

RESEARCH AND DEVELOPMENT INDICATORS IN 2005 - METHODOLOGY

1. THE LEGISLATION OF COUNTRIES OF THE EUROPEAN UNION FOR STATISTICS ON RESEARCH AND DEVELOPMENT

Countries of the European Union use the standard methodology for statistical indicators, statistical data are comparable at the international level. Development of human society is connected with results of scientific activities and using of high technology, the area of research and development was defined separately both from standpoint of financial sources and from standpoint of working potential.

Research and development indicators are important for information of politicians, legislators and general public, what position of the Czech Republic is in this area and how this position develops with comparison above all with other countries of the European Union.

1.1 Frascati manual – the international handbook OECD created for statistics of research and development

Frascati manual defines the area of research and development and gives basic standards for measuring of human and financing sources devoted to research and development activities.

The Czech Statistical Office, the department of statistics of research, development and information society use the methodology according to Frascati manual since the year 1995 in “The Annual Questionnaire on Research and Development”. The statistical survey of CZSO on research and development answers conditions given in following obligatory documents of the European Union:

1. **Decision No 1608/2003/EC of the European Parliament and of the Council** of 22 July 2003 concerning the production and development of Community statistics on science and technology. In focus of support of policy EU there is needed comparable statistics on research, development and innovation, statistics in the areas of science and technology.
2. **Commission Regulation (EC) No 753/2004** of 22 April 2004 implementing Decision No 1608/2003/EC of the European Parliament and of the Council as regards statistics on science and technology.

1.2 The legislation in the Czech Republic – the definitions of research and development

The concept of ‘research and development’ in the Czech Republic is defined in Act. No. 130/2002 Coll. on State Support to Research and Development from the Public sources. The Act provides for a system of state support to research and development and associated rights and duties of legal and natural persons engaged in R&D, as well as of the state authorities supporting them. Definitions of research and development in this law are according to definitions in Frascati manual.

Research is systematic and creative work that enriches understanding, including understanding the human, culture, and society, and with methods, which allow confirmation, supplementation or refutation of acquired knowledge. It includes:

- a) Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application of use in view.
- b) Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

2. RESEARCH AND DEVELOPMENT STATISTICS IN THE CZECH REPUBLIC

2.1 The annual statistical survey of the CZSO on research and development in the CR

Indicators R&D are surveyed in the CR by the exhaustive statistical survey, by the questionnaire: "The Annual Questionnaire on Research and Development". This questionnaire is distributed in two mutations by sectors of performance of research and development since the year 2005:

the mutation (a) is allocated for Business Enterprise and Private Non-Profit sector [VTR 5-01 (a)],

the mutation (b) is allocated for Government sector and Higher Education sector [VTR 5-01 (b)].

R&D survey is a mandatory survey as it is included in the Statistical surveys program by Act. No. 89/1995 Coll. on State Statistical Service, in a valid version.

The statistical survey on research and development fully respects methodological principles of the EU and the OECD based on the Frascati manual and Commission Regulation (EC) No 753/2004 of 22 April 2004. This survey is identified for the measure of financial and human sources devoted to research and development activities (indicators R&D from standpoint of "inputs").

Since 2001, mathematical-statistical methods for estimations of non-response have been used for responding units, which did not give questionnaires in given term.

2.2 Recommendations of EUROSTAT for statistics of research and development

New indicators for areas of science and technology are developed and recommended by the international statistical office EUROSTAT. Since the year 2005 these new indicators were surveyed by sex: age groups and citizenship in Government sector and Higher Education sector, further in these sectors so-called ABCD grades of academic staff.

Working group "Women and Science" of the European Commission recommended for indicator researchers to be indicator researchers of Higher Education sector equal to researchers of academic staff of Higher Education sector. Academic staff works in the Czech Republic also in Government sector, first of all in public research institutions of The Academy of Sciences.

Academic staff is surveyed by sex, grades and fields of science.

These grades are 4: **A, B, C, D**.

A: The single highest grade/post at which research is normally conducted within the institutional or corporate system. In the Czech Republic, there are researchers with the university degree professor.

B: Should include all researchers working in positions which are not as senior as the top position (A) but definitely more senior than the newly qualified PhD holders (C); i.e.: **below A and above C**. In the Czech Republic, there are researchers with the university degree associate professor and researchers with PhD without researchers newly qualified PhD in the surveyed year (the grade C).

C: The first grade/post into which a newly qualified PhD (ISCED6) graduate would normally be recruited within the institutional or corporate system.

D: Either postgraduate students not yet holding a PhD (ISCED6) degree who are engaged as researchers, (on the payroll) or researchers working in posts that do not normally require a PhD.

