowered by four percentage points. Most recently, a limited list which prohibits the prescribing of certain medicines at NHS expense has been introduced with the intention of saving £75 million and the level of permitted return on capital has been cut again by another four percentage points.

Inevitably, data permitting a quantitative assessment of the impact of the reductions in the pharmaceutical industry's revenues described above will not be forthcoming for some time. It is nevertheless possible to speculate about some of the possible consequences. First, a combination of rising development costs and increasing limitations on the capacity to fund such activities will mean that fewer manufacturers will be able to remain among the ranks of the major innovators. Second, for companies still able to sustain a significant research and development programme, revenue reductions may lead to a reappraisal of policy options. As a result some companies may decide to cut back on the number of potential new medicines undergoing investigation at any one time. Manufacturers are also likely to become increasingly risk conscious and focus their efforts to a greater extent on 'safer' areas of research, that is, on diseases and therapies where knowledge is well-advanced and the 'market' is of sufficient size to offer reasonable pros-

Table 9 Pharmaceutical consumption per person in 1983.

	£	£
Japan	94	(75)
USA	81	(55)
West Germany	66	(61)
Switzerland*	64	(58)
France	52	(51)
Belgium	49	(45)
Canada	46	(35)
Italy	37	
Sweden*	35	(34)
Finland	34	(32)
UK	32	(32)
Australia	28	(26)
Denmark*	28	(26)
Norway	27	(26)
New Zealand	25	(30)
Ireland	25	
Netherlands	25	(22)
Spain	24	(24)
Greece	17	
Portugal	12	

\*1982 data.

Notes:

1. Pharmaceutical consumption is equated with manufacturers' returns and therefore dispensing and other related expenditures are not included.
2. The figures in the first column were calculated using January 1985 exchange rates. Those in parentheses were based on 1983 rates.

Source Taylor and Griffin 1985.

pects of recouping investment costs. Such strategies are of course ill-suited to exploiting the exciting advances now beginning to emerge from investigations of the disease processes underlying much contemporary ill-health.

Finally, concern over the possibility of further measures to limit the industry's income from NHS sales may, in view of the rising costs of and risks inherent in pharmaceutical research, render the latter an increasingly unsound investment proposition. In this context, a survey conducted by a firm of accountants has found that 'drug companies have deferred or cancelled investment in pharmaceutical production and research facilities worth more than £138 million since the government announced its plans for a restricted list of National Health Service drugs' (*The Times* 1985). Towards the end of 1985 a major United States pharmaceutical manufacturer announced plans to reorganise its production facilities in the United Kingdom – causing the loss of 140 full-time jobs – following the introduction of the NHS restricted prescribing list (*Financial Times* 1985). And in January 1986 it was reported that another large American company was shutting its pre-clinical research

unit in the United Kingdom. Government policies over the preceding two and a half years were cited as a 'significant and important element' in arriving at the closure decision (*Scrip* 1986). Against this background, it is clearly possible that continued government action perceived as 'unfavourable' to the industry could lead other companies to reject the United Kingdom as a manufacturing and research base.

