

# General methodology

## R&D data (Tables 1 to 60)

### A. Definitions and coverage

#### 1. OECD standards

The R&D data used in this publication have been collected and presented in line with the standard OECD methodology for R&D statistics as laid out in the OECD “Frascati Manual” (see <http://oe.cd/Frascati>). The 2002 edition of the manual has now been superseded by the 2015 edition. The revised guidelines and definitions are in the course of being implemented and are not expected to change the main indicators significantly although some terminology changes will occur. This edition of MSTI has been compiled in accordance with the 2002 Frascati Manual; these changes will be made in a coming edition as R&D surveys move to the new standard.

#### 2. The two types of R&D data

Most R&D data are derived from retrospective surveys of the units actually carrying out or “performing” R&D tasks. Thus, the indicators in Tables 1 to 56 are based on the sum of performers’ reported R&D expenditures and personnel on national territory (i.e. excluding payments to international organisations and other performers abroad). Personnel data are expressed as full time equivalent (FTE) spent working 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; some recent data are provisional figures, national estimates, or projections (these data are annotated).

More up to date information on government support for R&D can be derived from budgetary sources. The indicators in Tables 57 to 60 are based on Government Budget Appropriations or Outlays for R&D (GBAORD) as reported by the funding ministry or agency and include payments to international organisations and other performers abroad.

The specifications of these two sets of R&D data vary significantly and, while they can be used complementary to one-another, they should not be combined.

#### 3. Fields of science

In general, the tables cover R&D in both Natural Sciences and Engineering (NSE, including agricultural and medical sciences) 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.

#### 4. 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, Higher Education, Government, and Private Non Profit institutions (PNP).

R&D expenditure is subdivided into five *sources of funds*, funds from Business Enterprises, from Government (public), from Higher Education, from PNPs, and from abroad. By convention and for international comparison purposes, public general university funds (GUF) are allocated to the government sector as a source of funds. Since the amounts financed by the Higher

Education and PNP sectors are small, they have been combined as “other national sources” in Tables 15 and 37.

### 5. R&D in the business enterprise sector

The Business Enterprise sector covers private and public enterprises and institutes serving such enterprises. The industry breakdown is made according to the main activity of the enterprises. However, for Belgium, France, and the United-Kingdom, data are distributed by product field as longer time series are available. National statistical regulations prevent publication of results where there are very few firms in the given category, hence there are many gaps in the tables broken down by industry.

The industrial classification used is the International Standard Industrial Classification, Revision 4 (ISIC Rev.4). The indicators on industrial BERD concern R&D-intensive manufacturing industries and services:

|  | ISIC Rev. 4 |
|--|-------------|
| • pharmaceutical industry (Table 39)                   | 21          |
| • computer, electronic and optical industry (Table 40) | 26          |
| • aerospace industry (Table 41)                        | 303         |
| • services industry (Table 42)                         | 45-99       |

The above mentioned indicators were calculated using mainly the Analytical Business Enterprise R&D database (ANBERD) for 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).

### 6. Government budget appropriations or outlays for R&D (GBAORD)

These data are assembled by national authorities using statistics collected for budgeting purposes. 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, have a different conceptual basis from the “performer reported” data in Tables 1 to 56 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 2015”, section 12.4).

The breakdown is as follows:

#### Defence (Table 58)

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).

#### Civil (Table 59)

Total GBAORD less Defence.

#### Economic development (Table 60)

R&D programmes financed for the purpose of the advancement of agriculture, fishery, forestry; industry; energy; and infrastructure and general planning of land use.

*Health and environment* (Table 60)

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.

*Education and society* (Table 60)

R&D programmes funded for the purpose of education; culture, recreation, religion and mass media; and political and social systems, structure and processes.

*Space* (Table 60)

Civil space R&D programmes.

*Non-oriented research* (Table 60)

Research programmes financed in view of the general advancement of knowledge.

*General university funds* (Table 60)

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.

Budget data are more timely than those derived from performer reports. Readers are warned that GBAORD data vary in coverage from government-financed GERD series and that these two types of data should not be combined.

