

INSTITUTO NACIONAL DE ESTADISTICA



Statistics on R&D Activities

Methodological report

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1. Introduction

The Statistics on research and experimental development (R&D) activities arose with the objective of measuring economic and human resources (inputs) destined to these activities, in order to satisfy a dual purpose:

1. To provide an instrument for management, planning, decision-making and control in terms of national scientific policy.
2. To provide statistical bodies with the information that they request, obtained in accordance with the international regulations that allow for comparability between the different countries.

Background

In 1960, the majority of the OECD Member States, stimulated by the rapid growth of national resources used for research and experimental development (R&D), began collection of statistical data in this field. During this first stage, theoretical difficulties were found, and the differences in scope, methods and concepts made international comparison difficult. It therefore seemed necessary to perform a normalisation in concepts and definitions that were accepted by all Member States of the OECD.

To this end, a group of experts was created, which met in Frascati (Italy), and which wrote and approved the document called the "Proposed Standard Practice for Surveys on Research and Experimental Development" (OECD, 1963), better known as the Frascati Manual.

This Manual is the methodological base for R&D Statistics.

The first survey on scientific and technical research in Spain, extended to both the public and the private sectors, was compiled with reference to the year 1964 by a group of Spanish experts in collaboration with the OECD. The results were published by the Ministry of Education and Science in 1966, in the so-called "Yellow Book".

Subsequently, the Planning group of the Technical Office of the *Juan de la Cierva* Trust Foundation conducted a "*Survey on scientific and technical research activities in Spain in 1967*". This was the first systematic and complete study on scientific and technical research activities of the public and private sectors. The compilation of a directory of companies, for this survey, served as the basis for the subsequent surveys conducted by the National Statistics Institute (INE).

Subsequently, in compliance with the Order of the Presidency of the Government dated 1 April 1971, which entrusted the INE with the compilation of the R&D statistics, this body began to conduct surveys on Scientific Research and Experimental Development activities, the first of which referred to the year 1969.

The R&D in Spain Statistics have been compiled following the recommendations dictated by the OECD in the Frascati Manual, whose sixth version was published in 2002. This Manual is one of the pillars of the actions carried out by the OECD in an effort to obtain a better understanding of the role of science and technology.

Likewise, on providing internationally accepted definitions and classifications of R&D, the results obtained from these Statistics comply with the criteria that allow for their international comparison.

In October 2015, the OECD published the seventh revision of the Manual under the name "Frascati Manual 2015. GUIDELINES FOR COLLECTING AND REPORTING DATA ON RESEARCH AND EXPERIMENTAL DEVELOPMENT".

2. Methodology

2.1 Objectives

The objective of this study is the measurement of the national effort in R&D activities, so that it is possible to provide the necessary information for adequately making scientific-technological policy decisions. To this end, the aim is to ascertain the economic and human resources used for research by all the economic sectors of the country.

In order to determine financial resources, the aggregate *Domestic Expenditure on R&D* is calculated, which is comprised of the set of R&D expenses for each of the sectors into which the economy has been broken down, notwithstanding the source of the funds and the financial backer's nationality. To ascertain human potential, the number of *Personnel* (researchers and other personnel) *dedicated to R&D activities*, in a full-time equivalence, is calculated.

2.2 Scope

POPULATION SCOPE

With these Statistics, a study is carried out on companies, public institutions, universities and other higher education centres and private non-profit institutions that carry out research and experimental development activities in any scientific field, and which are located within the national territory.

TERRITORIAL SCOPE

This includes all of Spain.

TEMPORAL SCOPE

The main reference period of these statistics is the year immediately prior to the year when the data is collected. For the *expenditure* characteristic, the reference period will be the calendar year. With regard to *personnel*, to determine the number of persons who work in R&D, the statistics use both the annual average and the full-time equivalence of the personnel who carry out R&D activities (persons/year).

The Statistics are compiled annually in accordance with European Union regulation (Commission Implementing Regulation No 995/2012 of 26 October 2012).

The implementation of the Technological Innovation Survey in companies has made its coordination with the R&D Statistics necessary, for the purpose of optimising the resources available without reducing the basic information provided until now and allowing for bearing in mind the information requests from national and international institutions, as well as those derived from the National Statistical Plan.

2.3 Statistical unit

These are the units from which the desired base information is obtained. For the purposes of the information collection and the presentation of results, the analysis units are grouped by sector, the contents of which are based to a large extent on the National Accounts System, with the difference that Higher Education has been considered an independent sector and households have been grouped within Private non-profit institutions. The following define the sectors considered, as well as the analysis units for each one of them.

COMPANY SECTOR

The business sector comprises:

- All resident companies, not only including legally incorporated companies, regardless of the residence of their shareholders. This group also encompasses any type of quasi-corporation, for example, entities that are able to generate profit or any other financial gain for their owners, that are recognised by law as legal entities that are independent from their owners and are established with the purpose of carrying out market production at economically significant prices.
- The unincorporated subsidiaries of non-resident companies that are deemed to be resident, since they participate in production within the economic territory over the long term.
- Any resident Private Non-Profit Institution (PNPI) producing market goods or services or providing a service to other companies.

PUBLIC ADMINISTRATION SECTOR

The Public Administration sector is composed of the following groups of resident institutional units:

- All units of the central, autonomous or local administration, including social security funds, except:
 1. the units that provide higher education services
 2. centres in which there is no training component, but whose R&D activities are controlled by a higher education institution
- All the non-profit institutions that are not controlled by units of the Administration and that do not belong to the higher education sector.

This sector does not include public enterprises, even when the entire capital of the company belongs to a unit of the Administration. Public enterprises are included in the business sector. The difference that characterises them is that public

companies are market producers, while the units classified as being in the Public Administration sector are not.

A sub-sectorisation is carried out within this sector, into:

- State administration
- Autonomous Community administration
- Local administration
- Private non-profit institutions mainly financed by the administration

The administration institutions that comprise this sector are the State, the Autonomous Institutions that are dependent on same, as well as state companies, public entities, ..., which due to their main activity and the source of their resources may be considered as belonging to the public administration sector. Also considered a part of this sector are the entities that administer Social Security, as well as hospitals that depend on the same, and which perform this function on behalf of the State.

The same occurs with the institutions that are dependent on the Autonomous and local administrations.

