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Contents

RESEARCH AND DEVELOPMENT IN THE UNITED KINGDOM IN 1989

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1. Introduction

This article brings together the main results from the two Research and Development (R & D) enquiries carried out by the Central Statistical Office (CSO). One survey is addressed on a regular annual basis to all government departments to measure their spending on R & D. The other survey provides estimates of R & D spending by industry and inquires into R & D in science and technology only.

2. Main points

- Total Gross Expenditure on R&D (GERD) in the UK in 1989 was £11.5 billion - a 4% increase on 1988 in real terms.

- Within this total:
  - £7.6 billion of R&D was performed in UK industry - a 3% real terms increase.
  - £1.7 billion of R&D was performed (intramural only) in UK government - a 6% real terms increase.

- Total Government expenditure on R&D in 1989-90 was £5.0 billion (including extramural) - about the same in real terms as in 1988-89.

- The Defence component of this was £2.6 billion - 23% of this total.

- Total Gross UK expenditure on R&D in the UK was 2.3% of GDP - higher than Italy; the same as France, but less than other countries shown in the table.

3. Total UK Research and Development (Table 1)

Gross domestic expenditure on research and development (GERD) in the UK rose from £10.4 billion in 1988 to £11.5 billion in 1989, an increase of 11 %. After adjusting to constant 1985 prices, the percentage increase was 4 %.

Within this total, R & D performed in industry, at £7.6 billion, was 10% higher than in 1988 or 3% in constant 1985 prices. For government (intramural only) the changes were 13% and 6% at current and constant prices respectively. For the other sectors combined (the Higher Education and non-profit making bodies), the changes were 13% and 6%

These figures relate to intramural expenditure in the sector concerned. In making long term comparisons the reader should note that the United Kingdom Atomic Energy Authority (UKAEA) was reclassified from government to industry in 1986 when it became a public corporation. This affects both the figures for expenditure and employment.

In the period 1975 to 1989 the proportion of total expenditure on R & D funded by government fell, while that funded by industry and other sources rose. Over the same period, total expenditure on R & D as a percentage of Gross Domestic Product (GDP) has fluctuated in the range 2.2 to 2.4 %. For industry the range has been 1.3 to 1.6, levelling on 1.5 in recent years.

Employment in R & D in central government fell during the period with some evidence of a levelling-off since 1986. Employment in industry has shown some variation throughout the period.

For the first time, in the 1989 benchmark industrial survey respondents were asked to classify their R & D expenditure by civil and defence purposes. This has enabled the overall (public and private) expenditure figures to be analysed by civil and defence. Overall, 23% of total R & D expenditure was recorded as being for defence purposes, -56% of Government, and 22% of industrial R & D expenditure. Expenditure on R & D for defence purposes in other sectors was relatively small (1% in each case). The Government sector accounted for over two thirds of the funding of defence R & D. Industry provided a fifth of the funds and overseas the most of the remaining 12%.

4. Government expenditure on R & D (Table 2-7)

Full details of Government spending on R&D were published in the Annual Review of Government Funded R & D[1]. The figures are based on returns to CSO from government departments for the financial year beginning April. They have a broader coverage than those in Table 1 as they include government expenditure on extramural R & D carried out elsewhere in the UK and overseas. To avoid double counting, spending by a department or research council performed elsewhere in central government is omitted. A more detailed explanation of the terms is given in the Annex.

Total gross expenditure by government at just over £5 billion in 1989 was 7% higher than in 1988. Intramural expenditure was less than half extramural expenditure as it has been since 1985. Total net expenditure at £4.8 billion in 1989 was 7% higher than in 1988. Defence accounted for the largest share of net expenditure (45%), slightly higher than in 1988, but similar to the figure for 1987 and lower than in earlier years. At constant 1985 prices total net expenditure in 1989 showed little change on 1988, while gross intramural expenditure showed an increase of just under 6%. As a percentage of GDP both civil and defence net expenditures declined from 1981to 1989.

Civil departments accounted for approximately 20 % of total gross expenditure in 1989-90 (Table 3), the Research Councils 17.5% , Defence 45% and the Higher Education Funding Councils (UFC and

PCFC) together 17.5%. Overall extramural expenditure for the civil departments was approximately three times the intramural spend. Together the Department of Energy and the Department of Trade and Industry account for about 60 % of civil extramural expenditure.

For the Research Councils total extramural expenditure is less than intramural expenditure though there are considerable variations from one council to another. For the Ministry of Defence extramural expenditure exceeds intramural expenditure, with more than £1.1 billion going to private industry. All the UFC and PCFC expenditure is recorded as extramural and going to higher education institutions. R & D in the Social Sciences accounted for about 7% of gross R & D expenditure, 9% of the extramural expenditure and 1% of intramural expenditure.

Over the period since 1981-82 there has been an increase of 42% in overall R & D expenditure (Table 4) 47% for civil departments and 37% for the Ministry of Defence. Defence R & D expenditure reached its peak in 1985-86 when it constituted just under 49% of all R & D expenditure. Three departments: DTI Energy and MAFF have consistently had the largest expenditures on civil R & D throughout the period.

In 1989-90, as in the two previous years, basic research was concentrated in the Research Councils with approximately 88% of recorded expenditure covered by them (Table 5) MOD and the Research Councils between them accounted for over 75% of expenditure on Applied Research. In 1989-90 MOD accounted for over 90% of experimental development.

