

SCIENCE AND TECHNOLOGY

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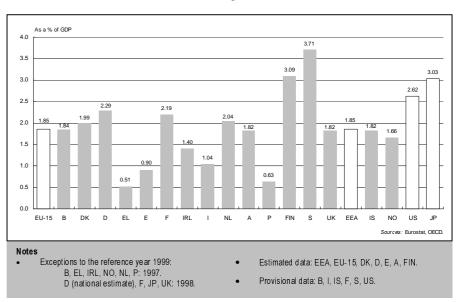


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R&D expenditure and personnel in Europe and its regions

Ibrahim Laafia

Figure 1: R&D expenditure as a % of GDP in Europe, the United States and Japan, all sectors — 1999



- ➤ In the EU-15, EUR 147 billion was spent on R&D in 1999, while 2.18 million persons measured in terms of head count (HC), or almost 1.63 million persons expressed as full-time equivalent (FTE), were engaged in R&D activities (¹).
- While resources devoted to R&D in the EU-15 increased in terms of volume in 1999 in relation to the previous year by 1.64 % for expenditure (PPS at 1990 prices), they remained relatively stable (0.32 %) for personnel (HC).
- ➤ Germany, France, the United Kingdom and Italy accounted for 75 % of R&D expenditure in Europe, but Finland, Ireland, Portugal and Spain had the highest annual growth rates over the last two years (1997–99) (²).
- ➤ The business enterprise sector was predominant: it accounted for 63 % of R&D expenditure and employed more than one out of every two people expressed in full-time equivalent engaged in R&D (54 %).
- R&D expenditure by region presented a contrasting image:
 - The highest R&D expenditure in terms of volume was in Île de France (F): ECU 11 889 million at current prices in 1997.
 - The highest R&D expenditure as a percentage of GDP was in the Braunschweig region (D): 4.87 % in 1997.

⁽¹⁾ Eurostat estimates.

⁽²⁾ R&D expenditure measured in PPS at 1990 prices, Ireland and Portugal: 1995-97.

Introductory remark

R&D expenditure and personnel, the principles of which are defined in the *Frascati Manual* (³), are two basic indicators for measuring scientific and technological activities. This 'Statistics in Focus' describes the state of R&D in the European Economic Area and its situation in

relation to the United States and Japan. As far as possible, the latest data available (1999) have been used. Special attention has also been paid to analysing R&D in the European regions (⁴).

R&D expenditure and personnel: a continuing gap between Europe and the United States/Japan

Gross domestic expenditure on R&D (GERD) in volume terms rose steadily over the past decade in the European Union, the United States and Japan. If all sectors are taken together (5), GERD in the EU-15 is estimated at EUR 147 billion in 1999. In the United States and Japan it accounted, respectively, for one and a half times (EUR 232 billion in 1999) and three-quarters of this amount (ECU 102 billion in 1998).

As a percentage of GDP, R&D expenditure in 1998 showed a considerable difference between the United

States (2.58 %; 2.66 % in 1999) and Japan (3.03 %) on one hand and the EU-15 (1.86 %; 1.85 % in 1999) (⁶) on the other. This difference was noticeable both in the gap (of almost one percentage point and in the trend), which was upward for the US and Japan and relatively stable for the EU-15 (Figure 2). It was due mainly to the situation in the business enterprise sector, where there was a marked difference between the three zones, while expenditure as a percentage of GDP remained very much the same in the two other sectors (government and higher education).

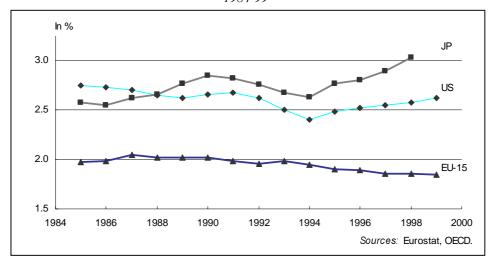


Figure 2: R&D expenditure as a % of GDP, all sectors 1984-99

⁽b) Levels of R&D intensity calculated according to the new European System of National Accounts, ESA 95, which replaced ESA 79.



⁽³⁾ The Proposed Standard Practice for Surveys of Research and Experimental Development, Frascati Manual, OECD, 1993.

