Government of the Czech Republic

Analysis of the Existing State of Research, Development and Innovation in the Czech Republic and a Comparison with the Situation Abroad in 2014

INTRODUCTION

SCIENCE IS NOT AN EXPENSE, IT IS AN INVESTMENT

"We need better cooperation between science and industry, we need to learn how better to transform new knowledge into cutting-edge technology and products."

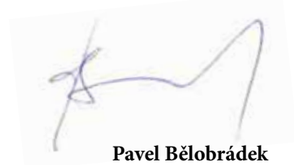
This analysis is the first that was not awarded externally but was developed directly by the Section of the Deputy Prime Minister for Science, Research and Innovation. It is also the first that does not simply describe the status quo, but also attempts to find solutions and compares the Czech Republic with other countries. The basic findings of this ground-breaking analysis are certainly interesting.

Thanks to this analysis we now know that, as far as aid for science and research is concerned, we are essentially on the same level as comparable western nations. It also shows that not only the volume, but also the quality of research is rising. However where we are lagging behind is in private investment into science and our ability to transform new scientific discoveries into new technologies and products which can be sold on global markets. At the same time, Czech research teams are underrepresented in international projects, which results in a situation where we cannot access funds from European research programmes.

The analysis also confirmed that our system of support for science, research and innovation is fragmented and lacks central coordination. This leads to inefficient use of European, national and regional resources and to duplication. This fact is an important reason for the establishment of an agency for science, which is currently under development.

Last, but not least, this analysis is the first to present the results of discussions between the so-called "sectoral platforms", which develop cooperation between research institutions and companies and provide estimates for the costs and sustainability of major research infrastructures (R&D&I centres) built with the help of European funds.

I think the authors of this analysis have done a good job, establishing a base from which we can progress further. For my part, their conclusions have confirmed what I have been saying for a long time, that we have a strong industrial and scientific base and modern research infrastructure. We do not even have a fatal lack of money, which is almost unique in the Czech environment. Unfortunately, our entrepreneurs and researchers are unable to work together and we are not always able to apply the money invested efficiently. My goal is therefore to ensure that all the elements of the "scientific and industrial complex" fit together and that science becomes a driving force for the national economy, a force which will use innovation to accelerate economic growth, which will be able to transform new discoveries into ground-breaking technologies and state-of-the-art hi-tech products, which can fundamentally improve our quality of life. Science is not a budgetary expense, science is the best investment in our common future.



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SUMMARY

The Analysis of the Existing State of Research, Development and Innovation in the Czech Republic and a Comparison with the Situation Abroad in 2014 has reached the following most significant findings that are commented on in detail further in the text and complemented with graphical outputs.

CHAPTER FINANCIAL FLOWS:

- The total expenditure on Research, Development and Innovation (RDI) in the Czech Republic amounted nearly to CZK 78 billion in 2013, which represents 1.91 % of the gross domestic product.

- Year-on-year GERD have been increasing, only in the last year the growth was not as intensive as in the previous years.

- When compared internationally, the Czech Republic is in the European average in terms of GERD.

- The group of states comparable to the Czech Republic also includes strong economies, such as the Netherlands, Belgium and France. The Czech Republic has even surpassed Great Britain, Norway and Ireland.

- Foreign public finances are the GERD element undergoing the most intensive increase, mostly due to the influence of the ESF.

- The goal of the Czech Republic within the Europe 2020 strategy in the form of annual public RDI investment of 1 % GDP is fulfilled thanks to the ESF, which provides 0.3 % of GDP.

- Business sources are used almost exclusively in the business sector; the support of public RDI was very low, the sum for the higher education and government sectors amounted to less than CZK 1 billion.

- Public funds were directed mostly to the public sector (CZK 12.5 billion to higher education and CZK 9.5 billion to government). The business sector was allocated almost CZK 5 billion. About 68 % of this allocation is used by manufacturing companies, 55 % by SMEs.

- In relation to public funds, the business sector in the Czech Republic is also supported indirectly by tax incentives. Indirect RDI support within the business sector amounted to CZK 2.3 billion in 2013; year-on-year comparison shows increasing trend in the number of entities exploiting the indirect support as well as in the total amount saved. However, this form of support is used mainly by large enterprises (70 % in 2013).

- When the RDI support in the business sector is compared internationally, taking both direct and indirect support in the Czech Republic into account, the situation in the Czech Republic is similar to the situation in Austria, Hungary and Norway.

- The disproportion in distribution of the individual financial resources between sectors performing RDI mark poor cooperation of businesses with the public sector, although this cooperation is supported from the state budget.

- The initiation stage of cooperation funded from the state budget did not increase the trust of the business sector towards the public sector that would demonstrate as an increase of business capital in public research.

CHAPTER FUNDING RDI FROM THE STATE BUDGET:

- The public national resources allocated for RDI execution in the Czech Republic are created mainly by the state budget for research, development and innovation, which amounted to CZK 26.6 billion in 2014.

- All arrangements concerning the elaboration of the state budget expenditure proposal and the medium-term outlook lie within the competence of the R&D Council.