Within the State Administration, and for result presentation purposes, due to its special importance, another sub-sectorisation has been carried out between major public research institutions (OPIS) directly involved in research tasks pursuant to the *Science Act by Law 14/2011, of 1 June, on Science, Technology and Innovation*, and other bodies of the State Administration, and other State Administration institutions. The following have been included within the section "Major OPIS":

- National Institute for Aerospace Technology (INTA)
- Higher Council for Scientific Research (CSIC)
- Canarias Astrophysics Institute (CAI)
- Geological and Mining Institute of Spain (IGME)
- National Agricultural Research and Technology Institute (INIA)
- Spanish Institute of Oceanography (IEO)
- Carlos III Institute of Health (ISCIII)
- Research Centre for Energy, Environment and Technology (CIEMAT)

HIGHER EDUCATION SECTOR

The higher education sector consists of all universities, technical schools and other institutions that offer official university education programmes, whatever the source of funding or legal nature, and all research institutes, centres, experimental stations and research clinics that carry out R&D activities under the direct control or administration of a higher education institution.

The following sub-sectorisation is carried out within this sector:

- public universities
- private universities
- other centres

PRIVATE NON-PROFIT INSTITUTION (PNPI) SECTOR

This sector includes:

- All the Non-Profit Institutions Serving Households (NPISH), according to the definition of the National Accounts System in 2008, except those classified in the higher education sector.
- For the purposes of the completeness of the presentation, households and individuals involved or not in market activities.

Excluded from this sector are the following private non-profit institutions:

- those whose main activity is for the benefit of companies.
- those that mainly serve the public administrations.
- those which are completely or mainly financed and controlled by the public administrations.
- those that offer higher education services or are controlled by higher education institutions.

SECTOR REST OF THE WORLD

The rest of the world sector includes all non-resident institutional units that perform transactions with other resident units, or have other economic links with resident units.

The rest of the world includes:

- All institutions and individuals without a headquarters, production premises or facilities within the economic territory in which or from which the unit takes part and intends to continue to participate, either indefinitely or for a specified amount of time but over the long term, in economic activities and transactions on a large scale.
- All international organisations and supranational authorities, including the facilities and operations that they carry out within the borders of the country.

This sector may be subdivided into:

- Business Sector
- Public Administration Sector

- Higher Education Sector
- Non-Profit Private Institutions Sector
- International Organizations

DEFINITION PROBLEMS BETWEEN SECTORS

In the event that any unit is of a mixed participation, between two or more sectors (university-company, university-public research institution, public administration-company, ...), to assign the unit to a specific sector it will be necessary to bear in mind whether the same imparts Higher Education, as well as the sector to which the institutions that mainly control and finance the unit belong.

2.4 Variables and their definition

ECONOMIC ACTIVITY

This variable is only studied in the companies sector.

The economic activity carried by a company is defined as the creation of added value through the production of goods and services.

Main economic activity is understood to be that which generates the greatest added value. In view of the difficulty when it comes to calculating the added value for companies that carry out these activities, the main activity is defined as that which generates the greatest turnover or, in its absence, that which employs the most employees.

The classification used is the National Classification of Economic Activities (CNAE-2009), according to the conditions contained in the Regulations for approval of NACE Rev.2, considering the activities presented in chart 1 and that coincide with those recommended by the OECD. This classification serves to determine who is carrying out the research.

Chart 1. List of branches of activity and their correspondence with the National Classification of Economic Activities (CNAE-2009)

Branch of activity	CNAE-2009
AGRICULTURE	01 to 03
1. Agriculture, cattle breeding, forestry and fishing	01, 02, 03
INDUSTRY	05 to 39
2. Extractive and petroleum industries	05, 06, 07, 08, 09, 19
2.1. Extractive industries	05, 06, 07, 08, 09
2.2. Petroleum industries	19
3. Food, beverages and tobacco	10, 11, 12
4. Textile, manufacture, leather and footwear	13, 14, 15
4.1. Textile	13
4.2. Tailoring	14
4.3. Leather and footwear	15
5. Wood, paper, publishing, graphic arts	16, 17, 18
5.1. Wood and cork	16
5.2. Cardboard and paper	17
5.3. Publishing, graphic arts and reproduction	18
6. Chemistry	20
7. Pharmacy	21
8. Cork and plastics	22
9. Various non-metallic ore products	23
10. Metallurgy	24
11. Metallic products	25
12. Manufacture of computer, electronic and optical products	26
13. Electrical material and equipment	27
14. Other machinery and equipment	28
15. Motor vehicles	29
16. Other transport material	30
16.1. Naval Construction	301
16.2. Manufacture of aircraft and spacecraft	303
16.3. Other transport equipment	30 (exc. 301, 303)
17. Furniture	31
18. Other manufacturing activities	32
19. Repair and installation of machinery and equipment	33
20. Energy and water	35, 36
21. Sanitation activities, waste management and decontamination activities	37, 38, 39
CONSTRUCTION	41 to 43
22. Construction	41, 42, 43
SERVICES	45 to 96
23. Trade	45, 46, 47
24. Transport and storing	49, 50, 51, 52, 53
25. Accommodation	55, 56
26. Information and communications	58, 59, 60, 61, 62, 63
26.1. Telecommunications	61
26.2. Programming, consultancy and other IT-related activities	62
26.3. Other information and communication services	58, 59, 60, 63
27. Financial and insurance activities	64, 65, 66
28. Real estate activities	68
29. Professional, scientific and technical activities	69, 70, 71, 72, 73, 74, 75

Branch of activity	CNAE-2009
29.1. R+D services	72
29.2. Other activities	69, 70, 71, 73, 74, 75
30. Administrative and support service activities	77, 78, 79, 80, 81, 82
31. Health activities and social services	86, 87, 88
32. Arts, recreation and entertainment activities	90, 91, 92, 93
33. Other services	95, 96

Given that the potentially researching units are investigated exhaustively, the following branches are also included within the Population Scope of the Survey:

CNAE-2009	Literal
85 (except 854)	Education (except post-secondary education)
94	Activities of membership organisations

Note: When collecting the R&D Statistics together with the Technological Innovation in Companies Survey (TIS), the companies that declared having carried out R&D activities are selected with probability 1 and, regarding the R&D collection of information, the companies with less than 10 employees of all branches of activity are included, except the CNAEs 84 and 854.

DIMENSION OR SIZE OF THE COMPANY

This variable is only studied in the companies sector.

