Chapter III – R&D Outputs

This chapter logically follows the previous Chapter II evaluating the R&D inputs (people and funds spent). Chapter III has three parts as follows:

- Part III.1 with basic data on R&D results in Czechia in the years 2001, 2003 and 2005 according to the Czech Information System of Research and Development (R&D IS) with all basic parameters of R&D evaluation for 2001–2004 made by the Research and Development Council;
- Part III.2 with bibliometric analysis of R&D outputs of selected countries for the period 2001–2005 made upon the database of ISI Thomson "National Science Indicators";
- Part III.3 with evaluation of the number of patent applications (patents) and patents granted by the Industrial Property Office of the Czech Republic (IPO CR), the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO).

In 2005 R&D Analysis and in all previous versions, basic data on R&D results in Czechia (numbers of individual types of results in total and numbers of results in the main R&D sectors) were given in the chapter concerning the Czech R&D Information System. Separated chapters were dedicated also to the results of bibliometric analysis and details about patent applications (patents) and granted patents.

Basic parameters for evaluation of research and development and its results for 2001–2004 are given for the first time. The selection of evaluated countries remained the same as in previous years. In Parts III.1 and III.3 data for the years 2001, 2003 and 2005 prevail; the bibliometric analysis evaluates the period 2001–2005.

Part III.1 shows beyond any doubts that first-class results are only scarce. The share of articles in impact journals is very low; articles in various proceedings prevail. The numbers of patents and verified new technologies remain very low despite their growth in 2003-2005. This situation concerning patents is confirmed also in Part III.3, where the international comparison of numbers of patent applications and patents granted to entities in monitored countries is made.

Part III.2 measures the publishing performance (publications and citations of published articles) with the same indicators as in 2005 R&D Analysis using the ISI Thomson database. Czechia overtook other new EU Members States being monitored in many indicators, but the difference against EU-15 countries still remains very high. The value of relative citation index of Czechia grew from 0.5 in 1994 to 0.9 in 2005, but still waits below the world database average. For many disciplines concerning an inanimate nature the relative citation index exceeds the world database average, even at relatively high numbers of publications. Low is the level of social sciences and humanities.

Part III.3 evaluates the numbers of invention applications (patent applications) and patents granted by the Industrial Property Office of the Czech Republic, the European Patent Office and the United States Patent and Trademark Office. Czechia and other new monitored EU Member States still considerably lag behind the EU-15 countries.

When measuring the performance of the Czech research and development, it is also necessary to bear in mind that R&D expenditures and numbers of research workers are substantially lower than in the EU-15 countries. Continued attention must therefore be given to the performance of the Czech research and development. Necessary improvement should be obtained from the gradually developed system for evaluation of research and development and its results.

Table III.1.1 Numbers of registered R&D results classified by type of a result and year of application, in total for the years 2001–2005

	2001	2003	2005
Professional book	1 526	1 530	1 353
Chapter in a book	2 256	2 598	2 557
Article in proceedings	18 231	21 665	21 097
Article in a periodical	19 926	19 846	19 564
Patent	85	64	112
Prototype, verified technology	364	209	495
Other results	2 159	2 566	5 095

Data in the table must be treated as a serious warning of the unsatisfactory performance of an important part of the Czech research and development. There is stagnation in the number of professional books, chapters in books and articles in periodicals, which are the standard outputs of basic research. At the same time, the public R&D expenditures as shown in Chapter II (Graph II.1.1) grew nearly 31 % in the period from 2001 to 2005. And furthermore, the category of "Articles in proceedings" includes also proceedings of conferences of lesser importance and various special proceedings; and as for the articles in periodicals, only a little more than one third is published in impact journals as shown in Table III.1.4.

At first sight, the growth in the number of patents, prototypes and verified technologies in 2005 seems gratifying when compared with situation in 2003. But second sight set on Part III.3 of this chapter and the Chapter IV Innovation and Competitiveness reveals that as for the number of patents Czechia significantly lags behind the EU average.

Table III.1.2 Numbers of R&D results registered between 2001 and 2005 and classified by category of a recipient and type of a result

	Academy of Sciences of CR	University institutions	Departmental institutions	Other legal and physical entities
Professional book	2 158	3 767	1 044	295
Chapter in a book	4 710	6 617	1 336	119
Article in proceedings	15 634	79 411	6 076	2 332
Article in a periodical	31 158	52 334	11 927	1 978
Patent	109	191	55	101
Prototype, verified technology	123	291	478	845
Other results	55 513	152 679	23 840	7 022

Data from the table do not allow concluding anything about better performance of university institutions in comparison with other segments of research and development supported from public funds. The reason for this is the wide spectre of quality of results in the categories "Article in proceedings" and "Article in a periodical". Different are also the

numbers of research workers in respective R&D segments. The next part concerning the evaluation of R&D and its results for 2000–2004 states that performances of universities and of the Academy of Sciences of CR are very close to each other (Table III.1.6).

This not very good state of performance is documented by data on the number of patents. The "Other legal and physical entities" segment, which is basically formed by entrepreneurial entities, reports a smaller number of patents than the Academy of Sciences and universities.

Selected results of evaluation of R&D and its outcomes for 2000–2004

For many years, the Czech system of R&D evaluation has been dominated by *ex ante* evaluation focused on evaluation of draft research programmes and R&D projects intended for targeted funding from the state budget and on evaluation of research plans intended for institutional funding. Less attention was paid to the evaluation of attained results, i.e. *ex post* evaluation, and generally no concrete conclusions were drawn from the evaluation findings.

The National Research and Development Policy of the Czech Republic for 2004–2008 marked the improvement of the R&D evaluation process as one of five main system priorities. The Government Resolution No. 5 of January 7, 2004, by which the National policy in research and development was approved, imposed on the Research and Development Council to produce and submit to the Government the proposal for evaluating research and development and its results by June 30, 2004. The proposed evaluation was approved by the Government by its Resolution No 644 of June 23, 2004. This Resolution imposed a number of concrete tasks on the Research and Development Council and the Ministry of Education, Youth and Sport including, inter alia, to develop a detailed and concrete methodology and deliver it to ministries and other central authorities supporting research and development from their own budget chapters.

The summary evaluation was made by the Research and Development Council according to the above mentioned methodology and using the databases of R&D Information System (R&D IS). First evaluation was made already in 2004; second evaluation using a considerably revised methodology in 2005. This second evaluation took into account data from 2000–2004.

Basic parameters of "Evaluation of R&D and its results in 2005"

The evaluation involved:

- **8 138** projects and research plans finished in 2000–2004;
- **952** institutions and their organisational units;
- **7** categories (types) of R&D results, to which following weights (points) were allocated.

Table III.1.3 Category and weight of results

Category (type) of a result	Weight (number of points)
Article in impact journal of the world ISI database (J_{imp})	**10 x** (IF[a)] / median IF of a discipline)
Article in reviewed non-impact journals (J_{rec})	**1** (Czech and Slovak) **2** (other language)
Professional book reviewed (B)	**5** (Czech and Slovak) **10** (other language)
Chapter in reviewed professional book (C)	**2** (Czech and Slovak) **4** (other language)
Article in proceedings (D)	**1** (Czech and Slovak) **2** (other language)
Patents and other results protected by separate regulations (P)	**25**
Prototype, pilot plant, verified technology and functional sample (T)	**25**

[a)] Impact factor of the journal, where the article was published.

- **172 885** results, of this 162 205 recognised results and 10 680 not recognised results[1] in following structure:

Table III.1.4 Types of results

	Articles in impact journals	Articles in non-impact journals	Books	Chapters in books	Articles in proceedings	Patents	Technology	In total
Number	24 383	42 560	5 872	11 563	76 462	299	1 050	162 205
Percentage	14.9	26.0	3.6	7.1	46.6	0.2	0.6	100

The evaluation has repeatedly confirmed that more than two thirds of results are articles in proceedings (46.6 %) and articles in non-impact journals (26.0 %). The share of articles in impact journals approaches 15 %. The numbers of R&D results with higher potential of commercial application, i.e. patents (0.2 %), prototypes, pilot plants, verified technologies or functional samples (0.6 %) are very low.

In addition, following was determined:

- overall weight of recognised results attained by solution of evaluated projects and research plans – **686 701**;
- average weight of recognised results attained by solution of evaluated projects and research plans related to CZK 1 million of state budget funds spent on these projects and research plans – **12.4**;
- sums of weights attained by respective institutions and their organisational units;
- four groups of institutions and their organisational units:
  - group of 192 institutions with no recognised results; these institutions obtained public support of CZK 1.040 billion from the state budget;
  - group of 295 institutions that attained the sum of weights between 0.01 and 4.13 and so their appraisal of state budget funds was below average (in total CZK 12.565 billion);
  - group of 258 institutions that attained the sum of weights between 4.14 and 12.40, and so their appraisal of state budget funds was at average level (in total CZK 20.310 billion); and
  - group of 207 institutions that attained higher sum of weights than is the average for the whole evaluation set (12.4), and so their appraisal of state budget funds was above average (in total CZK 21.524 billion).

The following table shows the numbers of institutions and their parts in respective R&D sectors and shares of those without any recognised results.

Table III.1.5 Numbers of evaluated institutions by sectors

Sector	Number of evaluated institutions in total	Number of institutions without any results	Share of institutions without any results (%)
Entrepreneurial sector [a)]	518	122	23.6

[1] Results submitted to the Research and Development Council did not meet the methodological requirements of the R&D Information System.

Non-profit organisations [b)]	40	24	60.0
Universities (faculties and other parts)	160	11	6.9
Academy of Sciences of CR (institutions and other worksites)	62	2	3.2
Other public sector [c)]	172	33	19.2
In total	952	192	20.2

[a)] Legal entities entered in the Companies´ Register.

[b)] Foundations, public benefit companies, interest associations of legal entities, civic associations, societies, etc.

[c)] State contributory organisations, organisational bodies of the state, organisations of the territorially self-governing units.

The shares of organisations without any recognised R&D results are exceptionally high both for non-profit organisations (60 %) and in the entrepreneurial sector (23.6 %). Also the situation in “Other public sector” category with departmental research institutions and various service organisations is unsatisfactory (19.2 %). The existing methodology does not yet allow making an absolutely precise evaluation of research for the state’s needs. Nevertheless, it is necessary that the providers of funds to institutions in these sectors improve substantially the way of evaluation of attained results and draw consequences from non-fulfilment of the objectives of R&D projects.

Discussion on interpretation of evaluation findings proved that a step was taken in the right direction, yet the applied methodology does not allow making any clear and objective conclusions about the performance and effectiveness of individual institutions and their respective organisational units and comparing them against each other. It was confirmed that the weight of attained results related to support granted from the state budget strongly depended on:

- the model (system) of support and way of reporting money spent by the institution; there is a great difference between models of support applied by entrepreneurial entities, universities and institutes of the Academy of Sciences;
- the discipline of the appropriate project or research plan;
- the size of an institution, amount of support and its share of the overall income of an institution, etc.

The given specifics will be taken into account for revisions of the evaluation methodology made in 2006 and 2007.

Practical impacts of evaluation results were applied in the group of R&D projects and research plans, for which no recognised results occurred neither in the monitored period, nor two years after their completion. The R&D budgets of competent providers (administrators of budget chapters) were reduced in 2007 by 10% of expenditures spent from the state budget on the above projects and research plans.

The foreign evaluations of research at universities and research non-university type institutions often use additional indicators of weight of attained results related to the number of research workers, or professors and research managers, as the case may be. The following table shows the weights for results attained in the sectors of university institutions, Academy of Sciences of CR and other public sector related to the number of research workers in these sectors. These numbers of research workers are round and converted (FTE) numbers of research workers in the evaluated period according to the results of the Czech Statistical Office survey.

