



**Main  
Science  
and Technology  
Indicators**

**Principaux  
indicateurs  
de la science  
et de la technologie**



**Volume 2010/1**

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**May 2010**

**MAIN SCIENCE AND TECHNOLOGY INDICATORS  
2010/1**

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## 1. STATISTICAL CONTENT

### 1.1. General description

This electronic publication is prepared by the Economic Analysis and Statistics (EAS) Division of the OECD Secretariat in collaboration with the Working Party of National Experts on Science and Technology Indicators (NESTI). It contains the main data series selected from the OECD Scientific and Technological Indicators database. One hundred of these series concern resources devoted to research and experimental development, and an additional 35 are measures of output and the impact of scientific and technological activities. Included also are 11 economic series used to calculate indicators such as growth rates at fixed prices, R&D expenditures as a percentage of GDP or industrial value added, and to convert data into a common currency using comparisons at purchasing power parities. These 151 series are grouped according to subject (see the list indicators in section 2)

There are series for 30 OECD Member countries and four zones (EU-27, EU-25, EU-15 and Total OECD). A special "adjusted" series for Japan has also been included up to 1995 (see Annex for further detail). Also available are series for nine non-member economies.

The OECD has been collecting R&D data for Member countries on a regular basis since the early 1960s. During the 1990s, it has also embarked in the collection of R&D data for selected non-Member economies, some of which are presented here. This publication presents various indicators of the level and trends in total national R&D efforts. The standard expenditure measure is the Gross Domestic Expenditure on Research and Experimental Development (GERD), which covers all R&D carried out on national territory in the year concerned. The pattern of financing and of performance of GERD is also presented.

Resources devoted to R&D can also be measured in labour terms as shown for researchers and for total R&D personnel. R&D personnel data are expressed in full-time equivalent (FTE), i.e. a person working half-time on R&D is counted as 0.5 person years, and headcount.

Further information is given on R&D performed in the Business Enterprise sector. This includes series showing data on total Business Enterprise R&D carried out by the major industries concerned. Sets of data are provided for R&D carried out in the Higher Education and Government sectors. All the above series 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 R&D financed by government can be derived from budget data. These data show government R&D appropriations distinguishing firstly between defence and civil programmes and secondly between the main objectives of civil R&D. Readers are warned that these budget R&D data vary in coverage from those in previous series and that these two types of data should not be combined.

Three series show data on R&D expenditure of foreign affiliates. These data come from the OECD database on foreign affiliates and in some cases are not directly comparable with standard Business Enterprise R&D.

The publication contains no direct measures of the output of Scientific and Technological activities, such as indicators based on innovation. However, three types of proxy indicators based on

data originally collected for other purposes are presented: patents, the technology balance of payments and trade in R&D intensive industries. While each of these indicators has its shortcomings, taken together they may throw light on countries' technological performances.

Patent data can be considered as proxy measures of the output of R&D in the form of inventions. The data presented show the total number and national percentages of triadic patent families, as well as the number of patent applications filed under the Patent Co-operation Treaty (PCT) in two specific sectors of interest: the ICT and biotechnology sectors.

The Technology Balance of Payments (TBP) series are data extracted from national sources (balance of payments or survey results) with the aim of measuring the flow of technological know-how and services into and out of the country concerned. The OECD manual "Proposed Standard Method of Compiling and Interpreting Technology Balance of Payments Data", TBP Manual 1990, gives the methodology for the international standards for compiling such data. The series quoted comprise money paid or received for the acquisition or use of patents, licences, trademarks, designs, inventions, know-how and closely related technical services.

Indicators of trade performance in R&D-intensive industries can be used as proxy measures of the industrial and economic impact of scientific and technological activity. The series concerned give trade balances and export market shares for five selected groups of R&D-intensive industries: aerospace, electronic, office machinery and computers, pharmaceuticals and instruments.

## **1.2. R&D data**

### **1.2.1. Definitions and Coverage**

#### *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).

#### *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 indicators in Series 1 to 58 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 expressed in full-time equivalent (FTE) on R&D (i.e. a person working half-time on R&D is counted as 0.5 person years) and headcount. Because of the complexity of the surveys, it is difficult to obtain very up-to-date series. In the present volume, some 2008 data are still provisional and data for later years are national estimates or projections (these data are annotated).

Please note that, given the difficulty of estimating defence R&D figures which are compatible with GERD (notably in industry), a number of countries have been unable to supply data and the information is shown in Series 5 with only one decimal.

More up-to-date information on government support for R&D can be derived from budgetary sources. The indicators in Series 59 to 62 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 these two sets of R&D data vary significantly and the two types of data should not be combined.

### *Fields of Science*

In general, the series cover R&D in both natural sciences (including agricultural and medical 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.

### *Sectors of Performance and Sources of Funds*

Domestic R&D efforts (expenditure or personnel) are divided into *four sectors of performance* for statistical purposes, Business Enterprise (industry), Higher Education, Government and Private Non-Profit institutions (PNP).

R&D expenditure is subdivided into five *sources of funds*, from Business Enterprise (industry), from Government (public), 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 Series 15 and 35.

### *R&D in the Business Enterprise Sector*

The Business Enterprise sector covers private and public enterprises and institutes serving such enterprises. The breakdown between industries is, in principle, made at the level of the enterprise, though some countries are able to break down the 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 series. In principle R&D institutes serving enterprises are classified to the industry concerned; when this is not done the percentage of BERD performed by non-manufacturing industry is overestimated compared with other countries.

The classification is according to the International Standard Industrial Classification (ISIC Rev.3) or nearest national classification as follows:

	ISIC Rev.3
• <i>aerospace industry</i> (Series 39)	353
• <i>electronic industry</i> (Series 40)	32
• <i>office machinery and computer industry</i> (Series 41)	30
• <i>pharmaceutical industry</i> (Series 42)	2423
• <i>medical, precision and optical instruments, watches and clocks (instruments) industry</i> (Series 43)	33
• <i>services industry</i> (Series 44)	50-99

The above mentioned indicators were calculated using the Analytical Business Enterprise R&D database (ANBERD) for the 29 OECD Member countries and selected non-member economies covered by this database. For further information on this database see [www.oecd.org/sti/anberd](http://www.oecd.org/sti/anberd).