- The proposal is divided into 11 budget chapters: Ministry of Education, Youth and Sports (MEYS), the Academy of Sciences of the Czech Republic (AS CR), Ministry of Industry and Trade (MIT), Ministry of Health (MH), Ministry of the Interior (MI), Ministry of Defence (MD), Ministry of Agriculture (MA), Ministry of Culture (MC), Czech Science Foundation (CZSF), Technology Agency of the Czech Republic (TA CR) and Office of the Government of the Czech Republic (OG CR).

- Two working groups were established in 2014 with the aim to precise communication with the particular budget chapters during elaboration of the state budget proposal; the working groups are coordinated by the Department of Science, Research and Innovation of the Office of the Government of the Czech Republic.

- 7 financial instruments of different nature are used to distribute the state budget resources under the Act on Support of Research, Experimental Development and Innovation from Public Funds.

- The institutions executing research and development are financed from multiple sources; the proportion of competitive funding financial instrument prevails in the long run over the Performance-basedfunding instruments, even in the public sector (government and higher education).

- In the Czech Republic the institutional support is provided mostly by MEYS (about CZK 7.5 billion to universities in 2014) and the Academy of Sciences of the Czech Republic (CZK 3 billion for the departments of the Academy of Sciences in 2014).

- Special-purpose support is provided mostly by the Czech Science Foundation (exploited mostly by universities and departments of the Academy of Sciences), the Technology Agency (directed mostly to businesses and universities) and MEYS (the largest part to universities).

- The special-purpose support of other Ministries allocated to founded is successfully exploited by universities as well.

- The system of support from the state budget is fragmented due to the combination of many providers and a large number of financial instruments.

- As far as the individual fields are concerned, the special-purpose support in the Czech Republic is directed in particular to the fields of Industry, Social Sciences and Humanities, Life Sciences and Medical Sciences (the support for each field exceeded CZK 1 billion in 2014).

- Within the particular scientific fields, the most supported ones were Genetics and Molecular Biology, Electronics and Optoelectronics, Electrical Engineering, Non-Nuclear and Nuclear Power Engineering, Art, Architecture, Cultural Heritage as well as Oncology and Haematology.

- The institutional support cannot be currently reliably divided according to the particular fields due to missing data on distribution within the entities, in particular universities.

- It is currently very difficult to interpret the volume of support in relation to the results and their quality because of different field division in the Czech Research, Development and Innovation Information System (RDI IS) and in international databases. Besides, the field groups are formed differently for the purposes of records and for the purposes of evaluation.

CHAPTER RDI SUPPORT IN THE CZECH REPUBLIC FROM EUROPEAN FUNDS:

- Foreign public resources constitute a significant element of RDI funding in the Czech Republic (nearly CZK 12.58 billion in 2013), and they keep growing year-on-year. Operational programmes are the main sources. The Horizon 2020 framework programme also presents great potential.

- In the selected areas of support within five operational programmes with direct connection to RDI decisions concerning 3,600 projects were issued by the end of the first quarter of 2015, in the amount of CZK 98.63 billion.

- The largest share of the support is provided within the Research and Development for Innovations Operational Programme (CZK 49.41 billion) and the Enterprise and Innovation Operational Programme (CZK 35.91 billion).

- RIS 3 is aimed at efficient direction of all available financial resources to the R&D sphere and the goal of the strategy is to allocate these resources effectively into areas identified as the most perspective ones for exploitation of the knowledge and innovation potential of the Czech Republic.

- The budget of the EU Research and Innovation Framework Programme – Horizon 2020 – was approved in the middle of 2013, providing over EUR 77.028 billion. The Czech Republic has reached a total project success rate of 18.1 % and the financial support of about EUR 38,215 thousand.

CHAPTER HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT:

- The significance of human resources for research and development is apparent, among other things, from the body of statistical data collected in relation to human resources. However, certain information is missing, e.g. data on the labour market in the Research and Development sphere, age structure, employee turnover as well as detailed gender statistics.

- The total number of R&D employees as of 31 December 2013 was 92,714. This represents an increase by 5.9 % when compared to the previous year.

- The majority of the employees are researchers (approximately 55 %), followed by technical workers (about 30 %) and other workers (15 %).

- The highest numbers of R&D employees are shown within the business sector (nearly 50 % share in the total R&D employment rate), the most researchers work in the higher education sector (23 thousand in 2013).

- The number of researchers has grown year-on-year in the business sector, while stagnating in the government sector.

- When compared internationally, the number of Research and Development employees in the Czech Republic is close to the numbers of Belgium or France, which also demonstrate, same as the Czech Republic, a slight dominance of employees in the business sector over the public sector (higher education and government).

- The higher education sector is unambiguously dominated by researchers with doctoral degrees (65 % in 2013), in the business sector, on the other hand, there are only 10 % of researchers with doctoral degree and their ratio has not been increasing considerably.

- In technical and natural sciences there is a significantly higher ratio of researchers to students in doctoral programmes (about three times higher) than in Social sciences and Humanities, where the number of students exceeds the number of researchers.

