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I. GENERAL DESCRIPTION

The electronic edition of the OECD *Research and Development Statistics* presents country tables giving the main basic statistical series selected from the OECD “Research & Development Database”. There are series for 30 OECD Member countries and nine non-member economies collected via the OECD/Eurostat International Survey of Resources Devoted to R&D. For each country, this publication includes 18 tables on *total national resources devoted to R&D* in 3 areas: (i) E01 to E11 - *expenditure*; (ii) P1 to P6 – *personnel*; and (iii) G1 - *government budget appropriation or outlays for R&D* (GBAORD).

The first set of tables deal with the standard expenditure measure, the *Gross Domestic Expenditure on Research and Experimental Development (GERD)* which covers all R&D carried out on national territory in the year concerned by sector of performance, giving information on its breakdown by source of funds, type of costs, type of R&D, field of science and socio-economic objective. R&D expenditure data are expressed in million national currency, million current PPP\$, and million constant \$ (2000 prices and PPPs).

The second set covers resources devoted to R&D measured in labour terms, where *R&D personnel* by sector of employment is broken down by gender, occupation, and field of science. Such R&D personnel level of resources data are expressed in full-time equivalent on R&D (FTE) – for example a person working half-time on R&D therefore counts as 0.5 FTE -- and in headcounts.

Datasets on R&D expenditure and personnel are also provided for R&D carried out in the *Business Enterprise Sector* with detailed data *by industry*, and R&D in the *Higher Education Sector* with detailed data *by field of science*.

The R&D expenditure and personnel tables are essentially based on retrospective surveys of the units carrying out the R&D, though national forecasts have been included when available. More up-to-date information on government intentions or objectives when committing money to R&D can be derived from budgets. These data are shown in the GBAORD table, which includes the breakdown of *government R&D budgets by socio-economic objective*. Users are warned that these budget R&D data vary in coverage from those in the R&D expenditure tables, and percentages from the two types of table should not be combined.

II. ORGANISATION OF THE ELECTRONIC EDITIONS

2.1. SOFTWARE

This edition of *Research and Development Statistics* is supplied with the Beyond 20/20™ browser under license from Ivation Datasystems Inc. The software is installed by running the SETUP.EXE file, which is the start-up file for the electronic product. This is a Windows-based data dissemination tool which allows you to bring the entire database on screen, and also to select the series, country and year desired to produce tables and graphics. It is then easy to move the series, country and time period elements to the axis of your choice. Beyond 20/20™ allows users to save a table into several formats in a user-friendly manner.

Refer to the accompanying *Quickstart Guide* for further details and general instructions on its use. This product also has an on-line help feature.

2.2. PRESENTATION OF THE FILES

2.2.1. List of tables

R&D expenditure

- E01. Gross domestic expenditure on R&D -- GERD -- by sector of performance and source of funds.
- E02. Gross domestic expenditure on R&D -- GERD -- by sector of performance and type of costs.
- E03. Current domestic and gross domestic expenditure on R&D by sector of performance and type of R&D.
- E04. Gross domestic expenditure on R&D -- GERD -- by sector of performance and field of science.
- E05. Gross domestic expenditure on R&D -- GERD -- by sector of performance and socio-economic objective.
- E06. Business enterprise intramural expenditure on R&D -- BERD -- by industry.
- E07. Business enterprise intramural expenditure on R&D -- BERD -- by industry and source of funds.
- E08. Business enterprise intramural expenditure on R&D -- BERD -- by industry and type of costs.
- E09. Business enterprise intramural expenditure on R&D -- BERD -- by size of firm and source of funds.
- E10. Higher education intramural expenditure on R&D -- HERD -- by field of science and source of funds.
- E11. Higher education intramural expenditure on R&D -- HERD -- by field of science and type of costs.

R&D personnel

- P1. R&D personnel by sex, sector of employment and occupation, in full-time equivalent.

- P2. R&D personnel by sector of employment and field of science, in full-time equivalent.
- P3. Researchers by sex, sector of employment and field of science in full-time equivalent.
- P4. R&D personnel by sex, sector of employment and occupation in headcount
- P5. Researchers by sex, sector of employment and field of science in headcount.
- P6. Total R&D personnel and researchers in the business enterprise sector by industry, in full-time equivalent on R&D.

Government budget appropriations or outlays for R&D

- G1. Government budget appropriations or outlays for R&D -- GBAORD -- by socio-economic objective.

2.2.2. Geographical coverage

The following countries are represented in all tables when data are available:

OECD countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

Non-member economies:

Argentina

China
Israel
Romania
Russian Federation
Singapore
Slovenia
South Africa
Chinese Taipei

2.3. STANDARD NOTES

In the electronic edition the information on the quality and international comparability of the data are included at the cell level. These standard footnotes are included in the data files:

- a) Break in series with previous year for which data is available.
- b) Secretariat estimate or projection based on national sources.
- c) National estimate or projection.
- d) Defence excluded (all or mostly).
- e) National results adjusted by the Secretariat to meet *Frascati Manual* norms.
- f) Including R&D in the social sciences and humanities.
- g) Excluding R&D in the social sciences and humanities.
- h) Federal or central government only.
- i) Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF).
- j) Excludes most or all capital expenditure.
- k) Note not currently used.
- l) Overestimated or based on overestimated data (see General Methodology).
- m) Underestimated or based on underestimated data (see General Methodology).
- n) Included elsewhere.
- o) Includes other classes.
- p) Provisional.
- q) Note not currently used
- r) Note not currently used.
- s) Unrevised breakdown not adding to the revised total.
- t) Do not correspond exactly to OECD norms (see General Methodology).
- u) University graduates instead of researchers.
- v) Incomplete breakdown. The sum of the elements does not add to the total (see General Methodology).
- w) Including extramural R&D expenditure.
- x) Confidential.

2.4. ABBREVIATIONS

BE	Business Enterprise sector (Industry).
BEMP	Business Enterprise R&D personnel.
BERD	Expenditure on R&D in the Business Enterprise sector.
FTE	Full-time Equivalent (on R&D).
GBAORD	Government Budget Appropriations or Outlays for R&D.
GDP	Gross Domestic Product.
GERD	Gross Domestic Expenditure on R&D.
GOVERD	Government Intramural Expenditure on R&D.
GUF	General University Funds.
HC	Headcount.
HE	Higher Education.
HEMP	Higher Education R&D personnel.
HERD	Expenditure on R&D in the Higher Education sector.
ISCED	International Standard Classification of Education, 1997.
ISIC	International Standard Industrial Classification.
N.E.C.	Not elsewhere classified.
NSE	Natural Sciences and Engineering.
PNP	Private Non-Profit Institutions/Private Non-Profit sector.
PPP	Purchasing Power Parities.
R&D	Research and Experimental Development.
SSH	Social Sciences and Humanities.
ST	Sub-total.
..	Data not available or not separately available.

For further explanations of the above terms, see the standard OECD methodology for the collection of R&D statistics entitled *The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys of Research and Experimental Development -- Frascati Manual 2002*, known simply as the "*Frascati Manual*".

III. STATISTICAL CONTENT

3.1. Definitions and coverage

3.1.1 *OECD standards*

The data in this publication have been collected and presented in line with the standard OECD methodology for R&D statistics entitled *The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys of Research and Experimental Development -- Frascati Manual 2002* (OECD)

3.1.2 *The two types of data*

Most R&D data are derived from retrospective surveys of the units actually carrying out or "performing" R&D projects. Thus, the statistics in the R&D expenditure and R&D personnel tables are based on the sum of performers' reports of their R&D expenditure and personnel on national territory (i.e. excluding payments to international organisations and other performers abroad). Personnel data are either expressed in full-time equivalent on R&D (FTE) (i.e. a person working half-time on R&D counts as 0.5 person-years) when measuring the level of R&D resources, or in headcount when measuring the number of personnel having R&D activities or certain characteristics of these personnel. Because of the complexity of the surveys, it is difficult to obtain very up-to-date series. In the present volume, 2006 and 2007 data are sometimes still provisional and most data for later years are national estimates or projections (these data have been annotated "c" or "p").

More up-to-date information on government support for R&D can be derived from budgetary sources. The statistics in the table Government budget appropriations or outlays for R&D -- GBAORD are based on government budget appropriations or outlays for R&D as reported by the funding ministry or agency, and include payments to international organisations and other performers abroad.