⁽¹⁾ The detailed data are available in Eurostat's New Cronos database, the references of which are given on page 8 of this issue.

⁽⁸⁾ GERD is broken down into four institutional sectors: business enterprise, government, higher education and private non-profit institutions.

Expenditure in the last of these sectors is negligible (less than 1 % of total expenditure in 1997).

Table 1: R&D expenditure in million PPS (1990 prices), all sectors, 1994-99

EU-15 111 800 110 000	US 186 868 174 450	JP : 67 710
110 000	174 450	67.710
		07 7 10
106 400	164 869	66 406
104 800	156 569	63 844
103 200	148 677	60 574
102 300	140 064	56 831
1.8 %	5.6 %	4.5 %
7.5 %	24.6 %	19.1 %
	Sources: Eu	ırostat, OECD.
	104 800 103 200 102 300	104 800 156 569 103 200 148 677 102 300 140 064 1.8 % 5.6 % 7.5 % 24.6 %

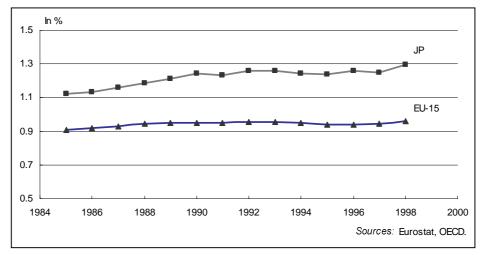
Table 2: R&D personnel in FTE in thousands, all sectors — 1994-99

	EU-15	US	JP
1999	1 626 700	:	:
1998	1 625 500	:	877 162
1997	1 586 100	:	846 493
1996	1 571 400	:	845 904
1995	1 558 900	:	826 656
1994	1 578 500	:	827 972
AAGR (1994-98)	0.7 %	:	1.5 %
TAG (1994-98)	3.0 %	:	5.9 %
		Sources: E	urostat, OECD.

In order to cancel out the impact of price variations on R&D expenditure, GERD has been calculated in 1990 purchasing power standards (PPS) at constant prices (Table 1). The greatest increase in the period 1994-98 was in the United States and Japan, which had overall rates of increase of 24.6 and 19.1 % respectively, compared with 7.5 % for the EU-15. For the United States and Japan, 1994 saw a break in the relative stagnation of R&D expenditure which had marked the early 1990s. This growth was reflected in high average annual growth rates (AAGR) of the order of 4.5 % for Japan and 5.6 % for the United States. Expenditure in the EU-15 followed the same trend but with a slight time-lag, since growth in expenditure was more marked with effect from 1996, which would seem to explain an AAGR slightly down (by 1.8 %) on those of the two other countries.

In terms of R&D personnel, over 2.18 million persons (head count — HC) were engaged in R&D activities in the EU-15 in 1999. Measured in full-time equivalent (FTE) and not in terms of head count, this represents a population of 1.63 million persons, or almost double the Japanese figure, which was 877 000 (⁷) in 1998. This situation is reversed, however, if the FTE figure is expressed as a percentage of the total labour force (Figure 3): in 1998 it was 1.30 % in Japan and 0.96 % in the EU-15. The business enterprise sector employed the largest proportion of R&D personnel: 72 % in Japan and 55 % in the EU-15 (1998).

Figure 3: R&D personnel (FTE) as a % of the labour force, all sectors 1985-98



⁽⁷⁾ Data for the United States are not available.



R&D activities in Europe: the Nordic countries confirm their leading positions

Figure 4: Overall resources devoted to R&D, all sectors — 1999

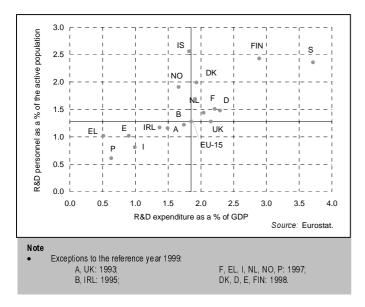
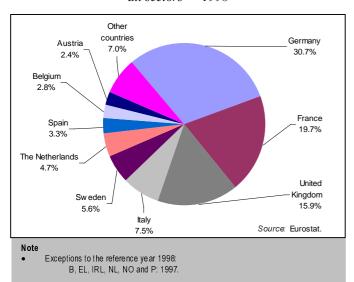


Figure 5: Distribution of R&D expenditure among the EEA countries in ECU, all sectors — 1998



Overall resources devoted to R&D

In 1999, the Nordic countries consolidated their positions of the previous years and displayed a highly dynamic commitment to R&D (8) at European level. This was particularly true for Sweden and Finland, where R&D expenditure was almost or even more than 3 % of GDP, while R&D personnel (HC) accounted for almost 2.5 % of the labour force (Figure 4).