- There is ongoing gender imbalance of research workers, namely in the business sector (85 % of researchers are men).

CHAPTER RDI INFRASTRUCTURES:

- The RDI infrastructures are areas where all segments of the innovation chain are efficiently connected, places for interaction of entities engaged in education and public research as well as the business sphere with the final effect of goods and services with high added value.

- The infrastructures can be considered the fundamental element of the RDI basis in the Czech Republic; however, they do not have legal personality.

- Similarly to entities executing RDI, the infrastructures in the Czech Republic are funded from multiple public, business, national and foreign sources.

- In 2005–2014 nearly CZK 84 billion were expended to support 289 projects related to the RDI infrastructures, over CZK 34.5 billion coming from the state budget.

- The ESF resources constitute a significant financial source for creation and development. The foundation of 8 European Centres of Excellence and 40 Regional Research and Development Centres was supported by more than CZK 41 billion, mostly from the resources within OP RDI.

- In terms of both the number of projects and the financial volume, the dominant support beneficiaries are entities / divisions focused on natural sciences, technical and medical sciences.

- A large number of infrastructures in the Czech Republic demonstrate the potential to improve the RDI quality and competitiveness; however, at the same time it places heavy demands on finance and qualified human resources in the future.

- The operating needs of the most significant infrastructures in the Czech Republic are funded from the state budget by means of a special instrument, the so-called Large Infrastructure Projects. In order to select suitable infrastructures, an international evaluation took place in 2014, which recommended funding of 58 infrastructures (42 of them as high-priority).

- So far there is a lack in connection of the infrastructures to the research and development needs of the most significant areas of national economy.

CHAPTER RESULTS OF RESEARCH AND DEVELOPMENT:

- The types of results collected at the central level in the Research, Development and Innovation Information System (RDI IS) are defined in the Czech Republic. These results can be divided into the group of publication and non-publication results, which is further divided into applied results and other results.

- The creation of results in the Czech Republic has been showing a long-term upward trend. The number of publication results has been increasing as well as the number of applied results; the maximum was reached in 2012.

- The largest number of results positively originates within Socials ciences and Humanities (mostly publications), with Industry being the second most significant group of fields as far as the number of results is concerned.

- The largest proportion of results in the particular field groups is demonstrated by universities, mostly those aimed at engineering and science.

- In the long run there have been a low proportion of applied results in the total number of results (currently less than 11 %). Moreover, there are very few patents within the applied results.

- The ratio of applied results is the most significant; however, it does not reach 50 %.

- The quality of publications has risen year-on-year as well as the level of international cooperation.

- As far as quality is concerned, there is an apparent increase in the proportion of publications in periodicals indexed in Web of Science. The largest number of such publications is produced by universities, in comparison to other publications by the departments of the Academy of Sciences.

- The highest number of quality publications originates in the fields of Biological Sciences, Chemical Sciences, Physical Sciences and Astronomy and Clinical Medicine. Furthermore, the publications in Clinical Medicine as well as Physics and Astronomy are significantly more quoted when compared to the global average.

- In terms of international cooperation measured by the numbers of collaborative publications, the Czech Republic is at a level comparable e.g. to Germany and Great Britain, slightly exceeding Italy and Spain. However, it falls markedly behind states such as Denmark, Belgium, Austria or Switzerland.

- Most joint publications created by Czech scientists are the results of collaboration with researchers from the United States, Germany, Britain and France. The assessment of the quality of the results and its relation to providing state budget resources to entities that created them has not been designed to a satisfactory degree, namely in applied research. The benefits of applied research and experimental development have not been quantified.

CHAPTER INNOVATION PERFORMANCE OF CZECH ECONOMY AND ITS I NTERNATIONAL COMPARISON:

- The assessment of innovation performance of the economy utilizes simple indicators as well as indicators composed of up to several tens of partial indicators.

- Based on simple indicators, such as knowledge intensity derived from the total RDI expenses, the Czech Republic exceeds states such as Poland and Hungary, on the other hand, lacks significantly when compared to the stronger economies, such as Germany and Austria.

- More credible comparison is provided by complex indicators, the most respected ones being the Summary Innovation Index (SII) and the Innovation Output Indicator (IOI). These indicators differ mostly in the approach to public sector investments into the RDI sector and education.

- Based on the SII complex indicator the EU Member States are divided into 4 groups according to the level of economy innovation – Innovation Leaders, Innovation Followers, Moderate Innovators and Modest Innovators. The Czech Republic falls into the group of “Moderate Innovators”. The Czech Republic is at a level comparable to Spain and Italy, significantly lags behind Sweden, Germany, Denmark, the Netherlands, Belgium and Austria. Based on the year-on-year development the position of the Czech Republic cannot be expected to improve considerably and the Czech Republic is not likely going to move to the higher group of "Innovation Followers", e.g. to the level of Austria.