The size of the companies is one of the most important variables when it comes to determining the behaviour of the companies. This dimension may be established by considering the magnitude of turnover, or by considering the number of persons that constitute the company's workforce.

EMPLOYED PERSONNEL

This variable is only studied in the companies sector.

This is defined as the number of persons who work within the company, as well as the number of persons whom, working outside the company, belong to and are paid by the same (for example, sales representatives and delivery personnel, repair and maintenance personnel who work on behalf of the company). It includes paid as well as unpaid personnel.

A worker from a temping agency is an agency employee and not an employee of the unit (company) where s/he works.

Those workers tied to the company by a labour contract and who are paid fixed or periodic amounts in the form of a wage, salary, commission, efficiency wage or payments in kind are considered *paid personnel*.

This can be permanent personnel (with an indefinite contract or work relation) or temporary personnel (with a contract of a determined duration).

Also considered as paid personnel are: owners paid for their work; students with formal agreements whereby they contribute to the company's production process

in exchange for remuneration and / or education services (interns); employees hired with a contract specifically destined to promoting the hiring of unemployed persons; home workers where there is an explicit agreement that they are paid according to the work they carry out and they are included in the payroll.

Also considered paid personnel are part-time workers, seasonal workers and persons on strike or who are on short-term leave, but it excludes those who are enjoying long-term leave.

Those persons who actively manage or participate in company work activities but do not receive fixed remuneration or a salary constitute *unpaid personnel*. Included are owners, autonomous partners who are active within the company and family assistance. Not included are partners who solely contribute capital, nor persons who are included in the payroll of another company in which they carry out their main activity.

TURNOVER

This variable is only studied in the companies sector.

It includes the amounts invoiced by the company during the reference year for services rendered and for the sale of goods that are the object of the company's trade.

These are accounted for, including the taxes that are paid on goods and services, with the exception of the VAT paid by the client. They are accounted for in net terms deducting refunds, as well as volume discounts, on sales. Not deducted are cash discounts nor discounts for prompt payment.

Business volume does not cover the sale of fixed assets nor production subsidies received. The amount of turnover is calculated as the sum of the net sales of goods and the rendering of services.

RESEARCH AND EXPERIMENTAL DEVELOPMENT (R&D)

This is defined as the set of creative work that is systematically undertaken for the purpose of increasing the volume of knowledge, including the knowledge of man, culture and society, as well as the use of this sum of knowledge to conceive new applications.

R&D activity is characterised by its novelty, creativity, uncertainty, systematicity, transferability and/or reproducibility (aimed at obtaining results that can be reproduced by others)

R&D includes three types of activity:

a) **Basic research.** This consists of theoretical or experimental work undertaken primarily to obtain new knowledge about the foundations of observable phenomena and facts, without the intention of granting them a particular application or use.

Basic research analyses properties, structures and relationships with the purpose of formulating and contrasting hypotheses, theories or laws. The researcher might not have any knowledge of genuine applications when carrying out the research. The results of basic research are not normally put on sale, but rather, are generally published in scientific magazines or are directly divulged among institutions or interested persons. This research is usually carried out in the Higher Education sector, but also, to a certain extent, in the Public Administration sector. In addition, companies in the private sector may carry out basic research, for the purpose of preparing for the following generation of technology.

b) **Applied research.** This also consists of original work undertaken with the objective of acquiring new knowledge. However, it is mainly directed towards a specific practical objective.

Applied research is undertaken to determine the possible uses of the results of basic research, or to determine new methods or forms for attaining specific predetermined objectives. This type of research implies taking into consideration all existing knowledge, in depth, with the intention of solving specific problems. This research facilitates putting ideas into practice

c) **Experimental development.** This consists of systematic work based on knowledge gained from research and practical experience, and the production of new knowledge, which is geared towards the manufacture of new products or processes, or to improve existing products or processes.

The following examples, extracted from the Frascati Manual, allow us to illustrate the differences between basic research, applied research and experimental development:

a) The study of a determined class of polymerisation reactions under diverse conditions, of the products obtained from the same and of their physical and chemical properties, is basic research. When attempts are made to optimise one of these reactions to obtain a polymer with certain physical or mechanical properties (that confer a particular use), applied research has been undertaken. Experimental development consists of undertaking, on a larger scale, the process optimised in the laboratory, and evaluating the possible polymer production methods and, eventually, the articles that may be manufactured from the same.

b) Theoretical research on the factors that determine the regional differences in economic growth is basic research; however, the same research, carried out with the objective of being able to develop state policy to this end, would be applied research. The establishment of operational models based on the knowledge obtained through research, and destined to reducing regional imbalance, is experimental development.

Definition problems between R&D and other scientific-technological activities

For statistical purposes, R&D must be differentiated from a broad range of related activities that have a scientific-technological base. These activities are very closely related to R&D, through both the information flows and with regard to the

operations, institutions and personnel, but, where possible, they should not be taken into account in the measurement of R&D activities.

The basic criteria that allows R&D to be distinguished from other related activities is the existence, within the core of R&D, of an appreciable element of creativity and the resolution of a scientific and / or technological uncertainty; or, in other words, when the solution to a problem does not seem evident to anyone who is up to date with the totality of the basic knowledge available and the techniques commonly used in the sector under consideration.

Related scientific and technological activities that should be excluded are the following:

Education and training

The research carried out by postgraduate students (doctoral theses) and the supervision of this work by professors must be included as R&D.

If this supervision solely consists of teaching R&D methods or reading or correcting the students' thesis, reports or work, it should be excluded from R&D.

Meanwhile, these supervision activities must be classified in R&D if they are equivalent to the administration and management of a specific R&D project that contains a sufficient element of creativity and which has as its objective the creation of new knowledge.

Other related scientific and technological activities

It includes the activities that are listed below, which must be excluded from R&D, except when they are solely or mainly carried out for the benefit of an R&D project.

a) Scientific and technical information service

Activities specialised in the collection, cataloguing, registration, classification, dissemination, translation, analysis and evaluation, carried out by scientific and technical personnel, bibliographic services, patent services, scientific and technical information dissemination services, and consultancy services, and scientific conferences, are excluded from R&D except when they are exclusively or mainly carried out in support of R&D tasks.

b) The collection of general data

It is usually carried out by public organisations for the purpose of compiling statistics on natural, biological or social phenomena that are of public interest, or with regard to which only the Public Administration has the means to compile. For example, it is possible to cite ordinary tasks for the preparation of topographic maps, elevated geological maps, hydrological, oceanographic and meteorological plans, as well as astronomy observations or the specific collection of social facts in the form of censuses, sample surveys,...