Among specific civil objectives the greatest expenditure was on Industrial production and technology with general research the largest subgroup followed by manufacture of motor vehicles/other transport (Table 6).

Between 1988-89 and 1989-90 there was a fall of 2.8 thousands employed by government on R&D (Table7). The MOD employed more than half of all workers on R & D in 1989-90 and together with the Research Councils more than three quarters of the scientists and engineers.

5. International Comparisons (Tables 8a,b and c)

Since 1984 gross expenditure on R & D as a percentage of GDP for all countries have been relatively stable. The United Kingdom at 2.3% was the same as France, higher than Italy but lower than the other countries shown.

In 1989 the United Kingdom Government funded proportionately less on R & D than all the countries listed apart from Italy and Japan. In terms of funding on defence R & D the United Kingdom was exceeded only by France and the United States; for civil R & D the figures show the UK to be above the USA and Japan[1] but below Italy, France, Germany and Sweden.

[1] but see Note 1 at Table 8b

6. R & D performed in UK Industry (Tables 9-14)

The results are drawn from the annual surveys of UK industry. Every fourth year the survey is a full scale "benchmark" survey with slimline surveys directed to the largest enterprises in the intervening years. The last benchmark survey was carried out in respect of 1989 and more detailed results are published in Business Monitor MO14[2]. More details of the survey are given in the Annex.

Total expenditure on R & D performed in UK industry in 1989 was £7.6 billion. The largest single product group was electronics in which expenditure increased by 28% between 1985 and 1989 (Table 9). This increase is nearer 25% when account is taken of some £50 million of expenditure originally classified to mechanical engineering in 1985 reclassified in 1986 to electronics. At constant prices these changes become 4% and 1% respectively. The next largest group was chemicals where expenditure increased by 80% over 1985 in current price terms or 45% at constant prices. The large decline in mechanical engineering of almost 22% reduces to 3% when account is taken of the above reclassification. The corresponding percentages in constant price terms are 37 and 22 percent respectively.

In the period from the previous benchmark survey in 1985 to the recent benchmark survey in 1989 there was a 4% increase in industry's own funding of industrially performed R&D from 66% to 70%; (Table 16) a 3% increase in overseas funds from 11% to 14%; and a decrease in the percentage attributed to direct Government funding from 23% to 16%.

Numbers of staff employed on R&D in industry increased by 2% between 1985 and 1989 (Table 11). The reported number of scientists and engineers employed increased by just under 5%. There was a decline - 50,000 to 46,000 - recorded in numbers of technicians, laboratory assistants and draughtsmen.

Overall, intramural R & D expenditure for civil purposes accounted for approximately 78% of all expenditure whilst that for defence purposes accounted for 22% (Table 12). There are considerable variations for different product groups. Almost 88% of expenditure on defence R & D was accounted for by the 2 product groups: electronics and aerospace. For electronics defence R & D accounted for 32% of all expenditure. For aerospace it accounted for 69%.

R & D for defence purposes drew 57% of its funding from Government compared to 5% for civil R&D(Table 13).

Overall approximately four times as many employees were working on R & D for civil purposes as for defence purposes (Table 14). Within the individual totals proportionately more were allocated to the scientists and engineers category in defence R & D as compared with civil (50% as compared with 48%).

ANNEX

Definitions

The R & D statistics in this article are based on definitions given in the Frascati Manual[3], published by the OECD for use by member states and applied by other international agencies as a basis for such figures. According to this manual, the definition of R & D is "....creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications". This definition covers work on both science and technology and the social sciences and humanities.

R&D is defined for the purposes of this article in the following categories:

Basic or fundamental research: experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
Applied research; research undertaken with either a general or a particular application in view.
Experimental Development: the use of the results of basic and applied research directed to the introduction of new materials, processes, products, devices and systems, or the improvement of existing ones. It should include the prototype or pilot plant stage, design and drawing required during R&D and innovative work done on contracts with outside organisations, government departments, and public bodies. Firms in the aerospace industry are asked to include expenditure on development batches.

Defence R&D

Defence includes all R&D programmes undertaken primarily for defence reasons regardless of their content or whether they have secondary civil applications. It includes nuclear and space R&D undertaken for defence purposes. It does not include civil R&D financed by Ministries of Defence, for instance on meteorology or telecommunications. It includes defence R&D commissioned by overseas clients.

Sectors of the Economy

Sectors of the economy are defined in a Central Statistical Office publication "Research and Development Expenditure and Employment"[4]. Central Government is defined as the government sector of national accounts[5] for the relevant periods. Thus it includes the research councils and, up to 1985, UKAEA which became a public corporation in 1986.

Sources

There are two annual surveys of R & D statistics. One is addressed to all government departments, the other to enterprise groups performing R & D in industry. On the industrial side every four years there is a benchmark survey with a "slimline" survey in intervening years. The benchmark survey covered "apex" companies (i.e. the parent company of a group of companies) or single companies who do not form part of a group, classified to production or construction on the CSO's VAT-based register; plus public corporations listed in the National Accounts. In addition, all known industrial research associations and private research laboratories and service companies known to fund R & D were included. For companies classified to production and construction the survey was restricted to those with more than 200 employees. The last such survey was in respect of 1989 and for the first time requested expenditure,funding and employment to be separated into civil and defence purposes.

The "slimline" surveys are directed at those companies which cover approximately 75 percent of the total expenditure in the benchmark year.