*Government Budget Appropriations or Outlays for R&D (GBAORD)*

These data are assembled by national authorities using statistics collected for budgets. This essentially involves 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 Series 1 to 58 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, specially developed for R&D analysis (see "Frascati Manual 2002", sections 8.7.3 and 8.7.4).

The breakdown is as follows:

<i>Defence</i>	(Series 60) All defence R&D financed by government, including military nuclear and space but excluding civilian R&D financed by ministries of defence (e.g. meteorology).
<i>Civil</i>	(Series 61) Total GBAORD less Defence.
<i>Economic</i>	(Series 62). R&D programmes financed for the purpose of the advancement of agriculture, fishery, forestry; industry; energy; and infrastructure and general planning of land use.
<i>Health and Environment</i>	(Series 62) R&D programmes funded for the purpose of the protection and improvement of human health; control and care of the environment; and for the exploration and exploitation of Earth.
<i>Education and Society</i>	(Series 62) R&D programmes funded for the purpose of education; culture, recreation, religion and mass media; and political and social systems, structure and processes.
<i>Space</i>	(Series 62) Civil space R&D programmes.
<i>Non-oriented Research</i>	(Series 62) Research programmes financed in view of the advancement of knowledge.
<i>General University Funds</i>	(Series 62) The estimated R&D content of "block grants" to the Higher Education sector. This category is generally absent or underestimated for countries where only federal government is included.

A set of data is also included for R&D financed by the European Commission using funds from the Community's own budget.

*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 OECD standards. These differences are generally too small to affect the general indicators quoted in this publication. The main exceptions are shown in the Annex.

*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 featured in MSTI, 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
Slovak Republic	30.1260 SKK	2009
Slovenia	239.640 SIT	2007
Spain	166.386 ESP	1999

### *Expenditures in Current Dollars*

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.

For most of the non-OECD economies featured in MSTI, PPP rates provided by the World Bank are used to convert data from national currency into PPPs.

Only TBP data have been converted using current exchange rates as these transactions are conducted on international markets.

### *Expenditure 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 projections 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) (Series B). Any growth rates calculated on the basis of these estimated rates are footnoted "b".

### *Compound Annual Growth Rates*

Average annual growth is calculated at compound rates when the intervals are not annual. Expenditure growth is calculated at constant prices.

### *Comparisons with Economic Indicators*

R&D expenditures are shown as a percentage of selected indicators drawn from the OECD National Accounts database updated for very recent years on the basis of the projections published in the *OECD Economic Outlook*. Any ratios where such estimated economic series are the denominator are footnoted "b" in the series concerned. R&D personnel are shown per thousand of selected indicators from the OECD National Accounts and Labour Force databases. The main economic indicators are also presented.

When possible, economic indicators for the non-member economies are also drawn from the OECD databases. Alternatively, other international databases are used, such as the Eurostat NewCronos database (in the case of Romania and Slovenia, plus Bulgaria, Cyprus, Estonia, Latvia, Lithuania and Malta for the EU zone totals), the International Monetary Fund, International Labour Organisation and World Bank databases, as well as various national data sources.

### *Zone Totals*

Zone totals have been calculated for the EU-27, the EU-25, the EU-15 and the OECD for most series. The OECD zone includes all Member countries of the OECD except Chile i.e. Australia,



Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. In order to provide indicators coherent with those in OECD studies the OECD total uses the adjusted series for Japan until 1995. In order to obtain a full set of data for the OECD countries the Secretariat has made a number of estimates to fill gaps and to bring series up to date. These estimates were done using simple statistical routines or information from national publications and observations of trends. Data points where such estimates exceed 25 % of the zone total have been suppressed. Mexico is included in the OECD total as from 1991. Czech Republic, Hungary, Poland and Slovak Republic are included in the OECD total as from 1995. OECD total integrates R&D expenditure data for Korea as from 1991 and personnel data as from 1995. Luxembourg is included in the OECD and EU totals beginning 2000, and Malta is included in the EU-27 and EU-25 total beginning 2002. Data for non-OECD countries used to calculate EU-27 and EU-25 have been provided by the Statistical Office of the European Commission (Eurostat).

Due to the difficulty in forecasting R&D budgets, the zone totals for GBAORD are essentially arithmetic totals of the available national data. For missing intermediate years, data are interpolated and the total is annotated "b". However, forecasts are not made nor are estimates for countries not providing GBAORD data. The resulting zone data are thus underestimated and are footnoted "m". Data points where the sum of unavailable data probably exceeds 25% of the expected zone total have been suppressed. R&D financed by the European Commission using funds from the Commission's own budget (data provided by Eurostat) is included in the zone totals..

### **1.2.2. Sources**

The data are derived from national R&D surveys and budgets and are supplied to the Secretariat via the Common OECD/ESTAT Core questionnaire.

## **1.3. R&D Expenditures of Foreign Affiliates**

### **1.3.1. Definitions and Coverage**

These data are collected as part of the OECD Secretariat effort to measure globalisation through the role of multinationals. Data on the activity of foreign affiliates are based on the concept of controlling interest and the statistical test for data collection is that of a majority interest (over 50% of shares that carry voting rights on a company's board of management). For further information on methodological and conceptual aspects of globalisation statistics, see *Handbook on Economic Globalisation Indicators* (OECD, 2005). Data, in some cases, are not directly comparable with standard Business Enterprise R&D. Details on national sources and definitions are published in *Measuring Globalisation, Activities of Multinationals, 2007*.