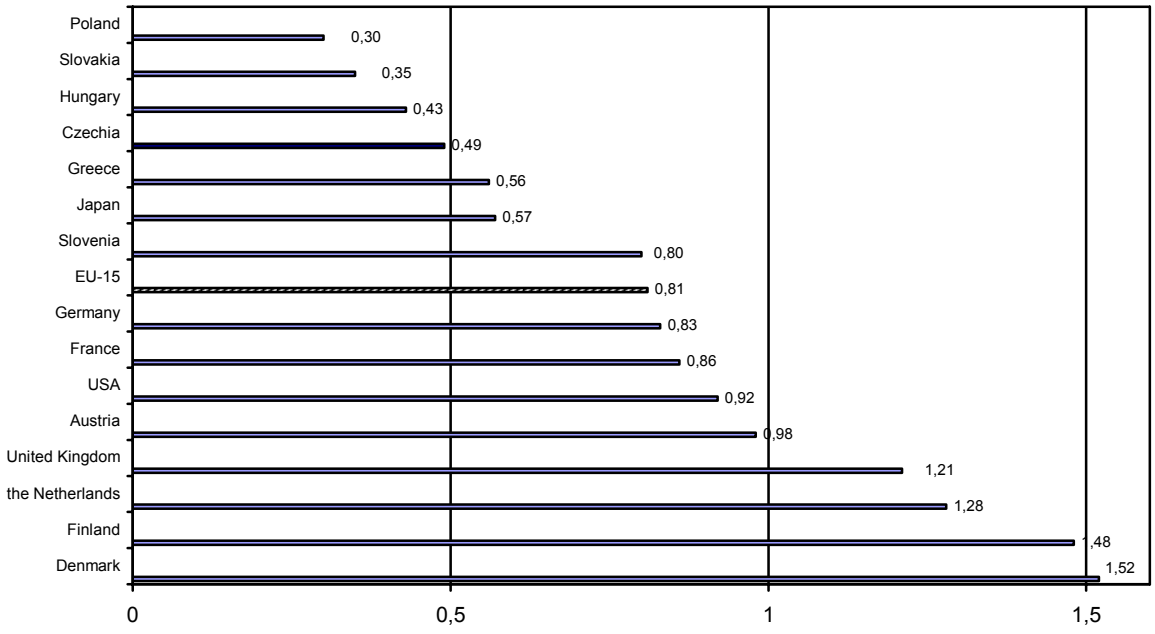
Table III.1.6 Comparison of relative weights of results attained in main sectors of public R&D

Sector	Weight of recognised results	Number of research workers (FTE)	Weight / number of R&D workers
Universities	370 350	4 300	86
Academy of Sciences of CR	252 630	3 600	70
Other public sector	49 570	1 100	45

Indicators of weight of attained results per one research worker at universities and institutes of the Academy of Sciences of CR are very close to each other. In both sectors (universities and AS CR) the weight figures are significantly higher than for other research organisations of public sector. The value of this indicator for organisations of "other public sector" supports the conclusion that providers of funds must intensify their pressure on these organisations to enhance their performance and effectiveness.

III.2. Bibliometry

III.2.1 Comparison of selected countries with Czechia by relative publications production (annual average 2001-2005)



Source: Thomson ISI® National Science Indicators (NSI), 1981-2005
Definition: RPP stands as abbreviation for indicator of the relative publications production indicating the number of publications produced by the research of a particular country per 1,000 inhabitants of that country.
Note: Detailed definition of indicators and the evaluation methodology are available at www.thomson.com/scientific/scientific/jsp

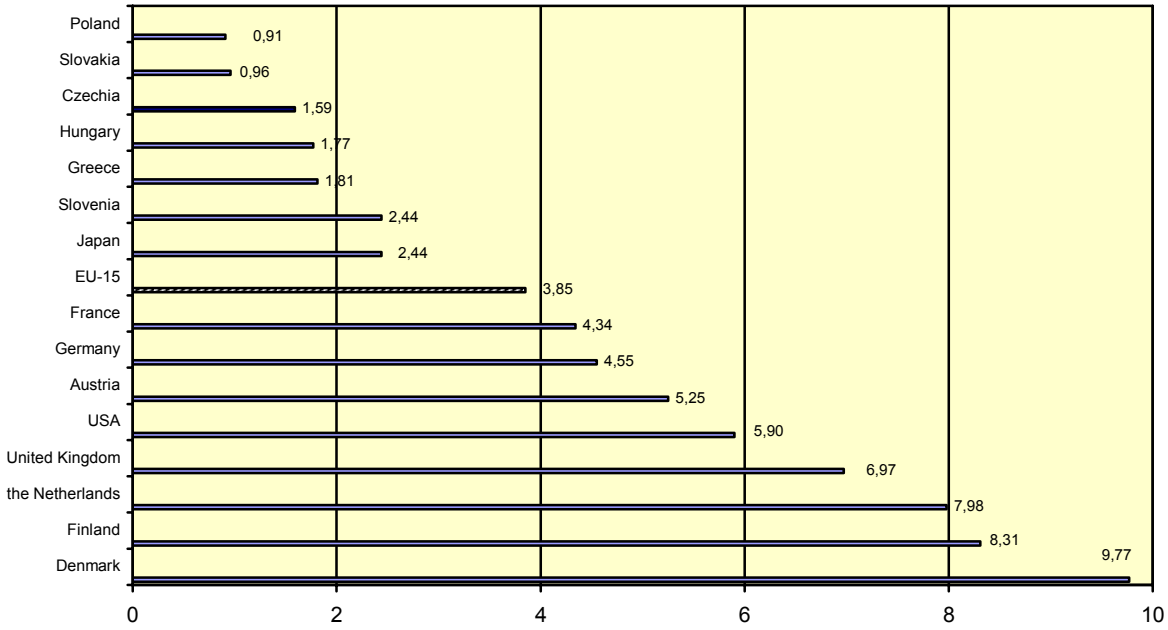
The indicator of professional research publications production enables to compare bibliographic outputs of that part of research of a particular country the main result of which is a new knowledge diffused through a professional research publication. These are particularly those parts of research classified in the Manual Frascati (Evaluation of scientific and technological activities, OECD, Paris 2002) as basic research and a portion of the applied research. The indicator of simple publications production discriminates smaller countries having smaller scope of research than the bigger ones. Therefore it is more just to use for comparison of countries the indicator of the ***relative publications production*** implementing the correction to the size of each country by conversion to 1,000 inhabitants of that country. The publications production is a quantitative indicator speaking nothing about their quality

Of the monitored countries, all EU-15 countries are above the EU-15 average (0.81); all new EU Member States are below this average, as well as Japan and Greece. More than one publication per 1,000 inhabitants per year is reported by Denmark (1.52 publication per 1,000 inhabitants per year), Finland, the Netherlands and the United Kingdom.

Of the new Member States, the least gap behind the EU-15 average is reported by Slovenia, distances of other monitored new EU Member States are larger. In 2004 R&D Analysis in which the period 1999–2003 was evaluated, Czechia reached RPP value = 0.42; in 2005 R&D Analysis RPP value = 0.45. In the current 2006 R&D Analysis, in which the period 2001-2005 is evaluated, Czechia reached RPP = 0.49. These three mentioned R&D Analyses saw also the EU-15 average growing from 0.74 to 0.77 and up to 0.81 in the presented analysis. So the distance between Czechia and the EU-15 average basically remains the same.

It is necessary to say that comparison based on the conversion to 1,000 inhabitants is not absolutely objective in case of more significant differences in the numbers of research workers or R&D expenditures respectively. It is clear that less research workers with less money will produce less scientific publications.

III.2.2 Comparison of selected countries with Czechia by relative production of citations (annual average 2001-2005)

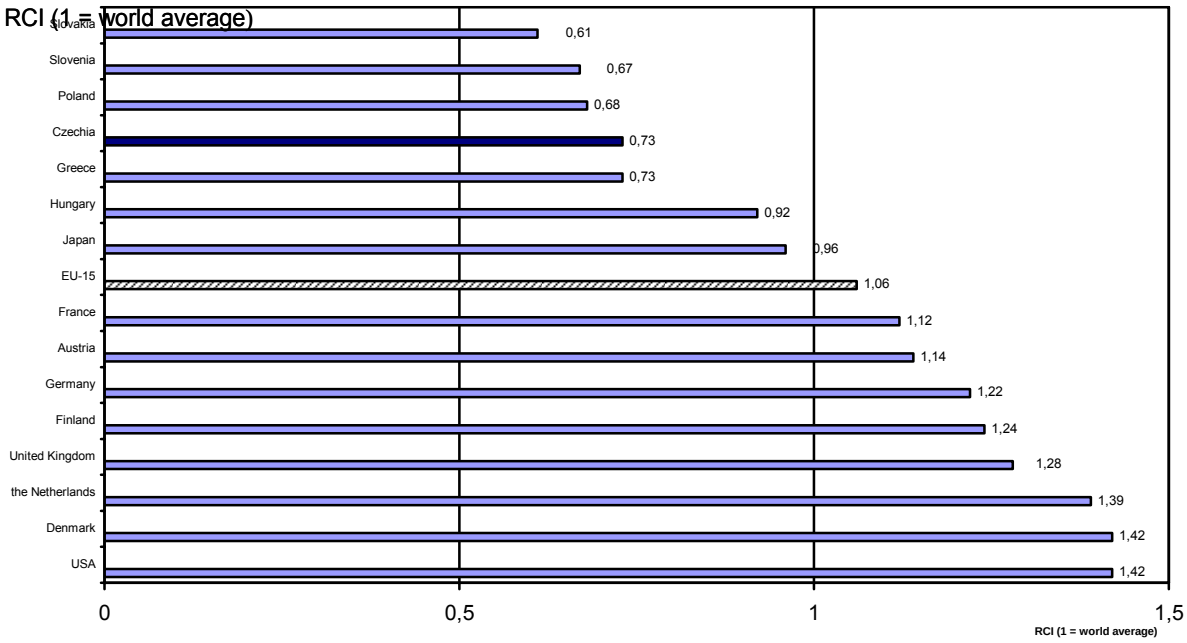


Source: Thomson ISI® National Science Indicators (NSI),1981–2005
Definition: RPC stands as abbreviation for indicator of the relative production of citations that indicates the number of citations of those publications that were produced by the research of a particular country per 1,000 inhabitants of that country.
Note: Detailed definition of indicators and the evaluation methodology are available at www.thomson.com/scientific/scientific/jsp

For evaluation of the publication's quality the number of its citations is used that with certain limitations speaks about the interest of the scientific community in the given work (e.g. it is not possible to compare numbers of citations of publications in different disciplines against each other). Similarly as with the production of publications, the indicator of the total production of citations would discriminate small countries and therefore the indicator of ***relative production of citations*** is used.

Likewise for the relative publications production, in this indicator all new EU Member States, as well as Greece and Japan, are markedly below the EU-15 average. Czechia, Slovakia and Poland close the table of 15 selected countries and EU made in the descending order as classified by value of the RPC indicator.

III.2.3 Comparison of selected countries with Czechia by relative citation index of a country (period 2001–2005)



Source: Thomson ISI® National Science Indicators (NSI),1981–2005

Definition: RCI stands as abbreviation for the relative citation impact of a given country (region) defined as the citation impact of a given country (region) divided by the citation impact of the Thomson ISI world database (citation register). The citation impact of a given country (region) indicates the average number of citations per publication produced by research of a given country (region) in 2000 – 2005, irrespective of the difference of disciplines. The RCI indicator compares the level of bibliometric quality of publications of a given country (region) with the average level of bibliometric quality of publications of the Thomson ISI world database given for 1999 - 2003.

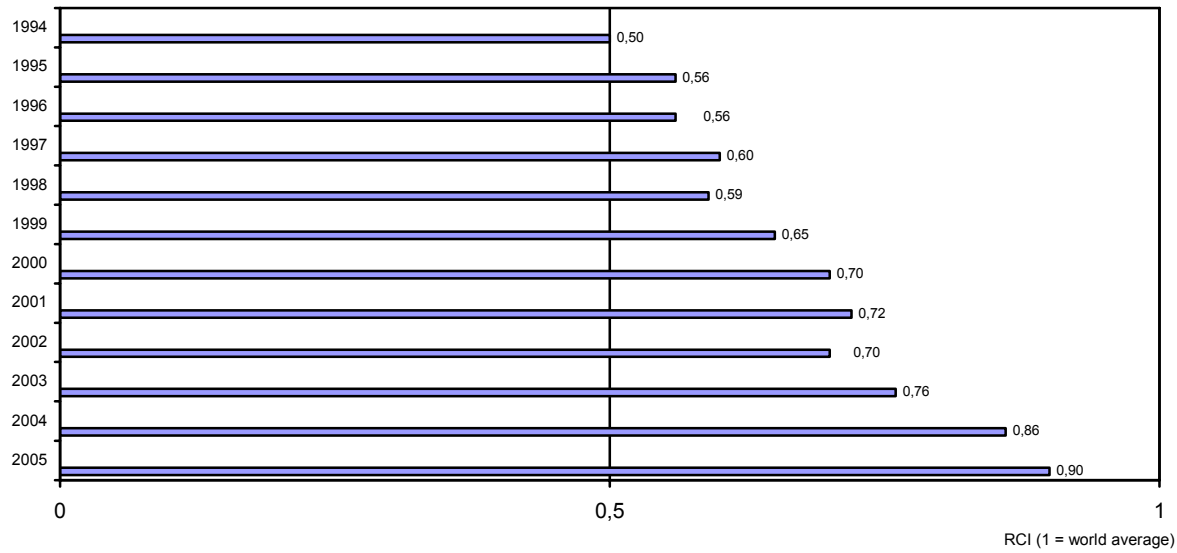
The value of RCI = 1 means that the given country (region) has the same level of bibliometric quality of publications as is the average bibliometric quality of publications of the Thomson ISI database. RCI > 1 indicates a level being higher than the average, RCI < 1 indicates a level being lower than the average.