Net and Gross Expenditure

In the Government survey the following details are collected:-

(a) gross intramural expenditure onsalariesandwages,materials and equipment and other current and capital expenditure;

(b) gross expenditure on R & D performed elsewhere within the central government sector, i.e. performed by Research Councils, under other Votes or with central government funds;

(c) gross expenditure on extramural R & D performed outside the central government sector and current and capital grants for research purpose (including subscriptions to research bodies), analysed by reciving sector;

(d) receipts used directedly to finance expenditure (appropriations-in-aid), analysed by paying sector (including other central government bodies);

Total gross expenditure= (a)+(c) only, (b) being excluded to avoid double-counting of payments from one part of central government to another.

Net Expenditure= (a)+(b)+(c)-(d); the aggregate of net expenditure on all returns equals the R & D element of the government's budget expenditure.

Objectives

The objectives for R & D expenditure defined by the European Community are referred to as "NABS"- the French acronym for "Nomenclature for the analysis and comparison of science programmes and budgets".

Rounding

Throughout these tables, components of totals have been rounded independently of the totals. Therefore the rounded totals will not always be equal to the sums of the rounded components. In the tables, "0.0" means less than 0.05 and ".." means zero.

Revisions

Some figures have been revised in the light of later information.

References

(1) Cabinet Office Annual Review of Government Funded Research & Development 1991, HMSO £25

(2) CSO Business Monitor MO14 1989, *Industrial Research and Development Expenditure and Employment*, HMSO £9.50

(3) *The Measurement of Scientific and Technical Activities* (The Frascati Manual), OECD Paris 1981, available from HMSO

(4) CSO Studies in Official Statistics No.27 *Research and Development Expenditure and Employment* HMSO £2

(5) The CSO Blue Book *United Kingdom National Accounts* 1991 edition, HMSO £13.95

Table 1

Expenditure and employment on research and development in the United Kingdom, 1978 to 1988

	1975	1978	1981	1983	1985	1986	1987r	1988r	1989 Total	(of which Defence)
(a) Expenditure at current prices (£m):										
Performed by:										
Government[1]	576	768	1356	1505	1630	1378	1360	1482	1675	(939)
Industry[2]	1340	2324	3792	4163	5122	5951	6335	6922	7600	(1653)
Higher education[3]	310	467	816	950	1174	1281	1397	1592	1774	(19)
Other	70	118	170	194	272	336	350	410	483	(5)
Total	2296	3677	6134	6812	8198	8945	9442	10405	11532	(2616)
As % GDP[4]:										
Total	2.2	2.2	2.4	2.2	2.3	2.3	2.2	2.2	2.3	(0.5)
Industry[2]	1.3	1.4	1.5	1.6	1.5	1.5	1.5	1.5	1.5	(0.3)
Funded by (%):										
Government [1]	55	49	49	50	43	42	39	37	37	(68)
Industry [2]	38	42	41	42	46	47	49	50	50	(20)
Other (including overseas sources)	7	9	10	8	11	11	12	12	13	(12)
	100	100	100	100	100	100	100	100	100	(100)
(b) Expenditure at 1985 prices (£m):										
Performed by:										
Government [1]	1604	1466	1699	1665	1630	1331	1251	1276	1351	(757)
Industry [2]	3733	4435	4752	4605	5122	5750	5828	5962	6129	(1333)
Others	1058	1116	1236	1265	1446	1561	1607	1724	1820	(20)
	6396	7017	7687	7535	8198	8642	8686	8962	9300	(2110)
(c) Employment on R&D end-year (thousands):										
Central Government	77	72	64	64	59	44	44	44	42	(21)
Industry[2]	181	190	195	186	173	188	185	185	176	(37)

[1] Includes an estimate for local authorities.
[2] There is a discontinuity from 1986, when UKAEA became a public corporation and ceased to be part of the Department of Energy.
[3] Change in coverage between 1978 and 1981 tends to inflate the apparent increase between these years.
[4] GDP=gross domestic product at market prices (average based) as in the UN definition.
r=revised

Table 2

Research and development financed by central government [1]

	Financial years beginning April								
	1981	1982	1983	1984	1985	1986[2]	1987	1988	1989
(a) Expenditure (£m) at current prices:									
Gross expenditure -									
Intramural	1296	1416	1440	1461	1554	1298	1352	1470	1665
Extramural	2360	2352	2475	2869	3150	3260	3244	3226	3378
Total gross expenditure	3656	3768	3915	4330	4704	4558	4596	4696	5043
Net expenditure -									
Defence	1576	1594	1792	1968	2116	2046	2015	1991	2161
Research Councils	421	451	480	507	528	558	616	645	745
Other civil	1398	1474	1523	1580	1707	1763	1788	1868	1926
Total net expenditure	3395	3519	3795	4054	4351	4367	4418	4504	4831
(b) Expenditure (£m) at constant 1985 prices:									
Total net expenditure	4254	4096	4194	4281	4351	4220	4064	3892	3906
Intramural (gross)	1624	1648	1591	1543	1554	1254	1244	1271	1346
(c) Net expenditure as a percentage of GDP at market prices:									
Defence	0.69	0.64	0.66	0.68	0.67	0.60	0.48	0.43	0.43
Civil	0.71	0.70	0.67	0.66	0.63	0.62	0.58	0.55	0.52
Total	1.40	1.34	1.33	1.34	1.30	1.22	1.06	0.97	0.95