### **1.3.2. Sources**

OECD database on Activities of Foreign Affiliates (AFA).

## 1.4. Patents

### 1.4.1. Definitions and Coverage

#### *Patents and Patent Families*

A patent family is defined as a set of patents taken in various countries for protecting a single invention. An inventor seeking protection files a first application (priority) generally in his/her country of residence. Then, the inventor has a 12-month legal delay for applying or not for protection of the original invention in other countries. Patent families, as opposed to patents, are provided with the intention of improving international comparability (the “home advantage” is suppressed, the values of the patents are more homogeneous).

The patent families presented in this publication refer to triadic families: i.e. a patent is a member of the patent families if and only if it is filed at the European Patent Office (EPO), the Japan Patent Office (JPO) and is granted by the US Patent & Trademark Office (USPTO).

In addition, the number of patent applications filed under the Patent Co-operation Treaty (PCT) is now provided for two specific sectors of interest: the ICT and biotechnology sectors. These sectors are defined according to selected classes of the International Patent Classification – IPC. The PCT procedure offers the possibility to seek patent rights in a large number of countries by filing a single international application with a single patent office, and then enter the national stage in the desired countries at a later date.

#### *Presentation and availability*

For patent counts, the choice of the country and date of reference among the set of information included in patent documents is important. Patents are presented here according to the country(ies) of residence of the inventor(s), giving thus a measure of technological innovativeness of researchers and laboratories located in a country.

The *priority date*, the date of the first international filing of a patent, is chosen as a reference date. It is the earliest available date and therefore the closest to the invention date. Although the *application date* may provide more recent series, counts by *application date* introduce a bias between residents and foreigners for a selected patent office with respect to the *priority date*. Residents usually first file a patent application at their domestic office, the extension of application to other countries takes one year following the traditional procedure, and up to two and a half years for the PCT procedure.

However, counting patent families according to the earliest priority date increases the drawback of traditional patent counts with respect to timeliness. The time lag between the priority date and the availability of information on patent applications to the EPO and JPO could be up to 4 years, whereas for the USPTO patent grants, the time lag could be up to 6 to 10 years. Hence, for this publication, patent families data up to 2001 were almost complete. Therefore, from priority years 2001 to 2008, patent families for individual countries are Secretariat estimates. Estimates are derived from the number of biadic patent families (EPO and JPO) and from the number of patent applications filed at the EPO for the latest years. The estimated series are revised twice a year using the most recent data available.

The PCT procedure expanded after 1990 and is increasingly used by applicants from all signatory states: since the early 2000s, most countries are well represented. For the transition period (1990-2000), cross-country comparisons or time trends should be interpreted with care.

A broader set of patent-related indicators is available on-line, along with methodological issues, at [www.oecd.org/sti/ipr-statistics](http://www.oecd.org/sti/ipr-statistics), covering notably patents by main technology classes, patents by regions, as well as indicators on international co-operation in patenting. For further details on patent data, refer to the *OECD Patent Statistics Manual*, 2009.

#### **1.4.2. Sources**

The data on patents at intellectual property offices (EPO, JPO, USPTO) are mainly derived from EPO's Worldwide Statistical Patent Database (PATSTAT, April 2010). The series on triadic patent families have been compiled by the Secretariat. The series on PCT applications are based on data published by the EPO.

### **1.5. Technology Balance of Payments (TBP)**

#### **1.5.1. Definitions and Coverage**

The TBP registers the commercial transactions related to international technology transfers. It consists of money paid or received for the acquisition and use of patents, licences, trademarks, designs, know-how and closely related technical services (including technical assistance) and for industrial R&D carried out abroad, etc.

Payments as a percentage of GERD (Series 71) give an indication of the share of imported technology to domestic R&D efforts.

It has not been possible to produce zone totals for the TBP due to the lack of data and because of the problem of excluding flows within the zones.

#### **1.5.2. Sources**

OECD database on Technological Balance of Payments (TBP).

### **1.6. Trade Balance and Export Market Shares for R&D-Intensive Industries**

#### **1.6.1. Definitions and Coverage**

These series present indicators concerning international trade in goods by selected R&D-intensive industries defined according to the standard International Standard Industrial Classification (ISIC) Revision 3. In general, prior to 1988 underlying source data are based on ISIC Revision 2..

These series are taken from the OECD STAN Bilateral Trade Database (BTD), which is derived from the OECD International Trade Statistics database. Original data by product have been

converted from the Harmonised System (HS) and the Standard International Trade Classification (SITC revision 2) to International Standard Industrial Classification (ISIC).

Industries concerned are the following:

	ISIC Rev.3
• <i>aerospace industry</i> (Series 72)	353
• <i>electronic industry</i> (Series 73)	32
• <i>office machinery and computer industry</i> (Series 74)	30
• <i>pharmaceutical industry</i> (Series 75)	2423
• <i>medical, precision and optical instruments, watches and clocks industry (instruments)</i> (Series 76)	33

A note indicating breaks in series is assigned to the first available year of revision 3 data. Until 1992 inclusive, the data for Belgium include Luxembourg.

The zone total for EU-15 excludes intra EU-trade. The OECD total has not been adjusted to exclude trade between Member countries. The zone totals are presented in ISIC Revision 3 from 1995.

From 2000, calculation of the Export market shares is relative to total aggregate exports of the declaring countries available in BTD. While not covering all countries of the world, the country coverage of BTD is considered to comprise close to 95% of world trade. Reporting countries included in STAN Bilateral Trade Database but not presented in this publication are Brazil, Estonia, Hong Kong, India, Indonesia, Malaysia, the Philippines and Thailand. Prior to 2000, Export market share was based on the share of OECD total exports (OECD = 100%).

### **1.6.2. Sources**

OECD STAN Bilateral Trade database, 2009 ([www.oecd.org/sti/btd](http://www.oecd.org/sti/btd)).