Note: Detailed definition of indicators and the evaluation methodology are available at www.thomson.com/scientific/scientific/jsp

As mentioned before, the evaluation of a relative production of both publications and citations (i.e. as converted to the number of inhabitants) is misleading in cases of larger differences in the relative number of research workers or relative amount of R&D expenditures in the countries being compared. A little more objective is the comparison by the ***relative citation impact***. The definition is given under the graph. Usually, all scientific production of a given country is compared against the world database. Often, even the individual scientific disciplines are compared (see Graphs III.2.5). Five years´ periods or individual years may be compared. Graph III.2.3 gives values for the period 2001–2005.

The results of monitored countries are similar to those attained for indicators of relative production of publications and relative production of citations (Graphs III.2.1 and III.2.2). The value of RCI for the new EU Member States, Greece and Japan is lower than the value for the world database as a whole. On the other hand, other monitored EU-15 Members States and USA report higher figures. Leading positions among the monitored countries are taken by USA and Denmark (RCI = 1.42). Denmark, the country with traditional high level of publication activity, is thus demonstrating its prominent position also in this indicator. Czechia overtook Slovenia in this RCI indicator and takes 12th place in the pack of evaluated countries.

III.2.4 Trend of the relative citation index of Czechia between 1994 and 2005



Source: Thomson ISI® National Science Indicators (NSI),1981–2005

Definition: Annual bibliometric quality of publications is expressed by the RCI indicator (for definition of the RCI indicator see definition for Graph III.2.3) for publications and their citations produced by the research of the Czech Republic for each given year.

Note: Detailed definition of indicators and the evaluation methodology are available at www.thomson.com/scientific/scientific/jsp

In 1994, the value of RCI indicator for Czechia was half the value of the world database standard. Since then, the RCI figure for Czechia has been experiencing a steady growth each year until now (with the exception of years 1996, 1998 and 2002) and for 2005 it is equal to 0.9 of the world database average.

A conclusion can be drawn that the ever increasing bibliometric quality of publications reflects the structural changes made particularly in the field of basic research in the course of transformation of the Czech research and development at the beginning of the 1990´s. This favourable development has been apparently caused by growth in R&D support, increasing emphasis laid upon the evaluation of research and its results at all control levels, more effective publication policy, and strengthening of international collaboration.

III.2.5 Comparison of the Czech standard of scientific disciplines with the world database by the relative citation index of a discipline in 2001–2005

The database "National Science Indicators" of Thomson ISI enables, inter alia, to measure the level of individual disciplines by the so called relative citation impact of a discipline (RCIO). It is possible to compare countries against each other or disciplines of selected countries against the citation impact of a discipline in the world database. Definition of indicator is given in following table.

Definition: RCIO stands as abbreviation for the relative citation impact of a discipline of a country defined as the citation impact of a discipline of the given country (region) divided by the citation impact of the same discipline of the world database (citation register) of Thomson ISI. It refers to publications and their citations produced by research of a given discipline in Czechia in a given period. The RCIO indicator compares the level of bibliometric quality of publications of a given discipline in a particular country (region) with the level of the world average bibliometric quality of publications of the same discipline in the given time period.

RCIO = 100 means that the discipline in a particular country (region) has the same level of bibliometric quality of publications as is that of the world average bibliometric quality of publications of the same discipline. RCIO > 100 means the level higher than average, while RCIO < 100 means the level lower than average.

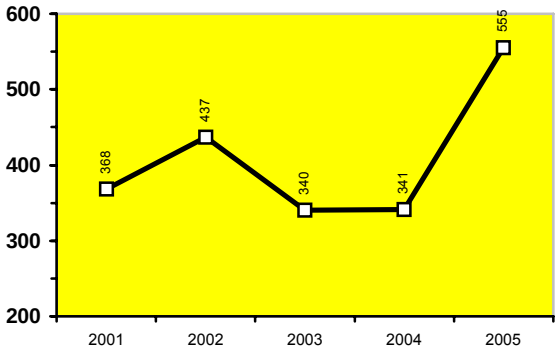
Note: Detailed definition of indicators and the evaluation methodology are available at www.thomson.com/scientific/scientific/jsp

The database, which was available for making 2006 R&D Analysis, gives figures for 104 scientific disciplines. Each discipline has its scientific journals allocated, in which Thomson ISI monitors published scientific articles and their citations. At present, nearly nine thousand of scientific journals are monitored, of them nearly six thousand from the field of natural sciences. Also social sciences, humanities, and art sciences have an adequate coverage. Certain disadvantage is that the mentioned scientific disciplines partly overlap even if they are clearly defined by the set of monitored journals. So the RCIO indicator cannot be considered an absolutely objective indicator of the standard of a discipline. The mutual comparison of standards in individual countries, the comparison with the average level of the world database, is a relatively objective one.

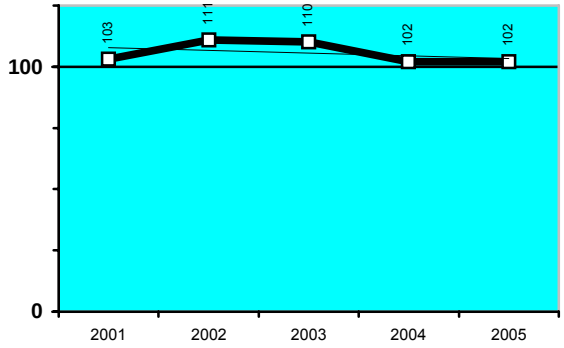
From among 104 scientific disciplines monitored in 2001–2005, Czechia reports 45 disciplines the relative citation impact of which exceeded 100 in any of the monitored years, so it was higher than the citation impact of the respective discipline in the world database. Below mentioned are RCIO figures for the best scientific disciplines from the field of inanimate nature, animated nature, technical sciences, chemistry and medical sciences. This part of the chapter mentions also RCIO figures for selected disciplines of social and human sciences and environmental sciences. For each discipline, there is also given the number of publications of Czech authors in journals specific to respective discipline.

Inanimate nature

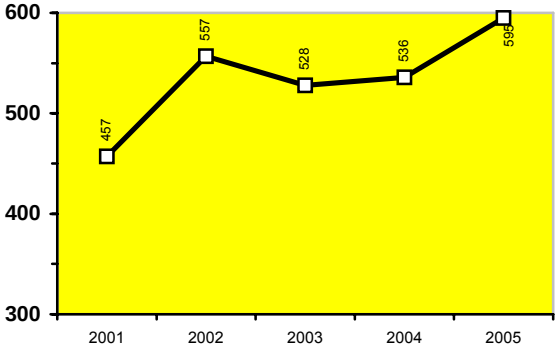
Physics - RCIO Numbers of publications



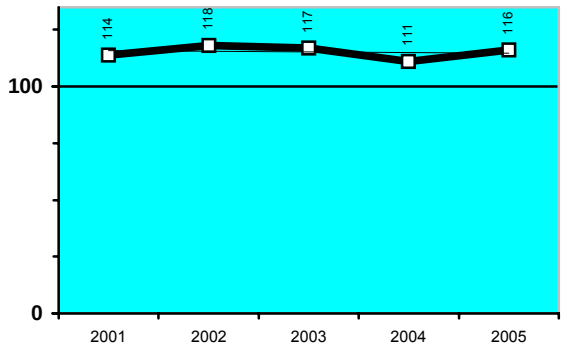
Applied physics, condensed matter physics, material sciences - RCIO



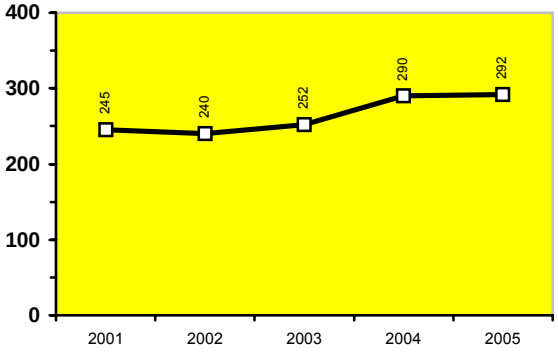
Numbers of publications



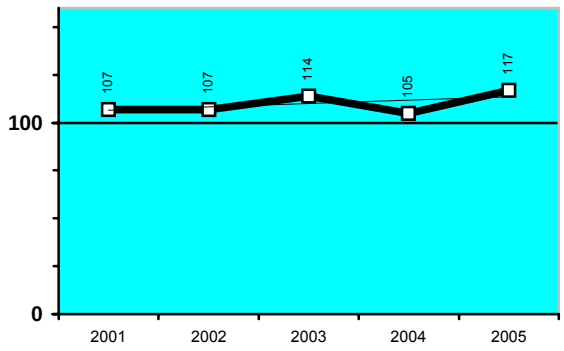
Physical chemistry - RCIO



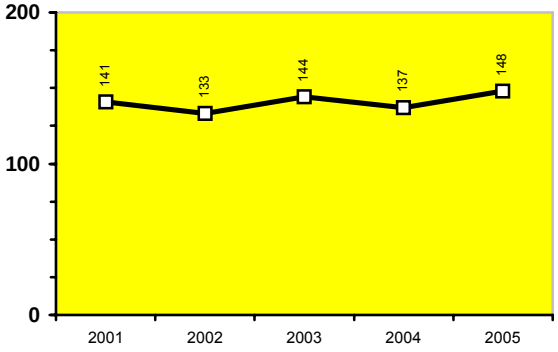
Numbers of publications



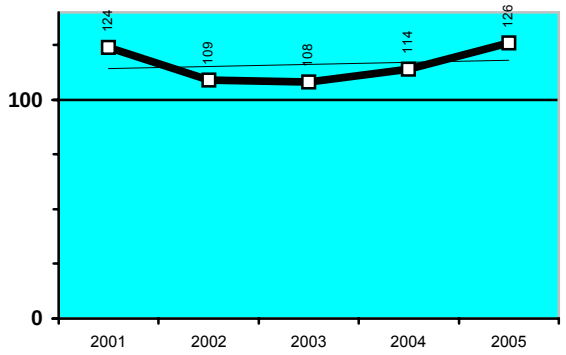
Mathematics – RCIO



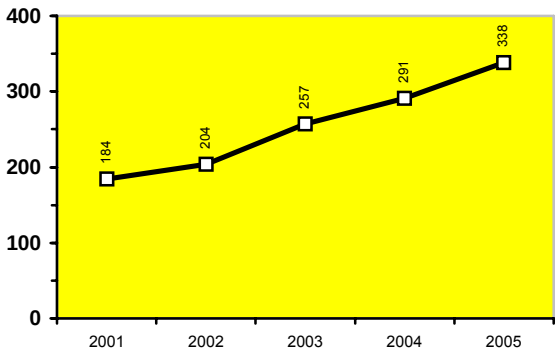
Numbers of publications



Engineering mathematics - RCIO



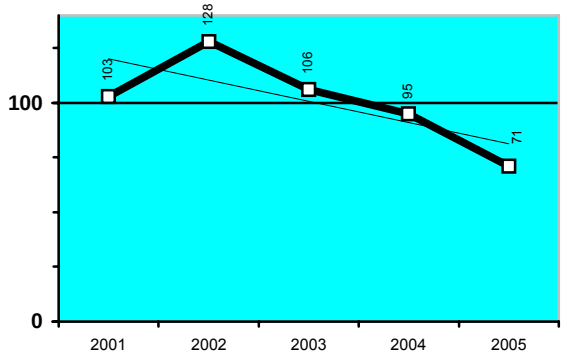
Numbers of publications



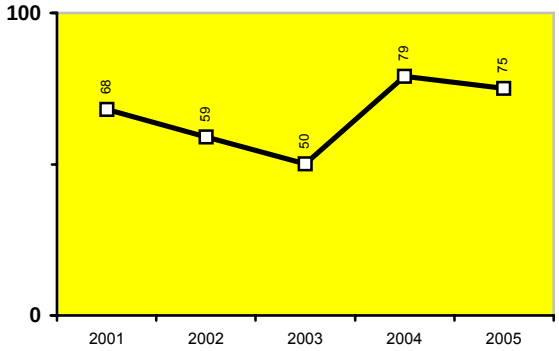
In all of the above mentioned disciplines the RCIO value has been exceeding 100 over the whole monitored period at a relatively high number of publications. In the discipline of applied physics, condensed matter physics, material sciences, the Czech research workers publish more than 400 scientific articles each year in the set of specialized periodicals.