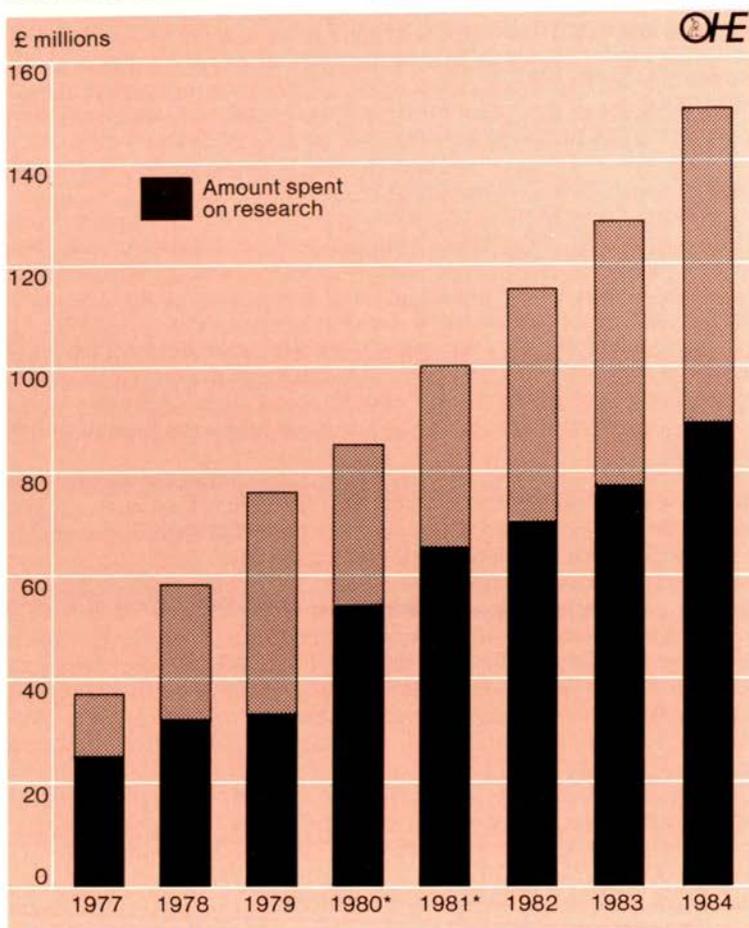
### **The medical charities**

At the same time as research funding by the academic and commercial sectors has become increasingly constrained, financial support for this activity provided by the medical charities has grown considerably. The latest annual report of the Association of Medical Research Charities (AMRC) records that the combined income of its 35 members amounted to £150 million in 1984 and that £89 million of this total was committed entirely to research (AMRC 1985). Furthermore, the latter sum understates the overall charitable commitment to research funding because it excludes the contributions of many other charities who do not belong to the Association.

The AMRC report indicates that the charities support research into a wide range of diseases but that two in particular, cancer and heart disease, attract substantial funding. Thus it may be estimated that the British Heart Foundation, the Cancer Research Campaign and the Imperial Cancer Research Fund together accounted for around 55 per cent of medical charities' spending on research in 1984. Expenditure on research projects by these bodies has led, and should continue to lead, to a clearer understanding of disease mechanisms which could in turn pave the way for therapeutic progress. In the field of cancer, for example, a succession of advances stemming from charity-financed research were reported during 1984, including the discovery of a cancer virus that appears to play a key role in cell multiplication. More recently, a research team substantially funded by the British Heart Foundation (BHF) has discovered two peptides believed to be capable of triggering constriction or dilation of the coronary arteries that could perhaps provide the basis for new medicines to control high blood pressure and coronary spasm (*The Times* 1985b).

The volume of research finance supplied by the medical charities has increased from £25 million in 1977 to £89 million in 1984 (Figure 9). Even when price inflation is taken into account this growth still represents a doubling of funds available from this source. Future trends will reflect developments in the charities sector as a whole – changes in both overall value and internal distribution patterns – and are therefore not readily predictable. Focusing on the latter, individual charities are increasingly employing new and more sophisticated techniques in order to gain a greater portion of this highly competitive 'market'. The extent to which medical research charities adopt innovative approaches to marketing will therefore influence how successfully they can improve upon their present relative shares – in 1984/85, 18 of the 35 members of AMRC were included in the Charities Aid Foundation

Figure 9 Annual income of the members of the Association of Medical Research Charities and expenditure on research, 1977-84.



\*Estimates derived from, but not specifically quoted in, relevant handbooks.

Source Handbook of the Association of Medical Research Charities, various years.

list of the top 200 grant seeking charities and together attracted 16 per cent of the group's total voluntary income of £526 million (CAF 1985).

Turning to the size of the charities market, it may be estimated that the total income of these bodies in 1984/85 amounted to £6.4 billion.<sup>14</sup> In unadjusted cash terms this sum was 16 per cent greater than the previous year, 36 per cent up on the 1982/83 figure and growth may be expected to continue. One of the reasons for this optimistic outlook is that the recent famine crisis in Africa may have led to a permanent increase in the numbers of people who wish to support charitable causes.

Potential also exists for growth in the charitable funds made available by industry. The Charities Aid Foundation (1985) has calculated that the leading 200 corporate donors gave £43 million to charities in 1984/85. After adjustments for inflation and an especially large once-only donation, this sum was 10 per cent greater than in 1983/84. On average, each of the 200 corporations donated an amount equivalent to 0.2 per cent of their pre-tax profits to charity. However, if these companies had matched the level of contribution estimated for the United States, the sum available from this source would have exceeded £300 million.

(At the time of writing, there are expectations that the forthcoming Budget will contain proposals to revise the taxation laws as they apply to charities in the United Kingdom. It is predicted that these amendments will enable individuals and companies who contribute to charities to offset donations against tax. Some projections indicate that the possible changes could lead to an increase in the annual income of the charities of 30 per cent (*The Times* 1986). However, in the absence of more detailed information, it is not feasible to offer further comment other than to make the point that charities obtain their income in different ways from a variety of sources so that the impact of any possible alteration in the tax laws is likely to vary from one organisation to another.)

Whilst long-term trends may have to remain largely speculative, there is perhaps a greater degree of certainty about the short-run prospects for charities' funding of medical research. Early in 1986, the Wellcome Trust sold one-fifth of its share in the Wellcome Foundation, the pharmaceutical company it wholly owned up to that point. The sale was expected to raise approximately £200 million which in turn will be re-invested to generate an annual income of around £15 million (Williams 1986). It is intended that all of this sum will be employed to support medical research.