The positions of Iceland, Denmark and Norway were unusual in the European R&D context: R&D personnel made up a very large percentage of the total labour force compared with the percentage of GDP accounted for by R&D expenditure.

In recent years there has been a trend towards a widening of the gap between the countries with a high level of R&D intensity and the European average. In contrast, the situation is reversed at the lower end of the table, since there is a tendency for the gap to narrow for countries such as Greece, Portugal and Spain, where the resources devoted to R&D have been moving closer to the European average.

R&D expenditure

R&D in Europe is dominated by the four largest countries, which together account for 75 % of total expenditure in the EU-15 (Figure 5). In 1998 Germany was in the lead with 31 % of EU-15 expenditure, followed by France (20 %), the United Kingdom (16 %) and Italy (7.5 %).

R&D expenditure in the Nordic countries, in particular Sweden and Finland, was over 3 % of GDP, well above the 1.85 % that is the average for the EEA countries as a whole (Figure 1, page 1). Even if expenditure as a percentage of GDP in France and Germany was still higher than the European average, in contrast to the United Kingdom and Italy, this percentage remained relatively stable or even decreased over time. The Nordic countries, on the other hand, expanded their R&D activities considerably. Thus, between 1991 and 1999, expenditure increased from 2.07 % to 3.09 % of GDP in Finland, from 2.87 % to 3.71 % in Sweden and from 1.16 % to 1.82 % in Iceland.

At a more detailed level, the distribution of overall R&D expenditure among the four institutional sectors shows a higher percentage in the business enterprise sector (64 %). This rate was over 50 % in most EU-15 countries and over 70 % in Sweden (76 %), Ireland (74 %) and Belgium (72 %). There were, however, three exceptions: Iceland, Portugal and Greece, where the higher education and government sectors together accounted for over 60 % of R&D expenditure (⁹).



⁽⁸⁾ Overall resources devoted to R&D means R&D expenditure measured as a percentage of GDP and R&D personnel as a percentage of the labour force.

^(°) The reference year is 1998 except for: A: 1993; B, EL, IRL, NL, NO, and P: 1997.