Table 2a

Research and development financed by central government [1]

	as a percentage								
	1981	1982	1983	1984	1985	1986[2]	1987	1988	1989
(a) Expenditure (£m) at current prices:									
Gross expenditure -									
Intramural	35.4	37.6	36.8	33.7	33.0	28.5	29.4	31.3	33.0
Extramural	64.6	62.4	63.2	66.3	67.0	71.5	70.6	68.7	67.0
Total gross expenditure	100	100	100	100	100	100	100	100	100
Net expenditure -									
Defence	46.4	45.3	47.2	48.5	48.6	46.9	45.6	44.2	44.7
Research Councils	12.4	12.8	12.6	12.5	12.1	12.8	13.9	14.3	15.4
Other civil	41.2	41.9	40.1	39.0	39.2	40.4	40.5	41.5	39.9
Total net expenditure	100	100	100	100	100	100	100	100	100

[1] As returned by government, including work performed overseas.

[2] There is a break in the series in 1986 when UKAEA became a public corporation.

Table 3

Gross central government expenditure on R&D-financial year 1989-90

£million

	Intramural expenditure					Extramural expenditure					
	Salaries and wages [1]	Other current costs	Total current costs	Capital costs	Total intramural expenditure	Higher education institutions	Private industry and public corporations	Other extramural expenditure	Overseas	Total extramural expenditure	Total gross expenditure
Civil Departments											
Agriculture, Fisheries, Food	29.4	24.8	54.2	4.1	58.4	4.9	1.2	5.6	0.0	11.7	70.1
Education	0.2	0.1	0.3	0.0	0.3	41.7	0.3	33.1	0.2	75.3	75.6
Employment Group	3.3	0.9	4.2	0.0	4.2	7.7	9.1	27.1	0.0	44.0	48.2
Energy	1.8	1.7	3.6	0.0	3.6	8.6	147.5	3.4	0.8	160.3	163.9
Environment	18.3	11.3	29.6	3.5	33.0	5.2	25.1	3.8	0.0	34.1	67.1
Health	9.5	13.2	22.6	1.6	24.2	12.0	1.8	22.9	0.1	36.8	61.0
Scottish Office	6.6	4.2	10.7	0.9	11.6	7.6	0.6	39.4	0.0	47.5	59.2
Trade and Industry	15.4	15.7	31.1	4.6	35.7	5.2	210.8	11.6	65.7	293.3	329.0
Other civil departments	50.2	26.5	76.7	4.4	81.1	17.5	10.1	10.9	11.1	49.5	130.6
Total civil departments	134.7	98.4	233.0	19.1	252.1	110.4	406.5	157.8	77.9	752.5	1004.7
Research Councils											
Agricultural and Food	67.6	22.5	90.2	12.9	103.1	16.3	..	..	..	16.3	119.3
Economic and Social	1.8	1.3	3.2	1.2	4.3	18.3	..	4.5	0.2	23.1	27.4
Medical	69.2	32.6	101.8	20.7	122.5	46.2	..	12.3	3.6	62.1	184.6
Natural Environment	53.6	35.1	88.6	38.1	126.7	11.9	0.2	6.6	2.0	20.7	147.4
Science and Engineering	50.9	47.5	98.4	19.2	117.5	148.3	0.5	48.1	90.1	287.0	404.6
Total Research Councils	243.1	139.0	382.2	92.1	474.1	241.0	0.7	71.5	95.9	409.2	883.3
Higher Education Funding Councils	..	..	..	..	..	890.8	..	..	..	890.8	890.8
Total civil	377.8	237.4	615.2	111.2	726.2	1242.2	407.2	229.3	173.8	2052.5	2778.8
Ministry of Defence	408.5	286.1	694.6	244.2	938.8	18.5	1152.5	8.6	145.8	1325.4	2264.3
Total	786.3	523.5	1309.8	355.4	1665.0	1260.7	1559.7	237.9	319.6	3377.9	5043.1
of which:											
Science and Technology	772.4	515.2	1287.6	353.9	1641.5	1022.4	1547.1	179.6	317.0	3066.1	4707.6
Social Science and Humanities	13.7	8.4	22.1	1.4	23.5	238.2	12.6	58.5	2.7	312.0	335.5

[1] Including employers' national insurance contributions.

Table 4

Net central government expenditure on R&D by departments in cash terms 1981-82 to 1989-90