### **1.7. Notes**

Information on the quality and international comparability of the data are included. As concerns the standard footnotes, the following cases are noted in the data file:

- 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* recommendations.
- f) (note not currently used)
- 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) Total intramural R&D expenditure instead of current intramural R&D expenditure.
- l) Overestimated or based on overestimated data.
- m) Underestimated or based on underestimated data.
- n) Included elsewhere.
- o) Includes other classes.
- p) Provisional.
- q) At current exchange rate and not at current purchasing power parities.
- r) (note not currently used).
- s) Unrevised breakdown not adding to the revised total.
- t) Do not correspond exactly to *Frascati Manual* recommendations.
- u) University graduates instead of researchers.
- v) The sum of the breakdown does not add to the total (see General Methodology).
- w) Including extramural R&D expenditure.
- x) Confidential

\*) Pre-EMU euro should not be used to form area aggregates or to carry out cross-country comparisons.

Further information is available in the Annex of this document and directly in the data files.

## 1.8. Abbreviations

### *R&D Terminology*

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
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HERD	Expenditure on R&D in the Higher Education Sector
NSE	Natural Sciences and Engineering
PNP	Private Non-Profit Institutions
R&D	Research and Experimental Development
SSH	Social Sciences and Humanities

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*.

### *Other*

GDP	Gross Domestic Product
ISIC	International Standard Industrial Classification

PCT	Patent Co-operation Treaty
PPP	Purchasing Power Parities
SITC	Standard International Trade Classification
TBP	Technology Balance of Payments

## 2. LIST OF INDICATORS

### *Indicators by subject:*

#### Gross domestic expenditure on R&D (GERD):

1. Gross Domestic Expenditure on R&D -- GERD (million current PPP \$)
- 1.a. GERD (million national currency - for euro area, pre-EMU euro or EUR)
2. GERD as a percentage of GDP
3. GERD -- (million 2000 dollars -- constant prices and PPP)
- 3.a. GERD -- Compound annual growth rate (constant prices)
4. GERD per capita population (current PPP \$)
5. Estimated Civil GERD as a percentage of GDP
6. Basic research expenditure as a percentage of GDP

#### R&D Personnel (FTE):

7. Total researchers (FTE)
- 7.a. Total researchers -- Compound annual growth rate
8. Total researchers per thousand total employment
- 8.a. Total researchers per thousand labour force
9. Total R&D personnel (FTE)
- 9.a. Total R&D personnel -- Compound annual growth rate
10. Total R&D personnel per thousand total employment
- 10.a. Total R&D personnel per thousand labour force

#### GERD by source of funds:

11. Industry-financed GERD as a percentage of GDP
12. Government-financed GERD as a percentage of GDP
13. Percentage of GERD financed by industry
14. Percentage of GERD financed by government
15. Percentage of GERD financed by other national sources
16. Percentage of GERD financed by abroad

#### GERD by performance sectors:

17. Percentage of GERD performed by the Business Enterprise sector
18. Percentage of GERD performed by the Higher Education sector
19. Percentage of GERD performed by the Government sector
20. Percentage of GERD performed by the Private Non-Profit sector

#### Researchers (headcount):

21. Total researchers (headcount)
- 21.a. Women researchers (headcount)
22. Women researchers as a percentage of total researchers (based on headcount)
- 22.a. Business Enterprise Sector: Total researchers (headcount)
- 22.b. Business Enterprise Sector: Women researchers (headcount)

- 22.c. Business Enterprise Sector: Women researchers as a percentage of total researchers (based on headcount)
- 22.d. Government Sector: Total researchers (headcount)
- 22.e. Government Sector: Women researchers (headcount)
- 22.f. Government Sector: Women researchers as a percentage of total researchers (based on headcount)
- 22.g. Higher Education sector: Total researchers (headcount)
- 22.h. Higher Education sector: Women researchers (headcount)
- 22.i. Higher Education sector: Women researchers as a percentage of total researchers (based on headcount)

**Business Enterprise Expenditure on R&D (BERD):**

- 23. Business Enterprise Expenditure on R&D -- BERD (million current PPP \$)
- 23.a. BERD (million national currency - for euro area, pre-EMU euro or EUR)
- 24. BERD as a percentage of GDP
- 25. BERD -- (million 2000 dollars -- constant prices and PPP)
- 25.a. BERD -- Compound annual growth rate (constant prices)
- 26. BERD as a percentage of value added in industry

**Business Enterprise R&D Personnel (FTE):**

- 27. Business Enterprise researchers (FTE)
- 27.a. Business Enterprise researchers -- Compound annual growth rate
- 28. Business Enterprise researchers as a percentage of national total
- 29. Business Enterprise researchers per thousand employment in industry
- 30. Total Business Enterprise R&D personnel (FTE)
- 30.a. Total Business Enterprise R&D personnel -- Compound annual growth rate
- 31. Total Business Enterprise R&D personnel as a percentage of national total
- 32. Total Business Enterprise R&D personnel per thousand employment in industry

**BERD by source of funds:**

- 33. Industry-financed BERD -- (million 2000 dollars -- constant prices and PPP)
- 33.a. Industry-financed BERD -- Compound annual growth rate (constant prices)
- 34. Industry-financed BERD as a percentage of value added in industry
- 35. Percentage of BERD financed by industry
- 36. Percentage of BERD financed by government
- 37. Percentage of BERD financed by other national sources
- 38. Percentage of BERD financed by abroad

**BERD performed in selected industries:**

- 39. BERD performed in the aerospace industry (million current PPP \$)
- 39.a. Percentage of BERD performed in the aerospace industry
- 40. BERD performed in the electronic industry (million current PPP \$)
- 40.a. Percentage of BERD performed in the electronic industry
- 41. BERD performed in the office machinery and computer industry (million current PPP \$)
- 41.a. Percentage of BERD performed in the office machinery and computer industry
- 42. BERD performed in the pharmaceutical industry (million current PPP \$)
- 42.a. Percentage of BERD performed in the pharmaceutical industry
- 43. BERD performed in the instruments industry (million current PPP \$)
- 43.a. Percentage of BERD performed in the instruments industry
- 44. BERD performed in service industries (million current PPP \$)
- 44.a. Percentage of BERD performed in service industries