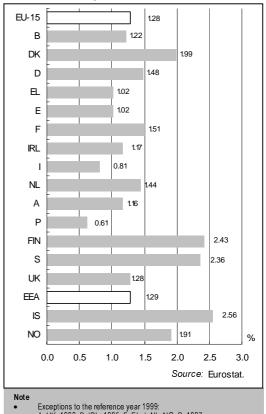
Country	Expenditure	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
EU-15	% of GDP	2.02 e	1.98 e	1.96 e	1.98 e	1.95 e	1.9 e	1.89 e	1.86 e	1.86 e	1.85 e
LO-13	ECU/EUR Mio	105 500 e	112 200 e	115 700 e	117 300 e	120 700 e	124 600 e	129 900 e	135 000 e	141 200 e	147 000 e
В	% of GDP	:	1.64	:	1.79 bp	1.78 bp	1.74 p	1.82 p	1.84 p	:	:
	ECU/EUR Mio	:	2 654	:	3 226 bp	3 434 bp	3 679 p	3 852 p	3 953 p	1	:
DK	% of GDP	1.63 e	1.70	1.74 e	1.80	:	1.84	1.85 e	1.94	1.93 e	1.99 €
	ECU/EUR Mio	1 653 e	1 783	1 907 e	2 068	:	2 530	2 671 e	2 895	2 993 e	3 249
D	% of GDP	2.67	2.57 b	2.45 b	2.40	2.31	2.26 b	2.26 e	2.29	2.29 e	:
	ECU/EUR Mio	32 548	36 350 b	37 800 b	39 547	40 272	42 524 b	42 356 e	42 767	44 051 e	:
EL	% of GDP	0.83	0.85	0.89 b	0.89	0.82	0.81	0.83 e	0.82	0.90	0.90
	ECU/EUR Mio	3 291	3 731	4 074 b	3 738	3 449	3 624	3 988 e	4 051	4 693	5 050
Е	% of GDP	:	0.37	:	0.48	:	0.49	:	0.51	:	:
	ECU/EUR Mio	:	264	:	374	:	437	:	542	:	:
F	% of GDP	:	2.41	2.43 b	2.47	2.39	2.31	2.30	2.21	2.19 p	:
	ECU/EUR Mio	:	23 399	24 726 b	26 202	26 681	27 426	28 134	27 520	28 319 p	:
IRL	% of GDP	0.86	0.97	1.01	1.18 e	1.31 e	1.37 e	1.42	1.40	:	:
	ECU/EUR Mio	317	375	418	505 e	614 e	688 e	809	968	:	:
1	% of GDP	1.30	1.24 b	1.20	1.14	1.07	1.00	1.01	0.99	1.02 p	1.04
	ECU/EUR Mio	11 170	11 516 b	11 255	9 566	9 080	8 386	9 778	10 149	10 822 p	11 466
NL	% of GDP	2.16	2.05	1.99	2.01	2.05 b	1.99	2.03	2.04	:	:
	ECU/EUR Mio	4 809	4 812	4 928	5 343	5 781 b	6 310	6 595	6 789	:	:
Α	% of GDP	1.41 e	1.49 e	1.47 e	1.49	1.56 e	1.55 e	1.60 e	1.68 e	1.80 e	1.82
	ECU/EUR Mio	1 774 e	2 007 e	2 133 e	2 327	2 581 e	2 799 e	2 927 e	3 073 e	3 395 e	3 552
Р	% of GDP	0.53	:	0.63	:	:	0.57	:	0.63	:	:
	ECU/EUR Mio	287	:	460	:	:	470	:	582	:	:
FIN	% of GDP	1.91	2.07	2.18	2.23	2.34	2.29	2.54	2.72	2.89	3.09
	ECU/EUR Mio	2 029	2 034	1 788	1 604	1 929	2 262	2 553	2 937	3 335	3 756
S	% of GDP ECU/EUR Mio	:	2.87 5 583	:	3.19	:	3.47 6.362	:	3.7 7 749	3.77 p	3.71
	% of GDP	2.21	2.12	2.11	5 068 2.15	2.1	1.98	1.93	1.84	8 000 p 1.82	8 318
UK	% OF GDP ECU/EUR Mio	16 889	17 331	17 146	17 273	17 994	17 035	17 864	21 387	22 865	:
	% of GDP	2.01 e	1.97 e	1,7 146 1.96 e	1.98 e	1.94 e	1.89 e	1.88 e		1.86 e	1.85
EEA	ECU/EUR Mio	107 000 e	1.97 e 113 800 e	117 500 e	1.96 e 119 100 e	1.94 e	126 600 e	132 000 e	1.86 e 137 300 e	143 700 e	149 700
	% of GDP	0.99	1.16	1.34	1.34	1.39	1.54	1.51 ep	1.87	2.02 e	1.82
IS	ECU/EUR Mio	49	63	71	69	73	82	86 ep	120	148 e	152
	% of GDP	:	1.65	:	1.73	:	1.71 b	:	1.66	:	:
NO	FCU/FUR Mio		1 571	:	1 716		1 919 b	:	2 268		
	% of GDP	2.66	2.68	2.62 b	2.5	2.4	2.48	2.52	2.55	2.58 p	2.62
US	ECU/EUR Mio	121 300	129 646	127 448 b	141 646	142 301	140 438	155 145	187 159	202 172 p	228 516
	% of GDP	2.85	2.82	2.76	2.68	2.63	2.77	2.8	2.89	3.03	220 310
JP	ECU/EUR Mio	66 849	77 624	79 167	97 864	104 078	108 681	101 558	107 021	102 555	:
		ne series, 'p': provisio		. 5 . 67	3, 304	.0.010	.00 001	.0.000	.0. 021	.02 300	