Department	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
Civil Departments									
Agriculture,Fisheries,Food	106.8	113.9	118.6	119.4	118.4	118.3	113.8	115.0	112.2
Education[1]	8.3	8.8	11.4	13.5	70.7	68.9	105.4	73.4	75.1
Employment Group	4.8	5.5	5.9	7.4	14.9	19.9	26.1	47.6	48.2
Energy[2]	238.8	244.5	237.8	232.0	221.9	192.4	176.4	190.2	166.1
Environment	38.3	35.9	32.4	38.2	45.7	59.0	62.1	63.0	70.4
Health[3]	28.2	28.9	27.7	25.6	27.2	49.4	47.3	50.3	58.2
Scottish Office	40.8	42.8	49.5	53.3	53.8	53.4	51.6	55.3	59.1
Trade and Industry[4]	284.9	284.0	313.1	346.7	374.4	362.9	324.4	314.4	310.0
Other civil departments[3]	106.7	109.6	110.7	113.7	110.8	119.3	121.1	128.1	135.5
Total civil departments	857.6	873.9	907.1	949.9	1037.9	1043.4	1028.1	1037.2	1034.8
Research Councils									
Agricultural and Food	41.4	43.1	44.4	45.9	44.7	46.3	49.4	55.0	62.2
Economic and Social	15.3	16.4	17.5	16.7	18.4	20.0	21.6	23.4	26.1
Medical	100.6	106.4	113.0	116.9	121.3	127.6	139.1	144.9	170.4
Natural Environment	52.1	55.2	59.8	62.1	66.1	68.0	70.8	81.7	107.0
Science and Engineering	212.0	230.0	245.1	265.3	277.4	295.9	334.5	339.6	379.1
Total Research Councils	421.4	451.1	479.8	506.9	528.0	557.7	615.5	644.6	744.9
Higher Education Funding Councils[1]	540.0	600.0	616.0	629.9	669.0	720.0	760.0	830.4	890.8
Total civil	1819.0	1925.0	2002.9	2086.7	2234.9	2321.1	2403.5	2512.2	2670.5
Ministry of Defence	1575.9	1593.7	1792.3	1967.5	2116.1	2046.1	2014.5	1991.4	2160.7
Total	3394.9	3518.7	3795.2	4054.2	4351.0	4367.2	4418.0	4503.6	4831.2
of which:									
Science and Technology	3202.3	3304.2	3580.9	3830.6	4114.6	4130.5	4169.2	4192.1	4496.6
Social Science and Humanities	192.6	214.5	214.3	223.6	236.4	236.7	248.8	311.5	334.6

[1] PCFC expenditure is separated from Education from 1988-89 and included with H.E. Funding Councils.
[2] From 1986-87 the figures exclude UKAEA which became a public corporation in April 1986.
[3] Social Security is seperated from Health from 1988-89 and included with other civil departments.
[4] In 1987-88 some expenditure was reclassified from R&D to technology transfer.The figures prior to 1987-88 should be reduced by up to £50m per annum for consistency with the later years.

Table 5

Gross central government expenditure on intramural research and development[1]

£ million

Current (i.e. non-capital) expenditure	1987-88 Basic research	Applied research	Devel-opment	Total	1988-89 Basic research	Applied research	Devel-opment	Total	1989-90 Basic research	Applied research	Devel-opment	Total
Civil departments												
Agriculture Fisheries & Food	..	17.6	37.3	54.9	5.6	21.5	27.3	54.4	6.1	32.8	15.3	54.2
Education	..	..	..	..	..	..	..	..	..	..	..	.
Employment Group	..	..	..	..	..	..	..	..	..	..	..	..
Energy	0.2	1.3	1.1	2.6	..	1.5	1.2	2.7	..	2.0	1.5	3.5
Environment	..	25.6	1.9	27.5	..	24.1	1.7	25.8	..	26.4	2.6	29.0
Health	..	..	..	..	..	15.9	2.4	18.3	..	17.0	2.9	19.9
Scottish Office	0.1	5.8	0.4	6.3	1.4	6.5	0.4	8.3	1.7	7.3	1.0	10.0
Trade & Industry	0.0	25.3	9.5	34.8	..	28.9	9.7	38.6	..	23.3	7.8	31.1
Other civil departments[2]	14.6	35.7	10.6	60.9	14.5	38.8	10.3	63.6	15.5	43.3	9.1	67.9
Total civil departments	14.9	111.3	60.8	187.0	21.5	137.2	53.0	211.7	23.3	152.1	40.2	215.6
Research Councils												
Agricultural & Food	50.5	32.0	..	82.5	55.7	30.3	..	86.0	61.6	28.6	..	90.2
Medical	..	85.0	..	85.0	..	88.3	..	88.3	..	101.8	..	101.8
Natural Environment	48.9	22.3	..	71.2	53.5	20.7	..	74.2	63.9	24.7	..	88.6
Science & Engineering	46.0	40.3	..	86.3	50.7	40.9	..	91.6	44.1	54.3	..	98.4
Total Research Councils	145.4	179.6	..	325.0	159.9	180.2	..	340.1	169.6	209.4	..	379.0
Total civil	160.3	290.9	60.8	512.0	181.4	317.4	53.0	551.8	192.9	361.5	40.2	594.6
Ministry of Defence	..	232.8	386.3	619.1	..	245.7	395.9	641.6	..	262.1	430.8	692.9
Total	160.3	523.7	447.1	1131.1	181.4	563.1	448.9	1193.4	192.9	623.6	471.0	287.5

[1] Excluding R & D in the social sciences and humanities.
[2] See note 3 at Table 4.

Table 6

Net central government expenditure on R&D: analysis by European Community objectives for R&D spending