If this data is collected or specially processed for scientific research purposes, its cost must be allocated to R&D, and should include planning, systemisation, etc. Market studies are also excluded.

c) Standardisation tests and work

This heading includes tasks destined to the adaptation to national rules, the adaptation to subsidiary rules, trials and routine analysis of materials, components, products, processes, earth, atmosphere,...

d) Viability studies

It refers to the study of an engineering project using existing techniques for the purpose of providing complementary information for putting the same into operation.

Conversely, viability studies of research projects form part of R&D.

e) Specialised medical care

This heading includes current practice tasks and the habitual application of specialised medical knowledge. Any medical care not directly linked to an R&D project is excluded from the scope of these statistics.

f) Work on patents and licences

This includes all administrative and legal tasks regarding patents and licences. Those tasks directly related to R&D projects form part of R&D.

g) Studies of a political and operational nature

The word *policy* includes national policy, regional and local policy, as well as company policy that pursues a certain economic objective. If it does not correspond to the definition of R&D, it is excluded from R&D.

h) Prospecting activities

It refers to the prospecting of the existing reserves of natural resources, such as the activities of geological surveying and drilling of exploration shafts in order to evaluate the resources in a deposit. This is not considered R&D.

i) Routine software development activities

These activities include the tasks relating to improvements in systems or programs already made available to the public before the commencement of the tasks. Also excluded are technical problems that have been overcome in previous projects pertaining to the same operating systems and computer architecture.

Nature of internal R&D activities

Units are asked about the nature of their R&D activities.

The Frascati Manual recommends that all units carrying out R&D work, either continuously or sporadically, be included in R&D surveys.

OTHER INDUSTRIAL ACTIVITIES

Below are outlined a few cases of problems in the delimitation of the line between R&D and other innovative activities.

i) Prototypes

The construction and trial of a prototype frequently constitute the most important phase of experimental development. Nevertheless, once the last modifications are introduced and the prototype trial phase has successfully finished, subsequent activities will not fall within the field of R&D.

ii) Pilot installations

The construction and use of a pilot installation forms part of R&D in that its main objective is to acquire experience and collect technical data, or data of a different kind, which will be used subsequently.

Once this experimental phase is finished, it cannot be considered R&D.

iii) Large-scale projects and very costly pilot installations

Large-scale projects, such as aerospace and defence activities, generally comprise a range of activities that go from experimental development to pre-production development. Under these conditions, the organisation that finances and/or carries out these projects frequently cannot establish a distinction between R&D and the remaining costs. It is important to look closely at the nature of costly pilot plants or prototypes, such as the first of a new line of nuclear power stations or of icebreakers. They may be constructed almost entirely from existing materials and use existing technology, and they are often built for simultaneous use for R&D and for providing the primary service concerned (power generation, ice breaking). The construction of such plants and prototypes should not be wholly credited to R&D. Only the additional costs due to the experimental nature of these products should be attributed to R&D.

iv) Manufacturing launch

The manufacturing launch phase begins when a prototype has been tested with satisfactory results. Given that it does not require new design work and industrial engineering, it must not be considered within R&D.

v) Detection of breakdowns

Difficulties in the launch phase may sometimes require complementary R&D tasks, but most commonly, operating defects, once detected, lead to minor modifications in the equipment and in processes. Therefore, these tasks should not be considered R&D.

vi) Supplementary R&D

When a new product or process is delivered to the production unit, some technical problems may arise, hence they will require supplementary R&D tasks. Such tasks should be borne in mind in the measure of R&D.

vii) Industrial equipment and engineering

In most cases, the industrial equipment and engineering phases of a product are considered a part of the production process. However, if the equipping phase is translated into new R&D tasks, these activities are classified as R&D.

viii) Production activities and related technical **activities**

This includes industrial production, pre-production and the allocation of goods and services, as well as the diverse technical services linked to the corporate sector and the whole economy, and related activities used by disciplines included within the social sciences, such as market research studies.

Financing and other indirect support activities

The genuine realisation of R&D activities requires the provision of funds and the management of the project and its financing. Strictly speaking, R&D financing activities of organisations such as ministries or committees of inquiry do not form part of R&D. Direct R&D support activities are distinguished from indirect R&D support activities. By agreement, the data on R&D personnel exclude indirect auxiliary activities, while they are taken into account in the R&D expenditure of those executing the activities, such as current costs. To this end, transport, storage, cleaning, repair, maintenance and security activities are some characteristic examples.

Some activities, such as those of a library, computing services, management and administration activities or office tasks, form part of genuine R&D if they are exclusively destined to R&D, but they become indirect support activities when they are carried out by central services that attend to both R&D activities and other activities.

Accounting activities associated with a specific R&D project are direct activities.

Other definition problems

a) Activities related to social sciences and humanities

Social sciences and humanities rely, much more than other scientific fields, on external disciplines and techniques to support their research activities.

Thus, *knowledge of man, culture and society* has been included in the definition of R&D. The notion of novelty should continue to serve as the basic criterion for the definition of the line between R&D and related scientific activities (routine). Said activities may only be considered to be within R&D if they form an integral part of a specific research project, or if they are solely destined to a specific research project.

b) Space exploration

The difficulty, in this case, is due to the fact that due to diverse reasons, a large part of this activity is currently routine. However, any space exploration still has the objective of increasing the sum of knowledge, hence it should be included completely within R&D.

INTERNAL R&D ACTIVITIES EXPENDITURE

The measurement of R&D expenditure is one of the procedures for obtaining the input of the research activity.

Defined as expenditure on R&D activities are all the amounts destined to R&D activities, carried out within the research department or unit (**expenditure on internal R&D**) or any motivated by the purchase of R&D outside the research department or unit (**expenditure on external R&D**), irrespective of the source of the funds. Expenditure incurred outside the department but related to internal support tasks of internal R&D (acquisition of supplies for R&D, for example) is also included as internal R&D expenditure.

Nature of R&D expenditure

Expenditure on internal R&D comprises all current expenditures plus the gross fixed capital expenditure for R&D implemented within a statistical unit during a specific reference period, regardless of the source of funding.

