13. SCIENCE AND TECHNOLOGY, INFORMATION SOCIETY

A. SCIENCE AND TECHNOLOGY

Science refers to a consistent system of verifiable observations and findings on a given set of phenomena as well as of methods used to obtain, process, explain in theory, and apply these observations and findings.

Technologies take three fundamental forms: (i) **tangible**: knowledge embodied in physical objects (machinery, equipment, instruments, etc.); (ii) **intangible**: knowledge accumulated in people (human capital), information embodied in electronic media and documents (software, plans, projects, results of observations, mathematical calculations, maps, etc.) and (iii) **institutional**: arrangement of activities and relations (organizational structure, management system, standards, regulations, etc.). Hence, while science is concerned about how and why certain things happen, technology is focussed on the means of their implementation.

Notes on tables

Table **13**-1. **Human resources in science and technology**

Human resources in science and technology (HRST) as defined in the Canberra Manual (Manual on The Measurement of Human Resources devoted to S&T, OECD, Paris, 1995) are people who **fulfil at least one** of the following conditions:

– having **tertiary education** (ISCED levels 5A, 5B and 6);

– not having tertiary education but being **employed in S&T occupations** (CZ-ISCO-88 major groups 2 and 3).

Persons who satisfy both the condition of having completed tertiary education and the condition of S&T occupation make up the **HRST core** (they are the most valuable people for the HRST system taking an active part in scientific and technological development).

Table **13**-2. **Persons with tertiary education**

In the Czech Republic they are persons who attained tertiary education in any field of study. Tertiary education is defined in ISCED 97 (International Standard Classification of Education) and includes ISCED levels 5A, 5B and 6 (see Chapter **21**. Education).

Table **13**-3. **Persons employed in science and technology occupations**

Persons employed in science and technology (S&T) occupations are those who have main job in science (CZ-ISCO major group 2: Professionals) or technology (CZ-ISCO major group 3: Technicians and associate professionals) occupations that is their main source of income.

The data come from the Labour Force Sample Survey (LFSS) of the CZSO (the table presents average annual data). More detailed data on the LFSS are available in Chapter **10**. Labour market, part B.

Table **13**-4. **Tertiary education students and graduates of science and engineering fields of education (CZ-ISCED 97)**

The table gives the total **number of tertiary education students and graduates** (ISCED levels 5A, 5B and 6) in the fields of **science** (life sciences, physical sciences, mathematics and statistics, computing) and **engineering, manufacturing and construction** (engineering and engineering trades, manufacturing and processing, architecture and building) defined in ISCED 97 (ISCED broad groups 4 and 5). Tertiary education students and graduates of science and engineering fields of education represent potential (students) and real (graduates) inflows of HRST.

The data come from data sources of the Institute for Information on Education. The table contains expert estimates based on statistical data on higher professional schools (as at 30 September), graduates (for school year) and Union Information from Students' Registers (outputs for students refer to 31 December, for graduates to calendar year). Expert estimates are based on data by fields of study and a table of correspondence between KKOV (National Classification of Education), ISCED 97 and fields of study. Since a field of study with the same code may have various contents depending on university and thus its classification to codes of ISCED 97 may not be quite clear, the data should be taken as expert estimates.

Data for universities and data for higher professional schools are collected differently, using different methodologies, so data cannot be summed to provide a total.

*Table **13**-5 to **13**-10. **Research and development***

*The terms **research** and **development** in the Czech Republic are defined in the Act on R&D Support from Public Funds. R&D is defined as **systematic creative work carried out for the purpose of obtaining or using new knowledge.***

__Research__ is creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of human beings, culture and society, using methods allowing confirmation, widening or refuting of knowledge obtained. It includes:

– *__basic research__, which is experimental or theoretical work undertaken to acquire knowledge of the basis of observed phenomena, to explain their causes and possible impacts when using obtained findings;*

– *__applied research__, which is experimental or theoretical work undertaken to acquire new findings for future use in practice. The part of applied research whose results are used in developing new products, technologies and services designed for business under special regulations (e.g. Commercial Code; the State Enterprise Act) is referred to as industrial research.*

__Development__ is systematic creative work drawing on existing knowledge gained from research and/or practical experience to produce new materials, products or equipment, introduce new or improved technologies, systems and services, including acquisition and testing of prototypes, pilot plants or demonstration plants.

The R&D data contained in this part of the chapter come from the annual R&D survey measuring human and financial resources designed for R&D activities. The survey is fully governed by EU and OECD methodological principles laid down in the Frascati manual (OECD, Paris 2002) and Commission Regulation (EC) on statistics on science and technology.

Reporting units in the R&D survey are all legal and natural persons conducting R&D (creative work undertaken on a systematic basis to acquire new knowledge or use it in practice) in the Czech Republic as their principal (CZ-NACE 73 – places of research) or secondary economic activity, irrespective of the number of personnel, sector or CZ-NACE activity.