	1987-88	1988-89	Outturn 1989-90
Exploration and exploitation of Earth			
Total	85.2	95.5	119.9
General research	73.9	81.8	107.1
Earth's main crust and mantle excluding sea bed	1.5	0.6	0.1
Atmosphere	4.5	4.6	4.5
Other	5.4	8.4	8.2
Infrastructure and general planning of land-use			
Total	66.8	66.8	71.6
Construction and planning of buildings	22.0	19.3	21.3
Transport systems	14.5	17.6	15.4
Civil engineering	13.9	9.9	13.2
Other	16.4	20.0	21.7
Control of environmental pollution			
Total	56.1	58.2	53.0
General research	10.5	6.1	6.8
Water pollution	5.8	4.2	6.8
Atmospheric pollution	8.0	9.6	9.2
Radioactive pollution	23.1	29.1	22.9
Other scientific research on pollution	8.8	9.2	7.3
Protection and promotion of human health			
Total	203.9	217.7	257.9
General research	175.1	186.5	217.1
Biomedical engineering and medicines	5.1	4.6	4.0
Nutrition and food hygiene	7.9	9.2	16.4
Other	15.8	17.4	20.4
Production, distribution and rational utilisation of energy			
Total	170.4	177.3	157.7
Nuclear fission	113.6	121.1	101.5
Nuclear fusion	20.6	24.7	22.6
Renewable energy sources	16.6	16.9	18.1
Other	19.5	14.6	15.5
Agricultural production and technology			
Total	196.1	206.3	194.9
General research	34.1	25.9	25.1
Animal products	22.4	37.3	23.6
Fishing and fish farming	10.0	10.2	10.4
Crops	85.4	81.3	79.0
Other	44.2	51.6	56.8
Industrial production and technology			
Total	411.8	394.8	451.6
General research	264.9	253.7	321.1
Manufacturing/processing techniques, materials	8.3	11.7	1.7
Manufacture of motor vehicles/other transport	105.4	103.8	119.9
Electrical and electronic engineering	3.0	3.1	2.2
Other	30.2	22.5	6.7
Social structure and relationships			
Total	70.5	95.5	100.4
Education and training	44.2	69.3	69.7
Other research with regard to society	26.2	26.2	30.7
Exploration and exploitation of space	129.2	146.4	145.1
Research financed from general university funds	795.6	830.4	890.8
Non-oriented research			
Total	209.3	215.9	222.9
Mathematics and natural sciences	121.8	137.1	141.9
Engineering sciences	7.3	7.4	0.5
Social science and humanities	9.0	2.6	2.9
Other	71.2	68.8	77.6
Other civil research	13.6	13.4	11.9
Defence	2009.1	1984.9	2153.5
TOTAL ALL OBJECTIVES	4418.0	4503.6	4831.2

Expenditure under any one objective may be the addition of R&D for more than one programme.

Table 7

Central government employment on research and development - average for the year

Thousands

	1988-89					1989-90				
	Science and technology			Social science	Total	Science and technology			Social science	Total
	Scientists and engineers	Technicians	Other[1]			Scientists and engineers	Technicians	Other[1]		
Civil departments										
Agriculture, Fisheries & Food	0.9	0.3	0.9	0.0	2.2	0.7	0.4	0.8	0.0	1.8
Education	..	..	..	0.0	0.0	..	..	..	0.0	0.0
Employment Group	..	..	..	0.2	0.2	..	..	..	0.2	0.2
Energy	0.0	..	0.0	..	0.1	0.0	..	0.0	..	0.1
Environment	0.4	0.2	0.3	0.0	0.9	0.5	0.0	0.3	0.0	1.0
Health [2]	0.4	0.1	0.1	..	0.6	0.4	0.1	0.1	0.0	0.6
Scottish Office	0.2	0.1	0.2	0.0	0.5	0.2	0.1	0.2	0.0	0.5
Trade and Industry	0.5	0.1	0.4	..	1.0	0.0	..	0.0	..	0.1
Other civil departments	1.0	0.6	1.0	0.2	2.8	1.0	0.7	0.9	0.3	2.8
Total civil departments	3.4	1.4	2.9	0.5	8.2	2.7	1.3	2.3	0.5	7.0
Research Councils										
Agricultural and Food	2.3	0.5	1.5	..	4.3	2.0	0.3	1.7	..	4.0
Medical	1.5	0.9	1.0	..	3.3	1.5	0.8	0.9	..	3.3
Natural Environment	1.2	0.1	1.3	..	2.5	1.2	0.4	1.2	..	2.7
Science and Engineering	1.1	0.2	1.5	..	2.7	1.1	0.2	1.4	..	2.7
Economic and Social	..	..	..	0.1	0.1	..	..	..	0.1	0.1
Total Research Councils	6.1	1.6	5.2	0.1	13.0	5.9	1.6	5.2	0.1	12.8
Total civil	9.5	3.1	8.1	0.6	21.2	8.6	2.9	7.6	0.6	19.8
Ministry of Defence	4.9	3.8	14.0	0.1	22.8	4.7	3.7	13.0	0.0	21.4
Total employed on R & D in science and technology	14.4	6.9	22.1	..	43.3	13.3	6.6	20.6	..	40.5
Total employed on social science research	0.4	0.0	0.3	..	0.7	0.4	0.0	0.3	..	0.7
Total employment on R&D	14.8	6.9	22.3	0.7	44.0	13.8	6.6	20.8	0.7	41.2

[1] Including administrative staff.
[2] Excluding hospital staff.

