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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 The 2002 edition of the manual has now been superseded by the 2015 edition.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 2015 Frascati Manual, some countries may still be following the 2002 edition for certain series or datapoints.

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 time such surveys take to undertake, 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 Allocations for R&D (GBARD) 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 in complement 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 also classified by *sources of funds*, including: funds from Business Enterprises, from Government, from Higher Education, from PNPs, and from the rest of the world. By convention and for international comparison purposes, public general university funds (GUF) are recorded as funds originating from the government sector. 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 a 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 BERD by industry 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 primarily using the Analytical Business Enterprise R&D database (ANBERD) for OECD Member countries and those selected non-member economies covered by the database. For further information on this database see: *http://oe.cd/anberd*.

6. *Government budget Allocations for R&D (GBARD)*

These statistics are assembled by national authorities using data collected for budgeting purposes. This essentially consists of identifying all the budget items involving R&D and measuring or estimating their R&D content. 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". Data are allocated to socio economic objectives on the basis of *intentions* at the time the funds are committed and not the actual content of the projects concerned. These breakdowns reflect *policies* at a given moment in time.

The classification used is the European Commission's Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets – (NABS) 2007, specially developed for R&D analysis (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 GBARD less Defence.

Economic development (Table 60)

R&D programmes financed for the purpose of transport, telecommunication and other infrastructures; energy; industrial production and technology; and agriculture (NABS chapters 04, 05, 06 and 08 respectively).

Health and environment (Table 60)

R&D programmes funded for the purpose of the exploration and exploitation of the earth; environment; and health (NABS chapters 01, 02 and 07 respectively).

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 (NABS chapters 09, 10 and 11 respectively).

Space (Table 60)

Civil space R&D programmes (NABS chapter 03).

Non-oriented research (Table 60)

Research programmes financed in view of the general advancement of knowledge, except General University Funds (NABS chapter 13).

General university funds (Table 60)

The estimated R&D content of "block grants" paid by government to the Higher Education sector. This category (NABS chapter 12) is generally absent or underestimated for countries where only federal government is included.

Budget data can be more timely than those derived from performer surveys. Readers are warned that GBARD 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 minor to materially affect the general indicators quoted in this publication. The main exceptions are shown in Annex 1.

8. Expenditure 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/prices-ppp*). Due to lags in availability, 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.

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

9. Expenditure in constant dollars

R&D expenditure series have been deflated using the implicit GDP deflator taken from the OECD National Accounts database. This is estimated for the most recent years based upon projections published in the biannual *OECD Economic Outlook* (except in the case of Norway where a deflator excluding trends in petroleum prices has been used) (Table B). Any expenditure 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 where available 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 BERD is null or negligible by definition. By doing so, the adjusted denominator (GDP, or Value Added, excluding non-relevant industries) better corresponds 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.

Data on GVA and employment in industry are mainly taken from the STructural ANalysis (STAN) Database, complemented by the OECD and Eurostat National Accounts databases, as well as national sources.

Impact of changes to the measurement of GDP on R&D to GDP ratios: the 2008 update to the System of National Accounts (SNA) implemented various accounting changes which impacted the level of GDP, one key change was recognising 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 reduced the R&D to GDP ratio, as the numerator stayed constant while the denominator increased to incorporate an element that was previously missing from the GDP estimate.

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 figures 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; Luxembourg is included in zone totals beginning 2000; Croatia and Malta are included in the EU-28 total beginning 2002; Chile is in the OECD total from 2007.

Data for non-OECD countries used to calculate EU-28 have been provided by 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 by national statistical agencies 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 controlled affiliate" (FCA) is a company located inside the country/economy of interest and in which a controlling stake (over 50% of voting shares) is owned by a company outside the country/economy of interest. These figures thus present the amounts spent on R&D by FCAs 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 BERD figures. 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), February 2018.

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 patent data are more homogeneous).

The patent families presented in this publication refer to triadic families: i.e. a patent is included 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 provided for two specific sectors of interest: the ICT and biotechnology sectors, alongside the total number of applications filed across all sectors. These sectors are defined according to selected classes of the International Patent Classification (IPC), *www.wipo.int/classifications/ipc/en/index.html*. From the 2017-1 MSTI edition onwards, the definition of ICT-related patents has been modified to better align with the evolution of the ICT sector, affecting the whole time-series. 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 to 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 exacerbate one drawback of traditional patent counts: timeliness. The time lag between the priority date and the availability of information on patent applications could be up to 4 years. From 2013 onwards, patent families for individual countries are Secretariat estimates, based on the latest trends in patent filings observed at the three patent 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 and time series 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, www.oecd.org/science/inno/oecdpatentstatisticsmanual.htm*.

B. Sources

The data on patents filed at intellectual property offices (EPO, JPO, USPTO) are mainly derived from EPO's Worldwide Statistical Patent Database (PATSTAT, Autumn 2017). Triadic patent families series have been compiled by the Secretariat. PCT applications series 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), June 2017.

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 categorised 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
• *pharmaceutical industry* (Table 70)	21
• *computer, electronic and optical industry* (Table 71)	26
• *aerospace industry* (Table 72)	303

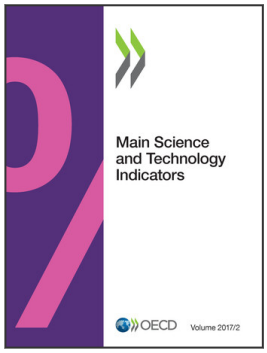
A note indicating a break in series is assigned to the first available year of ISIC Revision 4 data. Prior to 1993, the data for Belgium include Luxembourg.

The zone total for EU-15 (presented online only) 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), February 2018 (*http://oe.cd/btd*).



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