Current expenses

The current expenditure consists of *expenditure on staff labour* in R+D and *other current expenditure* attributable to R&D. Labour costs comprise the labour costs of staff employed in R+D (hereinafter referred to as "internal R&D staff"), as well as the salaries and annual wages and all associated social costs or benefits, such as the payment of bonuses, stock shares, paid holidays, as well as contributions to pension funds and other Social Security payments, payroll taxes, etc.

The labour costs associated with the employees of a statistical unit who provide supplementary services that are not included in data on R&D staff (e.g. security, catering, cleaning, maintenance, IT department, library staff, finance department staff or staff directly involved in promoting R&D activity) will not be included as labour costs, but as other running costs.

Travel allowances of R&D personnel should be included in other current costs.

A distinction should be made between the labour expenditure on researchers and the rest of the staff.

The remaining current costs include the cost of the acquisition of non-inventory material and different supplies not considered capital goods; consumption of energy (gas, electricity, ...) and water; books, magazines, reference material and subscriptions to libraries, participation in scientific companies, laboratory material (chemical products, animals, ...); and the real and allocated cost of small prototypes or models manufactured externally. Administration and other general costs (such as office expenses, postal expenses, telecommunications, insurance and bank interest) should also be included, in the proportion that they affect R&D activities.

Costs of indirect services (security, storage; use, repair and maintenance of buildings and equipment; information technology and library services;

cafeteria,...) must be included, both if they are services provided by the company itself, and if they are leased or acquired externally, in the proportion that they affect R&D activities.

By agreement, genuine or allocated provisions for the amortisation of buildings, installations and equipment must be excluded from the measure of internal costs.

Expenditure arising as a result of hiring external staff fully included in R&D activities should be included as *other current expenditure*. This is understood as people who, without being part of the unit's own staff, carry out R&D duties within it.

Capital expenses

This is the gross investment in fixed capital used by units in R&D programs.

It must be integrally declared within the period in which it has taken place, and cannot be considered an element of amortisation. It is necessary to record genuine costs, in such a manner that if other activities are carried out in the company, in addition to R&D, a proportion of total expenditure must be allocated to the latter, calculated according to the use of these capital goods. This expenditure may be in land and buildings, in equipment and instruments, and in the acquisition of specific software for R&D.

Expenditure on land and buildings arises as a result of the purchase of land for R&D purposes (for example, trial land, land for the construction of laboratories and pilot plants), as well as the construction costs of the buildings or the acquisition of the same, including the costs for important renovation, modification, extension or repair work.

Expenditure on instruments and equipment includes the expenditure corresponding to the acquisition of inventoried equipment and material used in R&D tasks.

Expenditure on the acquisition of specific software for R&D, includes the acquisition of software separately identifiable for its use in R&D, including the descriptions of the programs and the documentation that accompanies the systems and applications software. Also included are the quotas for the user licenses for the software acquired.

Approximation to company accounting

i) Intangible assets

Investment (or disinvestment) is defined as intangible assets such as the increases (or reductions) in the real value of this type of resource (computer applications, R&D costs, goodwill, industrial property, administrative concessions,...) carried out by the institution during the reference year.

ii) Material fixed assets

With regard to investments in material assets, the General Accounting Plan covers the following accounts:

1. Natural land and goods
2. Constructions
3. Technical installations
4. Machinery
5. Tools
6. Other installations
7. Furniture
8. Equipment for data processing
9. Transport elements
10. Other material fixed assets

Source of R&D funds

The intention with this question is to determine who finances the research.

R&D is an activity that implies important transfers of resources between units, organisations and sectors. These transfers are measured with the information provided by those carrying out R&D activities based on the amounts that said unit, organisation or sector has received from another unit, organisation or sector for the realisation of activities on internal R&D.

In order for this financial flow to be identified correctly, two conditions must be met:

- there must be a direct transfer of resources
- this transfer should also be budgeted and genuinely used for R&D activities.

The transaction may be in the form of a contract, financial assistance or a donation, and may consist of a monetary contribution or the contribution of other resources (for example personnel or material). In the case of important non-monetary transfers, it is necessary to evaluate the market value of the transaction, because all transfers must be expressed in financial terms.

Therefore, units must record the gross amount of their costs, even when these have been reduced through the granting of exemptions, deductions or assistance that has been subsequently made effective.

The basic classification by source of funds is the following:

Internal source of funds

- Funds for which the unit itself are responsible

External source of funds

- Funds from the Businesses sector.
- Funds from the Public Administration sector
- Funds from the Higher Education sector
- Funds from the nonprofit institutions sector

- Funds from the Rest of the World

The distinction has been made regarding the external source of funds, namely if they are with or without consideration

Depending on each sector, this classification may be broken down even further.

PURCHASE OF EXTERNAL R&D

Includes the funds paid to companies for research services and other units that are conducting R&D under contract. Excludes payments to collaborative R&D projects that should be recorded as part of the internal execution of the unit.

The basic classifications of the destination of R&D expenditure (external R&D) are as follows:

- Purchase of R&D (R&D) in Spain (without VAT) to:
 - Companies
 - Government agencies
 - Universities and other higher education centres
 - Private non-profit institutions
- Purchase of R&D (external R&D) in the rest of the world (without tax)
 - Companies of the rest of the world
 - Government agencies of the rest of the world
 - Universities and other higher education of the rest of the world
 - Private non-profit institutions of the rest of the world
 - Other international organisations

Depending on each sector, this classification may be broken down even further.

PERSONNEL IN R&D ACTIVITIES

The measure of personnel employed in R&D activities is the other manner in which R&D input may be obtained.

R&D personnel is defined as all personnel directly employed in R&D activities, without distinguishing their level of responsibility, as well as those who supply services directly linked to R&D work, such as managers, administrators and office personnel. Persons rendering indirect services, such as canteen, security, maintenance,..., are excluded, even though their wages must be accounted for as other current expenditure on R&D.

External staff have to be included as R&D staff, in a broken down form, taken to mean persons who, while not part of the unit's staff, carry out R&D duties within it.

Personnel data may be measured in two ways, in the number of physical persons and in full-time equivalence.

Number of physical persons

Data on the total number of persons who are completely or partially employed in R&D allow us to establish a correspondence with other series of data, such as, for example, education or employment, or population censuses. On the other hand, data regarding physical persons is the most appropriate measure to collect complementary information on the characteristics of R&D personnel, such as age, sex or country of origin.