Table 8a

OECD Science & Technology indicators

Year	Italy	France	Federal Republic of Germany	Japan[1]	Sweden	United States of America	United Kingdom
Gross Domestic Product (GDP)[3] (£ billion at ppp)							
1984	325.7	340.3	387.8	729.0	55.7	2044.8	324.3
1985	355.8	368.5	420.7	812.5	60.6	2258.5	355.0
1986	379.2	392.5	448.1	865.2	64.4	2422.1	381.9
1987	409.4	419.1	476.7	946.5	69.4	2627.2	419.9
1988	455.5	463.6	527.7	1068.7	75.7	2933.5	468.8
1989	495.8	507.4	575.1	1183.3	82.0	3181.8	511.9
Gross Expenditure on R&D (GERD) (£ billion at ppp)							
1984	3.3	7.5	n/a	17.9	n/a	56.8	n/a
1985	4.0	8.3	11.4	21.3	1.7	66.1	8.2
1986	4.3	8.8	n/a	22.4	n/a	70.7	8.9
1987	4.9	9.6	13.6	25.3	2.1	76.5	9.4
1988	5.6	10.6	15.0	29.1	n/a	84.1	10.4
1989	6.4	11.8	16.6	33.7	2.3	89.8	11.5
GERD as a percentage of GDP[3]							
1984	1.0	2.2	n/a	2.5	n/a	2.8	n/a
1985	1.1	2.3	2.7	2.6	2.9	2.9	2.3
1986	1.1	2.2	n/a	2.6	n/a	2.9	2.3
1987	1.2	2.3	2.9	2.7	3.0	2.9	2.2
1988	1.2	2.3	2.8	2.7	n/a	2.9	2.2
1989	1.3	2.3	2.9	n/a	2.8	2.8	2.3

Source OECD

[1] Data for Japan relating to GERD are adjusted by OECD.

[2] Some discontinuity arises for United Kingdom data, following the transfer of the UKAEA from the government sector to BERD in 1986.

[3] See note [4] at Table 1

Table 8b

Government funding of R&D for civil and defence objectives (at current prices)

£m[2]

	Italy	France	Federal Republic of Germany	Japan[1]	Sweden	United States of America	United Kingdom
1984, total expenditure	2084	4859	4288	3630	732	24318	4054
expenditure on defence R&D	173	1624	428	n/a	164	16108	1962
expenditure on civil R&D	1911	3235	3860	n/a	568	8210	2093
1985, total expenditure	2326	5289	4834	3938	759	28436	4351
expenditure on defence R&D	231	1654	577	151	182	19208	2111
expenditure on civil R&D	2095	3635	4257	3787	577	9228	2240
1986, total expenditure	2689	5345	4895	4154	762	30352	4367
expenditure on defence R&D	229	1737	593	171	198	21048	2041
expenditure on civil R&D	2460	3608	4302	3983	564	9304	2327
1987, total expenditure	3056	5774	5177	4512	824	33100	4418
expenditure on defence R&D	215	2072	659	201	222	22708	2009
expenditure on civil R&D	2841	3701	4518	4311	602	10392	2409
1988, total expenditure	3657	6330	5537	4999	929	35820	4504
expenditure on defence R&D	379	2359	686	241	223	24301	1985
expenditure on civil R&D	3279	3971	4851	4758	706	11519	2519
1989, total expenditure	3667	6989	6127	5604	984	38749	4831
expenditure on defence R&D	378	2588	784	287	243	25353	2153
expenditure on civil R&D	3289	4402	5343	5317	741	13395	2678

Source OECD

[1] Data for Japan are OECD estimates & relate to R&D only in science & engineering.

[2] Converted to £ sterling using OECD ppp.

Table 8c

Government funding of R&D for civil and defence objectives (as a ratio of GDP)

per cent

	Italy	France	Federal Republic of Germany	Japan[1]	Sweden	United States of America	United Kingdom
1984, total expenditure	0.64	1.43	1.11	0.50	1.32	1.19	1.25
expenditure on defence R&D	0.05	0.48	0.11	n/a	0.29	0.79	0.61
expenditure on civil R&D	0.59	0.95	1.00	n/a	1.02	0.40	0.64
1985, total expenditure	0.65	1.44	1.15	0.48	1.25	1.26	1.23
expenditure on defence R&D	0.06	0.45	0.14	0.02	0.30	0.85	0.60
expenditure on civil R&D	0.59	0.99	1.01	0.47	0.95	0.41	0.63
1986, total expenditure	0.72	1.38	1.11	0.49	1.20	1.28	1.14
expenditure on defence R&D	0.06	0.45	0.13	0.02	0.31	0.88	0.54
expenditure on civil R&D	0.66	0.93	0.97	0.47	0.89	0.39	0.61
1987, total expenditure	0.76	1.39	1.10	0.48	1.21	1.28	1.05
expenditure on defence R&D	0.05	0.50	0.14	0.02	0.32	0.88	0.48
expenditure on civil R&D	0.70	0.89	0.96	0.46	0.88	0.40	0.57
1988, total expenditure	0.81	1.37	1.05	0.47	1.24	1.23	0.96
expenditure on defence R&D	0.08	0.51	0.13	0.02	0.30	0.83	0.42
expenditure on civil R&D	0.72	0.86	0.92	0.45	0.94	0.40	0.54
1989, total expenditure	0.74	1.37	1.06	0.47	1.19	1.21	0.94
expenditure on defence R&D	0.08	0.51	0.14	0.02	0.29	0.79	0.42
expenditure on civil R&D	0.66	0.86	0.92	0.45	0.90	0.42	0.52