R&D personnel

Of the 2.17 million persons (HC) engaged in R&D in Europe in 1998, 70 % worked in the four largest countries: Germany (26 %), France (17 %), the United Kingdom (16 %) and Italy (8 %). Although these countries dominated the European stage in the same way as they did in terms of R&D expenditure, their estimated AAGR during the period 1996-98 (in so far as data are available) remained below the European average of 1.7 %. This average annual growth rate remained stable in Germany and Italy, thus continuing a trend going back to the mid-1990s, while in France there was a slight upward trend in this rate. In contrast, the highest AAGR were achieved by countries in which, except for Finland (11.4%), the number of R&D personnel remained low (less than 21 000 in FTE or 44 000 in HC). The countries in question are Iceland (22.5 %), Ireland (14.7 %), Portugal (8.0 %) and Greece $(7.1 \%) (^{10}).$

It was again the Nordic countries which had the highest percentage of the labour force engaged in R&D work: over 2.30% in Sweden, Finland and Iceland (Figure 6).

Figure 6: R&D personnel (HC) as a % of the labour force, all sectors — 1999



Exceptions to the reference year 1999:
 A, UK: 1993; B, IRL: 1995; F, EL, I, NL, NO, P: 1997;
 DK, D, E, FIN: 1998.



The reference period for calculating the AAGR is 1996-98 for all sectors, except for the following:
A: 1989-93; B: 1991-95; IRL: 1993-95;
FIN and S: 1995-98; F, EL, I, NL, NO and P: 1995-97.

Resources devoted to R&D in the European regions: the German regions clearly in the lead

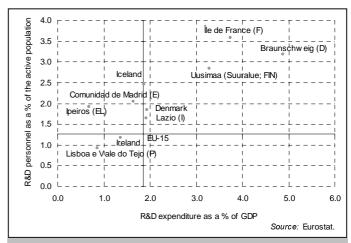
In 1997, the overall R&D commitment, all sectors taken together, of the leading regions of the EEA countries did not develop at the same rate (Figure 7). There were wide differences between the leading regions of Braunschweig (D), Île de France (F) and Uusimaa (Suuralue) (FIN) and the leading regions of the other countries. Expenditure as a percentage of GDP was four percentage points higher in the first region than in the last, and the percentage of R&D personnel in the labour force was two points higher.

R&D expenditure

The German regions form strong centres of European R&D, since seven of them were among the top ten in 1997 in terms of percentage of GDP (Table 4). These seven regions alone accounted for almost 15% of total R&D expenditure in volume terms in Europe. Three other non-German regions were in the top ten: Île de France (F), Midi-Pyrénées (F) and Uusimaa (FIN).

Of the regions with the highest R&D expenditure in volume terms, Île de France was in the lead (9 565 million PPS), ahead of Oberbayern (4 251 million PPS), Stuttgart (3 628 million PPS), Lombardia (2 268 million

Figure 7: Overall resources devoted to R&D: the first region per country in 1997, NUTS 2



Note

• Exceptions to the reference year 1997

IRL: 1995 and NUTS 1

PPS) and Köln (2 296 million PPS). These five regions alone accounted for over 20 % of the GERD of the European Union (Table 5).

Table 4: The dominant European regions, R&D expenditure measured as a % of GDP, all sectors, NUTS 2—1997

Region 1997	Country	R&D expenditure	Average annual growth rate	R&D expenditure	R&D expenditure
		as a % of GDP	(1995-1997)	in the EEA (PPS, 1990 prices)	(1990 prices)
	Ī	(%)	(%)	(%)	(Mio PPS)
Braunschw eig	D	4.87	0.7	1.12	1.204
Stuttgart	D	4.76	3.6	3.36	3.628
Oberbayern	D	4.29	- 0.1	3.94	4.251
Tübingen	D	4.02	0.6	1.07	1.156
Uusimaa (Suuralue)	FIN	3.74	11.1	0.99	1.072
Rheinhessen-Pfalz	D	3.63	10.5	1.02	1.098
Midi-Pyrénées	F	3.55	9.0	1.20	1.297
Île de France	F	3.28	1.4	8.95	9.656
Karlsruhe	D	3.25	4.2	1.61	1.743
Berlin	D	3.24	2.6	1.71	1.845
EU-15	EU-15	1.86	1.54		106 400
EEA	EEA	1.86	1.52	100.00	107 900
					Source: Eurosta