The specification of data on the national effort financed by government in the R&D expenditure tables differs significantly from the data on total government budget appropriations for R&D (GBAORD); combining these two sets of data would give erroneous estimates for civil and defence GERD.

3.1.3 *Fields of science*

In general, the data cover R&D in all fields of science (NSE+SSH), i.e. natural sciences (including medical and agricultural sciences) and engineering (NSE) and social sciences and humanities (SSH). A large number of countries collect data on R&D activities in the Business Enterprise sector for NSE only.

3.1.4 *Sectors of performance and sources of funds*

Domestic R&D efforts (expenditures or personnel) are divided into *four sectors of performance* for statistical purposes, Business Enterprise (industry), Higher Education, Government and Private Non Profit institutions (PNP). This publication provides data on each of the four sector totals and detailed information for the first two sectors only.

R&D expenditure is subdivided into *five sources of funds*: from Business Enterprise, from Government, from Higher Education, from PNPs and from Abroad. Since the amounts financed by the

Higher Education and PNP sectors are small, they have been combined as "other national sources" in the table "Business enterprise R&D by industry and source of funds".

3.1.5 *R&D in the Business Enterprise sector*

These data are intended to provide internationally comparable indicators of resources devoted to R&D and trends at industry level. The Business Enterprise sector covers private and public enterprises and institutes serving such enterprises.

The industry classification (see figure 3) is based on the International Standard Industrial Classification (ISIC, rev. 3.1) and data at the industry level are presented beginning 1987, year when most of the countries converted from ISIC rev.2 to the current ISIC rev. 3 classification. The table on the following page (figure 3) shows the breakdown by industry as recommended by *Frascati Manual*, collected in the OECD/Eurostat R&D questionnaire, and presented in this publication. This breakdown between industries is, in principle, made at the enterprise level, although some countries are able to break down R&D data for multi-product enterprises between their main lines of business. National statistical regulations prevent publication of results where there are very few firms in the given category, hence the many gaps in the tables. Depending on the country, R&D institutes serving enterprises are either classified with the industry concerned, or grouped under "Research and Development" (ISIC rev.3.1, Division 73). When these R&D institutes are classified with the industry served, the evaluation of R&D in these industries is more complete and more comparable between countries for the industries concerned. This results, however, in an underestimation of the percentage of BERD performed by the service sector as compared with other countries.

The *Frascati Manual* recommendation concerning data on R&D by industry is to report BERD on an enterprise basis (see FM section 3.4). When this is interpreted strictly, all the BERD of a diversified enterprise will be allocated to the industrial class of its principal activity. In circumstances where a few large firms dominate R&D spending in several areas, this can and does lead to underestimates of R&D associated with the secondary activities of the firms. Overall, R&D is therefore overestimated for some industries and underestimated for others. However, not all countries follow a strict enterprise basis for allocating R&D expenditures to industrial classes. Some countries make a disaggregation of the R&D of their largest, diversified firms into a number of different activities. In other countries, the enterprise approach has been abandoned and data are reported on a product field basis. This is why two classification criteria for BERD by industry are included in table "E06. BERD by industry" (see the variable CRITERIA: Main activity or Product field) depending on which approach is more closely followed by each country (only a few countries currently collect these data both ways and are therefore included according to both criteria). Tables E07 and E08 "BERD by industry and source of funds" and "BERD by industry and type of costs" present data for only one of the criteria, depending on the country.

Figure 3. Industry classification for resources devoted to R&D in the business enterprise sector

ISIC rev. 3.1	Nace rev. 3.3	
01, 02, 05	01, 02, 05	AGRICULTURE, HUNTING AND FORESTRY
10, 11, 12, 13, 14	10, 11, 12, 13, 14	MINING AND QUARRYING
15 - 37	15 - 37	MANUFACTURING
15, 16	15, 16	Food, beverages and tobacco
15	15	Food products and beverages
16	16	Tobacco products
17, 18, 19	17, 18, 19	Textiles, fur and leather
17	17	Textiles
18	18	Wearing apparel and fur
19	19	Leather products and footwear
20, 21, 22	20, 21, 22	Wood, paper, printing, publishing
20	20	Wood and cork (not furniture)
21	21	Pulp, paper and paper products
22	22	Publishing, printing and reproduction of recorded media
23, 24, 25	23, 24, 25	Coke, petroleum, nuclear fuel, chemicals and products, rubber and plastics
23	23	Coke, refined petroleum products and nuclear fuel
23 (less 232)	23 (less 23.2)	Coke and nuclear fuel
232	23.2	Refined petroleum products
24	24	Chemicals and chemical products
24 (less 2423)	24 (less 24.4)	Chemicals and chemical products (less pharmaceuticals)
2423	24.4	Pharmaceuticals
25	25	Rubber and plastic products
26	26	Non-metallic mineral products
27	27	Basic metals
271 + 2731	27.1-27.3 + 27.51 + 27.52	Basic metals, iron and steel
272 + 2732	27.4 + 27.53 + 27.54	Basic metals, non-ferrous
28-35	28-35	Fabricated metal products, machinery and equipment, instruments and transport
28	28	Fabricated metal products, except machinery and equipment
29	29	Machinery and equipment, n.e.c.
2911	29.11	Engines and turbines, except aircraft, vehicle and cycle
292	29.3 - 29.6	Special purpose machinery
2922	29.4	Machine tools
2927	29.6	Weapons and ammunition
30	30	Office, accounting and computing machinery
31	31	Electrical machinery and apparatus n.e.c.
311	31.1	Electrical motors, generators and transformers
312	31.2	Electricity distribution and control apparatus
313	31.3	Insulated wire and cable (includes optic fibre cables)
314	31.4	Accumulators, primary cells and primary batteries
315	31.5	Electric lamps and lighting equipment
319	31.6	Other electrical equipment n.e.c.
32	32	Radio, TV and communications equipment and apparatus
321	32.1	Electronic valves, tubes and components (includes semiconductors)
322	32.2	TV, radio transmitters and line apparatus
323	32.3	TV and radio receivers, sound and video goods
33	33	Medical, precision and optical instruments, watches and clocks (instruments)
3311	33.1	Medical appliances, instruments and control equipment
3312	33.2	Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
3313	33.3	Industrial process control equipment
332	33.4	Optical instruments and photographic equipment
333	33.5	Watches and clocks
34	34	Motor Vehicles, trailers and semi-trailers
35	35	Other Transport Equipment
351	35.1	Ships and boats
352	35.2	Railway and tramway locomotives and rolling stock
353	35.3	Aircraft and spacecraft
359	35.4 + 35.5	Transport equipment, n.e.c.
36	36	Furniture, other manufacturing n.e.c.
361	36.1	Furniture
369	36.2 - 36.6	Other manufacturing n.e.c.
37	37	Recycling
40, 41	40, 41	ELECTRICITY, GAS and WATER SUPPLY
45	45	CONSTRUCTION
50 - 99	50 - 99	SERVICES SECTOR
50, 51, 52	50, 51, 52	Wholesale, retail trade and motor vehicle repair
55	55	Hotels and restaurants
60 - 64	60 - 64	Transport, storage and communications
642	64.2	Telecommunications
60 - 64 less 642	60 - 64 less 64.2	Other
65, 66, 67	65, 66, 67	Financial intermediation (includes insurance)
70, 71, 72, 73, 74	70, 71, 72, 73, 74	Real estate, renting and business activities
72	72	Computer and related activities
722	72.2	Software consultancy and supply
73	73	Research and development
74	74	Other business activities
742	74.2 + 74.3	Architectural, engineering and other technical activities
75 - 99	75 - 99	Community, social and personal service activities, etc.
01 - 99	01 - 99	TOTAL BUSINESS ENTERPRISE R&D (BERD)

3.1.6 R&D in the Higher Education sector

These data are mainly intended to describe the characteristics and trends of R&D in the Higher Education sector by fields of science (see *Frascati Manual 2002*, section 3.7) because of the importance of the role played in R&D by universities and similar establishments. The Higher Education sector includes all universities, colleges of technology and other institutes of post-secondary education and also all research institutes, experimental stations and clinics operating under the direct control of, or administrated by, or associated with higher education establishments.