## Higher Education Expenditure on R&amp;D (HERD):

- 45. Higher Education Expenditure on R&D -- HERD (million current PPP \$)
- 45.a. HERD (million national currency - for euro area, pre-EMU euro or EUR)
- 46. HERD as a percentage of GDP
- 47. HERD (million 2000 dollars -- constant prices and PPP)
- 47.a. HERD -- Compound annual growth rate (constant prices)
- 48. Percentage of HERD financed by industry

## Higher Education R&amp;D Personnel (FTE):

- 49. Higher Education researchers (FTE)
- 49.a. Higher Education researchers -- Compound annual growth rate
- 50. Higher Education researchers as a percentage of national total
- 51. Higher Education Total R&D personnel (FTE)
- 51.a. Higher Education Total R&D personnel -- Compound annual growth rate

## Government Expenditure on R&amp;D:

- 52. Government Intramural Expenditure on R&D -- GOVERD (million current PPP \$)
- 52.a. GOVERD (million national currency - for euro area, pre-EMU euro or EUR)
- 53. GOVERD as a percentage of GDP
- 54. GOVERD (million 2000 dollars -- constant prices and PPP)
- 54.a. GOVERD -- Compound annual growth rate (constant prices)
- 55. Percentage of GOVERD financed by industry

## Government R&amp;D Personnel (FTE):

- 56. Government researchers (FTE)
- 56.a. Government researchers -- Compound annual growth rate
- 57. Government researchers as a percentage of national total
- 58. Government Total R&D personnel (FTE)
- 58.a. Government Total R&D personnel -- Compound annual growth rate

## Government Budget Appropriations or Outlays for R&amp;D by socio-economic objectives (GBAORD):

- 59. Total Government Budget Appropriations or Outlays for R&D -- GBAORD (million current PPP \$)
- 59.a. Total GBAORD (million national currency - for euro area: pre-EMU euro or EUR)
- 60. Defence Budget R&D as a percentage of Total GBAORD
- 61. Civil Budget R&D as a percentage of Total GBAORD
- 62.a.1. Civil GBAORD for Economic Development programmes (million current PPP \$)
- 62.a.2. Economic Development programmes as a percentage of Civil GBAORD
- 62.b.1. Civil GBAORD for Health and Environment programmes (million current PPP \$)
- 62.b.2. Health and Environment programmes as a percentage of Civil GBAORD
- 62.c.1. Civil GBAORD for Education and society (million current PPP \$)
- 62.c.2. Education and Society as a percentage of Civil GBAORD
- 62.d.1. Civil GBAORD for Space programmes (million current PPP \$)
- 62.d.2. Space programmes as a percentage of Civil GBAORD
- 62.e.1. Civil GBAORD for Non-oriented Research programmes (million current PPP \$)
- 62.e.2. Non-oriented Research programmes as a percentage of Civil GBAORD
- 62.f.1. Civil GBAORD for General University Funds (GUF) (million current PPP \$)
- 62.f.2. General University Funds (GUF) as a percentage of Civil GBAORD

## R&amp;D Expenditure of Foreign Affiliates:

- 63. R&D expenditure of foreign affiliates (million current PPP \$)
- 63.a. R&D expenditure of foreign affiliates (million national currency - for euro area, pre-EMU euro or EUR)
- 64. R&D expenditure of foreign affiliates as a percentage of R&D expenditure of enterprises

Patents:

- 65. Number of triadic patent families (priority year)
- 65.a. Number of patent applications to the PCT (priority year)
- 66. Share of countries in triadic patent families (priority year)
- 67. Number of patents in the ICT sector - applications filed under the PCT (priority year)
- 68. Number of patents in the biotechnology sector - applications filed under the PCT - (priority year)

Technology Balance of Payments (TBP):

- 69. Technology balance of payments: Receipts (million current dollars)
- 69.a. Technology balance of payments: Receipts (million national currency - for euro area, pre-EMU euro or EUR)
- 70. Technology balance of payments: Payments (million current dollars)
- 70.a. Technology balance of payments: Payments (million national currency - for euro area, pre-EMU euro or EUR)
- 71. Technology balance of payments: Payments as a percentage of GERD

International trade in R&D-intensive industries:

- 72. Export market share: Aerospace industry
- 72.a. Total imports: Aerospace industry (million current dollars)
- 72.b. Total exports: Aerospace industry (million current dollars)
- 73. Export market share: Electronic industry
- 73.a. Total imports: Electronic industry (million current dollars)
- 73.b. Total exports: Electronic industry (million current dollars)
- 74. Export market share: Office machinery and computer industry
- 74.a. Total imports: Office machinery and computer industry (million current dollars)
- 74.b. Total exports: Office machinery and computer industry (million current dollars)
- 75. Export market share: Pharmaceutical industry
- 75.a. Total imports: Pharmaceutical industry (million current dollars)
- 75.b. Total exports: Pharmaceutical industry (million current dollars)
- 76. Export market share: Instruments industry
- 76.a. Total imports: Instruments industry (million current dollars)
- 76.b. Total exports: Instruments industry (million current dollars)

Annex: Economic series:

- A.1. Gross Domestic Product (million national currency - for euro area, pre-EMU euro or EUR)
- A.2. Gross Domestic Product (million current PPP \$)
- B. Implicit GDP Price Indices (2000 = 1.00)
- C. Purchasing Power Parities (national currency per dollar)
- D.1. Value added of Industry (million national currency - for euro area, pre-EMU euro or EUR)
- D.2. Value added of Industry (million current PPP \$)
- E. Population (thousands)
- F. Total Employment (thousands)
- G. Industrial employment (thousands)
- H. Labour Force (thousands)
- I. Exchange rates (national currency per dollar)

## ANNEX NATIONAL SPECIFICATIONS

### *OECD Member Countries*

- **Australia** now compiles data according to SNA 2008, resulting in an increased GDP and therefore decreased R&D intensity.