Full-time equivalence (FTE) during one year

For measuring personnel, it is advisable to introduce the concept of full-time equivalence, given that the activity of R&D personnel is, in many cases, a partial or secondary activity. It considers that:

- **Full-time R&D personnel** is defined as persons who employ at least 90 per cent of their working day in R&D activities.
- **Part-time R&D personnel** is defined as persons who employ approximately 10 to 90 per cent of their working day in R&D activities, and the rest of the day to other types of activity.

Also considered as such are persons who have carried out R&D activities during a period shorter than one calendar year.

- **Full-time equivalence of part-time personnel** is the sum of the fractions of time that they have dedicated to R&D activities.
- **Personnel employed in R&D activities in full-time equivalence** is the sum of personnel employed full-time plus the equivalence of those persons working part-time.

Additionally, personnel employed in R&D activities is provided broken down by gender.

Occupation of R&D personnel

R&D personnel is classified according to the following categories:

- **Researchers**

These are scientists and engineers involved in the concept or creation of new knowledge, products, processes, methods and systems, and in the management of the corresponding projects.

Also included are managers and administrators dedicated to the planning and management of the scientific and technical aspects of the researchers' work and who, normally, have a category equal to or higher than that of persons employed directly as researchers, often dealing with former researchers or part-time researchers.

Also included are postgraduate students with a "*study salary/grant*" who carry out R&D activities.

As a general rule, they possess advanced university education but, for the purposes of this study, also included as researchers are those persons who, being devoid of the aforesaid qualification, occupy positions of this nature.

The Research Staff in Training (RST), Master's students who receive research scholarships and other research grants and carry out R&D activities, are included in the researchers category.

• **Technicians**

Technicians and similar personnel are persons whose main tasks require knowledge and technical experience in one or various fields: engineering, biological and physical sciences, or social sciences and humanities. They participate in R&D projects, carrying out scientific and technical tasks, applying operational principles and methods, generally under the supervision of researchers. Similar personnel carry out tasks corresponding to social sciences and humanities under the supervision of researchers.

Their tasks are mainly the following:

- search for bibliographic material and discover appropriate information sources in archives and libraries
- prepare computer programs
- prepare the necessary material and equipment for the realisation of experiments, trials and analyses
- carry out experiments, trials and analyses
- carry out measurements and calculations and prepare tables and graphs
- carry out surveys and interviews
- ensure logistical support to researchers.

Normally they possess intermediate-level university education (technical engineers and university diplomas), but others do not, although they occupy positions of an comparable level. It can also include top-level personnel entrusted with the use of very sophisticated appliances, but they are distinguished from researchers in that the latter are in charge of directing or orienting the research tasks.

• **Assistants**

Auxiliary staff includes workers, qualified or unqualified, and secretarial and office personnel who participate in the realisation of R&D projects, or who are directly related to said projects.

Included in this category are all managers and administrators mainly occupied with financial matters, personnel management and administration in general, provided that their activities are directly related to R&D tasks.

Qualifications of R&D personnel

The International Standard Classification of Education (ISCED) provides the basic elements that allow for R&D personnel to be classified, according to the academic qualification possessed, into the following categories:

- Doctorate
- Degree of over 240 ECTS credits, Licenciatura (higher university degree), Architecture, Engineering, Masters, Specialities in Health Sciences and equivalents.
- Degree of 240 ECTS credits, Diplomatura (Bachelor's degree), Architecture and Technical Engineering and equivalents; university postgraduate degree of under 1 year
- Ciclo Formativo de Grado Superior (Advanced Vocational Certificate), FPII (Second Level Vocational Training) and equivalents; university own diploma and degree courses of 2 or more years that require Upper Secondary Education.
- Bachiller (High-School Diploma), BUP (Versatile and Unified Baccalaureate), COU (University Orientation Course), Ciclo Formativo de Grado Medio (Intermediate Vocational Certificate), FPI (First Level Vocational Training), Intermediate Level/Professional Music and Dance, FP Basica (Basic Vocational Training) and equivalents; EO Languages - advanced level.
- Other studies (of a level lower than those outlined above).

FUNCTIONAL DISTRIBUTIONS

Type of research

A break-down of current costs on internal R&D according to the type of research carried out is requested from the units:

- Fundamental or basic research
- Applied research
- Experimental development

Scientific field or discipline

The classification by field of study or scientific discipline used is that proposed by UNESCO in the *Recommendation relating to the international standardisation of statistics on Science and Technology*, which considers the following important areas:

- Exact and Natural sciences
- Engineering and Technology
- Medical sciences
- Agricultural and Veterinary Sciences
- Social sciences

- Humanities and the Arts

This is the classification recommended for the companies sector. In the case of the Public Administration and tertiary education sectors, a more broken-down classification is used, which is presented in chart 3.

Socioeconomic objective

To determine the socioeconomic objective of the research, the research units are requested to distribute the resources assigned to R&D amongst the various socioeconomic objectives in proportion to the expenditure dedicated to each one.

The list of socioeconomic objectives used is that recommended in the Frascati Manual, indicated in chart 4.

REGIONALISATION OF THE RESOURCES DESTINED TO R&D

To ascertain the spatial distribution of the resources destined to R&D, a regionalisation of R&D expenditure and personnel is carried out by Autonomous Community. For this purpose, the research units that have carried out such R&D activities in several establishments located in different regions, are asked to distribute the expenses and the personnel among the Communities in which they have carried out said activities. To this end, the expenses that may be common to the different establishments in the research unit, are distributed geographically, according to the percentage that said unit estimates has corresponded to each establishment.