**7. 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 Annex 1.

**8. Expenditures in current dollars**

National currency data have been converted to USD using purchasing power parity (PPP) series (Table C) from the OECD National Accounts Division (see [www.oecd.org/std/ppp](http://www.oecd.org/std/ppp)). Due to lags, the PPP series are estimated in 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 series provided by the World Bank are used to convert data from national currency into USD. Only TBP data have been converted using current exchange rates as these transactions are conducted on international markets.

**9. Expenditures in constant dollars**

R&D expenditure series have been deflated using the implicit GDP deflator taken from the OECD National Accounts database estimated for the most recent years based upon projections 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) (Table B). Any expenditures series calculated on the basis of these estimated rates are footnoted “b”.

**10. Comparisons with economic indicators**

R&D expenditures are shown as a percentage of selected indicators drawn from the OECD National Accounts database and estimated for the most 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 tables concerned. R&D

personnel are expressed “per thousand” in relation to selected indicators from the OECD National Accounts and Labour Force databases. The main indicators used are shown in Annex 2.

R&D data are typically expressed as a percentage of GDP to allow cross-country comparisons. When compiling such indicators for the business enterprise sector, one may wish to exclude, from GDP measures, economic activities for which the Business R&D (BERD) is null or negligible by definition. By doing so, the adjusted denominator (GDP, or Value Added, excluding non-relevant industries) better correspond to the numerator (BERD) with which it is compared to. The MSTI variable “Value added in industry” is used to this end: it is calculated as the total Gross Value Added (GVA) excluding “real estate activities” (ISIC rev.4 68) where the “imputed rent of owner-occupied dwellings”, specific to the framework of the System of National Accounts, represents a significant share of total GVA and has no R&D counterpart. Moreover, the R&D performed by the community, social and personal services is mainly driven by R&D performers other than businesses. Consequently, the following service industries are also excluded: ISIC rev.4 84 to 88 and 97 to 98.

In the same way, some indicators on R&D personnel in the business sector are expressed as a percentage of industrial employment. The latter corresponds to total employment excluding ISIC rev.4 68, 84 to 88 and 97 to 98.

**Impact of changes to the measurement of GDP on R&D to GDP ratios:** the 2008 update to the System of National Accounts (SNA), recognised the role of R&D as an activity leading to the creation of knowledge assets. One implication of recognising R&D as an asset-creating activity is that the level of GDP was, in many countries, revised upwards by a magnitude close to the value of domestic business investment in R&D. This will then reduce the R&D to GDP ratio, as the numerator stays constant and the denominator increases to incorporate an element that was previously missing from the GDP estimate. Figures and indicators for countries which have not yet implemented a revision to their National Accounts figures to take into account the role of R&D as investment – or for which revised data are not yet available in the *National Accounts of OECD Countries* published by the OECD National Accounts Division – are flagged with the note Y (meaning “compiled according to the System of National Accounts 1993”). Users should be careful when comparing the R&D to GDP ratios of countries that have and have not capitalised R&D in their national accounts. Likewise, they should avoid comparing previously published R&D to GDP ratios and more recent ones.

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

## 11. Zone totals

Zone totals have been calculated for the OECD and the EU-28 for most tables. The OECD zone includes all Member countries of the OECD i.e Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

The EU-28 includes Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia,

Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. Zone totals for EU-15 (the first 15 countries of the EU-28) are available in the electronic editions of this publication.

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 computed using simple statistical routines or information from national publications and observations of trends. Data points where such estimates would exceed 25% of the zone total have been suppressed. Israel, Korea, and Mexico are included in the OECD total as of 1991. The Czech Republic, Estonia, Hungary, Latvia, Poland, the Slovak Republic and Slovenia are likewise included as of 1995; Chile from 2007; Luxembourg is included in zone totals beginning 2000. Croatia and Malta are included in the EU-28 total beginning 2002.

Data for non-OECD countries used to calculate EU-28 have been provided by the Statistical Office of the European Commission (Eurostat).

OECD estimates for the EU-15 and the EU-28 zones may slightly differ from those published by Eurostat. In this publication, in line with standard OECD practice, national estimates are aggregated using USD Purchasing Power Parity (PPP) indices instead of EUR exchange rates applied by Eurostat. For example, the EU-28 measure of GERD to GDP ratio will be an average of EU countries' GERD intensities, weighted by the share of countries' GDP to EU GDP expressed in USD by applying PPP conversion as opposed to EUR-based GDP shares.