Beginning with the 2007 data, industries are classified according to ANZSIC06. Prior to 2007, the classification used was ANZSIC93.

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.

Up to 1998, TBP data come from the Business Enterprise R&D Survey, and only refer to technical know-how. From 1999 TBP data are based on ABS's quarterly Survey of International Trade in Services, and include all TBP components except sale/purchase of patents and inventions.

- In **Austria** from 2007 onwards, the former "post-secondary colleges for teacher training" ("Paedagogische Akademien") have become "Universities of Education" and are, consequently surveyed as units of the Higher education sector (up to 2006 these units were covered in the Government sector).

In the BE sector, the "research premium" is included in "funds from government" beginning 2006. This measure was introduced for the first time for the calendar year 2002, and for the 2002 and 2004 data, government funding for R&D 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.

As from 1995, TBP data cover royalties and license fees, technology-related services and R&D performed abroad. Until 1991 inclusive, these data cover only royalties and license fees.

- For **Belgium**, beginning with the 1998 data, 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), data are based on full surveys and no longer on a combination of budget figures and survey findings.

The national total expenditures (Tables 1 to 4) are underestimated in 1987 and 1988, as is the contribution of government (Table 14) as R&D financed by federative 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 R&D expenditure tables cannot be estimated, though it probably affects R&D in the Government and Higher Education sectors.

As from 1995, TBP data are collected according to the OECD, IMF and Eurostat Manuals. Up to 2001, data refer to the Belgium-Luxembourg Economic Union (BLEU). From 2002 onwards, data refer to Belgium only.

- In **Canada**, 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.

As from 1989, non-federal sources are no longer excluded from General University Funds in GBAORD.

- For the **Czech Republic**, beginning 2005, there is a change in methodology for the collect of R&D personnel data in FTE. Data are provided in FTE by the reporting units, and based on new, more precise guidelines.

Between 2004 and 2008, some public research institutions were included in the business enterprise sector because of their classification as Non-financial enterprises (ISEKTOR 11) in the European System of Accounts (ESA). These institutions have been re-classified into the government sector and R&D expenditure and personnel data have been recalculated for those years.

Up to 2004, TBP data come from the balance of payments of the Czech National Bank. From 2005, TBP data are prepared by the Czech Statistical Office and come from the quarterly trade in services survey, except for the item "Sale/purchase of patents and inventions" which continues to be collected by the central bank.

- In **Denmark**, from reference year 2007, the surveys are conducted by Statistics Denmark. Modifications in the questionnaires have increased the response rate; this is particularly noticeable in the Business enterprise sector where survey response is now mandatory. Additionally, due to changes in the administrative structure, a number of institutes, previously classified in the Government sector, were merged with universities.

Until 2002, the HE-sector R&D expenditure was underestimated as 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.

As from 2001, a new principle concerning budgeting of commitments was introduced: 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 1983, 1988, and 1993, the method of assessing GBAORD data by socio-economic objectives changed, leading to breaks in series.

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

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 from 1997 and the implementation of ISCED-97, also included in Researchers are holders of engineering degrees and graduates of vocational polytechnics, degrees which are now classified in First Stage Tertiary Education (ISCED 5A).

In 1991, the method of measuring R&D expenditures in the Government and the Higher Education sectors changed. Since 1994, PNP institutions are included in the Government sector in non-survey years.

Data on GBAORD have been revised back to 1991 because of changes in R&D coefficients for certain research institutes. In 1991, there was an upward adjustment in the total due to the inclusion of pension costs. As from 1995, funds from external sources of the State research institutes are excluded from Government appropriations. As from 1997, the data covers appropriations for central university hospitals.

Until 1998 inclusive, TBP data refer to royalties and licence fees. As from 1999, data also include Architectural, engineering and other technical services, computer services and R&D performed abroad.

- In **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 which affects comparisons of the breakdown of R&D efforts 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.

Beginning with the 2006 survey, in order to better take into account SMEs, there is no longer a cut-off point in the business enterprise sector of one Full-time-equivalent on R&D for an enterprise to be included in the survey population.

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.

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%.

Due to changes in the methods used to evaluate domestic expenditure on defence, the results of the 1998 surveys revealed significant modifications requiring new estimates for 1997. This break in series relates also to the GBAORD data.

In 1997, the method used to measure R&D personnel in administrations has changed.

Between 1991 and 1992 France Télécom and GIAT Industries were transferred from the Government to the Business Enterprise sector following a change in their legal status.

- The data in this publication for **Germany** 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 1992 the methodology of the survey on resources devoted to R&D in the Government sector was changed, and the data for the Private Non-Profit sector have been included in the Government sector.

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.

Until 1985 inclusive, the TBP data for Germany cover transactions concerning patents, licence, trademarks, models and designs. As from 1986, this data also covers technical services, computer services and industrial R&D.

- In **Greece**, the methods of assessing R&D in the Higher Education sector changed in 1983, 1989 and 1995.

- In **Hungary** the breakdown of R&D expenditure data by sector of performance and by source of funds is not complete. 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 2004, only defence R&D performed in the civil sector is covered. Until 1993, Business Enterprise expenditure includes purchase of licenses and know-how. As from 1994, the Central Technology Fund has been reclassified from the Business Enterprise sector to the Government sector.

Up to 2003, the source of TBP data was the balance of payment statistics compiled by the Hungarian Central Bank, and data covered royalties and licence fees and sale/purchase of patents and inventions only. Since 2004, TBP data have been collected by the Hungarian Central Statistical Office from enterprise surveys on trade in services. TBP data also include computer services, architectural, engineering and other technical services and R&D carried out abroad.