3.1.7 Government budgetary appropriations or outlays for R&D (GBAORD)

These data are assembled by national authorities using statistics collected for budgets. This essentially consists of identifying all the budget items involving R&D and measuring or estimating their R&D content. The series generally cover federal or central government only. These estimates, based on funders' reports, are less accurate than the "performer-reported" data in the R&D expenditure and R&D personnel tables, but as they are derived from the budget, they can be linked back to policy issues by means of a classification by "objectives" or "goals". Programmes are allocated between socio-economic objectives on the basis of *intentions* at the time the funds are committed and not the actual content of the projects concerned. These breakdowns reflect *policies* at a given moment in time.

The classification used is the European Commission's Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets – NABS 2007, specially developed for R&D analysis. It is compatible with a similar classification used by the Nordic countries.

3.1.8 Expenditures in national currency

National currency data is expressed in euro for the Euro-area countries. Beginning with the year of entry into the Economic and Monetary Union (EMU), data are in EUR. For years prior to the year of entry into EMU, data have been converted from the former national currency using the appropriate irrevocable conversion rate. This presentation facilitates comparisons within a country over time and ensures that the historical evolution is preserved. Please note, however, that ***pre-EMU euro are a notional unit and should not be used to form area aggregates or to carry out cross-country comparisons.***

In the present publication, series stretch across the accession date of EMU member countries and thereby comprise both pre-accession data in the original national currency converted with the irrevocable conversion rate, and post-accession data in true EUR. Austrian national currency data, for example, is presented in 1999 ATS euro up through 1998, and beginning with the 1999 data, in EUR; similarly, Greek data is presented in 2001 GRD euro up through 2000, and beginning with the 2001 data, in EUR.

The Euro-area countries, their irrevocable EUR/national currency exchange rate and year of EMU accession are the following:

<i>Country</i>	<i>1 EUR =</i>	<i>Year of accession to EMU</i>
Austria	13.7603 ATS	1999
Belgium	40.3399 BEF	1999
Finland	5.94573 FIM	1999
France	6.55957 FRF	1999
Germany	1.95583 DEM	1999

Greece	340.750 GRD	2001
Ireland	0.787564 IEP	1999
Italy	1936.27 ITL	1999
Luxembourg	40.3399 LUF	1999
Netherlands	2.20371 NLG	1999
Portugal	200.482 PTE	1999
Slovenia	239.640 SIT	2007
Spain	166.386 ESP	1999

3.1.9 Expenditures in current dollars

National currency data have been converted to US\$ using purchasing power parities (PPPs). The PPPs are those developed by the OECD National Accounts Division (for further details see sections III and IV of *National Accounts of OECD countries, Volume 1, 1996-2007*, OECD 2009, as well as *Purchasing Power Parities and Real Expenditures - 2005 Benchmark Year*, OECD 2007), updated for the most recent years by comparing the growth in prices (implicit GDP deflator) in each country with that in the United States. These estimated parities are footnoted "b" in the tables as are any data converted to current dollars using them.

3.1.10 Expenditures in constant dollars

R&D expenditure series have been deflated using the implicit GDP deflator taken from the OECD National Accounts database updated for the most recent years by Secretariat forecasts of changes in the GDP deflator, as published twice a year in the *OECD Economic Outlook* (except in the case of Norway where a deflator excluding trends in petroleum prices has been used). These national currency data at 2000 prices have been converted to US\$ using 2000 purchasing power parities (PPPs). The PPPs are those developed by the OECD National Accounts Division, updated for the most recent years by comparing the growth in prices (implicit GDP deflator) in each country with that in the United States. These estimated parities are footnoted "b" in the series as are any data converted to current dollars using them.

3.1.11 International comparability

Though all OECD countries generally collect and report R&D in line with the *Frascati Manual*, some detailed national specifications may vary from *Frascati* standards. The main exceptions are shown in the "National specifications" section below. They mainly deal with:

- breaks in series;
- whether or not the data cover all fields of science (NSE and SSH);
- difficulties encountered by national authorities in measuring the amount of resources devoted to R&D in the Higher Education sector because of the close relationship between teaching and research activities;
- differences in the coverage of the Higher Education and Government sectors due to institutions at the "borderline" of the two;

- whether or not R&D institutes serving enterprises are included and whether or not they are classified according to the industry concerned.

3.2. National specifications

A summary, by country, of the main national departures from OECD norms is given below for years 1981 to present.

Sometimes retrospective revisions are received for the global data without the corresponding revision of the detailed breakdown (for example, a revision of the data covering expenditure by source of funds for total BERD and GERD without the corresponding revision of the BERD data by industry. Such data have been footnoted "s" in the tables concerned.

3.2.1 OECD countries:

- **Australia**

For recent years, the source of funds for Business enterprise R&D does not add up to the sector total because a very small percentage of BERD cannot be allocated to the specified financing sources.

In the breakdown of R&D expenditure by type of cost in the business enterprise sector, the labour costs of maintenance staff and assistants not directly engaged in R&D are included in the cost of R&D personnel instead of being included in "other current costs" as the *Frascati Manual* recommends.

In 2001, R&D in the Business enterprise sector saw a significant increase due to a change in government policy in regard to the R&D tax concession scheme (Introduction of the 175% Premium (Incremental) Tax Concession for additional investment in R&D; Introduction of an R&D Tax Offset for small companies in tax loss that undertake R&D, enabling them to 'cash out' their R&D tax losses; and a new treatment of R&D plant-asset depreciation that allows a 125% deduction for effective life depreciation of assets used in R&D activities (on a pro-rata basis).

From 1999, Australia has prepared its Federal Budget details according to the principles of accrual accounting, leading to a break in the series for GBAORD data. In 1999, the change from cash accounting to accrual accounting increased the estimate of GBAORD by AUD 232 million.

- **Austria**

For the BE sector, beginning 2006 the "research premium" is included in "funds from government". This measure was introduced for the first time for the calendar year 2002, and for the 2002 and 2004 data, government expenditure for R&D spent via the "research premium" was subsumed under "funds from enterprises".

In 2004, Statistics Austria's regular annual updating procedure of the R&D expenditure data resulted in revisions showing a significant increase compared to previous estimates, mainly due to the inclusion of results from the 2002 survey of the business enterprise sector.

An estimate of the R&D expenditures of provincial hospitals is prepared on the basis of the annual financial reports of the Bundesländer (federal provinces) (€46.34 million for 1989) and is included in the expenditure tables. No corresponding estimate of personnel data is available.

In 1993:

- Because several institutions in the PNP sector were reclassified in the government sector, most of the 1993 data for these two sectors are not comparable with the data for earlier years.
- The total for gross domestic expenditure on R&D (GERD) includes government funding which was not identified by the R&D surveys. It has not been possible to break this funding down by type of cost or type of R&D: it totalled € 65.6 million in 1993: 54.54 million for current R&D expenditure and 13.76 million for capital expenditure. Similarly, in the business enterprise sector, it has not been broken down by industry and source of funds: €34.96 million in 1993.

- **Belgium**

Beginning 1998, two large non-profit organisations, formerly included in the higher education sector, were reclassified in the government sector.

As from 1993 (1992 for the business enterprise sector), the methodology for R&D surveys changed: data are based on full surveys and no longer on a combination of budget figures and survey findings. There is accordingly a significant break in the series, and data for these years data cannot be compared with those for earlier years.

In 1989 the methods of evaluating the R&D effort changed (thereafter the surveys included the resources of communities and regions, which had become very significant following the reforms of Belgium's institutions of government in 1988), and from then on the data are not comparable with those for earlier years. This affects both GERD and GBAORD data.

In 1987 and 1988, gross domestic expenditure on R&D (GERD) and GERD financed by government are underestimated as R&D financed by federal authorities (about 2-4 % of GERD and 7-15 % of government-financed GERD) is excluded. As a breakdown of this sum by sector of performance is not available, the impact on the other detailed R&D expenditure tables by sector of performance will also be underestimated. As from 1983, data for GERD are not comparable with those for earlier years, because of changes in the methods of assessing R&D efforts in Belgium.

As from 1981, resources devoted to R&D in the business enterprise sector are underestimated in all the detailed industry tables since the resources of joint R&D centres of enterprises are not included (their breakdown by industry is no longer available). At the end of the 1970s the contribution of these centres represented approximately one-sixth of the R&D expenditure of non-manufacturing industries.

- **Canada**

Beginning 1996 (1997 for Quebec), to ease the burden on respondents, a cut-off point of R&D expenditure less than \$1 million was initiated, relying on administrative data from Canadian Customs and Revenue Agency (CCRA) to fill the gap. While this initiative reduced reporting burden, it resulted in a small understatement of the total value of intramural expenditure (approximately 2% in 1997, 1998 and 1999) and of the total number of R&D personnel for the most recent years reported. The figures are revised each year and any understatement is eliminated in subsequent years.