Chemical Sciences

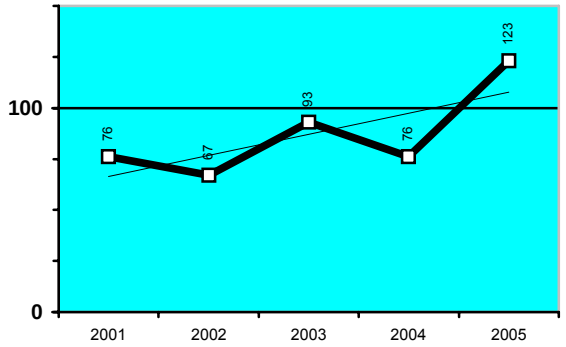
Chemical engineering – RCIO



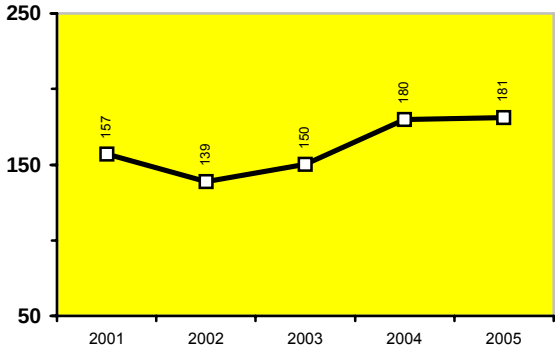
Numbers of publications



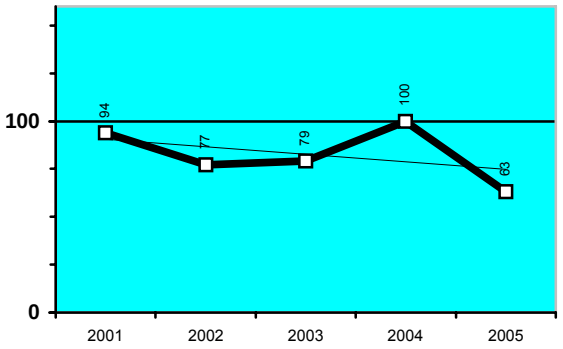
Organic chemistry, polymer sciences – RCIO



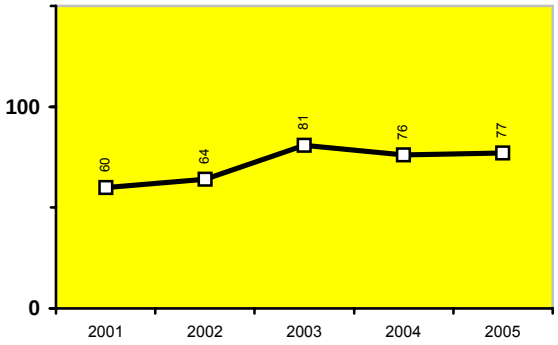
Numbers of publications



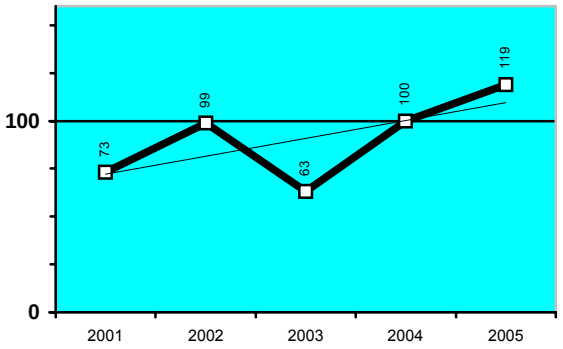
Inorganic and nuclear chemistry – RCIO



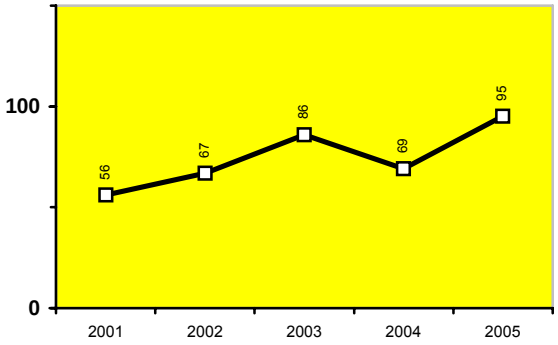
Numbers of publications



Pharmacology and toxicology – RCIO



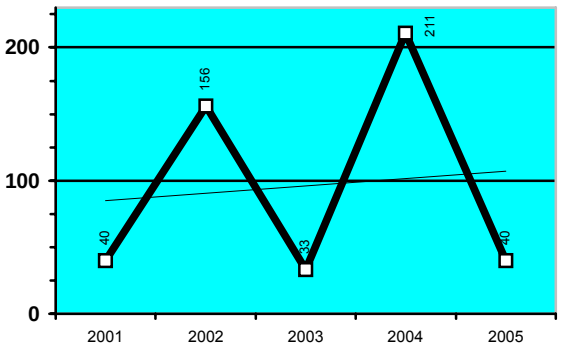
Numbers of publications



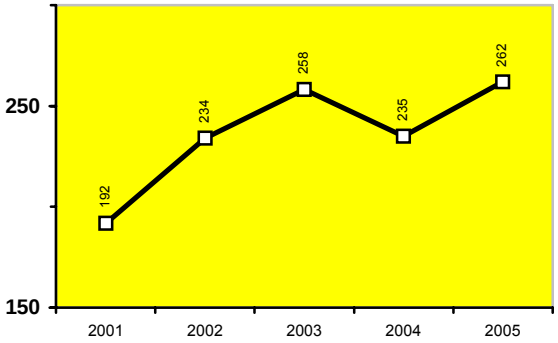
In chemical sciences the situation is somewhat worse than in the field of inanimate nature. Selected disciplines attained RCIO ≥ 100 only few times during the monitored period: Chemical engineering three times, inorganic and nuclear chemistry only once. The numbers of publications are lower than for the former disciplines. Only in the discipline of inorganic chemistry and polymer sciences the Czech research workers publish more than 100 scientific articles each year in specialized periodicals.

Technical Sciences

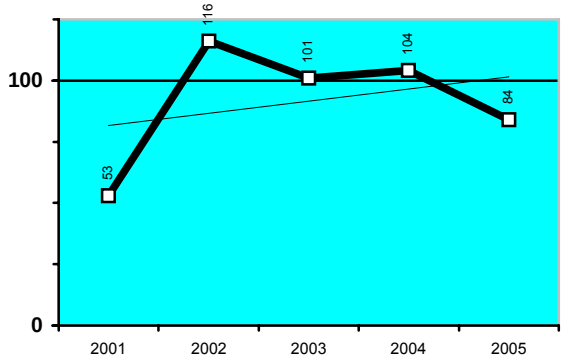
Spectroscopy, instruments, analytical instruments – RCIO



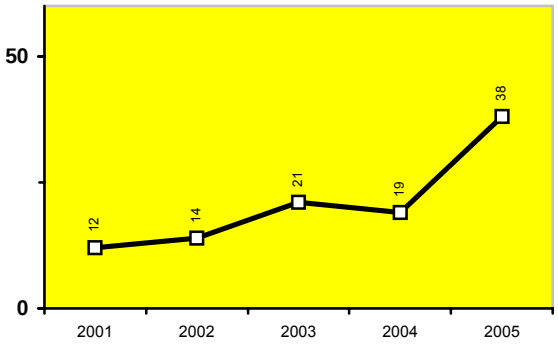
Numbers of publications



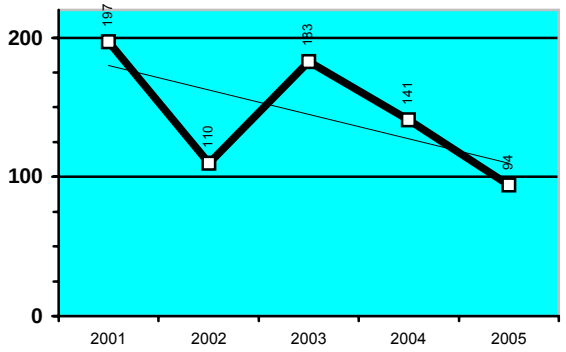
Nuclear engineering – RCIO



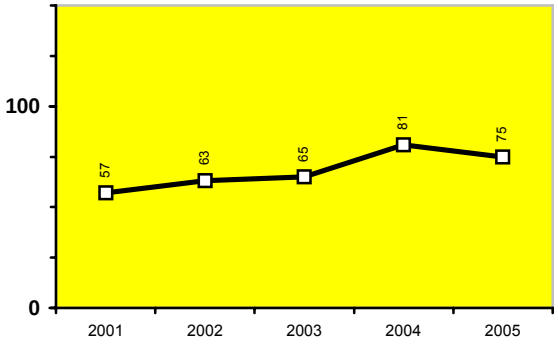
Numbers of publications



Instruments and measurement – RCIO



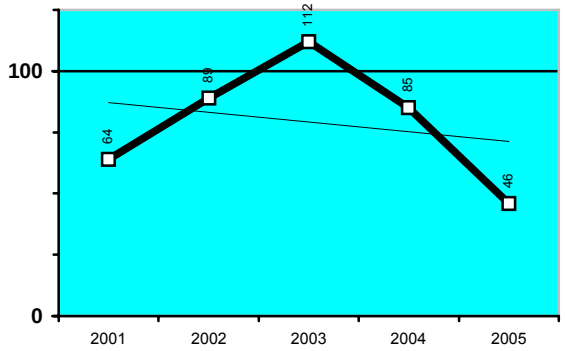
Numbers of publications



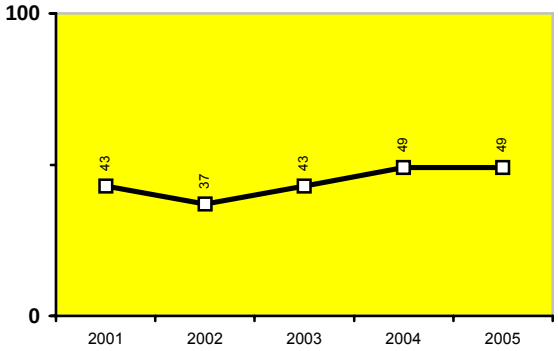
With the exception of 2005, the discipline of instruments and measurement has attained RCIO values higher than 100; 197 in 2001 and 183 in 2003. An unusual course is reported by spectroscopy, instruments, and analytical instruments – significantly poorer-than-average values in 2001, 2003 and 2005, and significantly higher-than-average RCIO values in the remaining years (156 in 2002; 211 in 2004).