- As from 1993, **Iceland** revised its methods for collection and processing budget data for GBAORD, resulting in a break in series.
- In **Ireland**, as of 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.  
The government data were revised back to 1992 inclusive, as some government expenditures are no longer classified as R&D.  
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).
- For **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.  
Up until 1990, the national total expenditures on R&D are overestimated by more than 10% as they include extramural R&D expenditures. As from 1991, data on extramural R&D expenditures are available separately and are excluded.  
As from 1992, TBP data includes Research and Development, Technical studies, Staff training, Secondment of technicians and experts and Other transactions in technology. Until 1991 inclusive, R&D performed abroad is excluded.
- 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.  
Up to and including 1995, Japanese data for R&D personnel was expressed as the number of physical persons (working on R&D) rather than in terms of full-time equivalent. In consequence R&D personnel and labour cost data were overestimated by international standards. Studies by some Japanese authorities had suggested that in order to reach FTE the numbers of researchers might be cut by perhaps 40% in the Higher Education sector and by about 30% for the national total. In consequence HERD would be reduced by about 25% and GERD by about 15%.  
In consequence, OECD calculated "adjusted" Japanese series (expenditures and researchers) for the Higher Education sector up to 1995 and, thus, for the national totals for use in its own reports. From 1996, data for R&D personnel are expressed in full-time equivalent. Therefore, labour cost data are no longer overestimated.  
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.
- In **Korea**, beginning with the 2008 data, the KSIC-9 industrial classification was applied.  
Prior to 2007, social sciences and humanities are excluded from the R&D data.  
For the TBP data, data for technology receipts and payments do not come from the same source and are therefore not comparable. Technology receipts data come from the R&D survey and are probably underestimated as all firms are not surveyed. Technology payments data (coming from the Bank of Korea) do not cover transactions for R&D abroad and purchases of patents.
- In **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.
- Beginning with the 2004 data, **Mexico**'s Business enterprise survey register was increased to include large firms previously not identified as R&D providers. The first R&D surveys based on the Frascati Manual covered the period 1992-93. Earlier data for R&D performed in the Government sector are based on broader national estimates, and thus do not exactly correspond to the recommendations of the Frascati Manual.

- Beginning with the 2007 data, the **Netherlands** improved estimation methods for R&D expenditure and personnel in the Higher Education sector

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.

Beginning with the 2004 data for the Higher education sector, data sources as well as estimation methods changed. This affects both R&D expenditure and Researchers.

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. Also beginning 2003, 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 (NOW), previously included in the Government sector, are now included with personnel in the higher education sector

In 1982 and 1990, the methodology of the survey on R&D expenditure in the Higher Education sector changed in the Netherlands. In 1994 and 1996 there were major expansions of the area covered by the Business Enterprise sector survey; R&D expenditure and personnel data in the latter sector and in the whole economy are thus not comparable with those for the previous years.

In 1990 and 1997, new methods of calculating GUF are used for GBAORD series.

- **New Zealand** revised the methods of collection and estimation of R&D data respectively in 1984 (for the Higher Education sector), 1992 (for GUF), and 2001 (BERD and national total and HE personnel).

- In **Norway** 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 sample was revised to improve coverage of small firms (10 to 50 employees) and non-manufacturing industries.

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

In 1987, own funds from Public enterprises have been reclassified from funds from Government to the funds from the Business Enterprise sector. As from 1989 R&D performed by PNP institutes has been included in the Government sector.

The growth in resources devoted to R&D in 1984 is due to the expansion of the area covered by the Business Enterprise sector survey.

The method for compiling GBAORD data changed in 1996. The series have been revised retrospectively to exclude contract research, state enterprises and payments to the European Commission.

Before 1988, TBP data cover only patent licensing and are consequently underestimated.

- For **Poland**, up to 1999, TBP data cover trade in techniques; transactions involving trademarks, patterns and designs; services with a technical content (including prospecting until 1995 and spatial planning, town planning and architectonic work); R&D performed abroad. From 2000, all categories are covered (acquisition/disposal of non-produced, non-financial assets, royalties and licence fees, computer services, architectural, engineering and other technical services and R&D services).

- In **Portugal**, due to methodological improvements in the 2008 R&D survey as well as complementary information collected from internal databases, there is now a more complete and accurate measure of R&D resources, both expenditure and personnel, in the Higher education sector.

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.

New methodological procedures have been adopted for the 1997 survey so that only R&D activities are

covered in the survey. The classification of BERD by NACE (Rev 1) was introduced and the data have been revised back to 1995. Some of the PNP units have been resectored in the Business Enterprise and Higher Education sectors.

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.

GBAORD data have been revised back to 1986 according to a new methodological exercise.

- For the **Slovak Republic**, data before 1994 refer to the Research and Development Base (RDB) and cover the whole activity of institutions and not only R&D. Defence R&D was totally excluded until 1997 and only partially included thereafter.

Since 2002, a new budget classification compatible with 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.

Until 1997 inclusive, TBP data refer to royalties and licence fees and R&D performed abroad. As from 1998, data also include Architectural, engineering and other technical services, computer services and sale/purchase of patents and inventions.

- For **Spain**, beginning 2008, the R&D questionnaire includes a specific category for on-site consultants undertaking R&D projects in the enterprise; as well as a specific category within the breakdown of current costs.

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

R&D personnel data prior to 1989 are underestimated because the R&D personnel data for the Higher Education sector only include researchers. In consequence, total R&D personnel in Spain may be underestimated for these years by between 10 and 15 %.

In 1992 there was an upward re-estimation of the General University Funds causing a break in series in the financing of HERD and GERD. In 1995, the sources of funds for R&D in the Higher Education sector were reviewed; own funds are now separated from the General University Funds where they were previously included.

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 in 1997 of the Spanish contribution to CERN has involved substantial changes in the “Energy” category.