The sources of funds for the higher education sector for General University Funds (GUF) have been adjusted at the national total level (GERD by sector of performance) but not for the detailed data by scientific discipline (HERD by sector of performance and field of science).

As from 1992, certain organisations were classified from the PNP sector to the HE sector. This revised data more accurately reflect the growing partnerships between universities, hospitals, and research institutes, and follow more closely the definition of the HE sector in the *Frascati Manual 2002*

As from 1989, General University Funds from non-federal sources are included in GBAORD.

As from 1988, included in the R&D expenditure of the higher education sector are the estimated values for R&D in hospitals not covered by University reports and not previously included.

In 1987, modifications in the number of categories collected in the survey resulted in a break in series.

- **Czech Republic**

Beginning 2005, there is a change in methodology for the collection of R&D personnel data in FTE. Data are provided in FTE by the reporting units, and based on new, more precise guidelines.

As from 1998, reclassification of some funding sources (Ministry of Education and Grants agency, etc.) from higher education to government funding. This reclassification is most significant in the higher education sector.

As from 1995, the survey methodology was amended in order to collect data complying with OECD standards:

- Ancillary activities are excluded.
- All sources of funding are available, except General University Funds (GUF).
- Defence-related R&D is included.
- Personnel data by occupation are expressed in FTE on R&D.

Until 1994 inclusive the data are not in line with the *Frascati Manual*:

- The data relate to all the activities of units making up the “R&D base”, corresponding to scientific and technical activity rather than R&D proper. The national authorities consider that around 10% of all expenditure is devoted to activities other than R&D.
- The data on expenditure cover only expenditure financed by government.
- Defence-related R&D is excluded.

- **Denmark**

Until 2002, the HE-sector R&D expenditure was underestimated as all R&D carried out in hospital departments at the university-hospitals was included in the Government sector.

As of 2002, the business enterprise survey specifically requests data on researchers, technicians and other. Earlier data for R&D personnel by occupation are based on qualification.

Up to 1995 and as from 2001, R&D expenditure by type of R&D (Basic Research, Applied Research and Experimental Development) is based on the sum of current intramural R&D expenditure. For the 1997 to 1999 breakdown by type of R&D, the national total, when available, is based on current intramural R&D expenditure for the BE sector and total intramural R&D expenditure for the three other sectors.

As from 2001, a new principle concerning budgeting of commitments was introduced for GBAORD: from 2001 commitments of grants are carried to the debit side at the time of entering the commitment, where previously commitment of grants was carried to the debit side at maturity.

As from 1999, provincial and local government funding is included in the GBAORD data (in particular funding in provincial hospitals), as well as funding from the Danish National Research Foundation and the Danish Investment Fund. In 1993, 1988 and 1983 changes in the method of assessing government budget appropriations or outlays for R&D (GBAORD) by socio-economic objective led to breaks in the series.

Before 1992, GBAORD data included non-government sources.

- **Finland**

Beginning 2004, R&D personnel data are available according to occupation. Previous breakdown was by formal qualification.

Beginning 1999, R&D in polytechnic schools is included.

In 1998, due to a greater number of responses to the BE survey on the group level, the questionnaire category funds from other foreign enterprises of the group have been merged with business enterprise funds (own funds) thus reducing the share of funds coming from abroad.

As from 1997, the higher education sector covers central university hospitals, as do GBAORD data which cover appropriations for R&D for central university hospitals.

As from 1995:

- Industrial classifications are more detailed and data is now available for some industries that were previously grouped elsewhere. However, the revisions also caused some other difficulties in comparisons with earlier years for some industries:
 - Basic metals and Research and development are not quite comparable with earlier figures because of the new classification of certain firms;
 - Electronic equipment previously included other industries.
- Funds from external sources of the State research institutes are excluded from Government appropriations for R&D (GBAORD).

As from 1994, PNP institutions are included in the government sector in non-survey years, meaning a break in series for the data relating to the government sector for those years. In 1993 R&D by PNPs represented a little over 3 % of total government plus PNP R&D expenditure, around 4 % of R&D personnel and 5.5 % of researchers.

In 1991:

- The method of evaluating R&D expenditure by the government and higher education sectors changed; in particular, the coefficient for calculating pension costs was raised from 15 to 25 % of salary. As a result, R&D expenditure by these sectors in 1991, and R&D financing by government and total national GERD, are not comparable with those for previous years.
- Similarly, data on GBAORD have been revised back to 1991 because of changes in R&D coefficients for certain research institutes and there was an upward adjustment in the total in 1991, due to the inclusion of pension costs.

In 1987, it would appear that the estimated expenditure on buildings and equipment, and hence capital expenditure, in the government and higher education sectors is not comparable with data for earlier years.

In 1983, changes to the methodologies limit comparability for the detailed breakdowns for the higher education and government sectors.

In 1981 some data were retrospectively revised by the national authorities, and from that year the sectoral totals for government and higher education are no longer comparable with data for earlier years. The corresponding revisions in the more detailed breakdowns by category of cost or personnel have not been supplied.

- **France**

The National Centre for Scientific Research (CNRS) is included in the higher education sector whereas in other countries, such as Italy for example, this type of organisation is classified in the government sector. This affects comparisons of the breakdown of the R&D effort by sector of performance.

In 2007, a new methodology was introduced to correct for some double-counting in source of funds for universities, and the Higher Education R&D expenditure data revised for 2004. Also in 2007, the sampling method in the BE sector was modified and the 2004 data revised according to the new methodology.

In 2001, coverage of the BE sector was expanded, and the data communicated by the Ministry of Defence now cover research that was not considered R&D in earlier years. The latter also affects the GBAORD data for the Defense socio-economic objective.

Details on the gender characteristics of R&D personnel expressed in headcount are available only for R&D personnel who are paid by the institution in which they work. As concerns the total headcount data, in the interest of coherency with the gender data, only taken into account are R&D personnel who are paid by the institution in which they work. This results in an underestimation of about 3% for the R&D personnel based on headcount. This underestimation mostly effects the Government and higher education sectors which are underestimated by 10% and 5% respectively.

In 2000, several methodological changes which improved the quality of the public sector data have resulted in a break in series for that year: social charges and civil pensions are better evaluated in universities' research expenses; modification of responses from some institutes to better harmonise with the corresponding multi-annual programme; and implementation of a redesigned questionnaire. National sources estimate that the previous method would have produced a 1.6% increase in GERD, where the current method results in 4%.

As from 1997:

- the method used to evaluate R&D personnel in the Government, higher education and PNP sectors has changed
- estimates for R&D expenditure and personnel are significantly revised due to results of the 1998 survey:
 - new methods used to evaluate domestic expenditure on defence;
 - Re-evaluation of R&D activities of very large enterprises;
 - Re-evaluation of clinical research and re-evaluation of R&D effort of one civil organisation.

Consequently, 1997 R&D personnel data for the Government, higher education and PNP sectors are not comparable with those of previous years and 1997 data on intramural R&D of BE sector and funding of R&D by Government and BE sectors are not comparable with those of previous years.

As from 1992:

- Data for the enterprise and government sectors are not comparable to the corresponding 1991 data because France Télécom and GIAT Industries were transferred from government to business enterprise following a change in their legal status. This also affects GBAORD data.
- There is an additional change affecting GBAORD data: Data are based on a survey on socio-economic objectives sent to the agencies and ministries administering the civilian R&D budget, but beginning 1992, also to subsidiary agencies.,
- Repayments of reimbursable assistance have been taken into account in the breakdown of R&D expenditure by source of funds.
- The survey method for the PNP sector changed.

In 1984, a break in the GBAORD series occurred following the introduction of new methodologies.

In 1983, the objective "Non-oriented Research" was revised upwards, primarily at the expense of the "Protection and improvement of human health" and "Exploration and exploitation of the Earth" objectives. Following adoption of the NABS '83, there was a break in the Defence objective.

- **Germany**

The data in this publication cover unified Germany from 1991 and western Germany only until 1990.

The method for calculating public-financed R&D in the business enterprise sector was reviewed, resulting in the revision of business enterprise R&D and the national total back to 1991.

In the higher education sector it has not been possible to include some funding in the breakdown of R&D expenditure by type of cost or type of activity or by main scientific field or in some detailed breakdowns by field of science (HERD by field of science and type of cost).