Table 2. R&D Classification Fields

1. Natural Sciences

- 1.1 Mathematics
- 1.2 Information and Communication Sciences
- 1.3 Physical Sciences
- 1.4 Chemical Sciences
- 1.5 Earth Sciences and Environmental Sciences
- 1.6 Biological Sciences
- 1.7 Other Natural Sciences

2. Engineering and Technology

- 2.1 Civil Engineering
- 2.2 Electrical, Electronic and Computer Engineering
- 2.3 Mechanical Engineering
- 2.4 Chemical Engineering
- 2.5 Material Engineering
- 2.6 Medical Engineering
- 2.7 Environmental Engineering
- 2.8 Environmental Biotechnology
- 2.9 Industrial Biotechnology
- 2.10 Nanotechnology
- 2.11 Other Engineering and Technologies

3. Health Sciences

- 3.1 Basic Medicine
- 3.2 Clinical Medicine
- 3.3 Health sciences
- 3.4 Medical Biotechnology
- 3.5 Other Health Sciences

4. Agricultural and Veterinary Sciences

- 4.1 Agriculture, Forestry and Fishing
- 4.2 Animal and Dairy Science
- 4.3 Veterinary Sciences
- 4.4 Agricultural Biotechnology
- 4.5 Other Agricultural Sciences

5. Social Sciences

- 5.1 Psychology and Cognitive Science
- 5.2 Economy and Trade
- 5.3 Education
- 5.4 Sociology
- 5.5 Law
- 5.6 Political Science
- 5.7 Social and Economic Geography
- 5.8 Media
- 5.9 Other Social Sciences

6. Humanities and Arts

- 6.1 History and Archaeology
- 6.2 Language and Literature
- 6.3 Philosophy, Ethics and Religion
- 6.4 Arts (Art, Art History, Performing Arts, Music)
- 6.5 Other Human Sciences

Chart 3. Classification by socio-economic objectives

1. Exploration and exploitation of the earth

Includes the research related to the earth's crust and mantle, seas, oceans and atmosphere, and their exploitation. Also includes climatic and meteorological research, polar exploration and hydrology.

2. Environment

Includes the R&D related to the control of pollution, aimed at the identification and analysis of the sources of pollution and their causes, and all pollutants, including their dispersal in the environment and the effects on man, species (fauna, flora, microorganisms) and biosphere. Development of monitoring facilities for the measurement of all kinds of pollution. The elimination and prevention of all forms of pollution in all types of environment.

3. Exploration and exploitation of space

Includes all R&D related to civil space. R&D in the defence field is included in chapter 13. It should be noticed that civil space R&D is not, in general, concerned with particular objectives, it frequently has a specific goal, such as the increase of general knowledge (e.g. astronomy), or relates to particular applications (e.g. telecommunications satellites).

4. Transport, telecommunication and other infrastructures

Includes R&D related to infrastructure and land development, including the construction of buildings. The general planning of land-use. Protection against harmful effects in town and country planning but does not include R&D related to other types of pollution.

5. Energy

Includes R&D related to the production, storage, transportation, distribution and rational use of all forms of energy. Processes designed to increase the efficiency of energy production and distribution, and the study of energy conservation. Does not include R&D related to prospecting, or vehicle and engine propulsion.

6. Industrial production and technology

Includes R&D related to the improvement of industrial production and technology. Industrial products and their manufacturing processes, except where they form an integral part of other objectives (e.g. defence, space, energy, agriculture).

7. Health

Includes R&D related to protecting, promoting and restoring human health –broadly interpreted to include health aspects of nutrition and food hygiene. It ranges from preventative medicine, including all aspects of medical and surgical treatment, both for individuals and groups, and the provision of hospital and home care, to social medicine and paediatric and geriatric research.

8. Agriculture

Includes R&D related to the promotion of agriculture, forestry, fisheries and foodstuff production. Chemical fertilizers, biocides, biological pest control and the mechanization of agriculture; The impact of agricultural forestry activities on the environment; The field of developing food productivity and technology; Veterinary science and other agricultural sciences. It does not include R&D related to the reduction of pollution; The development of rural areas, the construction and planning of buildings, the improvement of rural rest and recreation and agricultural water supply; Energy measures; The food industry.

9. Education

Includes R&D related to education general and special, including pre-, primary and secondary school, tertiary education, and post secondary non-tertiary education.

10. Culture, recreation, religion and mass media

Includes R&D related to social phenomena of cultural activities, religion and leisure activities, as well as racial and cultural integration. The concept of "culture" covers the sociology of science, art, religion, sport and leisure and also comprises inter alia R&D on the media, the mastery of languages and social integration, libraries, archives and external cultural policy.

11. Political and social systems, structures and processes

Includes R&D related to the political structure of society; Public administration issues and economic policy; Regional studies and multi-level governance; Social change, social processes and social conflicts; The development of social security and social assistance systems; The social aspects of the organization of work.

12. Non-oriented research

Covers all the budgetary appropriations allocated to R&D but that cannot be attributed to an objective. A supplementary distribution by scientific disciplines may be useful.

13. Defence

Includes R&D related to military purposes. Basic, nuclear and space R&D financed by Ministries of Defence. The R&D financed by Ministries of Defence in the fields of meteorology, telecommunications and health, should be classified in the relevant chapters.

OTHER CLASSIFICATION CHARACTERISTICS

Apart from the institutional sub-sectorisation of the companies sector (public, private), companies are asked whether they are independent or they form part of a group of companies.

The companies that form part of a group of companies are classified, in turn, according to their relationship with the group in:

- holding company (if it has effective control of the group)
- subsidiaries (if more than 50 per cent of the capital is held by a holding company)
- joint venture companies (if participation is 50 per cent)
- associated company (if participation is below 50%)

These companies are also asked, for classification purposes, where the group's headquarters are located.

In addition, to avoid duplicities, the full name of the group is requested or, in its absence, the name of the holding company.

In the public administration sector, apart from the institutional sub-sectorisation (State Administration, Autonomous Administration and Local Administration), non-profit institutions controlled and/or financed mainly by the Administration are also included.

To avoid duplicities, information is also requested on the administrative unit immediately above, to which the public organisation responds. In the case of health centres (hospital, clinic, sanatorium, hospital complex,...), information is requested to the functional dependence of the centre, according to the following categories:

- National Health Management Institute
- Autonomous Community Health Service
- Council or City Hall (including Regional Parliament, City Council and similar)
- Other units from the State Administration and Social Security
- Other units from the Autonomous Administration
- Other entities (public organisations from different administrations sharing jurisdiction, private charities, private non charity,...)

In the higher education sector, the budget for the general expenditure of the university and its total staff are requested.

This sector is also asked about the relation of research centres and university institutes whose research data are included in the questionnaire to be filled out by the university, and the relation of those research centres dependent on the same

but whose research data are not included in the questionnaire, for the purpose of being able to address them.

Within the private non-profit institution sector, information is requested for the main activity undertaken by the centre or institution.

In the four sectors (Business, Public Administration, Higher Education and Private Non-Profit Institutions) the questionnaire contains a paragraph on the classification of the unit, with a series of questions arising from the "decision tree" of the Frascati Manual 2015.