Consequently, if it is assumed that the other members of the Association of Medical Research Charities maintain their current level of spending (in cash terms) then in 1987 charitable funding should

<sup>14</sup> This estimate is calculated on the basis that the income of the top 200 grant seeking charities - £956.7 million in 1984/85 - accounts for between 10 and 20 per cent of the total charitable income (CAF 1985).

amount to £105 million. This sum may be compared with the MRC's grant-in-aid from the government of £128 million for 1986/87. On past performance, it is however more likely that the funding capacities of the charities will continue to grow. Even if only two-thirds of the increase realised between 1983 and 1984 is achieved annually between the latter year and 1987 (that is 10 per cent instead of 15 per cent) then the funds available for research should rise to £118 million. Adding to this sum the estimated new additional contribution from the Wellcome Trust yields a grand total of £133 million.

This calculation is based on assumptions that are, of course, susceptible to error. For example, the projected growth in the funds made available for research by the charities may be inaccurate as indeed might be the value of the new investment income anticipated by the Wellcome Trust. In addition, the precision of the exercise carried out above is marred by inconsistencies in the financial year-ends to which different charities operate. Nevertheless, on the basis of current evidence, it seems highly likely that in the near future charitable bodies will be making a larger financial contribution to medical research than the government via its grant-in-aid to the Medical Research Council.

## Discussion

This paper has drawn attention to a disturbing contemporary paradox. It is widely believed, both within and outside government, that the future economic prosperity of the United Kingdom will depend to a large extent on the success of the nation's innovation-based industries. It is the contention of many observers, however, that insufficient support is being given to research, a key pre-requisite for the take-off and growth of these wealth-generating enterprises. The promise by central government to protect basic research – the seedcorn of tomorrow's technologies – against (retail price) inflation has indeed been kept: between 1981–82 and 1985–86 the science budget increased by 6 per cent in real terms (Walden 1986). However, this minimal growth has failed to accommodate the special needs of scientific research and development at a time of unprecedented growth in the scope for progress. As a result, potentially valuable research initiatives have remained unfunded and, with morale at a low ebb throughout the research community, highly qualified scientists are now leaving the United Kingdom to seek opportunities abroad.<sup>15</sup>

In response to this damaging situation it was announced in the recent public expenditure review that a further £45 million – compared with previous plans – would be allocated to the Science Budget to cover

15 A recent investigation conducted by the Advisory Board for the Research Councils found that even university research groups selected to receive additional equipment grants were losing not only their most talented students and post-doctoral research workers but outstanding senior scientists as well (Bray 1985a).

**Table 10 Science Budget Allocations, 1985/86 and 1986/87, £ millions.**

	1985/86	1986/87
Agricultural and Food Research Council	50.3	52.7
Economic and Social Research Council	23.6	23.6
Medical Research Council	122.3	128.3
Natural Environment Research Council	67.3	70.3
Science and Engineering Research Council	298.0	315.5
British Museum (Natural History)	16.2	17.2
Royal Society	5.9	6.4

Source *Nature* 1985c.

the three-year period between 1986/87 and 1988/89 (Table 10). At the same time, it is proposed to increase from £7 million to £10 million the sum available during each of the next three years to the University Grants Committee for improving equipment in selected centres of research. These additional resources will provide welcome short-term relief for research funding but their longer term adequacy is open to question. Focusing on the Science Budget, the Advisory Board for the Research Councils argued in its 1985 report to the Secretary of State for extra funding of £15, £30 and £40 million during 1986/87, 1987/88 and 1988/89 respectively. These requests would allow for an estimated real growth in the Science Budget of just one per cent per annum (Wrigglesworth 1985). But even resource expansion on this scale does not match the demands expressed by other groups of commentators. The Education, Science and Arts Select Committee, for example, recommended in its 1985 report an annual increase of three per cent. And a document published in conjunction with the recent launch of the 'Save British Science' campaign argues that 'combining the assessments made by the Research Councils and the University Grants Committee additional sums of the order of £100 million per annum are required just to prevent continuing decline'.

There is no convenient formula for determining how much of the nation's resources should be channelled into research. From one point of view, it might be argued that the United Kingdom's current economic status is such that the levels of expenditure required to maintain a position at the forefront of scientific investigation cannot be afforded. Following this line of reasoning might lead to the conclusion that the United Kingdom should pursue an approach to science akin to that adopted in former times by Japan – that is, a concentration on exploiting the inventions of other nations. Success in this strategy could eventually lead to a regeneration of national wealth which would in turn finance renewed membership of the elite group of innovating nations.