Higher education's "own funds" are combined with government funding.

For 1997, the methodology of assessing GBAORD by socio-economic objective changed. The 1997 total budget figure of the Federal Ministry of Education, Science, Research and Technology was reduced, but the global reduction was not available by socio-economic objective. Therefore, total GBAORD reflects the adjusted budget figure, and the sum of the breakdown does not add to the total. This is also the case beginning with the 2001 GBAORD data.

In 1995 the method of evaluating R&D resources in the higher education sector changed and was applied retroactively to 1981 to make the 1981 to 1994 data compatible with the more recent data.

As from 1993, R&D expenditure in the government sector, and consequently total GERD, includes R&D performed in German research institutions located abroad. This amounts to

between 0.6 and 0.7 % of R&D expenditure in the government sector and less than 0.1 % of GERD.

In 1992:

- The restructuring that took place after unification created over 100 non-university research units in the government sector.
- The methodology of the survey on resources devoted to R&D in the government sector was altered.
- From that year on, resources devoted to R&D by the PNP sector have been included in the government sector.

As from 1991, graduate students conducting research and receiving grants for that purpose were included for the first time among higher education researchers (close to 10 000 FTE). The relevant grants paid to them in 1991 were included in higher education R&D expenditure (HERD), so total grants paid to higher education in 1991 were well above the earlier figures, because only grants paid directly by government had been included up till then; the outcome was an increase in total government funding for R&D performed by higher education in that year.

In 1987 a new survey for the PNP sector.

In 1985 several changes concerning the government sector.

In 1981 and 1983: downwards adjustment of R&D performed by the government sector and of government funding to higher education.

- **Greece**

In 1995 following the revision of research coefficients used to evaluate resources devoted to R&D by higher education, R&D expenditure and personnel for this sector, for national totals and for GUF in GBAORD are not comparable to those for previous years.

As from 1993, the PNP sector is included in the survey.

In 1991 some activities included until then under “office machinery and computers” (and hence in the corresponding sub-total “machinery, equipment, instruments and transport equipment”) in manufacturing were reclassified in services under “computer and related activities” (and hence in the corresponding sub-total “real estate, renting and business activities”).

In 1989 the “research coefficients” used to evaluate resources devoted to R&D by higher education were revised.

In 1983:

- The methodology for evaluating resources devoted to R&D by higher education changed. The “research coefficients” used for the calculations were established on the basis of a survey of higher education institutions. This applies to GBAORD data also.
- The methodology for identifying R&D personnel was brought into line with the recommendations of the *Frascati Manual*, resulting in changes to personnel costs.
- methodology for GBAORD data was modified to make the data more internationally comparable: Public enterprises are excluded (break in series); Orientation to global data from each institution (Research Centres).

- **Hungary**

Prior to 2004, only defence-related R&D expenditure performed in the civil sector was covered and R&D expenditure by the armed forces was excluded.

Beginning 2006, government-financed R&D, some of which was not allocated to the appropriate sector, is now allocated, in particular to the Business enterprise sector. Prior to 2006, breakdown of R&D expenditure by sector of performance was incomplete.

Since 1998 personnel dealing with activities related to safety and warehouse operations in R&D units are excluded, in accordance with the *Frascati Manual*.

As from 1994:

- Payments for licences and know-how, previously included in business enterprise expenditure on R&D (BERD), were removed.
- The Central Technology Fund (KMÚFA), previously included in the business enterprise sector, was reclassified in the government sector.

- **Iceland**

In 1993 and also in 2002, Iceland revised its methods for collection and processing budget data for GBAORD by socio-economic objective, resulting in breaks in series.

- **Ireland**

As from 2000, personnel data in the government sector were surveyed in FTE. Prior to 2000, data were collected for human resources devoted to S&T in FTE, and the R&D expenditure to total S&T expenditure ratio was applied.

In 2000, the Advancement of research objective for GBAORD tripled in magnitude due to additional funding from the Higher Education Authority (HEA) and from the Science Foundation Ireland (SFI).

Back to 1992 inclusive, the Government sector data was revised, as some expenditure is no longer classified as R&D.

Back to 1985 inclusive, HERD time series have been revised following results of the 1993 full survey of R&D in the higher education sector.

In 1985 data on R&D in “office machinery and computers” became separately available and have been excluded from “Electronic equipment” since then.

As from 1983, non-government monies are no longer included in the GBAORD series.

- **Italy**

In 2005 and 1997, new methods for estimating R&D in universities were introduced, resulting in breaks in series in the higher education sector and the national total.

In 1998, reclassification of an enterprise from one industry to another explains much of the decline in BERD performed in the Office machinery and computer industry.

As from 1991, extramural expenditure is collected separately in Italian R&D surveys and can thus be excluded from most data.

Until 1990, the data for Gross domestic expenditure on R&D by sector of performance and source of funds – were based on all intramural and extramural R&D expenditure (including extramural expenditure abroad). In relation to the *Frascati Manual* recommendations, the

inclusion of extramural R&D expenditure leads to gross domestic expenditure on R&D (GERD) being overestimated. This relates most particularly to R&D expenditure by the business enterprise sector, but concerns the government sector as well.

Extramural expenditure represented:

- At national level, over 6 % of GERD in 1991 and some 15 % in 1993. In 1991, over 20 % of such extramural expenditure represented financing abroad; in 1993, over 26 %.
- For the business enterprise sector, 11 % in 1991 and around 15 % in 1993 of its R&D expenditure (BERD). Over 13 % in 1991 and around 18 % in 1993 of R&D financed by the business enterprise sector was extramural expenditure (a quarter of the sector's extramural expenditure represented payments abroad).
- For the government sector, only 1 % of its R&D expenditure (GOVERD).

As from 1987, the breakdown of R&D expenditure by type of R&D is based on total expenditure and not current expenditure on R&D.

In 1984 for the GBAORD data, part of the data for the ENEA (National Committee for R&D of Nuclear Energy and of Alternative Sources of Energy) were transferred from the objective "Environment" to "Health", reducing the former by half and increasing the latter accordingly.

• Japan

In Japan, beginning with the 2002/2003 survey (OECD data 2002), the coefficients supplied by the Ministry of Education, Culture, Sports, Science and Technology were applied to doctoral level students as well as teachers when calculating FTE for the HE sector, resulting in a break in series for that year.

As from 2001, the PNP institutes serving enterprises, previously classified in the PNP sector, have been transferred to the business enterprise sector.

As from 1996:

- The data for R&D personnel is expressed in full-time equivalent and the labour costs for R&D have consequently been adjusted.
- The scope of the business enterprise survey was widened to include computer services and related activities (ISIC rev. 3, 72), which accounted for close to 2 % of the sector total.

Until and including 1995, data provided for R&D personnel and consequently labour cost data are overestimated by international standards. Data for researchers are expressed in number of persons regularly employed in R&D rather than in full-time equivalent. Studies by some Japanese authorities suggest that in order to reach FTE, the number of researchers might be reduced by perhaps 40 % in the higher education sector and by about 30 % for the national total. That would reduce HERD by about 25 % and GERD by about 15 %. OECD calculated, through 1995, the adjusted series for both expenditure and researchers for the higher education sector and the national total, and these data appear in the OECD publications Main Science and Technology Indicators, as well as various studies and analytical reports.

The breakdown of R&D expenditure in the higher education sector by source of funds has been adjusted by the Secretariat, at the national total level (GERD by source of funds), for funds from the government and higher education sectors, in particular for an estimate of GUF. The corresponding adjustment has not been made to the detailed data by scientific discipline (HERD by field of science and source of funds) where the funding from higher education includes GUF – such data are marked with the note O, meaning "Includes other classes". For 1990, the breakdown of higher education source of funds was adjusted by the Japanese

authorities using a different method, meaning a break in series in that year, mainly for direct financing by government. Reverting to adjustment by the Secretariat in 1991 resulted in a further break in series for direct financing by government.

GBAORD data represent the budget for S&T and cover central government only. Military procurement contracts are excluded from defence GBAORD and before 2001, GUF excludes social sciences and humanities.

- **Korea**

Social sciences and humanities are excluded from the R&D data, R&D is underestimated notably in the Government, Higher education and PNP sectors.

Breakdown of researchers by field of science (headcount) is based on university diploma rather than the area in which the research is conducted. Therefore, the category “not elsewhere specified” includes those who work in the NSE but whose degrees are in the Social Sciences and Humanities.