Animated nature

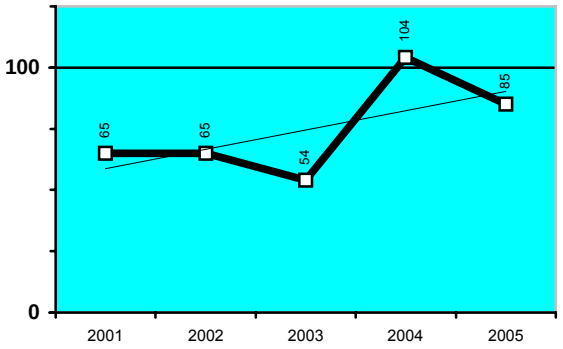
Botany and zoology – RCIO



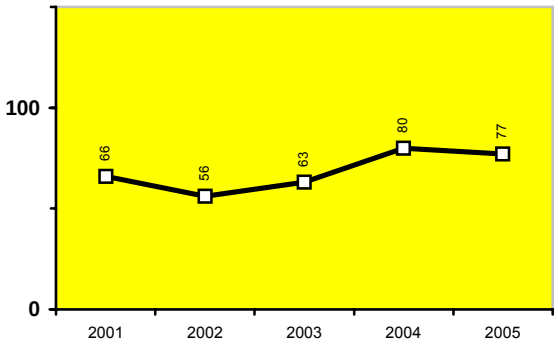
Numbers of publications



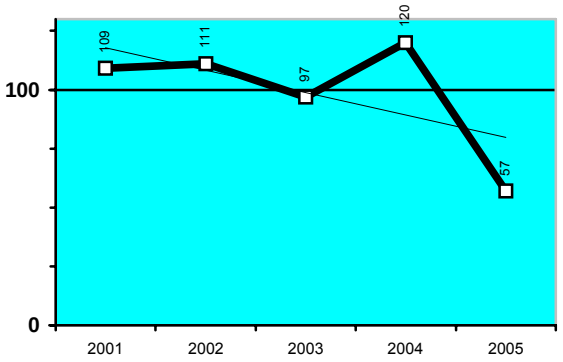
Molecular biology and genetics – RCIO



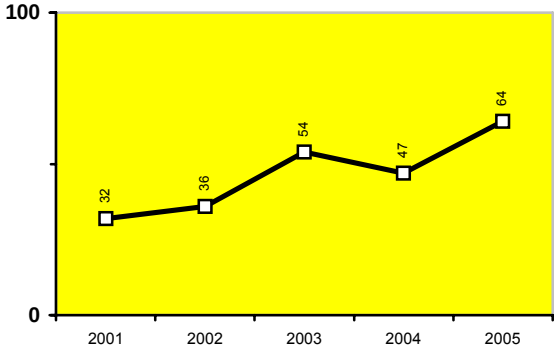
Numbers of publications



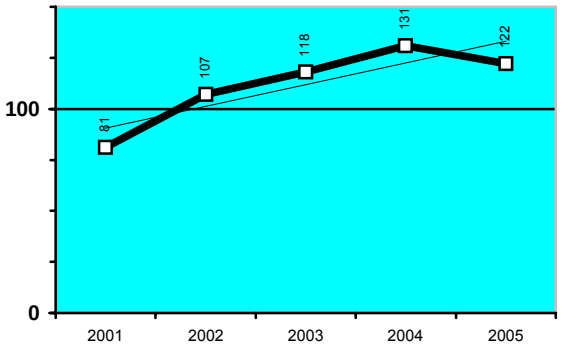
Entomology – RCIO



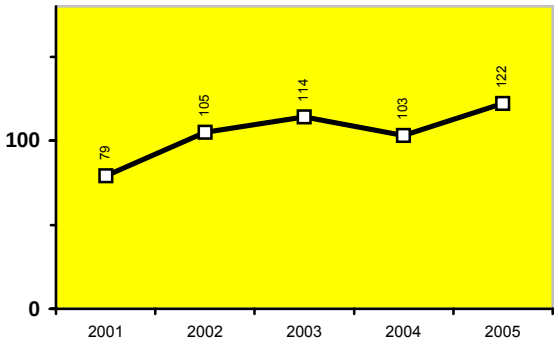
Numbers of publications



Veterinary medicine – RCIO



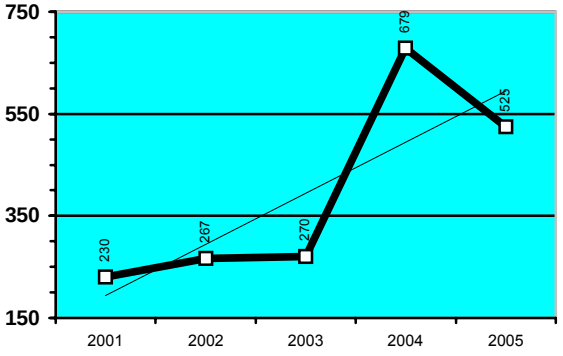
Numbers of publications

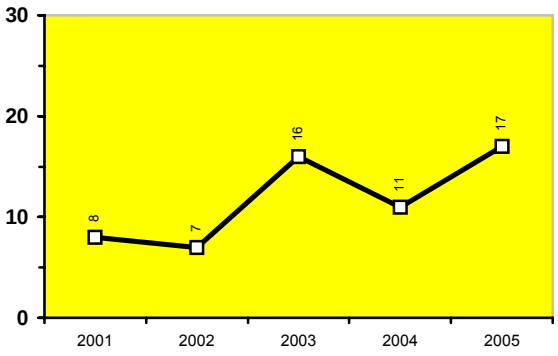


The best discipline of the above is the veterinary medicine reporting RCIO values > 100 (with the exception of 2001) at a relatively high number of publications. Disciplines of botany, zoology, molecular biology, and genetics attained RCIO ≥ 100 only in one year.

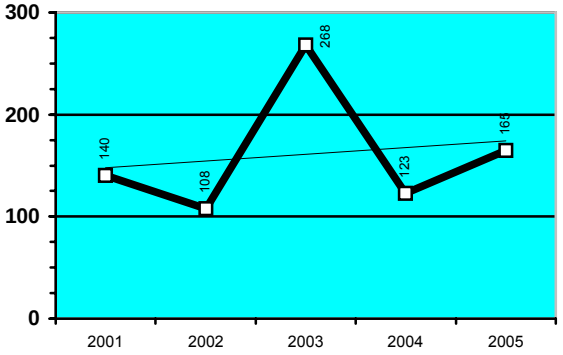
Medical Sciences

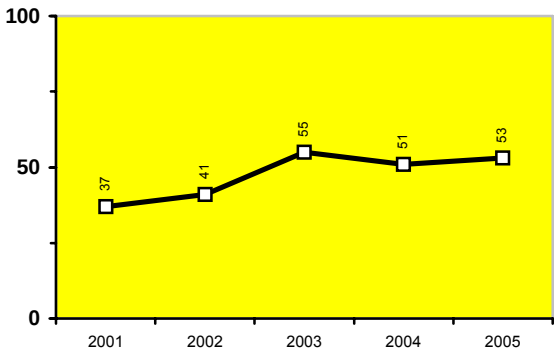
General and internal medicine – RCIO Numbers of publications



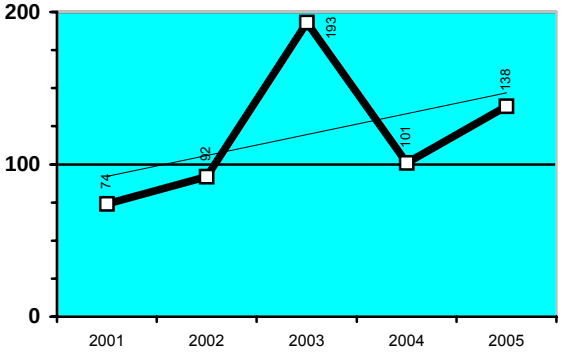


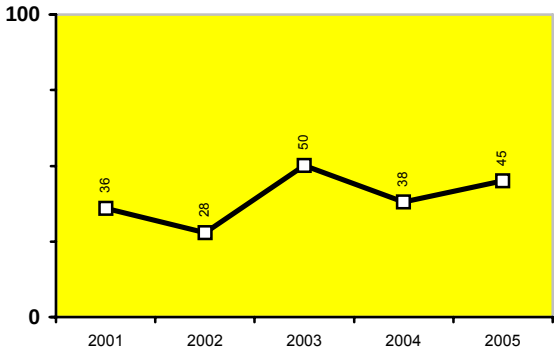
Cardiology, respiration medicine – RCIO Numbers of publications



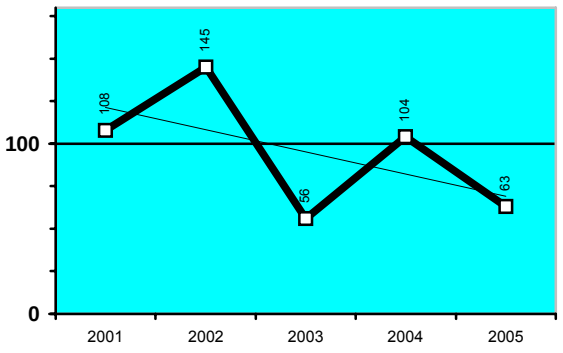


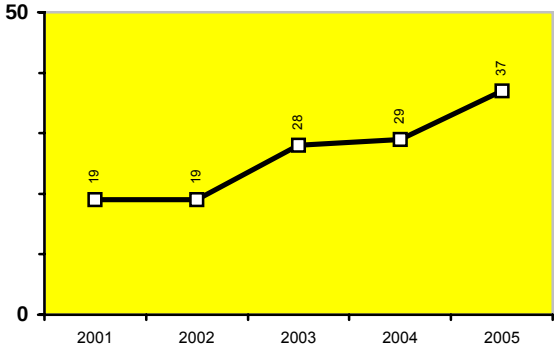
Cardiology and haematology – RCIO Numbers of publications





Oncology – RCIO Numbers of publications





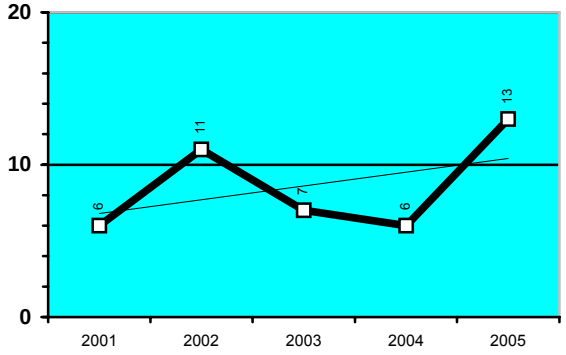
From among 104 disciplines defined by sets of journals monitored by Thomson ISI, the Czech research workers report significantly best results in general and internal medicine. In

this discipline, RCIO values in 2004 and 2005 are more than five times the average of this discipline in the world database. In 2001–2003, RCIO values are more than twofold the average of the world database. All above disciplines of medical sciences are characterised by a considerable variation of RCIO values over the monitored period. The numbers of publications are relatively low; the lowest for the very discipline of general and internal medicine with highly above average RCIO figures.

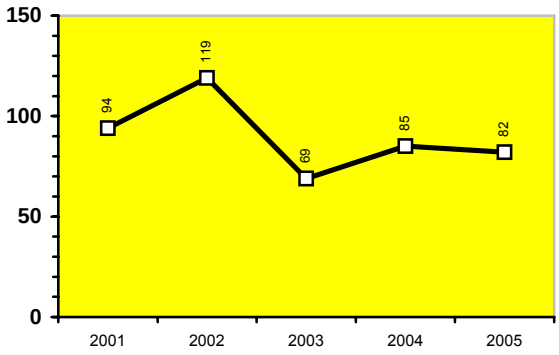
The medical sciences themselves illustrate the argument about a certain questionability of the discipline evaluation by RCIO disciplines defined by sets of periodicals. In Thomson ISI system, cardiology is included partly in the discipline of cardiology and respiration medicine and partly in cardiology and haematology.