- The Czech Republic falls behind Austria mainly in venture capital investments (more substantial year-on-year decrease than in Austria), the number of international patents and cooperation among innovating SMEs (decrease in the Czech Republic, increase in Austria). On the other hand, the RDI expenditure (both public and business) are growing faster in the Czech Republic.

- Based on the IOI indicator, the Czech Republic reaches values one third to one half lower than the countries that regularly take the top places in innovation and competitiveness charts.

- According to the partial IOI indicators, the Czech Republic exceeds the European average and the level of Austria in innovation of fast growing businesses and in the export of high-tech and medium-tech goods. On the contrary, the Czech Republic lacks in the number of international patent applications the most.

CHAPTER SECTORS OF NATIONAL ECONOMY IN RELATION TO RDI:

- The Czech economy is driven by enterprises manufacturing products with high added value, which invest great amounts of financial resources in their own research, development and innovations.

- The RIS 3 aimed at efficient direction of financial resources (European, national and private) to these purposes should be one of the instruments of effective management of the RDI sphere at the national and regional level.

- Therefore the significant sectors of the Czech economy have been identified based on the GDP contribution and the intensity of research and development measured by the amount of expended financial resources.

- However, the above method shows certain deficiencies: the data limit in relation to using aggregated data, the fact that no other entity aspects are taken into account apart from the financial one or the fact that newly formed industries based on the newest technologies are not included.

- The proposal of field-specific financial support according to the analysis that is limited to the known structure of special-purpose support thus does not reflect the importance of the field in national economy.

- The field specification of the institutional support and foreign financial resources cannot yet be objectively determined. A transformation of this situation is one of the RIS 3 strategy goals.

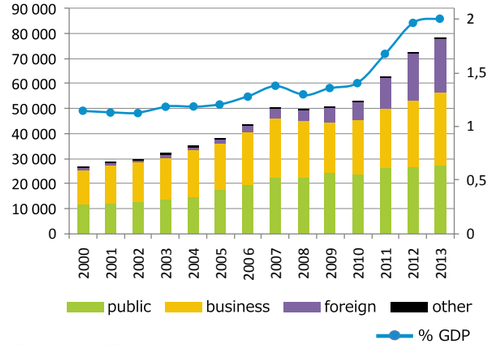
- For this reason the RDI Department of the Office of the Government has set up 10 sector platforms as a pilot project for finding sector priorities and trends within the respective fields while accounting for the R&D expenses in the business sector fields, as well as strategic relations and the use of the latest technologies.

INTERPRETATION PART

1. FINANCIAL FLOWS

The total expenditure on Research, Development and Innovation (RDI) in the Czech Republic amounted nearly to CZK 78 billion in 2013, (Figure 1.1). There was an increase of 7.6 % in comparison to 2012. The increase was caused mostly by the growth of foreign (12.7 %) and business (11.2 %) resources; national public resources increased only by 1.4 %. In relation to the gross domestic product, the aggregate RDI expenditure in 2013 reached 1.91 %, which nearly equals to the value of 2012 (1.88 %). The intensity of growth experienced in the previous years thus dropped.

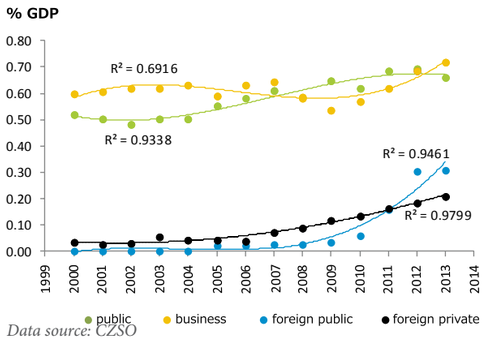
Figure 1.1: Total RDI expenditure (GERD) in the Czech Republic in 2000–2013 according to funding sources (in current prices)



Data source: CZSO

The progress of the respective GERD constituents according to funding sources in time is apparent from Figure 1.2. Public national resources showed upward trend till 2002 when the Act on Support of Research, Experimental Development and Innovation came into effect. However, in the last two years there has been obvious stagnation at values around 0.7 % GDP. The national business resources were growing slightly till 2008. Consequently, there was a sharp drop, probably as a reaction to the global economic crisis. However, since 2010 there has been an apparent year-on-year growth, which meant exceeding the value from 2008. There has been a slight steady increase in foreign private expenditure since 2007. Foreign public finance, coming mostly from the EU Structural Funds, has been a very significant RDI source in the last five years. Figure 1.2 demonstrates their rapid increase between 2010, 2011 and 2012 to 0.30% GDP. In 2013 the growth was not as substantial as in the previous years (0.31 % GDP). The Czech Republic has set a goal within the Europe 2020 of annual public RDI investment of 1 % GDP. However, today this goal is met solely thanks to foreign public resources (most notably the EU Structural Funds), which currently represent 0.3 % GDP. Expenditure from public budgets (state budget, regional self-government budgets) currently comprises only 0.7 % GDP. Therefore it is necessary to prepare the RDI system, in particular to set national public resources, for the period after 2020 when the ESI funds are not available.