- **Luxembourg**

In 2004, the significant increase in R&D performed in the higher education sector is due to the re-defined role of higher education in the national system of innovation and research, in particular the newly created University of Luxembourg.

- **Mexico**

Beginning with the 2004 data, Mexico’s Business enterprise survey register was increased to include large firms previously not identified as R&D providers.

1993 is the first year for which a complete set of internationally comparable data on R&D in Mexico is available.

1993 and 1994: the data on resources devoted to R&D in the government sector and by PNP come from the first national R&D surveys of those sectors based on the *Frascati Manual*; they are not comparable with the estimates available for previous years for the government sector.

1992 and 1993: the data on resources devoted to R&D in the business enterprise sector and in higher education come from the first national R&D surveys based on the *Frascati Manual*; they are not comparable with the estimates available for those sectors for earlier years.

Until 1996 inclusive, GBAORD data covered Federal government only.

- **Netherlands**

In 2006, a large company was re-classified from ISIC/NACE 30 to ISIC/NACE 32, resulting in a break in series for those two industries.

In 2003:

- Statistics Netherlands revised the panel of the R&D survey for the Government and PNP sectors, resulting in breaks in series for both sectors.
- R&D personnel in the PNP sector are grouped with Government sector R&D personnel.

In 2002 for the Higher education sector, there was a reclassification of a significant number of Researchers into the Technicians category.

As from 2000, newly-recruited researchers on the payroll of the Netherlands Organisation for Scientific Research (NWO), previously included in the Government sector, are now included with personnel in the higher education sector.

In 1997, a new methodology for calculating GUF was implemented and GBAORD series were revised back to 1990.

In 1996, firms with 10 to 49 employees in the Service sector were included in the scope of the business enterprise sector. Following this enlargement of the scope of the survey in the business enterprise sector, 1996 data on R&D expenditure and personnel in the Service sector, for the BE sector total, as well as the national total, are not directly comparable with those for earlier years.

In 1994:

- firms with 10 to 49 employees in the Manufacturing sector were included in the scope of the business enterprise sector. Following this enlargement of the scope of the survey in the business enterprise sector, 1994 data on R&D expenditure and personnel in the Manufacturing industries, the BE sector total, as well as the national total, are not directly comparable with those for earlier years.
- Following the reclassification of certain institutes from PNP to government, the data for those two sectors are not comparable with data for earlier years.

As from 1991 business enterprise SSH R&D, corresponding to R&D by institutes serving business enterprise only, was included in the PNP sector.

As from 1990, as a result of the 1994 changed methodology of the survey on HE, R&D expenditure changed, and one consequence was an apparent increase of the government contribution to R&D performed by higher education.

As from 1985 the breakdown of R&D expenditure by type of R&D is based on total expenditure rather than current intramural expenditure on R&D.

In 1982, as a result of a change in the method of estimating data on R&D by higher education, the data for 1982 (or 1983, depending on availability) for R&D in the higher education sector and the national total are not comparable with those for earlier years.

- **New Zealand**

Time comparisons are occasionally restricted because of changes to the method of collecting and estimating data in 1984 (higher education and national total), 1987 (BERD by industry), 1992 (GUF for higher education and hence the national total), and 2001 (BERD, HE personnel, and hence national totals for expenditure and R&D personnel).

- **Norway**

In the breakdown of gross domestic expenditure on R&D (GERD) by sector of performance and socio-economic objective, capital expenditure has not been allocated by objective but shown under “not elsewhere classified”.

In 2007, break in series with previous years because of change of compilation method for health enterprises. This affects both Higher education sector (university hospitals) and Government sector (other hospitals).

In 1995 the survey of the business enterprise sector was considerably enlarged to include a sample of units with 10 or more employees (previously the lower limit was 50 employees) in

branches traditionally covered by the survey; several services were also brought in. As a result, the 1995 data are not comparable with those for earlier years.

As from 1991 personnel in central administration units of higher education are not included in the data, but the cost of such personnel is included in other current R&D expenditure (in line with the *Frascati Manual*).

As from 1989 R&D performed by PNP is included in the government sector.

As from 1987:

- The BE survey was expanded to include Bank and Insurance Services and more Engineering Services.
- The “own funds” of commercial State enterprises (included as executive units in the business enterprise sector), previously included in government funds, were reclassified as own funds of business enterprises.

In 1984 the coverage of the survey was expanded to include more private firms, notably within the branches of Transport, Commercial and Engineering Services and Other activities (ISIC 71, 8323/24).

The method for compiling GBAORD data changed in 1996. The series have been revised back to 1983 to exclude contract research (net approach), state enterprises and payments to the European Commission.

- **Poland**

Current R&D expenditure by type of R&D is overestimated because it includes a portion of capital expenditure relating to special equipment for research.

Before 1995, defence R&D was mostly excluded.

- **Portugal**

Beginning with the 2007 survey, the following measures resulted in a significant increase in Business enterprise R&D: the reintroduction of the fiscal incentive, SIFIDE; an increase in the number of the firms performing R&D activities; and an updating of the Business Enterprise register.

In 1997, due to a new accounting method for structural funds from the European Commission, funds from Abroad and direct Government financing are not comparable with those of earlier years.

As from 1995 resulting from new methods used for the 1997 survey:

- the classification by NACE Rev 1 of R&D activities in the BE sector was introduced and the data have been revised back to 1995.
- units of the PNP sector mainly controlled/financed by the BE and the HE sectors were reclassified under these sectors of performance following the guidelines of the *Frascati Manual* (Section 3, table 3.1).

As from 1992 the data for researchers and technicians are not comparable with those for earlier years because the classification of R&D personnel by occupation was revised for the survey relating to 1995 and retrospectively to 1992.

As from 1988 R&D personnel in the business enterprise sector is broken down by occupation and the data relating to researchers and technicians are not comparable with those for earlier years where breakdown by occupation was based on formal qualifications with data for researchers covering university graduates or holders of other post-secondary qualifications.

Until and including 1986:

- data for researchers in the business enterprise sector cover university graduates or holders of other post-secondary qualifications.
- for all sectors for R&D expenditure and personnel data, the components of the sub-total of “Social Sciences and Humanities” do not include the “pluridisciplinary fields of science” which are included in the SSH sub-total.

GBAORD data by socio-economic objective have been revised back to 1986 according to a new methodological exercise introduced in 1997.

- **Slovak Republic**

Since 2002, a new budget classification compatible with the Classification of the Functions of Government (COFOG) enables the identification of government budget appropriations for defence R&D. The defence category includes R&D appropriations for defence, safety and security of the country. For earlier years, defence R&D was included in the GBAORD total.

As from 1997, some Defence R&D is separately available in the socio-economic breakdown of GERD, but it seems that Defence R&D is still largely underestimated in GERD objective data when comparing with information on Defence R&D provided by the Ministry of Defence for the specific table on Defence GERD by sector of performance and source of funds. The defence objective for GERD for years 1997 to 1999 represents respectively 28%, 31% and 44.5% of the later. Before 1997, institutions under the Ministry of Defence are not covered by the national R&D survey.

In 1997, change in the methodology of institutional classification by sectors, resulting in the reclassification of some institutions from the Government sector to the business enterprise sector.

Before 1997 Defence R&D was totally excluded.

Before 1994 data referred to “Research and Development Base” (RDB) and cover the whole activity of institutions and not only R&D. In 1994 *Frascati Manual* definitions were adopted in the national R&D survey.

- **Spain**

From 2002, R&D expenditure and personnel data for the business enterprise sector include the occasional and the systematic R&D

In 2002, the decrease in the R&D of the PNP sector is due to reclassification of certain institutes to the Business and Government sectors following *Frascati Manual* guidelines.

In 1997:

- The defence objective in GBAORD almost doubled in magnitude due to an exceptional contribution by the Ministry for Industry and Energy.
- The incorporation of the Spanish contribution to CERN has involved substantial changes in the “Energy” category.

The inclusion of loans to be repaid has produced a break in series. In 1995:

- Higher education's own funds were separated from GUF, in which they had earlier been included. As a result the 1995 data for GUF, the sub-total of government finance for R&D in the higher education sector and the national level are not comparable with those for previous years.
- The marked increase in funding from abroad in the higher education sector is chiefly due to funds from the European Commission, which have to some extent taken the place of government funding.