Source OECD

[1] See note 1 at Table 8b

Table 9

Intramural expenditure on R&D in broad product groups of industry, 1975 to 1989

£million

	At current prices								
	1975	1978	1981	1983	1985	1986	1987	1988	1989
All product groups	1340.1	2324.3	3792.5	4163.3	5121.6	5950.7	6335.2	6921.6	7600.0
All products of manufacturing industry	1275.4	2212.6	3511.7	3869.9	4673.2	5070.4	5371.6	5933.0	6450.5
Chemicals	227.4	394.1	617.4	735.0	941.9	1037.9	1303.0	1573.5	1692.4
Mechanical engineering	98.4	174.1	234.0	249.6	262.6	218.4	240.6	225.2	205.6
Electronics	284.0	656.6	1235.3	1473.9	1758.6	1999.7	1901.6	2160.5	2259.3
Other electrical engineering	73.0	100.8	120.8	117.7	125.6	152.5	142.2	147.0	113.6
Motor vehicles	88.3	129.7	180.4	239.5	371.6	394.2	450.5	468.3	504.3
Aerospace	291.5	424.6	762.9	720.0	818.0	829.6	870.9	850.0	1070.1
Other manufactured products	212.8	332.6	361.1	334.3	394.9	438.1	462.8	508.5	605.4
Non-manufactured products	64.8	111.7	280.8	293.5	448.4	880.3	963.6	988.6	1149.4
	At 1985 prices								
	1975	1978	1981	1983	1985	1986	1987	1988	1989
All product groups	3732.9	4435.7	4752.5	4605.4	5121.6	5749.5	5828.2	5961.8	6129.0
All products of manufacturing industry	3552.6	4222.5	4400.6	4280.9	4673.2	4898.9	4941.7	5110.2	5202.0
Chemicals	633.4	752.1	773.7	813.1	941.9	1002.8	1198.7	1355.3	1364.8
Mechanical engineering	274.1	332.3	293.2	276.1	262.6	211.0	221.3	194.0	165.8
Electronics	791.1	1253.1	1548.0	1630.4	1758.6	1932.1	1749.4	1860.9	1822.0
Other electrical engineering	203.3	192.4	151.4	130.2	125.6	147.3	130.8	126.6	91.6
Motor vehicles	246.0	247.5	226.1	264.9	371.6	380.9	414.4	403.4	406.7
Aerospace	812.0	810.3	956.0	796.5	818.0	801.5	801.2	732.1	863.0
Other manufactured products	592.8	634.7	452.5	369.8	394.9	423.3	425.8	438.0	488.2
Non-manufactured products	180.5	213.2	351.9	324.7	448.4	850.5	886.5	851.5	926.9

Source: MO14, HMSO, August, 1991

Table 10

Sources of funds for R&D within industry in the UK, 1975 to 1989

	1975	1978	1981	1983	1985	1986	1987	1988	1989
Total (£m)	1340.1	2324.3	3792.5	4163.3	5121.6	5950.7	6335.2	6921.6	7600.0
UK Government	413.9	679.4	1137.2	1257.6	1175.5	1391.8	1267.0	1176.7	1248.7
Overseas	84.6	185.2	331.3	283.2	569.0	727.0	760.2	830.6	1023.2
Own funds and other	841.6	1459.7	2324.0	2622.5	3377.1	3831.9	4307.9	4914.3	5328.2
Per cent of total	100	100	100	100	100	100	100	100	100
UK Government	31	29	30	30	23	23	20	17	16
Overseas	6	8	9	7	11	12	12	12	14
Own funds and other	63	63	61	63	66	65	68	71	70

Source: MO14, HMSO, August, 1991

Table 11

Employment on intramural industrial R&D by occupational group 1975 to 1989

	1975	1978	1981	1983	1985	1986	1987	1988	1989
Total employment (thousands)	181	190	195	186	173	188	185	185	176
Scientists and engineers	62	68	77	77	81	87	87	89	85
Technicians, laboratory assistants and draughtsmen	61	64	66	60	50	49	49	46	46
Administrative, clerical, industrial and other staff	58	58	52	49	42	52	49	50	45
Per cent of total	100	100	100	100	100	100	100	100	100
Scientists and engineers	34	36	39	41	47	46	47	48	48
Technicians, laboratory assistants and draughtsmen	34	34	34	32	29	26	26	25	26
Administrative, clerical, industrial and other staff	32	31	27	26	24	28	26	27	26

Source: MO14, HMSO, August, 1991

Table 12

Intramural R&D Expenditure Civil/ Defence Analysis 1989

£million

	Civil	Defence	Total
All product groups	5946.9	1653.1	7600.0
All manufactured products	4884.4	1566.1	6450.5
Chemicals	1673.7	18.5	1692.4
Mechanical engineering	175.2	30.4	205.6
Electronics	1538.5	720.7	2259.3
Other electrical engineering	108.3	5.3	113.6
Motor vehicles	495.9	8.4	504.3
Aerospace	335.3	734.9	1070.1
Other manufactured products	557.5	47.9	605.4
Non-manufactured products	1062.5	86.9	1149.4

Source: MO14, HMSO, August, 1991

Table 13

Civil/defence analysis of intramural expenditure on industrial R&D by sources of funds, 1989

£million

	Civil	Defence	Total
Total	5946.9	1653.1	7600.0
UK Government	305.5	943.1	1248.7
Private Industry	472.5	62.0	534.5
Own funds and other	4429.6	364.1	4793.7
Overseas	739.3	283.9	1023.2

Source: MO14, HMSO, August, 1991

Table 14

Civil/defence analysis of employment on industrial R&D, 1989

	Civil	Defence	Total
Total(thousands)	138	38	176
Scientists and engineers	66	19	85
Technicians, laboratory assistants and draughtsmen	37	9	46
Administrative, clerical and others	36	9	45

Source: MO14, HMSO, August, 1991