The R&D personnel and R&D expenditure data are always totals from collected questionnaires. Since the year 2001, mathematical and statistical methods have been used to make estimates for non-response.

*The R&D indicators are observed in the following four key **R&D sectors** derived from institutional sectors and sub-sectors used in the national accounts:*

– *__business enterprise sector,__ which comprises all companies, organizations and institutions whose principal activity is market production of goods or services for sale to the general public at an economically significant price;*

– *__general government sector__, which comprises institutions of central and local government, except for publicly managed higher education institutions. This sector includes especially workplaces of the Academy of Sciences of the Czech Republic and other places of research under the competence of ministries (on 1 January 2007 the statute of most of these entities changed to public research institutions), public libraries, archives, museums and other cultural establishments conducting R&D as their secondary activity;*

– *__higher education sector,__ which comprises universities and other institutions of post-secondary education. It also includes all research institutes, experimental facilities and clinics whose work is*

directly controlled or managed by higher education institutions or they are associated with them. Since 2005, in compliance with OECD methodology, the sector also includes teaching hospitals. This sector is not a separate institutional sector of national accounting but has been separately identified by the OECD for its important role in R&D;

– **non-profit institutions serving households sector** *(referred to as the "private non-profit sector"), which comprises private institutions, including private persons and households, whose primary aim is not profit formation but providing non-market services to households. They include, e.g., associations of research organizations, societies, unions, movements, federations or foundations.*

Table *13*-6. *R&D personnel and R&D expenditure: by region*

*The data are broken down by **region** according to the **location** of R&D activities of reporting units, which are mainly individual faculties of universities but also certain research institutes under the competence of ministries.*

Table *13*-7. *R&D personnel: by sector and occupation*

R&D personnel include researchers, technicians and other supporting and administrative staff in the reporting units.

***By occupation**, R&D personnel are split into:*

– **researchers***: professionals engaged in the conception or generation of new knowledge, products, processes, methods and systems or managing of such projects. They are mostly scientific specialists or heads of R&D departments;*

– **technicians and equivalent staff** *(referred to as "technicians"): persons who participate in R&D activities by performing scientific and technical tasks involving the application of concepts and operational methods, usually under the supervision of researchers;*

– **other supporting staff** *(referred to as "other personnel"): skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D activities or directly associated with such activities; included are also managers and office staff who provide direct support for R&D.*

The number of R&D personnel is measured by two basic indicators – headcount (HC) and full-time equivalent (FTE):

– **headcount as at 31 December** *refers to registered number of active R&D personnel employed (full or part-time) at the end of reference year in the reporting units;*

– **full-time equivalent (FTE)** *refers to average registered number of FTE R&D personnel.*

One FTE equals one-year (full-time) work of a member of personnel who is 100% engaged in R&D activities. For personnel engaged also in other activities, only the R&D-related working time is counted, so that overestimation of the number of personnel engaged in R&D is avoided. The indicator also includes the number of FTE persons working for the reporting unit under contract for work or contract of service.

In 2005 the FTE calculation was changed in compliance with OECD requirements to improve the international comparability of national data. Starting from 2005, the FTE R&D personnel data are not comparable with those for previous years (1995–2004).

Table *13*-8. *Total R&D expenditure: by target sector and source of funds*

***Total expenditure** is all R&D current and capital expenditure made within the statistical unit or economic sector irrespective of the source of funds. Included is also expenditure made outside the statistical unit but in support of R&D (e.g., purchase of supplies for R&D).*

Among the sectors of R&D expenditure are the business enterprise sector, the general government sector, the higher education sector and the private non-profit sector. The sources of R&D funds include business enterprise, general government, funds from abroad and other national funds.

Funds from abroad *are sources of institutions and individuals outside the political borders of the country. They are also all international organisations (European Commission, NATO, etc.), including their institutions within the country.*

*Table **13**-10.* **Government budget appropriations or outlays for R&D by socio-economic objectives (GBAORD)**

The data were received from the Government Council for Research and Development and the Ministry of Education, Youth and Sport of the CR. Complementary data are received directly from individual providers of state support for R&D. The methodology for data collection and processing is in the OECD Frascati Manual; data security is governed by Commission Regulation (EC) No. 753/2004. The classification of socio-economic objectives is in NABS – Nomenclature for the Analysis and Comparison of Science Programmes and Budgets (Eurostat, Rev. 1992).

*Table **13**-11.* **Patents granted in the Czech Republic**

*The **patent** is a public deed issued by national (in the Czech Republic by the Industrial Property Office) or international patent office which provides legal protection of the invention for up to 20 years on the territory for which it has been issued. A granted European Patent (EP) can be validated (by filing a Czech translation of the patent with the Industrial Property Office of the CR and paying the administrative charge) in the Czech Republic starting from 2003. Patents are granted on inventions which are novel, inventive and capable of industrial application. The patent granting procedure commences by filing a **patent application** with the Industrial Property Office of the CR (IPO CR). Patent is effective from the day its granting is announced in the Official Journal of IPO CR.*

The data are processed by the CZSO from data sources of IPO CR. Patent data are classified according to methodology set out in the OECD Patent Manual (OECD, Paris, 1994). The International Patent Classification (IPC) makes it possible to classify utility models and granted patents to technological areas. Patent data broken down by patent applicant's country are classified, using the fractional method (e.g., if two applicants from different countries file together a patent application, a half of the patent is assigned to each country).