Social sciences and humanities

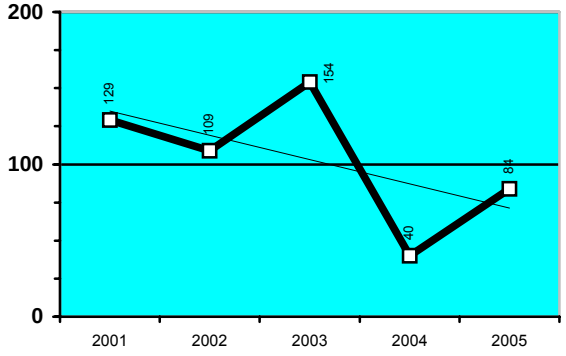
Economics – RCIO



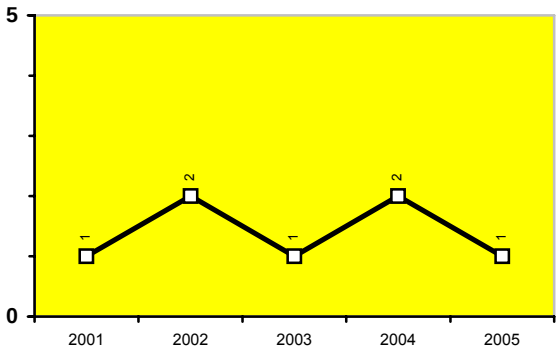
Numbers of publications



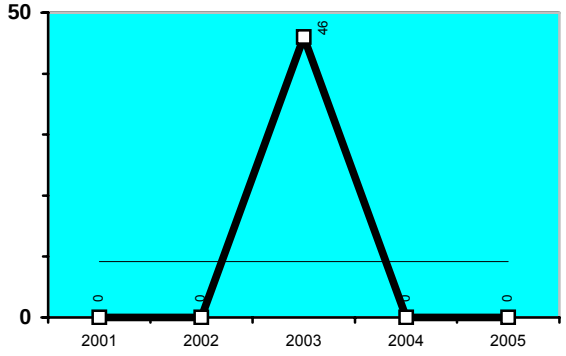
Pedagogy – RCIO



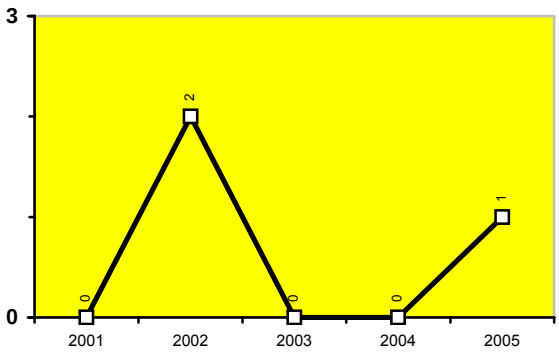
Numbers of publications



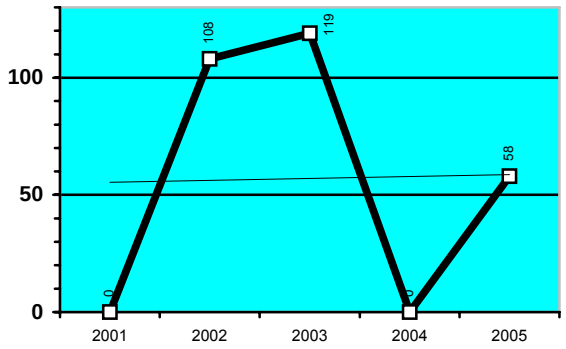
Law – RCIO



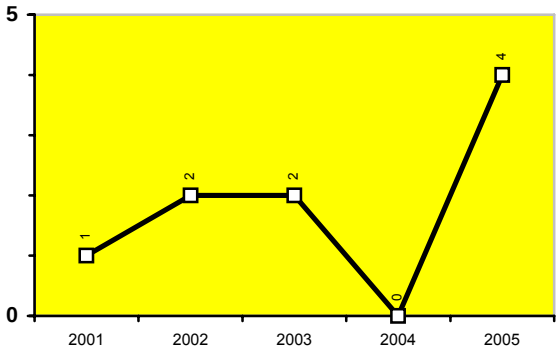
Numbers of publications



History – RCIO



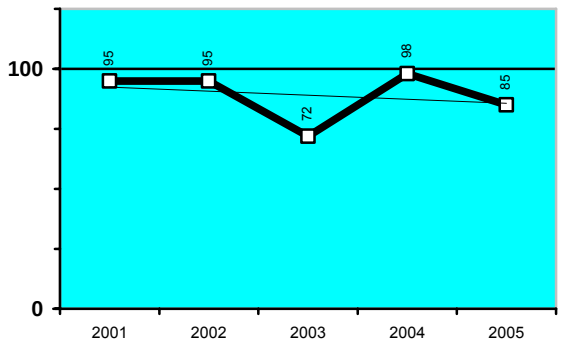
Numbers of publications



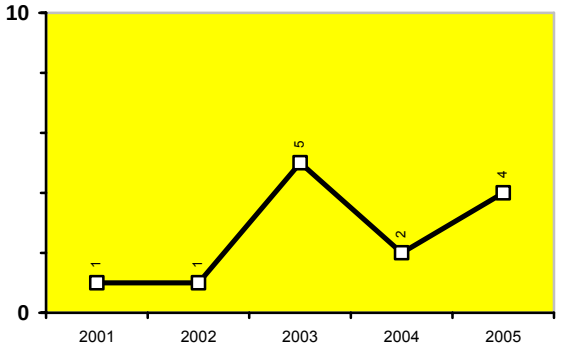
Most disciplines of social and human sciences in Czechia are considerably below the average when measured by RCIO indicator in the Thomson ISI system of discipline evaluation. RCIO value for economics moved around 10% of the world database average in the monitored years. Neither can be marked as satisfactory the number of publications, when taking into account the scope of economics as a discipline and number of workers concerned with it in Czechia. The disciplines of pedagogy and history attained RCIO values higher than average of the world database in three and two years respectively, but with a minimum number of publications. The worst level of publishing activity is reported by law.

Environmental Sciences

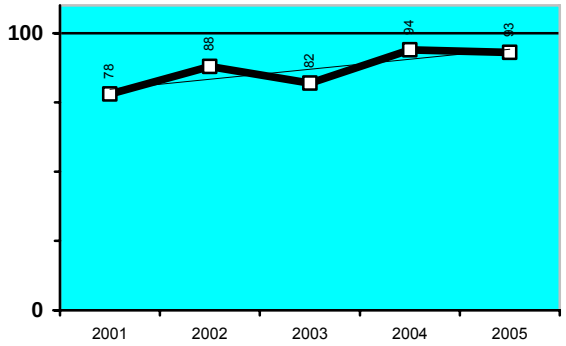
Environmental studies, geography, developing countries - RCIO



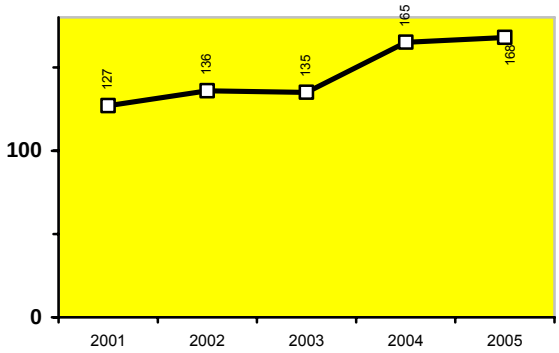
Numbers of publications



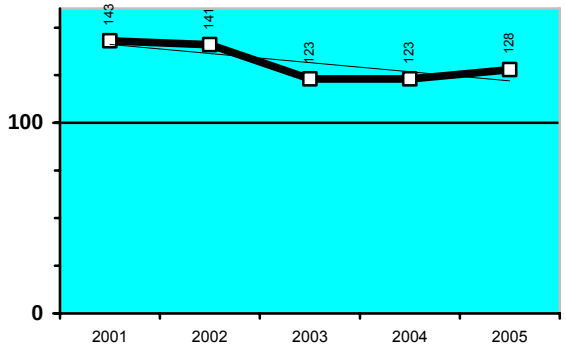
Environment, ecology - RCIO



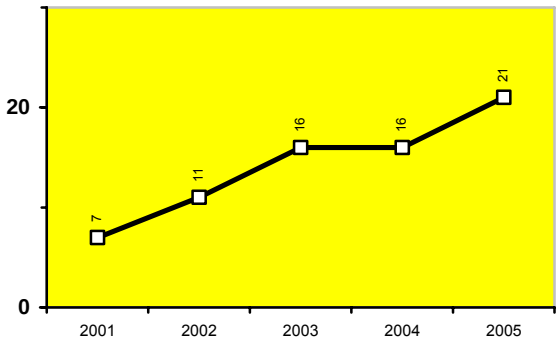
Numbers of publications



Environmental engineering, power engineering - RCIO



Numbers of publications



From among the above three disciplines of environmental sciences, the best results are attained by Czech research workers dealing with environmental and power engineering. RCIO has been exceeding the discipline's average in the world database over the whole period 2001-2005, While numbers of publications were growing in the monitored period, they are still very low (21 publications in 2005). The RCIO values for environment and ecology were slightly below the world database average over the whole period. Numbers of publications are relatively high.

III.3. Invention applications, granted patents

The numbers of invention applications (patents) or numbers of granted patents respectively are generally considered to be one of indicators of the R&D success rate. The inventions basically arise as products of research and development. It does not matter that many times there can be a great time lag between the research and development works and the grant of a patent. In Czechia, and basically in all new EU Members States, the discussions relatively often reveal oversimplifying approaches taken to the indicator of the number of applications or granted patents. Very often R&D entities complain of very complicated patent granting procedures and high financial demands of patent acquisition and maintenance. It is difficult to enforce the concept that not the number of applications or granted patents as such, but the economic benefit from obtaining a competitive advantage on the market on the basis of legal protection of an invention by patent or from the sale of licence is what counts.

At present, there are two systems protecting the inventions in Europe: the system of European patents and the national patent systems. The first one is based upon the Convention on the Grant of European Patents (the "Munich Convention"). The national patent systems are based upon the national patent rights of respective countries. In both

systems it is possible to use the Patent Cooperation Treaty (PCT), with essential part of the patent granting procedure taking place at international level.

The Convention on the Grant of European Patents or the European Patent Convention was signed in October 1973 in Munich and took effect on October 7, 1977. It established a single system for patent granting for all Treaty states, on the basis of which the applicant may acquire the invention protection, with one patent application and by common procedure, in all Treaty states that he/she identifies in the European patent application[2]. Once a European patent is granted, the invention is protected in these countries in the same way as by national patents. The Convention on the Grant of European Patents set up the European Patent Organisation (as its legislative body) and the European Patent Office (as its executive body)[3].

The already mentioned Patent Cooperation Treaty (PCT) was signed on June 19, 1970 in Washington. It took effect on January 28, 1978. According to PCT, the international application has the same effect in all treaty states as the national application. The PCT administrator is the World Intellectual Property Organisation – WIPO. At present, WIPO has 183 member states[4]. One hundred and thirty-three of them are PCT member states. Within the so called international phase of the procedure, the object of international application is subjected to search on the state of the art, and/or the preliminary inquiry on patentability, if necessary. These are then used in the so called national or regional phase of procedure before national or regional patent offices (e.g. EPO), where the procedure on grant of national or regional patents is finished[5].

Besides the already existing systems, the introduction of the Community patent at the EU level has been under preparation for many years now (based originally on the 1975 Luxembourg Convention). Its adoption is obstructed by certain live questions, particularly as far as the language regime is concerned. Its adoption would create a unitary (common) and autonomous system of patents for the whole EU. Despite efforts of the EU bodies, the Community patent looks unlikely to be implemented in the near future.

This part of Chapter III follows up with 2004 and 2005 analyses. It contains data on the numbers of patents being applied (invention applications) in 2001, 2003 and 2005 at the Industrial Property Office (IPO) of CR, the European Patent Office (EPO) and the U.S. Patent and Trademark Office (USPTO) and on the numbers of patents being granted by these offices. In many cases, data from 2001 and 2003 were put more precisely. Data were taken from the annual reports of the respective patent offices for 2005. In the view of the extended scope of the presented analysis, this part includes also applications of utility models (designs) with IPO. The utility model provides protection to technical solutions that are generally applied to innovations of lower levels. The Czech patent act terminology, that uses the term “invention application”, is maintained as well as the EPO and USPTO terminologies that use the name “patent application”.

Data are in compliance with both the OECD and Eurostat methodology for R&D evaluation as converted to one million inhabitants of respective country. Sometimes, the numbers of patents as converted to the number of employed persons are used in abroad.

Table III.3.1 Invention applications filed in a national way at the Industrial Property Office of CR (number)

	Applications in total	Domestic applicants	Foreign applicants	Of this international PCT applications
2001	4 733	578	4 155	3 370

[2] Typically, it takes a little longer than four years to grant a patent. For other information on the European patent granting procedure see www.epo.org.
[3] See the European Patent Office (EPO) website http://www.european-patent-office.org.
[4] See the list of members on http://www.wipo.org/membres/membres/index.html.
[5] For additional information on PCT system see the notes on methodology in the Eurostat reference data bank *NewCronos,* Theme 9, Domain: patents.