The major flaw in this argument is that the pace of scientific advance

is now so fast that absence from the leading edge of progress, no matter how temporary, would yield a 'knowledge gap' that could rapidly become too costly to bridge. Furthermore, it is axiomatic that even the pursuit of a policy of exploiting other nations' innovations requires that a detailed understanding of new scientific developments is maintained in order to be in a position to benefit from such progress.

The opposing viewpoint holds that it is precisely because of her present economic situation and the need to find new ways of creating wealth that the United Kingdom ought to be investing substantially in research. Furthermore, the additional resources involved exceed those that are necessary simply to accommodate retail price inflation. In order for the United Kingdom to be internationally competitive in this field, expenditure has to be of a magnitude that permits research at the frontiers of the possible. In other words 'second rate research is hardly worth doing' (Kingman 1985).

The UK government spends a proportion of the nation's gross domestic product on civil research that is broadly similar to the group average for the United States, Japan, Germany, France, Italy and the United Kingdom (1983 data). In cash terms, however, only the government of Italy spends less on this activity than the United Kingdom. The same relative position in the league table obtained in 1981 (Table 11). International comparisons of this nature have of course to be treated with caution. In addition to the difficulties of constructing a consistent data base noted earlier in this paper, there is no straightforward relationship between the volume of funds invested in research and subsequent output. The quality and distribution of resource inputs and the efficiency of the organisation and performance of research work have an essential bearing on productivity and, in common with materials and personnel costs, vary from one country to another. Despite these

**Table 11 Government spending on civil research and development in 1981 and 1983.**

	1981		1983	
	% of GDP	\$ millions	% of GDP	\$ millions
France	0.812	4,371	0.943	5,786
Germany	1.050	6,698	1.035	7,275
Italy	0.612	2,783	0.666	3,295
Japan	0.522	5,213	0.515	5,559
United Kingdom	0.642	3,000	0.677	3,745
United States	0.589	17,134	0.422	13,832
Average	0.705		0.710	

*Note* Japanese figures are for 1980 and 1981 respectively.

*Source* Annual Review of Government funded R & D, 1984 and 1985.

caveats, it is a widely held view that the UK government should be spending more on civil research than is presently the case.

Attention has focused on four possible means to increasing the funds available for research. First, a series of administrative changes has been proposed that would reduce the extent to which available resources are consumed in non-research uses. The Education, Science and Arts Select Committee, for example, recommended that the superannuation costs of the research councils' staffs should be funded as a separate item in the Department of Education and Science vote, that is they should not be met from the Science Budget. In addition, the Committee argued that international scientific subscriptions should only partially be met out of research council budgets.

Second, it has been suggested that government finance supplied to research councils should be uprated annually on the basis of a new 'research cost index', instead of simply in line with retail price inflation (Lamb 1985). According to Lamb's calculations, the inflation rate relevant to research costs lies between two and eight per cent above the ordinary index of retail prices. Such an approach would certainly enable the volume of research to be maintained at a constant level. It might be argued, however, that now is a time of rapidly increasing opportunities for advancing scientific knowledge and consequently an additional element reflecting this potential should be incorporated into the index as well.

Third, the private sector is seen, especially by government, as a potentially fruitful source of finance for academic research. Contacts between the two sectors already exist through commissioned projects (Table 12), science parks and, of course, on a personal basis. An extension of these linkages might help to resolve this country's apparent difficulty in commercialising its research successes in addition to swelling the pool of available research funds. However, such a development would not be without potentially significant implications for the nation's science base. Concern has been expressed, for example, that it could lead to a greater concentration on applied projects at the expense of basic research. It might also foster a shift of skilled manpower out of

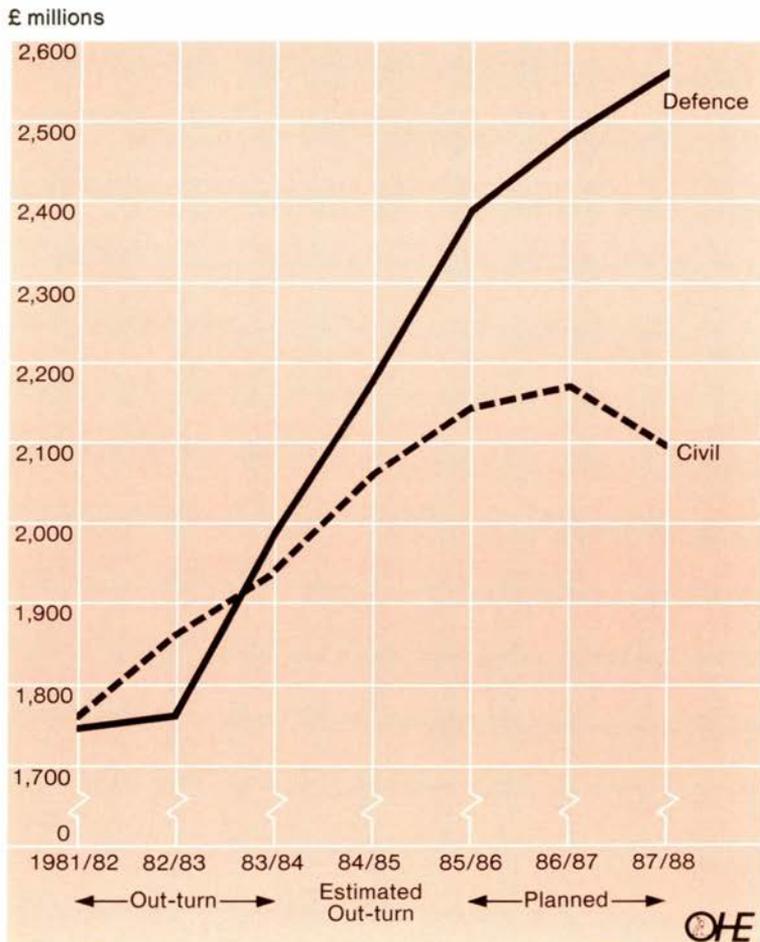
**Table 12 Income of universities in Great Britain from research grants and contracts other than from Government sources, 1980–81 to 1983–84.**