As from 1994, due to the availability of the breakdown of support personnel between Technician and Other in the higher education sector, the corresponding categories for total R&D personnel are no longer underestimated.

As from 1992:

- There was an upward re-estimation of GUF. This caused a break in series of HERD and GERD and of total government financing of HERD and GERD. It should be noted that there was no equivalent re-estimation for the data on budget appropriations for R&D (GBAORD), where the source and method of estimation are both different for GUF.
- Labour costs and current intramural expenditure are no longer underestimated as payroll costs for technicians and other support personnel in the higher education sector, previously not included, are incorporated in HERD.
- The method of estimating current and capital R&D expenditure by the higher education sector changed and the relevant data are now collected by a questionnaire sent to universities, which provide estimates.

Prior to 1989, the data for total R&D personnel, technicians and other supporting staff are underestimated because those for the higher education sector only cover researchers. As a result, total R&D personnel in Spain may be underestimated for these years by between 10 and 15 %. Totals for technicians and other supporting staff are still underestimated until 1994, as separately available data are missing for the higher education sector.

The series for R&D expenditure and personnel in the higher education sector were revised upwards, retrospectively, back to 1980 to allow for a change in the method of evaluating the 1988 data following the 1989-90 survey on the allocation of teachers' working time.

- **Sweden**

Concerning the Government sector, the 2007 data from the County councils exclude Researchers and Total R&D personnel, resulting in the personnel data being underestimated for that year.

Until 2005, R&D data were underestimated:

- R&D performed in the government sector covered central government units only.
- Companies between 10-49 employees were excluded from coverage.

Furthermore, until 1991, the data for the business enterprise, government and PNP sectors, and consequently for national totals, were further underestimated as the data for R&D performed by these sectors excluded the social sciences and humanities.

Beginning 2007, Researchers in the Business enterprise, Government and PNP sectors are now surveyed by occupation; prior to that year, university graduates were counted in their place.

Beginning 2005, FTE on R&D in the Higher education sector reflects a change in survey method.

As from 1998:

- GBAORD data are on a calendar year basis (January-December) instead of the period July-June which has been used until 1994. Budget appropriations for 1995 and 1996 are estimates based on the period July 1995-December 1996.
- GBAORD data exclude funding from *Public Research Foundations*.

In 1997:

- Due to a change in statute, the R&D funding from *Public Research Foundations* previously considered as coming from the PNP sector has been reclassified as coming from the government sector. Consequently, 1997 data on R&D funding from Government and PNP sectors are not comparable to those for previous years.
- The sharp decrease in R&D personnel in the PNP sector is partially due to modification of the national questionnaire.

In 1995, A number of institutions in the PNP sector have been reclassified to the Business enterprise or Government sectors.

As from 1993:

- SSH R&D was also included in the government, PNP and business enterprise sectors (in the latter case, this may affect service industries essentially); 1993 R&D data for Government and PNP sectors are not comparable with those for previous years.
- In the higher education sector, R&D personnel employed in hospitals administered by local government were not included (1 900 FTE in 1989 and 1991). But graduate students performing R&D funded from outside were included for the first time (1 322 FTE in 1993).
- The breakdown of R&D expenditure and personnel by field of science in the higher education sector is incomplete.
- Public utilities of central government are excluded from the GBAORD data.

• **Switzerland**

The business enterprise sector comprises private enterprises only. Public enterprises are included in the government sector.

GBAORD series, with the exception of GUF, cover federal government only.

As from the reference year 2000, the Government sector no longer includes the telecommunications companies that have been privatised (Swisscom).

As from 1998:

- The Federal Office of Agriculture (and its research institutes), no longer break down their R&D by socio-economic objective but group all under “Agriculture”. This results, for the Government R&D expenditure by socio-economic objective and for the GBAORD series,

in a break in series both in the Agriculture and Health objectives, where half of the funds previously declared under Health are now declared under Agriculture.

- The field of telecommunications within the Federal Post has become the private enterprise Swisscom and is no longer considered in the GBAORD objective Infrastructure.

Before 1994, GBAORD did not include the public sector financed R&D mandates.

In 1992, R&D personnel data for the HE are not comparable with those for previous years following modifications in the evaluation method.

Comparisons over time are extremely limited as a result of various changes in the coverage of data and classifications in 1983, 1986, 1988 and 1989.

In 1986, 1989 and beginning 1992, GBAORD were broken down according to NABS for direct federal funds with the intramural R&D expenditures of the federal public sector. R&D mandates and contributions in Switzerland and abroad are shown under the heading “other civil research”. Indirect federal and cantonal funds are included in GUF. Idem for 1988 and 1990 with the exception that while indirect federal funds are included in GUF, data on indirect cantonal funds are not available.

Since 1983, total GBAORD have comprised direct federal funding in Switzerland and abroad (i.e. intramural expenditures, R&D mandates and contributions in Switzerland and abroad) and indirect federal and cantonal funding (governed by the higher education act and GUF). Prior to 1983, there are no data on indirect federal and cantonal funding.

- **Turkey**

Total R&D personnel and the totals for technicians and other support staff for Turkey are underestimated as only the number of researchers (in FTE for R&D) is available for higher education R&D personnel.

From 1994 to 1999, R&D expenditure by type of R&D (Basic research, Applied research, Experimental development) is based on total intramural instead of current R&D expenditure

As from 1993, the survey was extended to include Financial Intermediation, Software consultancy and Other computer services. Consequently, 1993 data for Sub-Total Services are not comparable with those for previous years.

- **United Kingdom**

In 2001, the government research agency, the Defence Evaluation and Research Agency (DERA) was disestablished and two new organisations were created. Around one quarter of DERA remained within the Ministry of Defence as a government agency, whilst the remaining three quarters became a private limited company, resulting in a break in series in both the Government and business enterprise sectors as well as GBAORD.

Until 2000, in the business enterprise sector, R&D funding by business also includes funds that may accrue from other national sources such as higher education or PNPs.

Due to lack of official data for the higher education sector, the OECD Secretariat has made estimates for total researchers beginning 1999 and total R&D personnel beginning 1994.

All government R&D expenditure corresponds to expenditure by public services plus an estimate with three components: a small amount of R&D not identified by the government sector survey; R&D performed by local authorities; and as from 1991 an estimate of the portion of R&D performed by NHS hospitals (for the 1991 break in series, see below). This

estimate supplementing government R&D expenditure is not broken down by type of cost or by type of R&D.

Following work to enhance the estimates of R&D by PNPs undertaken in 1996, estimates for R&D performed by the PNP sector were substantially revised downwards, in particular the funding from the business enterprise sector. The data for previous years were revised accordingly.

In 1996, break in series for GBAORD due to a change in methodology for “GUF”.

As from 1995 for the GBAORD data, the Health objective has been broadened to include the total net costs to *National Health Service* trusts of their involvement in R&D.

In 1993:

- The UK questionnaire asks contributors to identify the original source of funds, rather than the direct source as in previous years. This will overcome the problem caused by sub-contracting which would have caused under-reporting of government-funded R&D in previous years.
- The fall in government R&D personnel is chiefly due to the exclusion of staff in the *Atomic Weapons Establishment*, transferred from government to the enterprise sector.
- A new method of estimating government-funded R&D in the higher education sector, introduced in 1994, was applied retrospectively to 1993.

In 1992:

- Business enterprise R&D data are revised to correct misreporting in several product groups in the business enterprise sector. Consequently, national totals and business enterprise R&D data are revised for 1992 to 1998.
- The increase in R&D personnel in the government sector is chiefly due to the inclusion of staff of the Scottish Agricultural Research Institute, the Scottish Agricultural College and Scottish Natural Heritage, transferred from the PNP sector to government.

As from 1991:

- Overall data for the government sector include an estimate of R&D support costs in NHS hospitals; those costs are excluded in the breakdown of R&D expenditure by type of cost or type of R&D. R&D personnel in NHS hospitals are not included in the data for government R&D personnel as this information was not available.
- Data concerning researchers and technicians in the government sector follow the *Frascati Manual* definitions; prior to 1991, researchers covered graduate scientists and engineers, and technicians covered non-graduate scientists and engineers.

Between 1985 (85/86) and 1986 (86/87), the *United Kingdom Atomic Energy Authority* (UKAEA) was transferred from government to the enterprise sector.