3. SORTING FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

The reporting units

According to the recommendations of the Frascati manual, all legal and natural persons who carry out R&D (or their local units - working places devoted to R&D) as their primary or secondary activities despite their size were included in the reporting units (R&D units). R&D covers both formal R&D in R&D units and informal or occasional R&D in other units. The basic criterion for differentiating the R&D activities is the measurable presence of innovation in R&D.

The Czech Statistical Office updates the existing database of reporting units engaged in research and development annually, namely on the base of the cooperation with the Research and Development Council, on the base of answers in other statistical surveys, whether reporting units are engaged in research and development (e.g. in questionnaires for Structural Business Statistics) and further from administrative sources.

In the Czech Republic, there are engaged in research and development employees R&D workplaces in business sector, employees of universities, employees of public research institutions and others.

The structure of R&D personnel and intramural expenditure on R&D are surveyed in various sorting by the statistical survey VTR 5-01.

SORTING FOR PERFORMANCE OF RESEARCH AND DEVELOPMENT

(common sorting for the structure of R&D personnel and intramural expenditure on R&D)

1) **Sectors for performance of research and development** were created on the base of Classification of institutional sectors and subsectors (ISECTOR) used in National accounts:

a) **Business Enterprise sector** includes all firms, organizations and institutions, whose principal activity is to produce goods or services (excluding the area of higher education) for sale to general public at an economically significant price. This sector is composed from ISECTOR 11: Non-financial corporation, ISECTOR 12: Financial corporations, ISECTOR 141: Employers and ISECTOR 142: Other own-account workers.

*There were introduced in this sector indicators of **globalisation – internationalisation of research and development** according to the manual of OECD "Handbook on Economic Globalisation Indicators (2005)". There are surveyed expenditure on research and development and researchers in FTE in firms under foreign control in the Czech Republic. In these firms more than 50 % voting rights belong to foreign investor (foreign parent firm), these firms are called affiliated company (subsidiary firms).*

Research and development workplaces of these firms have above all ISECTOR 11003: Foreign controlled non-financial corporations, further here count research and development workplaces with ISECTOR 12203: Foreign controlled other monetary financial institutions, ISECTOR 12303: Foreign controlled other financial intermediaries, except insurance corporations and pension funds, ISECTOR 12403: Foreign controlled financial auxiliaries and ISECTOR 12503: Foreign controlled insurance corporations and pension funds.

b) **Government sector** includes state administration authorities at all levels (central, regional, local), except for publicly managed institutes of higher education (ISECTOR 13: General government).

c) **Higher Education sector** comprises all universities, colleges of technology, and other institutes of post-secondary education. Reporting units of this sector have first of all CZ-NACE 803000 Higher education (all ISECTOR); further since the year 2005 there are 11 university hospitals according the methodology OECD, these university hospitals have ISECTOR 11 in the Czech Republic. This

sector is not any separate institutional sector of national accounting – the OECD separated it out as it has an important role to play in research and development.

- d) **Private non-profit institutions serving households sector (Private non-profit sector)** comprises private or semi-public institutions not established to make profits and private individuals and households. There are associations of research institutions, clubs, societies, groups and endowment (ISECTOR 14: Households without 141 and 142 and ISECTOR 15: Non-profit institutions serving households).
- 2) **Field of science and technology**, the reporting units determine one main field of science and technology, where are major provided research and development activities. These areas are: natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences and humanities.
 - 3) **Regional sorting**, sorting by CZ-NUTS 3 (“14 higher territorial administrative units”): Capital Prague and regions: Středočeský, Jihočeský, Plzeňský, Karlovarský, Ústecký, Liberecký, Královéhradecký, Pardubický, Vysočina, Jihomoravský, Olomoucký, Zlínský, Moravskoslezský. Research and development indicators are surveyed by regions in the CR since the year 2001, there were introduced except place domicile also workplace by region of research and development for reporting units.
 - 4) **Categories of organizations according to number of employees**: 0 employees , 1-9 employees, 10-49 employees, 50-249 employees, 250-499 employees and 500 and more employees.
 - 5) **Classification by main activity of economic subjects** (CZ-NACE is General Industrial Classification of Economic Activities) - only for Business Enterprise sector.
 - 6) **Main technological and knowledge groups of branches** defined by CZ-NACE - only for Business Enterprise sector.

4. DEFINITIONS OF RESEARCH AND DEVELOPMENT INDICATORS

4.1 Intramural expenditure on research and development

4.1.1 Basic definitions according to OECD (Frascati manual)

According to the definition OECD in Frascati manual: expenditure are the total cost of carrying out the R&D concerned, including indirect support activities. R&D expenditure means total expenditures on R&D activities within the organisation, i.e. domestic expenditures. Both R&D current and capital expenditures on fixed assets are included. From expenditures being spent outside the organisation only those are included which serve as a support to the internal research and development (e.g. purchase of equipment for R&D). The depreciation of buildings, machinery equipment and equipment is excluded.