2.5 Sample design

Due to the coordination of the R&D Statistics and the Technological Innovation in Companies Survey (TIS), the population framework is the Central Companies Directory (CCD). This directory is an organised information register with identification, localisation and territorial distribution data, and classification by size and economic activity of company-type units, obtained from administrative sources and complemented by other information that stems from current INE statistical operations.

Likewise, the survey includes within the target population of the study a directory of units (companies, public research organisations, ...) that are considered possible research units, either because they compiled statistics in previous years, or because they have received public financing for realising R&D during the survey reference year, or because they have declared the realisation of systematic R&D activities in the innovation survey for the year prior to the reference year.

Information is requested each year on the destination of R&D funds from diverse State Administration and Autonomous Community organisations. This information is cross-referenced with the directories from the previous year, incorporating new registrations, modifications, and delistings.

The population of target companies of these statistics has been stratified by crossing the following variables:

- a) Belonging to the directory of companies that potentially might carry out research, which is analysed exhaustively.
- b) Size of the company: The following brackets are considered:
 - Fewer than 10 employees
 - 10 to 49 employees
 - 50 to 199 employees
 - 200 employees and over

The strata comprised of companies with 200 or more employees have been analysed exhaustively.

c) Main branch of activity, according to CNAE-2009: 43 divisions or groups of activity are considered.

d) Autonomous Community in which the company has its headquarters.

SIZE OF THE SAMPLE. ALLOCATION

The sample size of the R&D Statistics is comprised of approximately 45,000 companies, 537 are public administration centres (including public hospitals), 83 are universities, 120 are centres of higher education, and 116 are private non-profit institutions. Companies, public organisations, universities and private non-profit institutions that comprise the directory of possible research units have been analysed exhaustively. The remaining units of the companies sector have been studied through sampling.

ESTIMATORS

The estimator of the total of a characteristic X in domain m is given by:

$$\hat{X}_m = \sum_{j \in m} X_j \cdot F_j ,$$

where X_j is the value of characteristic X from questionnaire j belonging to domain m.

F_j is the elevation factor from questionnaire j that is calculated as follows:

a) If company j was selected in stratum h, and according to the data from the questionnaire, it is included within a different stratum k, then: $F_j = \frac{N_h}{n_h}$ (1)

b) If company j continues to belong to the same stratum h, where it was selected, then:

$$F_j = \frac{\hat{N}_h^*}{n_h} \quad (2)$$

c) In specific cases that are appropriately specified, $F_j=1$ (3)

Variables used

N_h , number of companies in stratum h.

n_h , number of companies selected in stratum h.

n_h^* , number of companies that have replied, selected in stratum h and that have not changed stratum.

$$\hat{N}_h^* = N_h \left(1 - \frac{n_h}{n_h}\right) - \sum_{k \neq h} \sum_{j=1}^{n_h^k} F_j$$

with n_h^* being the number of companies selected in stratum h and which have the following incidents: they correspond to closures, they are duplicated or outside the scope.

$n_{h,k}^k$, number of companies selected in stratum h , and which according to the questionnaire are in the different stratum k .

Sample errors are also calculated by expressing the variation of the estimator of the total stratified sample.

2.6 Collection of the information

The collection of the questionnaires for this statistic in the business sector has been coordinated with the collection of the Innovation in Companies Survey. This collection was carried out by the Large Companies Unit of the INE and by an external company.

The information relating to R&D of the public administration, higher education and private non-profit institutions sectors is collected directly from the Promoter Service of the Statistic.

The follow-up of the calendar of the field work and the quality control of the information has been carried out from the Central Services of the INE

The personnel involved in the survey work are compelled by law to preserve statistical secrecy.

The survey inspectors are responsible for the theoretical and practical training of the personnel involved in the same, and for the control of the work relating to the collection of the information. To this end, the corresponding manuals and training and enquiry documents are prepared.

Information units are sent the survey presentation letter, without the paper-based questionnaire. The letter includes the user and password for filling in the form via website. Since 2013, the access to the web-based completion is carried out via the safe protocol website <https://iria.ine.es>

Once the letter is received, companies have a period of 15 days to complete and return the questionnaire.

The collection unit establishes an initial telephone contact with the company to verify receipt of the letter. If the established period has passed, and the completed questionnaire has not been received, the necessary telephone and written claims are made.

The completion of the R&D Statistics is considered compulsory in the National Statistical Plan.

The collection unit puts into practice an integrated information collection procedure, which consists of the filtering and recording of the data as soon as the

information is received. If necessary, the companies are requested the necessary clarifications regarding the data provided.

2.7 Processing of the information

The following are the processing phases with regard to information from the companies sector:

- Manual control and filtering of the company questionnaires within the collection unit, in order to recover possible missing data or to correct questionnaire errors
- Recording, filtering and interactive correction of the inconsistencies in the information validated in the collection unit
- Control of the information received in the department promoting the survey
- Control of the scope and processing of errors by the INE department promoting the survey
- Imputation of partial non-response
- Compilation of a first phase of results analysis tables
- Use of macro-edition techniques at the INE department promoting the survey to eliminate errors and inconsistencies in the aggregates, which have not been detected in the previous micro-filtering phase
- Analysis of the data
- Creation of definitive data files
- Obtaining of final results tables in the department promoting the survey, compiled from the final data file in the companies sector

For the remaining sectors, the aforesaid INE department handles all the information processing phases (control of the scope, filtering, recording, analysis and attainment of results tables).

2.8 Presentation of the results

The tabulation of results presented in this publication has been structured in the following way:

- 1) National results, broken down into:
 - a) Total sectors
 - b) Business Sector
 - c) Public Administration Sector

- d) Higher Education Sector
- 2) Results by autonomous communities, divided into:
 - f) Total sectors
 - g) Business Sector
 - h) Public Administration Sector
 - i) Higher Education Sector
 - j) Private Non-Profit Institutions Sector
- 3) Coverage of the statistic

The results pertaining to the companies sector are presented in tables, bearing in mind two classification variables:

- Main economic activity group, according to codes of CNAE-2009
- Division of the company according to number of employed persons

Moreover, results tables may be obtained that meet the information requirements of international institutions (OECD, Eurostat, UNESCO), national institutions, and individual users, via personalised requests for aggregate data, which may be provided so long as statistical secrecy is maintained.

This publication is available on CD and the website of the National Statistics Institute <http://www.ine.es/en/>.