Between 1985 and 1986 R&D expenditure by a group of research institutes grant-aided by the *Agriculture and Food Research Council* in England and Wales seems to have been included with expenditure by the Research Council and transferred to the government sector; the institutes' staff appear to have been transferred over a longer period.

Fresh estimates were made for R&D performed in the PNP sector, in particular regarding the proportion of expenditure funded by business. Downward revisions were made retrospectively to 1985.

- **United States**

Following a survey in 2005 of the federally-funded research and development centres (FFRDCs), it was determined that FFRDC R&D belongs in the government sector rather than in the sector of the FFRDC administrator as had been reported in the past. This R&D expenditure has been reclassified from the other three performing sectors to the Government sector and data revised back to 1981.

Depreciation is reported in place of capital expenditure in the business enterprise sector.

R&D expenditure data for the United States are somewhat underestimated for a number of reasons:

- R&D performed in the government sector covers only federal government activities. State and local government establishments are excluded.
- In the higher education sector, R&D in the humanities is excluded as is capital expenditure.
- R&D expenditure in the PNP sector covers current expenditure only.
- As far as R&D personnel data are concerned, only data covering research scientists and engineers (RSE) are collected, hence no data are available for total R&D personnel in the United States. Researchers in the government sector exclude military personnel. In the higher education and PNP sectors, researchers refer to employed doctoral scientists and engineers who report their primary work activity as research, experimental development or the management of R&D, plus, for the higher education sector, the number of full-time equivalent graduate students with research assistantships averaging an estimated 50% of their time engaged in R&D activities.

Beginning 2000, due to lack of official data for the higher education sector, the total researchers figure is an OECD estimate.

Beginning with the 2000 GBAORD data, budgets for capital expenditure – “R&D plant” in national terminology - are included. GBAORD data for earlier years relate to budgets for current costs only.

As from 1999:

- As of this reference year, the North American Industrial Classification System (NAICS) was introduced into the survey. The switch from SIC-based estimates to NAICS-based estimates constitutes a break in time series in the detailed industry series.
- Agriculture R&D is not surveyed in the BE sector.

Breakdown by type of R&D (basic research, applied research, etc.) was revised back to 1998 in the business enterprise and higher education sectors due to improved estimation procedures. Higher education (and national total) data were also revised due to an improved methodology that corrects for double-counting of R&D funds passed between institutions.

As from 1998, as concerns the GBAORD data, some components previously included under Energy have been transferred to Advancement of knowledge, resulting in a break in series for these two objectives.

For 1996, figures are separately available for R&D in Agriculture, Mining and Construction and these sectors are not included in the Services sub-total for that year.

Prior to 1996, the sub-total R&D expenditure for the Services sector in BE, which is calculated as a residual, included Agriculture, Mining and Construction.

As from 1993, researchers in the HE and PNP sectors include persons who obtained their doctorates from outside the United States (25 000 and 2 000 researchers respectively in 1993); these persons were excluded in earlier years.

As from 1987, Higher education R&D personnel also include those who report their primary work activity as design.

As from 1985:

- The methodology for estimating the number of researchers was changed. In the government, higher education and PNP sectors the latest data refer to employed doctoral scientists and engineers who report their primary work activity as research, experimental development or the management of R&D, plus the number of full-time equivalent graduate students with research assistantships averaging an estimated 50 % of their time engaged in R&D activities.
- Researchers in the government sector exclude military personnel.

3.2.2 *Non-member economies:*

- **Argentina**

Frascati Manual definitions are followed.

Since 2002, the source of funds data for private non-profit organisations, universities and S&T public organisations are requested for in R&D. Before 2002, these source of funds data were requested in terms of STA. These data were converted into R&D by means of a coefficient for each sector of performance. The main source of funds for science and technology activities in Argentina is the National Budget.

Since 1997, data for human resources are strictly R&D. Before that, human resources data were expressed in terms of Science and Technology Activities (STA), involving R&D and diffusion activities of S&T (library services, training services, conferences, etc.). These earlier data have not been transferred to the OECD database.

- **China**

The data presented are in line with the *Frascati Manual* recommendations and are available since 1991. The government and higher education sectors cover all fields of NSE and SSH while the business enterprise sector only covers the fields of NSE. There are only few organisations in the private non-profit sector. Hence no R&D survey has been carried out in this sector and the data are not available.

Before 2000, all of the personnel data and 95% of the expenditure data in the business enterprise sector are for large and medium-sized enterprises only. Since 2000 however, the survey covers almost all industries and all enterprises above a certain threshold. In 2000 and 2004, a census of all enterprises was held, while in the intermediate years data for small enterprises are estimated.

Due to the reform of the S&T system some government institutions have become enterprises, and their R&D data have been added to the enterprise sector since 2000.

For independent research institutions, data on researchers are collected, but for the other sectors data are collected according to the UNESCO concept of “scientist and engineer”, which differs from the *Frascati Manual* notion of researcher. The concept of “scientist and engineer” is a combination of academic degree and occupation, closely linked to core HRST

as defined by the Canberra Manual. The definitions are however sometimes difficult to apply in practice. It could be that data on R&D personnel and researchers are overestimated.

- **Israel**

Since 2001, the government sector in Israel is covered by a survey. Before 2001, data on R&D expenditure in the government sector were estimated through financial reports and interviews of accountants.

Data for the higher education sector are partly based on data from financial reports of the universities. Humanities and law are only partially covered in the higher education sector.

Hospitals and medical centres are included in the PNP sector and in the government sector, as are university hospitals.

- **Romania**

A substantial proportion of R&D expenditure and R&D personnel reported in the data for the business enterprise sector are performed/employed in public enterprises (57.4% and 62% respectively for the year 2003).

The higher education sector includes faculty hospitals. For some of these hospitals, as well as for other types of medical centres, there are problems of delimitation between R&D activities and health activities and in these cases no data is available on R&D expenditures and personnel. The higher education sector does not include experimental stations: given the specific nature of their activity, these are directly co-ordinated by the Ministry of Agriculture, and therefore included in the business enterprise sector.

- **Russian Federation**

The business enterprise sector includes all organisations and enterprises whose main activity is connected with the production of goods and services for sale, including those owned by the state, and private non-profit institutions serving the above-mentioned organisations. In practice however, R&D performed in this sector is carried out mostly by industrial research institutes other than enterprises. This particularity reflects the traditional organisation of Russian R&D.

Headcount data include full-time personnel only, and hence are underestimated, while data in full-time equivalents (FTE) are calculated on the basis of both full-time and part-time personnel. This explains why the FTE data are greater than the headcount data.

New budgetary procedures introduced in 2005 have resulted in items previously classified as GBAORD being attributed to other headings and have affected the coverage and breakdown by socio-economic objective.

- **Singapore**

The Public Research Centres are located within the universities and draw upon university expertise. They are closely linked with the universities and several have 'spun off' from university research groups. However they are administratively separate from the universities and funded by the Agency for Science, Technology and Research (A*STAR) and industry. The centres have been included in the 'Public Research Institutes and Centres' category in the R&D survey since 1995. Until 1995 they were subsumed in the Higher Education sector. This leads to a discontinuity in the statistics for the Government/Public and Higher Education sectors between 1994 and 1995.

- **South Africa**

For the 2001/02 R&D survey, no comprehensive business register was available, nor was there any official register of the specific subset of those entities that actually conduct R&D. However, lists of firms surveyed in previous R&D surveys, those covered in previous technology audits, public listings of the top 200 companies in the economy, as well as lists of firms that participate in public innovation and R&D support programmes were available to the survey agency. These lists provided the basis for a sample of all firms known to have R&D activities. There may however be an underestimation of R&D expenditure by 10% to 15%.

- **Chinese Taipei**

Each university has one or two research institutes, which receive government funding. These are usually included in the Higher Education sector. Several are directly funded by the National Science Council (NSC) and counted in the government sector. There are also Regional Centres for Instrumentation that are major national research facilities used by all sectors. The NSC monitors the budgets of the institutes and if their budget derives overwhelmingly (greater than 80%) from non-university sources, they are classified as belonging to the government research sector.

Since 2003, the business sector includes R&D data of private enterprises in the sectors of electricity, gas and water supply; construction; and services, which were not surveyed before.

Postgraduate students engaged in R&D were not included in the higher education sector until 2002.

Researchers must have a university degree or above.

3.3 Sources

The data are derived from national R&D surveys and budgets and are mainly supplied to the Secretariat via the OECD/Eurostat International Survey of Resources Devoted to R&D.