	<i>£ million</i>
1980–81	77.2
1981–82	74.8
1982–83	90.7
1983–84	110.7

*Note* Data in 1980–81 not collected in same format as later years.

*Source* *Hansard*, 20th January 1986, col. 81.

Figure 10 Government spending (out-turn and planned) on civil and defence research, 1981/82–1987/88.



Source Annual Review of Government Funded R & D 1985.

the academic centres into private enterprise.

Finally, it has been argued that present funding of civil research by government could be raised to more appropriate levels by a re-ordering of spending priorities. Table 2 showed that in 1983/84 the government spent almost £46 million more on defence research than on its civil counterpart. Furthermore, the size of this differential will, according to

the 1985 annual review of government funded research and development, increase ten-fold between 1984/85 and 1987/88 (Figure 10). Yet attention was drawn in the recent Commons debate on scientific research (December 1985) to the fact that defence activities account for just 3 per cent of British exports and that only rarely do research and development activities in this sector stimulate commercial advance (Skeet 1985). Against this background it has been argued that 'we ought either to shift the balance, or alternatively find a mechanism by which defence investment can have more interconnection with the civil and in particular academic research' (Kingman 1985).<sup>16</sup>

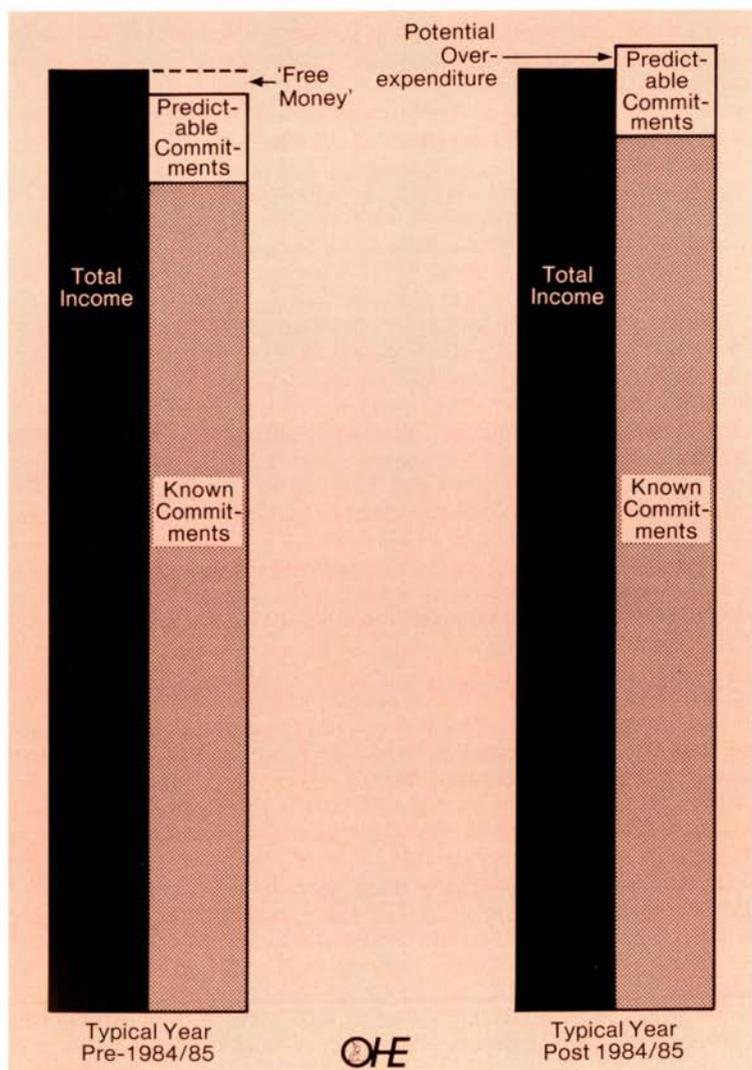
It is unlikely that the proposals outlined above for raising the government's contribution to civil research would be accorded the same priority ranking by different commentators. There would, however, probably be near universal agreement among these same individuals with the conclusions reached by the Education, Science and Arts Select Committee in its 1985 report. The latter emphasised that 'the economy of a modern industrial state depends especially on the efficiency with which it can exploit science and technology and that basic or pure research, and related strategic research, is essential to this process. In order to ensure that the United Kingdom is competitive with other developed and developing industrial nations the government should give a higher priority to the support of civil scientific research'. In this respect 'the basic and strategic research supported by the Science Budget is of particular importance because it is this source in combination with universities and polytechnics, which provides the science base for the development of new industry and advanced skills.' To this end the Select Committee argued that the Science Budget should be increased as a matter of urgency. It should also be protected, not just in the narrow sense of preventing further erosion of the science base through inflationary pressures, but to the extent that it may accommodate the rapid pace of development now taking place throughout practically the entire spectrum of science.