4.1.2 The structure of intramural expenditure on research and development

Expenditure on R&D are statistically surveyed in these structures:

1) Type of costs on research and development:

1. **Current costs** on R&D, there are surveyed in the structure:
 - 1.1. **Labour costs** of R&D personnel – these comprise annual wages and salaries of R&D employees recalculated by time devoted R&D activities, including health and social insurance, which are paid by employer for employees.
 - 1.2. **Labour costs of persons with short-term contracts for R&D**
 - 1.3. **Other current costs** – purchases of materials, supplies and equipment to support R&D performed by the reporting unit, further costs for services rented or purchased for R&D. The depreciation of buildings, machinery equipment and equipment is excluded.
 2. **Capital expenditure** on R&D, there are surveyed in the structure:
 - 2.1. **Land and buildings** – expenditure on lands acquired for R&D (e.g. experimental laboratories) and buildings constructed or purchased, expenditure on technical assessment of buildings etc.
 - 2.2. **Instruments and equipment** – expenditure on technical and other equipment necessary for performance of R&D (machines, instruments and equipments including their software equipment).
- 2) **Source of funds** – identifying five main sectors as sources of funds for realization (performance of R&D):
- a) **Business Enterprise sector** includes financing from own sources and from sources of other subject of Business Enterprise sector.
 - b) **Government sector** includes public funds devoted on R&D from government budget by means of state budget chapters and budgets of regions.
 - c) **Higher Education sector** sets own receipts of higher education sector.
 - d) **Private Non-Profit sector**.
 - e) **Rest of the world (abroad)** includes all institutions and individuals located outside the political borders of a country and further all international organizations (except business enterprises), including facilities and operations within the country's borders. Since the year 2005, there are surveyed sources from abroad in sorting on private funds and public funds.

3) **Expenditure by type of R&D activity** – basic research, applied research, experimental development (described in the chapter 1.2).

4) **Expenditure on R&D by socio-economic objectives** – there were defined 13 main socio-economic objectives in the classification NABS [more in the questionnaire VTR 5-01 (b)]. Socio-economic objectives of R&D work are divided by primary objectives. Where there are problems in identifying the primary purpose of the financing of the R&D or where there seem to be differences between the “purpose” and the “content” of a programme, two principles originally developed may be of use:

- a) Direct derivation: A project which owes its existence solely to the technical needs of another programme is directly derived from the said programme and should be classified with it.
- b) Indirect derivation: Where the results of R&D undertaken for one purpose are subsequently reworked to give an application relevant to another objective, this is indirect derivation and should be credited to the objective to which the subsequent R&D is oriented.

5) **Expenditure on R&D by industry served (the Modification of CZ-NACE)**

Reporting units indicated numeric codes in a new section of the questionnaire VTR 5-01 by the added classification since the year 2005. Expenditure on R&D are divided into the main activity and adjoining activities in R&D. In the year 2004 there was filled one code for the main activity in R&D in the title of the questionnaire, this indicator is new since the year 2004.

6) **Expenditure by selected areas of R&D** – on the base of recommendation according to Frascati manual and Eurostat there are surveyed separately expenditure on research and development in selected areas of R&D, where is not possible have information by means of using classifications. Newly monitored areas by the questionnaire VTR 5-01 are since the year 2005:

- a) **Information and communication technologies** – research and development related with information and communication technologies are defined optimally by the branch of the product according the Classification of Products by Activity (SKP in the CR):
SKP 30 Office, accounting and computing machinery
SKP 31.3 Insulated wire and cable
SKP 32.1 Electronic valves and tubes and other electronic components
SKP 32.2 Television and radio transmitters and apparatus for line telephony and line telegraphy
SKP 32.3 Television and radio receivers, sound and video recording or reproducing apparatus and associated goods
SKP 33.2 Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment
SKP 33.3 Industrial process control equipment
SKP 64.2 Telecommunications
SKP 72 Computer and related activities
- b) **Software** – development of software, if it presents a scientific – technological advance. Examples of R&D: new theorems and algorithms of computer science, new or significant changed operating systems, programming languages, application programs, development of Internet technology etc.
- c) **Biotechnology** – the definition OECD: the application of S&T to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services. Some examples (non-exhaustive): genomics, R&D of DNA, genetic engineering, R&D of peptides, lipids, hormones, vaccines, biotechnological processes (e.g. fermentation).
- d) **New materials** – new materials for using can be new for a market or for an enterprise.

- e) **Nanotechnologies and nanomaterials** – Nanotechnology: there are many definitions at the international level, there are technologies engaged in the smallest parts of matter, of which is possible to manipulate. Examples: nanoelectronics in development of semiconductor triodes, diodes etc. for minimisation of a size of PC, optoelectronics, optoelectronic character of semiconductors, receptor outside of biosensors for biological systems, new microscopic techniques. Nanotechnologies can combine physics, informatics, electronics, biology, biotechnology, chemistry, etc.