Figure 1.2: Total RDI expenditure (GERD) funding sources in current prices expressed as GDP %



Data source: CZSO

In comparison to other countries, the Czech Republic falls into the global average considering the aggregate RDI expenditure expressed as GDP percentage (Figure 1.3). The group of states comparable to the Czech Republic also includes strong economies, such as the Netherlands, Belgium and France. The Czech Republic has even surpassed Great Britain, Norway and Ireland. Countries such as Poland, Slovakia and also Spain and Italy significantly lag behind the Czech Republic. Among the European countries that support RDI markedly more than the Czech Republic (around 3 % GDP) are Germany, Switzerland, Austria, Denmark, Finland and Sweden. The United States and Japan show similar

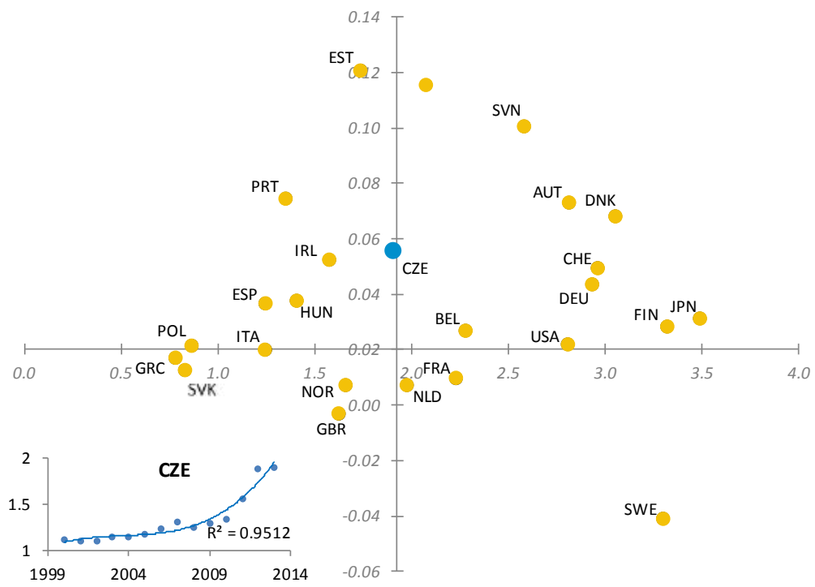
level of support. As far as the trend of total RDI support abroad is concerned, it is increasing in the majority of countries providing strong RDI support (with the exception of Sweden).

The most important source of finance for RDI execution in 2013 (Table 1.4) were national business resources exceeding CZK 29 billion. These were followed by public resources, i.e. mostly the state budget in the total amount of nearly CZK 27 billion. There was also a significant contribution from foreign sources, both public (CZK 12.5 billion) and private (CZK 8.5 billion).

Disproportion in distribution of the respective financial resources has been noticed between sectors performing RDI. Business sources were used almost exclusively in the business sector; the support of public RDI was very low, the sum for the higher education and government sectors amounted to less than CZK 1 billion. On the other hand, public funds, even though they were directed mostly to the public sector (CZK 12.5 billion to higher education and CZK 9.5 billion to government), were also directed to the business sector, which was allocated almost CZK 5 billion. However, the presented figure of CZK 5 billion for 2013 does not express the expenses of real manufacturing companies. The business sector also includes public companies1 (e.g. healthcare facilities, except for university hospitals or state enterprises) and certain entities complying with the definition of research organizations that are not parts of the higher education and government sectors but under the Act on Support of Research and Development from Public Funds they can be supported institutionally (e.g. the Institute for Clinical and Experimental Medicine, the National Centre for Research, Development and Testing of Aerospace). The above entities considerably distort the picture of RDI support in companies.

1) http://www.mfcr.cz/cs/verejny-sektor/hospodareni/rozpoctove-ramce-statisticke-informace/verejny-sektor/verejne-spolecnosti/2014/seznam-verejnych-spolecnosti-v-cr-rijen-17019

Figure 1.3: Total RDI expenditure (GERD) in 2000–2013 in the EU and OECD countries



Horizontal axis: GERD value in 2013 as GDP % | Vertical axis: increase / decrease intensity in 2000–2013 expressed as a regression straight line slope (positive value showing an upward trend, negative value showing a downward trend) | The intersection point marks the theoretical EU 28 position. | The part in the bottom left-hand corner demonstrates the progress in the Czech Republic in the respective years. | Data source: OECD – Main Science and Technology Indicators

Table 1.4: Financial Flows in RDI in 2013 (in millions of CZK)

		2013 – millions of CZK				
Entities performing RDI	Non-profit organizations	264	80	129	41	14
	Universities, university hospitals	20 793	417	12 529	7 830	17
	Departments of AS CR, department research organizations	14 240	465	9 449	2 845	1 481
	Companies, private research organizations	42 097	28 306	4 880	1 860	7 051
		TOTAL	29 269	26 987	12 576	8 563
			Domestic private	State budgets of CR	Public foreign	Private foreign
			Financial resources allocated to RDI			