Some of the problems facing scientific research in general apply equally to the specific area of medical research. As a consequence of inadequate finance, the Medical Research Council has had to cut recurrent expenditure in existing units and has been unable to fund substantial numbers of first-rate research grant applications. The council has also foregone opportunities to set up new teams in its own institutes and units. An especially unfortunate impact of this era of financial stringency is the inability rapidly to respond to exciting new research opportunities because of the dearth of any 'free money' (Figure 11).

From an international perspective, government funding of medical research does not appear to match the levels obtaining in many other leading industrial nations. A comparison of public biomedical research and development expenditure per capita in 19 OECD countries in 1970,

<sup>16</sup> For example, a transfer of just one per cent of the funds allocated to defence research in 1983/84 to the Medical Research Council would have raised the latter's funding capacity by almost one fifth in that year.

Figure 11 Allocation of funds available to the Medical Research Council.



Source Noble 1985.

1975 and 1980 revealed that the United Kingdom consistently spent an amount that was below the average for the group as a whole (Shepard and Durch 1984). Furthermore, this disparity widened over time as mean expenditure rose 39 per cent between 1970 and 1980 whilst growth for the United Kingdom was only 6 per cent. The more recent experience of the Medical Research Council and the universities described in this paper suggest that the United Kingdom's relative standing in this context is more likely to have deteriorated than improved since 1980.

In the immediate future the Medical Research Council will benefit, in common with the other research councils (apart from the Economic and Social Research Council) from the increased financial allocations following the 1985 Public Expenditure Survey. Table 10 shows that the Council's grant-in-aid will rise from £122.3 million in 1985/86 to £128.3 million in 1986/87. This represents an increase of 4.9 per cent but it remains to be seen whether this amount will be sufficient to generate a real increase in resources and thus enable the wealth of opportunities presented by biomedical research to be exploited.

The recent experience of the medical charities contrasts sharply with that of the Medical Research Council. The funds made available by these bodies for research purposes have grown substantially – at the end of the 1970s these sums were equivalent to approximately 45 per cent of the Medical Research Council's total income and had risen to 73 per cent by the mid-1980s. Furthermore, current evidence suggests that the second half of the 1980s will see, for the first time, charitable expenditure on research exceeding the amount supplied by the Medical Research Council.

Consequently, the medical charities are performing an increasingly vital role in sustaining medical research in this country. These bodies are, for example, able to offer financial backing for initiatives that the academic sector has approved but has not been in a position to fund. It would be erroneous, however, to employ this development to justify further restrictions in the growth of resources allocated to the Medical Research Council. Charitable funds have become essential to achieving an overall level of expenditure that is arguably commensurate with the financial exigencies of contemporary biomedical research – they are clearly not 'bonus' resources available to support 'unnecessary' projects. Yet the funds that the charities channel into medical research are dependent on donations from the public and industry and are therefore potentially susceptible to sharp year-on-year fluctuation. In addition, a substantial proportion of the charities' total expenditure is directed at just two disease entities, cancer and heart disease. This pattern of distribution reflects proper public concern at the volume of morbidity and mortality generated by these particular diseases but it also means that other major illnesses, such as senile dementia, are not significantly funded by the charities sector.

Furthermore, the approaches to research funding adopted by the MRC and the medical charities are significantly different. The former

has a major commitment to long-term research in the sciences basic to medicine whereas the charities apply most of their funds – approximately two-thirds – to clearly defined projects of limited duration (Evered 1986). The two sources of finance should not therefore be seen as substitutes for one another. Finally, the responsibility for research training rests substantially with the Medical Research Council and is not a direct objective of the charities' expenditure on research projects.