2002	4 277	528	3 749	3 200
2003	3 579	627	2 952	2 745
2004	1 252	619	633	524
2005	830	586	244	145

Source: IPO CR 2005 Annual Report

The accession of Czechia to the European Patent Convention led to a decline in the number of applications filed both by domestic and foreign applicants. This decline was more significant in case of foreign applicants. More than half of applications of foreign applicants are filed under the Patent Cooperation Treaty (PCT).

This decline is compensated by a dynamic growth in patent applications filed with the European Patent Office (EPO), for which Czechia is designated as a country with intended (applied for) protection. In 2003 and 2004, thus filed patent applications always doubled their numbers.

Table III.3.2 – European patent applications, in which Czechia is designated

	2002	2003	2004
Number	25 928	50 419	100 658

Source: IPO CR 2005 Annual Report

Table III.3.3 Patents granted in Czechia (number)

	2001	2003	2005
Patents granted in the "national" way	1 719	1 802	1 551
Of this: to domestic applicants	241	259	349
Of this: to foreign applicants	1 478	1 543	1 202
EP – validated since 2003		3	753
In total	1 719	1 805	2 304

Source: IPO CR 2005 Annual Report

The numbers of patents granted in the national way decline as well (both patents granted to domestic and foreign applicants). This decline is caused by accession of Czechia to the European patent system. By contrast, the number of patents granted by EPO with effect in Czechia has increased. In 2005, the share of European patents effective in Czechia (validated – the patent's owner delivered the translation of the patent document to the Czech language and paid the administrative charges) was nearly half the number of patents granted in the national way.

Table III.3.4 – European patents with effects in Czechia

	2003	2004	2005
Number	18	876	5 077
Of this: validated	3	102	753

Source: IPO CR 2005 Annual Report

Table III.3.5 Patents granted and validated in Czechia classified by selected countries

	2001	2003	2005
Czechia	241	259	349
Germany	507	541	755 (411 + 344)

USA	298	272	271 (212 + 59)
France	94	105	181 (107 + 74)
Switzerland	93	112	106 (71 + 35)

Source: IPO CR 2005 Annual Report

Besides Czechia, the table shows countries with the highest numbers of granted and validated patents. The numbers of patents granted to entities from Germany, USA and Switzerland went down in 2005 when compared with 2003. The numbers of patents validated in Czechia are relatively high for Germany and France (second number in brackets is for 2005). The number of validated patents is expected to grow quickly. The rising interest of German applicants shows evidence of growing German investments in Czechia.

Table III.3.6 Applications of utility models in Czechia (IPO)

	2001	2003	2005
Domestic applicants	1091	1066	1105
Foreign applicants	75	51	80
Applications in total	1166	1117	1185

Source: IPO CR 2005 Annual Report

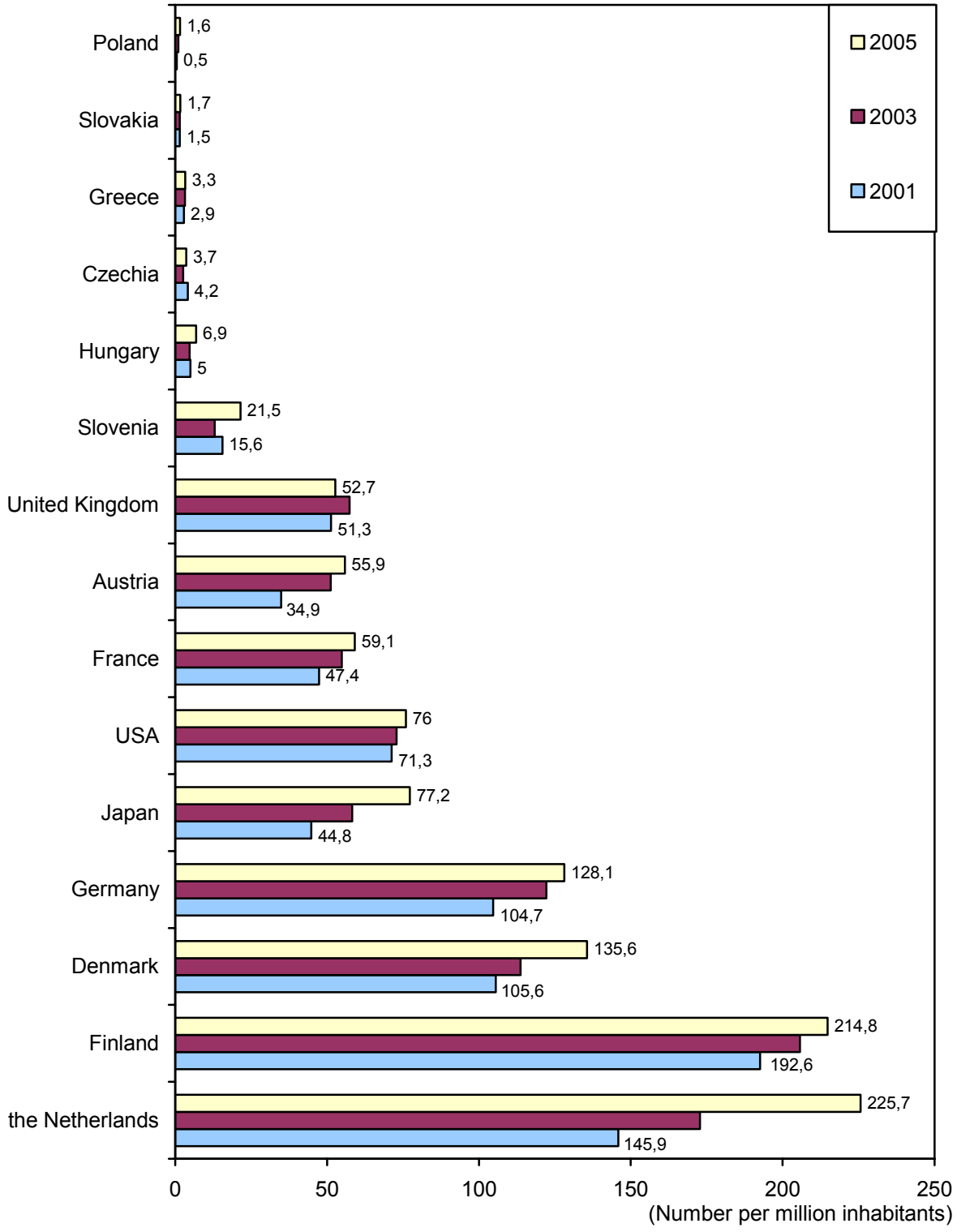
As mentioned at the beginning of this part, utility model applications can be considered as a relatively objective indicator of the innovation activity level. Protection by form of a utility model is provided by IPO CR and other ca 40 states. The main difference against the patent protection is that the utility model cannot protect the ways of manufacturing or working activity and biological reproductive materials. Another differences lie in lower requirements for creative level of the protected solution, absence of factual survey prior to entry, length of protection validity and amount of administrative charges. The numbers of utility model applications remain substantially unchanged in 2001, 2003 and 2005.

Conclusions on inventiveness and innovation potential of respective countries can be drawn from the number of applications and patents granted by the major patent offices like the European Patent Office (EPO), U.S. Patent and Trademark Office (USPTO) and Japan Patent Office (JPO). The patent applications and patents granted by the European Patent Office are included in regular evaluations of research and development made by OECD[6]. The numbers of patents obtained at EPO and USPTO are also included in annual evaluations of innovation activity of the EU Member States produced by the European Commission[7].

Graph III.3.1 on the following page shows the numbers of patent applications filed with EPO for selected countries as converted to one million inhabitants of these countries. More than 100 patent applications per one million inhabitants are reported by the Netherlands, Finland, Denmark and Germany. The numbers of patent applications from selected new EU Member States and Greece are lower in one order than from most of the selected EU-15 countries. The numbers of patent applications for new EU Member States basically stagnated in the monitored years; in most of the selected EU-15 countries they grew, with the Netherlands showing the quickest pace.

[6] Main Science and Technology Indicators (MSTI), OECD.
[7] European Innovation Scoreboard.

III.3.1 Patent applications filed with EPO (number of applications per one million inhabitants)



Source: European Patent Office Yearbooks, 2001 to 2005, Section of Statistics – total numbers of applications; Research and Development Council – conversions to one million inhabitants according to OECD in Figures 2005

Graph III.3.2 shows the numbers of patents granted by EPO to applicants from selected countries in 2001, 2003 and 2005. Values can be characterised in basically the same way as for Graph III.3.1 showing the number of applications: new EU Members States and Greece lagging well behind other evaluated EU-15 states and leading positions taken by the Netherlands, Finland and Germany. The first place in granted patents is occupied by Finland. The numbers of patents granted in 2005 to selected EU-15 countries and USA, with the exception of Finland, went down against 2003. The numbers of patents granted to applicants from selected new Member States, with the exception of Slovenia, are so low that it is not possible to draw any concrete conclusions from their development.

Graphs III.3.3 and III.3.4 show numbers of patent applications and patents granted by USPTO to the same set of countries in 2001, 2003 and 2005. USA and Japan are markedly dominant in both applications and granted patents. In the set of selected EU Member States, Finland is the first in both cases (356 patent applications per million inhabitants and 149.6 granted patents per million inhabitants – both figures for 2005). This lagging behind of the new EU Member States and Greece is similar like in case of applications and patents granted by EPO.

The reasons behind this backwardness of new EU Member States remain unchanged: Export of industrial products, which contributes to a relative favourable growth of their economy, is still based on prices determined by lower manufacturing cost; sale of “novelties” protected by patents is low; protection of industrial rights is underestimated; collaboration of organisations producing patentable R&D knowledge (universities, state research institutions) with industrial sphere is insufficient. Also the relative complexity and financial demands of patenting play its roles. Large, often supranational companies file hundreds of patent applications each year and have established strong and well-qualified capacities for ensuring the protection of industrial rights.

Following table shows three major patent applicants with EPO in 2005.

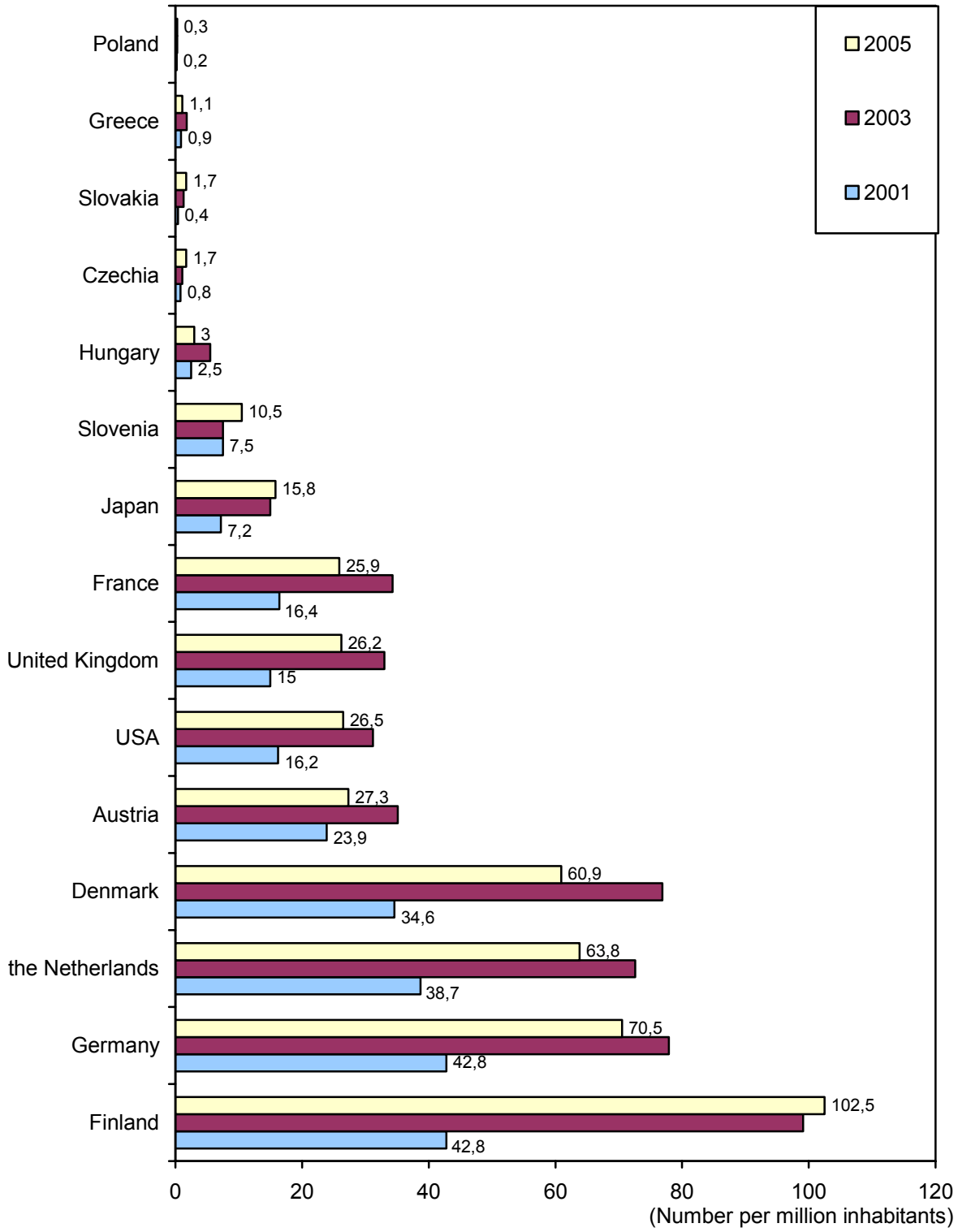
Table III.3.7 Major patent applicants with EPO