Up to 1992, TBP data come from the annual survey into technological transfer in companies conducted by the Ministry of Science and Technology (former Ministry of Industry and Energy). From 1996 onwards, TBP data come from the balance of payments statistics compiled by the Spanish Central Bank. All TBP items are covered.

- Beginning 2007 in **Sweden**, 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.

Until 2005, R&D data for Sweden were underestimated: R&D in the Government sector covered central government units only and companies between 10-49 employees were excluded from the coverage. Moreover, prior to 1993 the surveys in the Business Enterprise, Government and Private Non-Profit sectors excluded R&D in the social sciences and humanities. Also beginning 2005, FTE on R&D in the Higher education sector reflects a change in survey method. Concerning the Government sector, beginning 2005, the data exclude R&D personnel from the County councils, resulting in the personnel data being underestimated.

As from 1997, funding from the Public Research Foundations, previously classified in the PNP sector, is considered as funding from the government sector.

In 1995, some institutions from the PNP sector have been reclassified to the Business Enterprise or the Government sectors, and in the Higher Education sector, capital expenditures are excluded.

As from 1998, GBAORD series refer to the calendar year (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. Also from 1998, funding from the Public Research Foundations is excluded from the GBAORD data.

Up to 1993, TBP data came from the R&D survey and referred to the transactions linked to patents, licences, royalties and know-how. From 2003, the data are based on the quarterly trade in services survey. All TBP components are covered.

- In **Switzerland**, the Business Enterprise sector comprises private enterprises only. Public enterprises are included in the Government sector.

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

GBAORD series, with the exception of GUF, cover federal government only. 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". For GBAORD this results in a break in series for both Agriculture and Health objectives, where half of the funds previously declared under Health are now declared under Agriculture. Also in 1998, the telecommunications field of the Federal Post office has become the private enterprise Swisscom which is no longer included under the Infrastructure objective in GBAORD. Before 1994, GBAORD did not include the public sector financed R&D mandates.

The TBP statistics are drawn from the *Swiss balance of payments*. They include sales and purchases of intangible assets, technological services (construction services, commercial and technical consulting), license and patent fees, including management fees, computer and information services.

- Total R&D personnel data for **Turkey** (Tables 9 and 10) are underestimated because personnel data for the Higher Education sector only include researchers.

- Beginning with the 2005 data, **United Kingdom** counts of researchers in full-time equivalent on R&D reflect a more accurate measure of post-graduate students. Estimates are based on the sum of student time allocated to different research activities (some students may be involved in several research projects). Students who spend 50% or more of their time on research activities are counted as one FTE; those for whom it is less than 50% are not counted.

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 for GBAORD.

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

Until 1994 in the business enterprise sector, R&D funding by business includes funds that may have been collected from other national sources such as higher education or PNPs.

A new method of estimating government-financed R&D in the Higher Education sector was applied as from 1993.

Reclassification of institutes explains most of the growth of the R&D personnel in the Government sector between 1991 and 1992 and the decline in the following year.

As from 1991 the data for the Government sector include an estimate for R&D expenditures in the public health services.

Between 1985 and 1986 the "United Kingdom Atomic Energy Authority" was transferred from the Government sector to the Business Enterprise sector. Expenditure revisions have been made back to 1985.

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.

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

Oil company operations have been included in the United Kingdom TBP data as from 1984. From 1996 onwards the TBP data cover sale of patents and inventions, patent licensing, trademark patterns and designs, technology-related services and R&D.

- For the **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

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

- i) R&D performed in the Government sector covers only federal government activities. State and local government establishments are excluded;
- ii) in the Higher Education sector R&D in the humanities is excluded, as are capital expenditures;
- iii) R&D expenditure in the PNP sector covers only current expenditure.

Depreciation is reported in place of gross capital expenditures in the Business Enterprise sector.

Higher education (and national total) data were revised back to 1998 due to an improved methodology that corrects for double-counting of R&D funds passed between institutions.

Breakdown by type of R&D (basic research, applied research, etc.) was also revised back to 1998 in the business enterprise and higher education sectors due to improved estimation procedures.

No data is available for total R&D personnel; only data for R&D scientists and engineers are collected. The methodology for estimating researchers was changed as from 1985. In the Government, Higher Education and PNP sectors the data since then refer to employed doctoral scientists and engineers who report their primary work activity as research, 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. As from 1985 researchers in the Government sector exclude military personnel. As from 1987, Higher education R&D personnel also include those who report their primary work activity as design. For the years 2000 to 2007, due to lack of official data for the higher education sector, the total researchers figure is an OECD estimate.

2009 GBAORD data also include the one time incremental R&D funding legislated in the American Recovery and Reinvestment Act of 2009. 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.

Up to 2000, the United States TBP data cover only royalties and licence fees. From 2001, data also include “Research, development and testing services”. Beginning 2006, new statistics on total trade for several types of services are available for the first time. As from 2006, TBP data include royalties and license fees related to industrial processes, business format franchising fees, trademarks and other intangibles; research, development and testing services; computer and data processing services; architectural, engineering and other technical services; industrial engineering services.

### *Non-Member Economies*

- In **Argentina**, Frascati Manual definitions are followed. 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 have not been transferred to the OECD database. 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.
- The data presented for **China** 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.

- 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.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

- In **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.

- In the **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.

- In **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.

Data for TBP receipts do not include services with a technical content, unless covered under ‘licensing of new technologies’.

- For **Slovenia**, beginning reference year 2008, survey coverage was expanded to include some innovative companies that were not previously recognized as R&D performers.
- For the 2001/02 R&D survey in **South Africa**, 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 purposive sample of all firms known to have R&D activities. There may however be an underestimation of R&D expenditure by 10% to 15%.
- In **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.

TBP data do not include R&D performed abroad, services with a technical content, or transactions involving trademarks, design, patterns (sale, licensing, franchising).