Despite growth – albeit at markedly different rates – in funding by the Medical Research Council and the charities, the major source of finance for research and development programmes aimed at improving the health of the community is still the pharmaceutical industry. In 1984, the industry spent £490 million on the search for and development of new medicines, practically double the expenditure recorded at the start of the decade. Future trends are, however, less clear. The innate risks of pharmaceutical research are now being compounded by reduced income earning opportunities which in turn are the result of diminished effective patent lives and government measures to reduce the NHS medicines bill. In consequence, industrial investment in research and development in this country is becoming less attractive.

A continuation of this trend could have a number of highly undesirable consequences. A slow-down in the rate of growth of the industry's research and development effort could significantly delay the availability of much needed medicines for treating conditions such as schizophrenia, senile dementia and multiple sclerosis. Continued deterioration in the politico-economic environment coupled with further weakening of the academic medical research base could eventually lead to corporate policy decisions to relocate research facilities outside the United Kingdom. Such a development would cause job losses and severely damage the substantial trade surplus generated by the industry in this country (£835 million in 1985). It would also inhibit the scope for academic/industry collaboration at precisely the same time as the Medical Research Council<sup>17</sup> and others suggest that there is a pressing need to strengthen these linkages.

Yet arguably the most disturbing impact of a substantial shift of industrial research resources out of the United Kingdom would be the demise of this country as one of the world's leading pharmaceutical innovators. Many of today's most frequently prescribed types of medicine originated in laboratories in the United Kingdom – for example, non-steroidal anti-inflammatories for arthritic pain, beta blockers for hypertension and many other indications, sodium cromoglycate for

17 In the 1984/85 annual report of the Medical Research Council it was reported that a centre for collaborative research will be established to promote the transfer of research discoveries, ideas and techniques from its laboratories to industry and to those who deliver health care. And as an example of the potential that exists for collaborative ventures, Harefield Hospital in west London has recently announced that it is to establish what is claimed to be the world's first 'medi-park' (*The Times* 1986a). The project will enable manufacturers of pharmaceuticals and medical equipment to carry out research into heart disease in conjunction with the hospital's cardiac transplant unit.

asthma and H2 antagonists for treating stomach ulcers. Indeed, five of the 12 leading pharmaceutical products in terms of worldwide sales in 1984 were discovered in the United Kingdom (*Scrip* 1985). Against this background, a substantial erosion of the UK's innovative capacity would clearly have profound implications for the future development of new medicines and hence for the health of communities throughout the world.

Potential dangers such as these are steadily gaining greater recognition. The Commons Public Accounts Committee has recently questioned the adequacy of profits achieved by pharmaceutical manufacturers on their sales to the NHS. In 1984–85 the target rate of return on capital for government contracts (essentially, defence work) was set at 16.9 per cent but for the current year has been raised to 19.6 per cent. In contrast, pharmaceutical companies' returns have been reduced this year from 21 per cent to between 15 and 17 per cent. The inadequacy of pharmaceutical manufacturers' returns may in fact be greater than implied by the figures above because the industry carries higher risks and, unlike defence contractors, has no guarantee of supply to its client, the NHS.

A favourable reaction on the part of government to this observation would undoubtedly relieve some of the immediate pressures facing pharmaceutical industry research just as the recently announced increases in the Science Budget will provide temporary respite for the academic sector. Yet 'fire brigade' responses of this nature disguise the real need for a long-term approach to research policy. Repeated short-term financial crises damage morale within the research community, diminish investment confidence in the commercial sector and encourage short-term 'safe' projects at the expense of potentially more fruitful longer term initiatives. Given the increasing conflict between politico-economic funding constraints and the accelerating growth of opportunities for advancing scientific understanding, these and other related difficulties appear set to intensify in the foreseeable future.

It may therefore be argued that the time is now ripe for a fundamental reappraisal of the United Kingdom's research strategies. This paper has been concerned primarily with the funding of research by government but quite clearly there are many other issues that require attention. The latter include, for example, the means of promoting effective interlinkages between academia, industry and the voluntary sector, the incentives to encourage commercial investment in research,<sup>18</sup> the appropriate training for scientists, the extension of international collaboration and the potential value of a more vigorous sponsorship of science and research within government. There are, of course, no easy solutions. Research contains many uncertainties – the

18 Data collected by Sussex University's Science Policy Research Unit indicate that research and development financed by industry in Britain grew at 0.9 per cent per annum between 1967 and 1982. In contrast, the corresponding growth rate in Japan was 9.8 per cent whilst France and Germany achieved 5.9 per cent and the United States 4.1 per cent (*Financial Times* 1985).

benefits and costs of investment frequently emerge only after many years of investigation and cannot be foreseen with accuracy at the time funding decisions have to be made – and gives rise to much contentious debate. But once conclusions have been reached concerning, *inter alia*, the appropriate level of resource input, the directions in which the latter should be channelled and the settings in which research programmes are most effectively carried out, the fundamental requirement is a commitment to long-term support that facilitates rational planning of research initiatives.