The financial resources allocated to RDI do not include other resources (such as income in the form of student fees, journal subscriptions, publication activities) in the total amount of CZK 459 million of CZK | Data source: CZSO

A detailed analysis of the direct support of the business sector based on the data from RDI IS (after data harmonization2) for 2014 (Figure 1.5) shows that from the total support allocated to the business sector, which amounted to CZK 4.03 billion, CZK 369 million (9 %) was expended on support of long-term conceptual development of 27 entities complying with the definition of research organization3. The remaining CZK 3.66 billion was used for support of RDI projects; the sum of CZK 933 million (23 % of the total business sector support) was aimed at public enterprises, namely 140 entities, 54 large enterprises were allocated the amount of CZK 518 million (13 %) and 957 small and medium-sized enterprises (SMEs) gained resources amounting to CZK 2.21 billion (55 %).

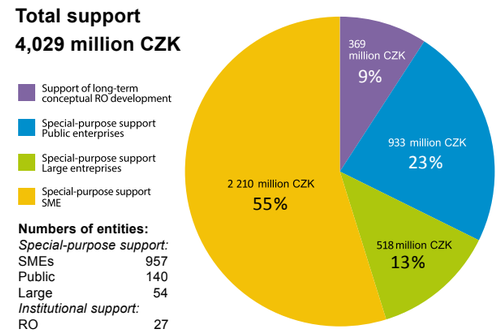
Public foreign resources were directed mostly to the higher education sector (nearly CZK 8 billion). The government sector has drawn nearly CZK 3 billion, the business sector has drawn nearly CZK 2 billion. This support is related mostly to drawing from the Operational Programmes, namely OP RDI (Research and Development for Innovations Operational Programme) and OPEI (Operational Programme Enterprise and Innovations).

Private foreign resources were directed mostly to enterprises (CZK 7 billion) and to the government sector (CZK 1.5 billion). For the most part they were used to pay the licence fees of the Institute of Organic Chemistry and Biochemistry AS CR, v.v.i.

2) RDI IS categorizes the entities differently. The data from RDI IS were converted to the CZSO categories used in the Annual Survey on Research and Development.

3) According to the Process of Research Organization Evaluation approved by the Research and Development Council at its 261st meeting on 28 January 2011

Figure 1.5: Direct support of RDI in the business sector from the state budget in 2014



Data source: RDI IS after adjustments of the entity categories in compliance with the methodology for the CZSO statistical findings

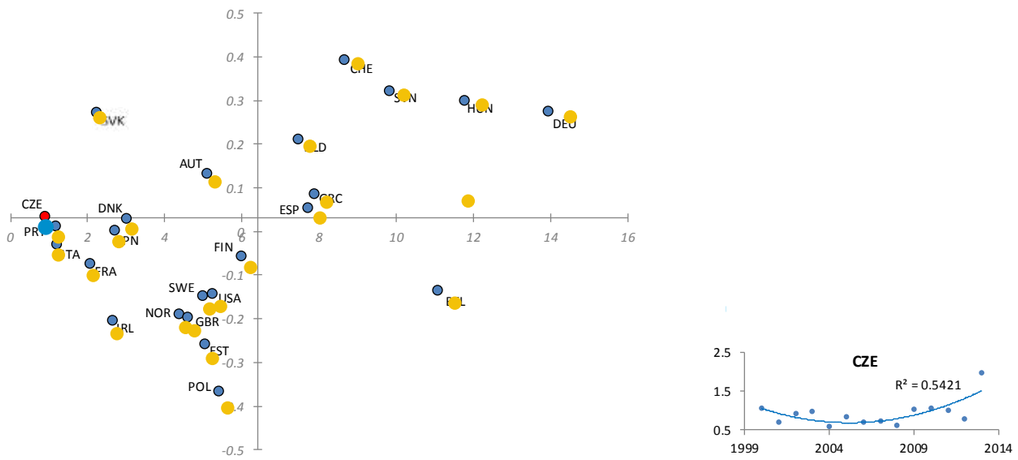
As demonstrated by Table 1.4, the business sector was able to operate with the greatest volume of funds in 2013, as the total exceeded CZK 42 billion, the major part of which was from its own (67 %) and from foreign business sources (17 %). Moreover, as much as 12 % of the funds were received by the business sector entities from the state budget and 4% from foreign public sources.

The higher education sector expended about CZK 21 billion on RDI; about 60 % from domestic public resources, 38 % from foreign public resources and only 2 % from business resources. From the CZK 14 billion expended by the government sector, 66% were from domestic public resources, 20 % from foreign public resources, 11 % from foreign business resources and only 3 % from domestic business resources.

When compared internationally, the imbalance of resources directed from businesses to public entities and the financial sources provided to businesses from the state budget is apparent. The low ratio of private resources for the public (high education and government) sector probably indicates the insufficiently functioning cooperation between the business and the public sectors in RDI performance. Both sectors have materially different notions of cooperation. The public sector itself tries to define the objectives and results of cooperation with regard to the development of science, whereas the business sector aims more towards a particular economic effect and the timeframe for achieving it. The inefficiency of the cooperation can also be caused by the fact that the business sector is saturated from public resources as far as its research needs go.