4.2 Research and development personnel

4.2.1 Basic definitions according to OECD (Frascati manual)

R&D personnel are researchers who are employed directly on R&D, other helping persons, technicians, administrators and other persons working at R&D performing units. Further R&D personnel are persons who provide direct services such as R&D managers, secretaries and clerical staff. Persons providing an indirect service, such as canteen and security staff, are excluded.

The category of R&D personnel covers all persons of age above 15, in paid employment. Formal connection with occupation is called employment relationship and special short-term working contracts (individuals engaged in R&D under special contracts of service or for a short-term work) with individuals for R&D performance are also included.

4.2.2 The structure of research and development personnel

Number of R&D personnel is determined by two main indicators by sex:

1. Registered number of employees at 31 December in Head Count. Reporting units indicated total number of employees in research and development regardless of time devoted on research and development activities.

Further there were recorded number of persons with short-term contracts for research and development by the questionnaire VTR 5-01 since the year 2005. From 2001 to 2004, there were surveyed number of short-term contracts for research and development.

2. Full-time equivalent (FTE), time devoted to R&D by persons recalculated to time fully devoted to R&D. For employees, who are engaged also in another activity, than R&D, there is calculated only adequate proportion of their working time. The indicator FTE includes also number of hours devoted R&D by persons with short-term contracts.

From the year 1995 to 2004 there were calculated FTE in CZSO from records of reporting units, which classified employees into intervals 0-30% (x), 30-70% (y), 70-100% (z) of working time devoted to research and development. Calculations FTE of reporting units did: $a = (0,15*x) + (0,5*y) + (0,85*z)$.

Since the year 2005, calculations FTE are provided directly by reporting units, which counted FTE according to examples given in the questionnaire VTR 5-01. One FTE is equal one-year's full time work of employee on R&D.

4.2.3 Categories of R&D personnel

Personnel of research and development are divided in these categories by sex:

1) Classification by occupation – according to the Classification by occupation (KZAM.R), which is compatible with the international classification ISCO-88.

R&D personnel are:

1. **Researchers** are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned. Researchers are the most important group of R&D employees – they create a pillar of R&D activity. There are mostly employees included into major group 2, “Professionals” (Research and professional intellectual workers) and subdivision 1237 (R&D Department Managers) of the present valid CZ- ISCO-88.
2. **Technicians and equivalent staff** - participate in R&D by performing scientific and technical tasks including the application of concepts and operational methods, normally under the supervision of researchers. There are mainly employees included in the class 31 (Technicians in physical, technical and related fields) and class 32 (Technicians in the field of biology, health and agricultural professionals and staff in related fields) CZ- ISCO-88.
3. **Other supporting staff** include craftsmen, secretarial and clerical staff participating in R&D activities or directly associated with such projects. There are included managers and administrators insofar as their activities are direct serving to R&D.

2) Classification by level of formal qualification – according to the classification K KOV, which is compatible with ISCED. These groups are defined by level of education of personnel.

R&D personnel and researchers (researchers since the year 2005) are statistically surveyed by level of formal qualification:

- a) **Professors** (academic staff) - *in the mutation (b) for Government sector and Higher Education sector*
- b) **Associate professors** (academic staff) – *in the mutation (b) for Government sector and Higher Education sector*
- c) **Holders of doctorate degrees** of university level or equivalent (ISCED level 6) - this category includes holders of degrees earned at universities proper and also at specialised institutes of university status (the degree V according to K KOV). Newly there are surveyed newly qualified PhDs - *in the mutation (b) for Government sector and Higher Education sector*
- d) **Holders of basic university degrees**, holders of tertiary-level degrees (ISCED level 5A). Category 5A includes holders of degrees earned at universities proper and also at specialised institutes of university status (the degrees R and T according to K KOV)
- e) **Holders of other tertiary level diplomas** (ISCED level 5B). This class includes holders of other post-secondary tertiary diplomas. Subject matter is specialised, presented at a level requiring the equivalent of full secondary level education to master it (the degree N according to K KOV)
- f) **Holders of diplomas at the secondary education** (ISCED level 3 and 4). There are employees with degrees H, J, K, L, M according to K KOV.
- g) **Other qualifications** (ISCED lower than 3). There are employees with degrees A, B, C, D, E according to K KOV.

Researchers at 31 December are surveyed in the Government sector and in the Higher Education sector in these sorting:

3) Age structure of researchers – registered number of employed researchers in physical persons at 31 December is surveyed by age groups (in years): up to 25, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 and more.

4) Citizenship of researchers - registered number of employed researchers in physical persons at 31 December is surveyed by citizenship, reporting units fill codes of countries by the Classification of countries (CZ-GEONOM).