Table 5: The European regions with high R&D potential measured as a % of total R&D expenditure of the EEA, all sectors, NUTS 2—1997

Region 1997	Country	R&D expenditure	R&D expenditure	Average annual growth rate	R&D expenditure
		in the EEA (PPS, 1990 prices)	as a % of GDP	(1995-1997)	(1990 prices)
		(%)	(%)	(%)	(Mio PPS)
Île de France	F	8.95	3.28	1.4	9.656
Oberbayern	D	3.94	4.29	- 0.1	4.251
Stuttgart	D	3.36	4.76	3.6	3.628
Lombardia	1	2.13	1.22	1.3	2.268
Köln	D	2.13	3.14	- 4.6	2.296
Darmstadt	D	2.09	2.45	1.0	2.250
Rhône-Alpes	F	2.07	2.37	7.2	2.231
Denmark	DK	1.76	1.94	6.1	1.899
Berlin	D	1.71	3.24	2.6	1.845
Lazio	1	1.68	1.92	0.2	1.786
EU-15	EU-15		1.86	1.54	106 400
EEA	EEA	100.00	1.86	1.52	107 900

Notes for Tables 4 and 5

- Exception to the reference years: Lombardia and Lazio: 1996; 1994-96
- Regions accounting for less than 0.1 % of the total R&D expenditure in the
- EEA are not included
- The classifications cover 89 regions.



> ESSENTIAL INFORMATION - METHODOLOGICAL NOTES

Research and development input indicators at the regional level (*R&D* expenditure and *R&D* personnel)

The definitions of R&D personnel and R&D expenditure are taken from the *Frascati Manual* and concern the variables at national level (for further details, see the *Frascati Manual*, § 279 ff and § 333 ff respectively). For the purposes of regional statistics, these definitions have been adapted to the region (see *Regional Manual* (11), Part C: Priority Indicators, § 132 ff).

Intramural expenditure on R&D (GERD) at the regional level (Regional Manual, § 134)

Regional intramural expenditure covers all expenditure relating to R&D carried out in a unit or statistical sector in a region, irrespective of the origin of the funds.

R&D personnel at the regional level (Regional Manual, § 151)

All persons employed *directly* on R&D in a region should be counted, as well as those providing *direct* services such as R&D managers, administrators and clerical staff. Those providing an *indirect* service, such as canteen and security staff, should be excluded, even though their wages and salaries are included as an overhead cost in the measurement of R&D expenditure.

• Full-time equivalent — FTE

Full-time equivalent corresponds to one year's work by one person. Thus, someone who normally devotes 40 % of his/her time to R&D and the rest to other activities (e.g. teaching, university administration or counselling) should be counted as only 0.4 FTE.

• Personnel in head count — HC

The number of individuals who are employed mainly or partly on R&D. For purposes of comparison between different regions and periods, this indicator is often used in conjunction with employment or population variables.

(11) The Regional Dimension of R&D and Innovation Statistics, Regional Manual, European Commission, Eurostat, 1996.

Institutional classifications

Internal expenditure and R&D personnel are broken down by institutional sector, i.e. the sector in which the R&D is performed. There are four main sectors: business enterprise, government, higher education and private non-profit institutions.

The business enterprise sector (BES)

With regard to R&D, the business enterprise sector includes (Frascati Manual, § 145):

- all firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price; and
- the private non-profit institutes mainly serving them.

The government sector (GOV)

In the field of R&D, the government sector includes (*Frascati Manual*, § 168):

- all departments, offices and other bodies which furnish but normally do not sell to the community those common services, other than higher education, which cannot otherwise be conveniently and economically provided and administer the state and the economic and social policy of the community. (Public enterprises are included in the business enterprise sector); and
- PNP controlled and mainly financed by government.

The higher education sector (HES)

This sector is composed of (Frascati Manual, § 190):

all universities, colleges of technology and other institutes of postsecondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments.

The private non-profit sector (PNP)

The field covered by this sector includes (Frascati Manual, § 178):

- Non-market, private non-profit institutions serving households (i.e. the general public); and
- private individuals or households.



Further information:

Reference publications

Statistics on Science and Technology in Europe Title Catalogue No

KS-32-00-904-EN-C **EUR 35**

Databases

New Cronos, Theme 9

Domain: ZRD2

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