Place	Company	Number of patent applications
1.	Philips	4 883
2.	Siemens	1 863
3.	Samsung Electronic	1 585

Source: European Patent Office Yearbook 2005

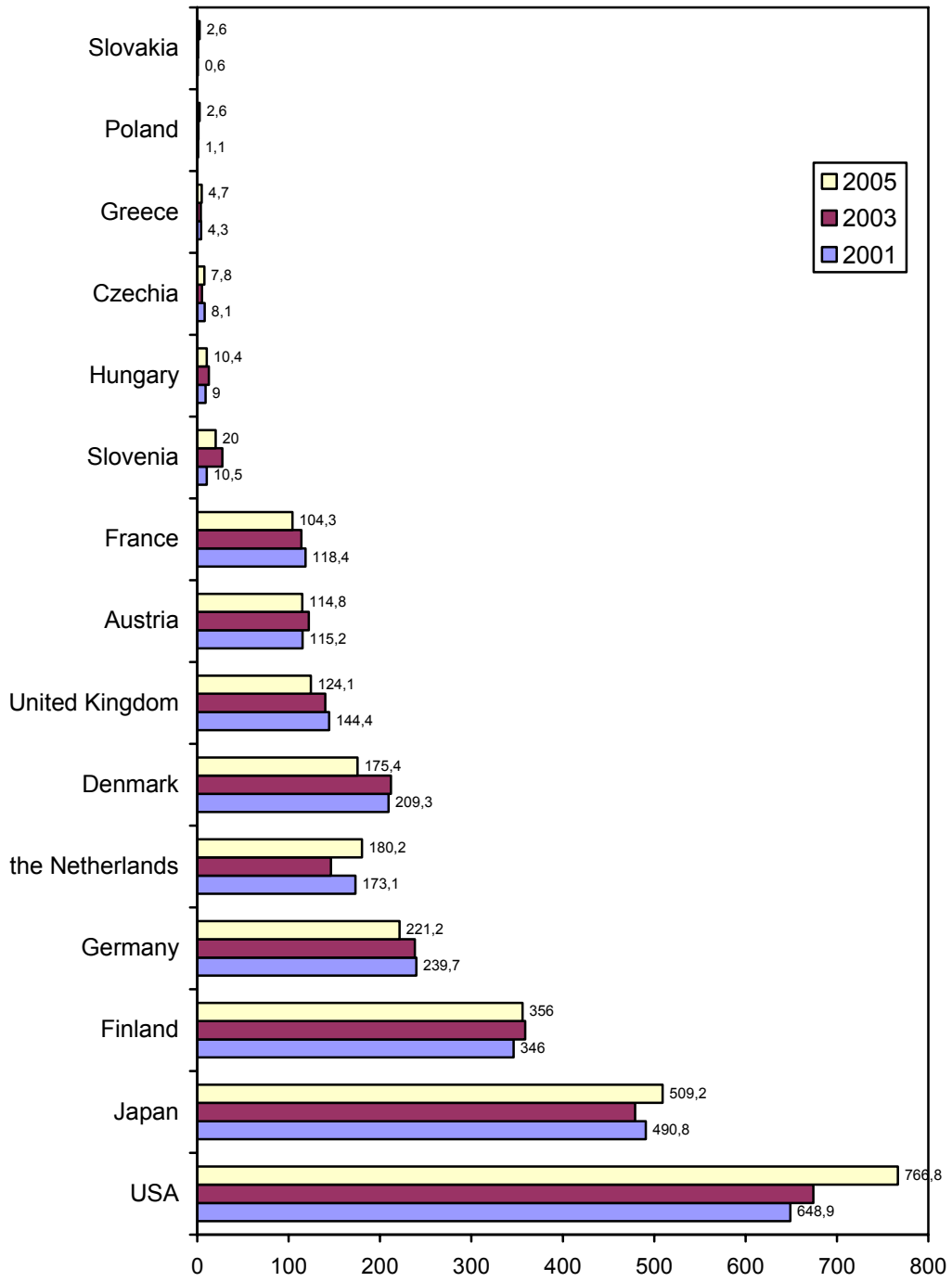
The eleventh place is occupied by the Finnish company Nokia with 668 filed patent applications, which is more than half of all patent applications from Finland and more in order than all patent applications of Czech applicants.

III.3.2 Patents granted by EPO (number of patents per one million inhabitants)



Source: European Patent Office Yearbooks, 2001 to 2005, Section of Statistics – total numbers of granted patents; Research and Development Council – conversions to one million inhabitants according to OECD in Figures 2005

III.3.3 Patent applications filed with USPTO (number of applications per one million inhabitants)

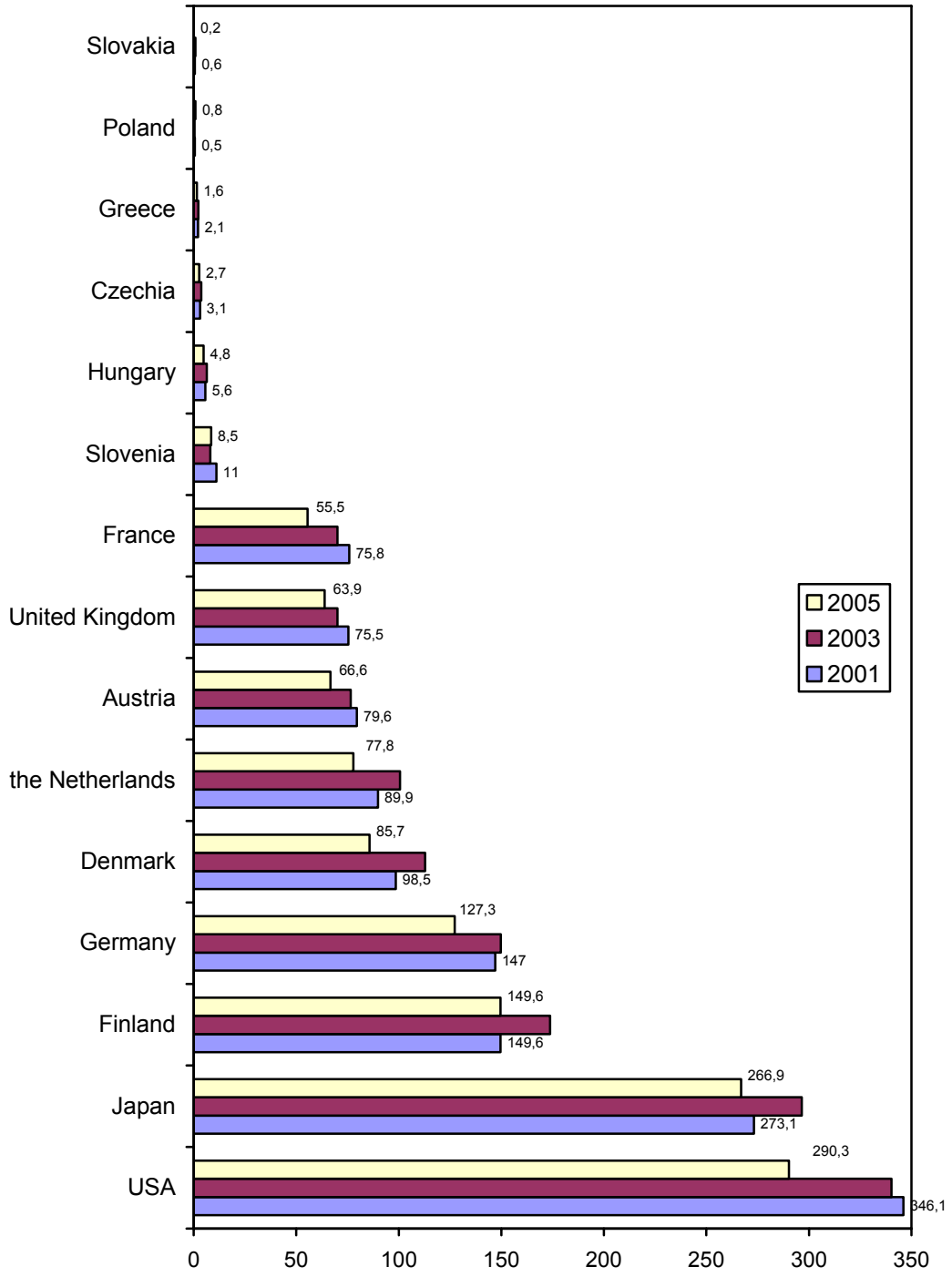


Source: Numbers of patent applications – U.S. Patent and Trademark Office (USPTO); Performance and Accountability Report Fiscal Year 2005; Research and Development Council – conversions to one million inhabitants according to OECD in Figures 2005

Date for 2005 ─ only preliminary figures

Data for certain countries were put more precisely in comparison with 2005 R&D Analysis.

III.3.4 Patents granted by USPTO (number of patents per one million inhabitants)



Source: Number of granted patents – U.S. Patent and Trademark Office (USPTO); Performance and Accountability Report Fiscal Year 2005. Research and Development Council – conversions to one million inhabitants according to OECD in Figures 2005

Date for 2005 – only preliminary figures

Data for certain countries were put more precisely in comparison with 2005 R&D Analysis.

Besides summary statistics concerning the overall numbers of patents, also patents in various categories like high-tech, information and communication technologies, and biotechnologies are monitored. The monitoring covers both invention applications (patents) and granted patents. The category of high technology includes following groups of the International Patent Classification: AVI – Aviation; CAB – Computers and automated business equipment; CTE – Communication technologies; LSR – Lasers; MGE – Micro-organisms and genetic engineering; SMC – Semi-conductors. Same system has been implemented by the Industrial Property Office of CR, too.

Table III.3.8 – Share of high-tech invention applications in the overall number of applications filed with IPO CR (%)

	2001	2003	2005
Share (%)	7.6	6.0	28.3

Source: IPO CR 2005 Annual Report; Secretariat of the Research and Development Council – calculation of shares

The table shows shares in the overall number of invention applications filed in the national way. The increase of the share to nearly 30 % in 2005 is influenced by the time lag as a result of a marked decline in the total number of invention applications in 2004 and 2005 (see also Table III.3.1).

The following table shows shares of high-tech patent applications filed with EPO in the overall number of applications in 2002.

Table III.3.9 – Share of high-tech patent applications in the overall number of applications filed with EPO (%)

	USA	The Netherlands	Japan	UK	France	Greece	Denmark	Germany	Austria	Hungary	Poland	Slovakia	Slovenia	Czechia
Share (%)	29.8	28.0	25.5	22.5	21.4	20.1	18.0	15.0	14.6	14.0	12.5	10.3	9.0	6.2

Source: Eurostat; Statistics in Focus 3/2006, Patent applications to the EPO at National level

Inventions in the field of high technology usually arise on the basis of research and development. It is therefore possible to say that they are more objective measure of the level of research and development than the overall numbers of patent applications. Czechia reports the lowest share of high-tech invention applications (6.8 %) among the monitored countries. Hungary is the best among the new EU-25 Member States (14 %). In case of Japan, the Netherlands and USA, the share of patent applications from this area exceeds one fourth of the overall number of applied patents.