*Tables **13**-12 and **13**-13.* **Licences acquired and provided: patents and utility models**

*A **licence** is one of the possibilities to use industrial rights and intellectual property on a commercial basis. There are several criteria of dividing licences. The basic division is into licence provision (sale) – active licences, and licence acquisition (purchase) – passive licences.*

*A **licence agreement** refers to granting the right, in agreed scope and territory, of acquisition (purchase) or provision (sale) of patented or non-patented inventions, utility models, industrial designs, topography of semi-conductor products, new varieties of plants and animal breeds, or trademarks. The licence provider entitles the licence acquirer to exercise industrial property rights in agreed scope and territory and the licence acquirer undertakes to make agreed payment.*
The data come from the annual licence survey measuring the number of licence agreements on some of the types of industrial property protection in the Czech Republic effective in the reference year and the value of licence fees paid/received by Czech entities in the reference year. Besides the total number of licence agreements effective in the reference year, the survey also measures newly concluded licence agreements, subject of licence agreements and country of contracting partner.

Data on the number of effective licence agreements and value of paid/received licence fees are the totals of data from collected questionnaires. Since the year 2007, mathematical and statistical methods have been used to make estimates for non-response.

Some of the entities (especially licence providers) are natural persons without company registration number (IČO) and cannot be sent the statistical form. For this reason the number of purchased and sold licences for the Czech Republic does not add up.

*Table **13**-14. **External trade in high-tech goods***

> High-tech goods have been defined by the OECD in terms of the Standard International Trade Classification (SITC), Rev. 3. They are goods produced mostly in technologically advanced plants with high R&D intensity. The definition allows producing internationally comparable data on external trade in high-tech goods. High-tech goods are divided into nine basic groups.

> Data on exports and imports of high-tech goods used to be received from the Ministry of Finance of the CR – Directorate General of Customs. Since 2004 they have been from data sources of the CZSO (External Trade Statistics Database).

*Table **13**-15. **Technology balance of payments***

> Data on **receipts and payments** obtained from the **technology balance of payments** (TBP) show the volume of external trade in industrial property and advanced technology know-how. The idea and methodology of these statistics are based on the Manual for the Measurement and Interpretation of Technology Balance of Payments Data – TBP Manual, OECD, 1990.

> Up to 2004 the data came from data sources of the Czech National Bank , namely from the current account of the balance of payments. Since 2005 the results of a CZSO direct survey among respondents on exports and imports of services have been used. Due to changes in the data collection methodology, only data starting from 2005 are published now. The individual TBP items are defined in the EBOPS Classification (Extended Balance of Payments Services Classification).

*Tables **13**-16 and **13**-17. **High-tech sector: key indicators***

> The high-tech sector definition has been developed by the OECD and includes high-tech economic activities. These activities, which produce high added value, are in the Czech Republic identified in the Industrial Classification of Economic Activities (CZ-NACE):

1. High-tech manufacturing sector:

  244 – Manufacture of pharmaceuticals, medicinal chemicals and botanical products

  30 – Manufacture of office machinery and computers

  32 – Manufacture of radio, television and communication equipment and apparatus

  33 – Manufacture of medical, precision and optical instruments, watches and clocks

  353 – Manufacture of aircraft and spacecraft

2. High-tech services sector:

  64 – Post and telecommunications

  72 – Computer and related activities

  73 – Research and development

> Average registered number of employees, turnover and value added data come from the annual structural survey in businesses classified to selected production industries and R&D expenditure data from the annual R&D survey.

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> The data in the tables are comparable with those published in previous Statistical Yearbooks. In Table **13**-14 due to revision of classification used for external trade in high-tech goods the data since 2007 are not comparable with those from previous years.

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More detailed information on science and technology is available in other CZSO publications published in accordance with the Catalogue of Publications 2009 in thematic group 9 – SERVICES, subgroup 96 – Science and Research:

– 9601-09 "Research and Development Indicators 2008" (Czech-English) – October 2009

– 9611-09"Government Budget Appropriations or Outlays for R&D (GBOARD) in the Czech Republic 2008" (Czech-English) – November 2009

and in publication not included in the Catalogue of Publications 2009:

– "Statistical Yearbook of Science, Technology and Innovation 2009" (Czech and English) – September 2009

Further data can be found on the website of the Czech Statistical Office at:

– http://czso.cz/eng/redakce.nsf/i/science_and_research_veda