As for the ratio of domestic business resources provided to the public higher education sector (Figure 1.6), it is the lowest of all EU countries. The trend of this indicator in the period of 2000–2013 in the Czech Republic is constant, showing slight fluctuation between 0.6 and 1.1 %; the slight increase in the second half of the period is caused by the value in 2013 reaching nearly 2 %. However, even this amount is very low when compared to other EU countries (the mean value within the EU exceeding 6%). In the current situation of the RDI system, based on the trend no substantial improvement of the position of the Czech Republic is to be expected in the following years.

Figure 1.6: The ratio of business resources in the RDI expenditure within the higher education sector (HERD) in EU and OECD countries (in %)



Horizontal axis: mean value for 2000–2013 in % | Vertical axis: increase / decrease intensity in 2000–2013 expressed as a regression straight line slope (positive value showing an upward trend, negative value showing a downward trend) | The intersection point marks the theoretical EU 28 position. | The part in the bottom right-hand corner demonstrates the progress in the Czech Republic in the respective years. | Data source: OECD – Main Science and Technology Indicators

The following financial resources are included in the business resources:

- *Income from sales of research and development services (research for business needs)*
- Income from licence fees (e.g. patents, know-how)
- Other income (e.g. renting buildings and facilities, sales of property, paid courses, guidance and counselling, financial gifts).

The ratio of domestic business resources provided to the public sector is not as critically low as in the higher education sector (Figure 1.7). However, even in relation to this indicator, CR with the value of 6.5 % lags behind the mean value of the EU Member States (8 %). The support of the government sector from business resources is at a level comparable to the Czech Republic in France, Austria and Spain. However, unlike the above countries, the Czech Republic demonstrated a decreasing trend in 2002–2013 (from 10 % to 3 %), which is the third most substantial intensity in the EU. Without a strategic intervention at the national level, no improvements of the situation can be expected in the coming years. On the contrary, the ratio of business sector finance coming from the state budget in CR (Figure 1.8) is the second highest, after Slovakia. Unlike Slovakia, France, Italy and Poland, all of which are countries whose value in the 2000–2013 horizon exceeds 10 % despite the substantial decrease, the ratio in the Czech Republic demonstrated a constant trend. A more detailed look at the progress in the Czech Republic indicates a slight increase since the beginning of the period, with a maximum of 17 % in 2009. Only in the last four years of the specified period, there was a slight decrease under 15 %. The above parameters in the Czech Republic indicate the unwillingness of companies to cooperate with the public sector within RDI, even though this kind of cooperation is supported from the state budget. Whereas the support of the business sector from the state budget in 2000–2013 amounted to approximately 15 % of the volume of finance expended by the business sector on RDI (Figure 1.8), companies only supported the public sector by 1 % of the funds (Figure 1.6 for the higher education sector) and 6 % (Figure 1.7 for the government sector[4]) respectively, expended on RDI within the public sector. On the contrary, for instance in Germany the direct support of companies from the state budget amounted only to 4.5 % (Figure 1.8), with companies providing support of 14 % to the higher education sector (Figure 1.6) and 9 % to the government sector (Figure 1.7). The motivation effect does not seem to be fulfilled in the Czech Republic, as the initiation stage of cooperation funded from the state budget did not increase the trust of the business sector towards the public sector that would demonstrate as an increase of business capital in public research.

4) It seems probable that after deducing the licence fees of the Institute of Organic Chemistry and Biochemistry AS CR, v.v.i., the stated ratio would be considerably lower.

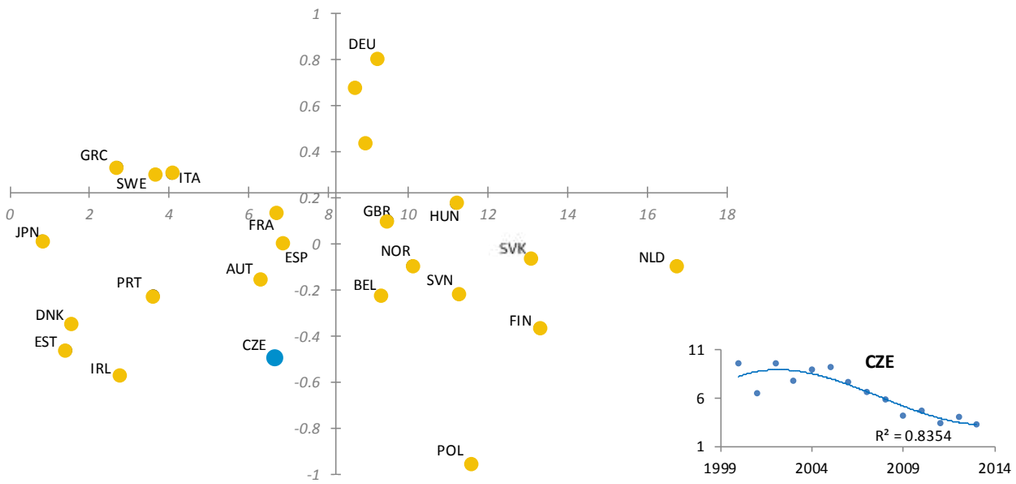
Figure 1.7: The ratio of business resources in the RDI expenditure within the government sector (GOVERD) in EU and OECD countries (in %)