## References

- Advisory Board for the Research Councils (1985). Science and Public Expenditure 1985. A report to the Secretary of State for Education and Science.
- Association of Medical Research Charities (1985). Handbook for 1985/86. London: The Development Trust for the Young Disabled.
- Bray J (1985). *Hansard*, 14 June, Cols. 1133–99.
- Bray J (1985a). *Hansard*, 16 December, Col. 65.
- Brooke P (1985). Evidence to the Education, Science and Arts Select Committee quoted in the latter's report: The Future of the Science Budget.
- Cabinet Office (1984). Annual Review of Government Funded R & D 1984. HMSO.
- Campbell P (1984). *Nature*, 310, 267.
- Centre for Medicines Research (1986). Private Communication.
- Charities Aid Foundation (1985). Charity Statistics 1984/85.
- Chew R, Teeling Smith G and Wells N (1985). Pharmaceuticals in Seven Nations. London: OHE.
- Chilver H and Merrison A (1983). First joint report by the chairmen of the Advisory Council for Applied Research and Development and the Advisory Board for the Research Councils. HMSO.
- Connor S (1985). *New Scientist*, 5 September issue, 48–50.
- Department of Trade and Industry (1985). Industrial R & D in the UK in 1983. *British Business*, 18 January issue, 130–32.
- Dickinson C J (1985). *British Medical Journal*, 1, 337–38.
- Education, Science and Arts Committee (1985). Report on The Future of the Science Budget. Volume 1. HMSO.
- Evered D (1986). Medical Research Today, what the charities are doing. Association of Medical Research Charities.
- Financial Times* (1985). 28 November issue.
- Gowans J (1985). Comments reported in *The Daily Telegraph*, 5 December issue.
- Guardian* (1985). 19 February issue.
- Irvine J M (1984). Letter in *The Times*, 20 November issue.
- Jack D (1985). Private Communication.

Joseph K (1985). *Hansard* 14 June. Cols. 1133–99.

Kingman J (1985). Evidence to the Education, Science and Arts Select Committee quoted in the latter's report: The Future of the Science Budget.

Kingman J (1985a). Quoted in *Hansard*, 16 December, Col. 53.

Lamb J (1985). *New Scientist*, 5 September issue, 61–62.

Martin B, Irvine J and Turner R (1984). *New Scientist*, 8 November issue, 25–29.

Medical Research Council (1985). Annual Report for 1984/85.

Medical Research Council (1986). Private Communication.

*Nature* (1984). Dead-end for British research, 310, 261–62.

*Nature* (1985). Parliament's chance to act, 315, 529–30.

*Nature* (1985a). Where has all the stuffing gone?, 318, 1.

*Nature* (1985b). MRC defends core of excellence, 318, 498.

*Nature* (1985c). A little more all round, 318, 589.

*New Scientist* (1985). Season of good will?, 19/26 December issue, 2.

Noble D (1985). *Medical Research Council News*, March issue, 10–12.

Pharmaceutical Sector Committee (1981). Research and Development costs, patents and regulatory controls, a consultative document. National Economic Development Office.

*Scrip* (1985). 17 June issue, 27.

*Scrip* (1986). 27 January issue.

Shepard D S and Durch J S (1984). International comparison of resource allocation in health services: an analysis of expenditures on biomedical research in 19 industrialised countries. Harvard School of Public Health, Institute for Health Research.

Skeet T H H (1985). *Hansard*, 16 December 1985, Col. 53.

Subak-Sharpe J H and Marsden H S (1986). Letter in *The Times*, 21 January issue.

Taylor D G and Griffin J P (1985). *Pharmaceutical Journal*, 23 February issue, 228–30.

*The Times* (1985). 5 February issue.

*The Times* (1985a). 21 October issue.

*The Times* (1985b). 4 November issue.

*The Times* (1986). 19 February issue.

*The Times* (1986a). 22 February issue.

Walden G (1985). *Hansard*, 16 December, Col. 69.

Walden G (1986). *Hansard*, 28 January, Col. 436.

Walker S A and Prentis R A (1985). *Pharmaceutical Journal*, 5 January issue, 11–13.

Wellcome Trust (1985). The Wellcome Trust 1982–84, fifteenth report.

Williams P O (1986). Private Communication.

Williams R J P (1985). Letter in the *Guardian*, 12 December issue.

Wrigglesworth I (1985). *Hansard*, 16 December, Col. 55.

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