## B. Sources

The data are derived from national R&D surveys and budgets are supplied to the Secretariat via an OECD/Eurostat co-ordinated collection.

## R&D expenditures of foreign affiliates (Tables 61 and 62)

### A. Definitions and coverage

These data are collected as part of the OECD effort to measure globalisation through the role of multinationals. A “foreign affiliate” is a company located outside the country/economy of interest and in which a controlling stake (over 50% of voting shares) is owned by a company within the country/economy of interest (i.e. that for which the R&D statistics are being compiled). These figures thus present the amounts spent on R&D by foreign affiliates of companies based in the domestic economy. 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*. Data are available on-line at <http://oe.cd/amne>.

### B. Sources

OECD database on Activities of Multinational Enterprises (AMNE), December 2016.

## Patents (Tables 63 to 66)

### A. Definitions and coverage

#### 1. Patents and patent families

A patent family is defined as a set of patents protecting a single invention across various jurisdictions. Inventors seeking protection file a first application (priority) often in their country of residence. Following this, there is a period where protection may also be applied

for in other jurisdictions. 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 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, as well as the total number of applications filed across all 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.

## 2. 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 (or countries) of residence of the inventor(s), giving an indication 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 the 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 could be up to 4 years. From priority years 2012 to 2014, patent families for individual countries are Secretariat estimates, based on the latest trends on patent filings observed at the three offices. Furthermore, because of changes in the rules and regulations at the USPTO, triadic patent families before 2001 are based on USPTO granted patents.

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 at <http://oe.cd/ipstats>, along with methodological notes. These present patents by main technology classes and by region, as well as indicators on international co-operation in patenting. For further details on patent data, refer to the *OECD Patent Statistics Manual, 2009*.

## B. Sources

The data on patents at intellectual property offices (EPO, JPO, USPTO) are mainly derived from EPO’s Worldwide Statistical Patent Database (PATSTAT, Autumn 2016). 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.

## Technology balance of payments (TBP) (Tables 67 to 69)

### A. Definitions and coverage

The TBP registers 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 (Table 69) give an indication of the share of imported technology in relation to domestic R&D efforts.

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

### B. Sources

OECD database on Technological Balance of Payments (TBP), Decembre 2016.

## International trade in highly R&D-intensive industries (Tables 70 to 72)

### A. Definitions and coverage

These tables present indicators concerning the international trade in goods of selected R&D intensive industries. Data are presented in accordance with the International Standard Industrial Classification, Revision 4 (ISIC Rev.4). In general, prior to 1988 underlying source data are based on ISIC Revision 2.

These series are taken from the OECD's Bilateral Trade in Goods by Industry and End-use Category database (BTDixE), derived from the OECD International Trade Statistics and United Nations Statistics Division COMTRADE databases, which have been converted from the Harmonised System (HS) to International Standard Industrial Classification (ISIC).

Industries covered are as follows:

|   | ISIC Rev. 4 |
|---|-------------|
| • <i>pharmaceutical industry</i> (Table 70)                   | 21          |
| • <i>computer, electronic and optical industry</i> (Table 71) | 26          |
| • <i>aerospace industry</i> (Table 72)                        | 303         |

A note indicating a break in series is assigned to the first available year of ISIC Revision 4 data. Prior to 1993, the data for Belgium include Luxembourg.

The zone total for EU-15 (presented online) excludes intra-EU trade. The OECD total has not been adjusted to exclude trade between member countries.

From 1996, calculation of the Export market shares is relative to total aggregate exports of the declaring countries available in the OECD BTDixE database. Reporting economies included in BTDixE but not presented in this publication notably include Brazil, Hong Kong, India, Indonesia, Malaysia, the Philippines, Saudi Arabia and Thailand. Prior to 1996, Export market shares are based on the share of OECD total exports.

### B. Sources

OECD Bilateral Trade in Goods by Industry and End-use Category database (BTDixE), December 2016 ([www.oecd.org/sti/btd](http://www.oecd.org/sti/btd)).





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