Horizontal axis: mean value for 2000–2013 in % | Vertical axis: increase / decrease intensity in 2000–2013 expressed as a regression straight line slope (positive value showing an upward trend, negative value showing a downward trend) | The intersection point marks the theoretical EU 28 position. | Výřez vpravo dole demonstruje průběh v jednotlivých letech v ČR. | Data source: OECD – Main Science and Technology Indicators

The part in the top right-hand corner demonstrates the progress in the Czech Republic in the respective years.

- *Income from sales of research and development services (research for business needs)*
- *Income from licence fees (e.g. patents, know-how)*
- *Other income (e.g. renting buildings and facilities, sales of property, paid courses, guidance and counselling, financial gifts).*

Figure 1.8: The ratio of financial resources from the state budget in the total RDI expenditure in the business sector (BERD) in EU and OECD countries (in %)



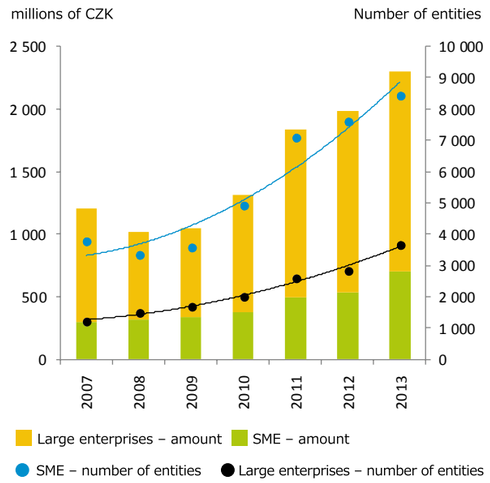
Horizontal axis: mean value for 2000–2013 | Vertical axis: increase / decrease intensity in 2000–2013 expressed as a regression straight line slope (positive value showing an upward trend, negative value showing a downward trend) | The intersection point marks the theoretical EU 28 position. | The part in the top right-hand corner demonstrates the progress in the Czech Republic in the respective years. | Data source: OECD – Main Science and Technology Indicators
The financial resources from the state budget include the funds expended on co-financing the EU Operational and Framework Programmes.

The RDI expenditure within the business sector, presented in Figure 1.7, is based on the direct support of the business sector, plus it is considerably distorted by entities included in the business sector. The RDI expenditure shown by manufacturing companies after excluding the public enterprises and research organizations is about one third lower in reality (see the detailed analysis above). Apart from the direct support from the state budget, the companies are also supported indirectly by means of tax incentices[5]. However, the indirect support cannot reflect in the expenses of the given year but of the following year when the tax savings are reflected in the budget. The indirect support of RDI in the business sector in the Czech Republic reached the level of CZK 2.3 billion in 2013 (Figure 1.9); in total the companies gained about CZK 5 billion from both sources of support (after excluding public enterprises and research organizations from the direct support of the business sector). The year-on-year comparison (data available from 2007 onwards) shows an increasing trend in the number of entities exploiting the indirect support as well as in the total amount saved. However, this form of support is used mainly by large enterprises (70 % in 2013). Moreover, this type of support is more prone to abuse.

If one follows the RDI expenditure within the business sector originated directly in the state budget and at the same time the so-called indirect support of RDI in the business sector, the comparison on an international scale will be different than if solely the expenses related to the direct support are taken into account (Figure 1.9).

5) Pursuant to Section 34(4) of Act No. 586/1992 Coll., on Income Tax.

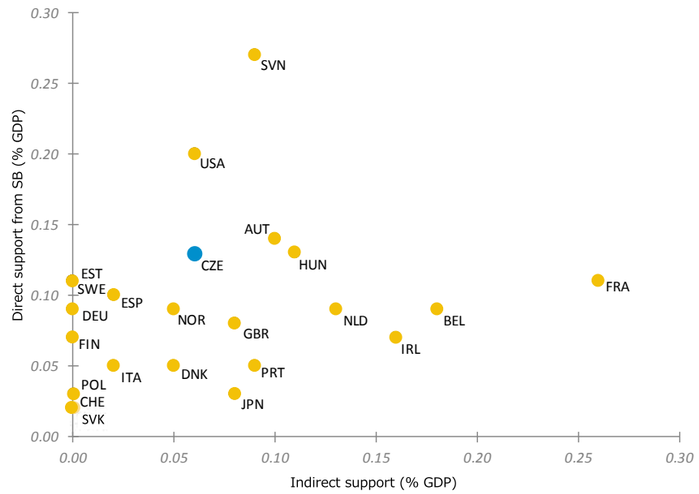
Figure 1.9: Indirect support of RDI in the business sector in the Czech Republic in 2007–2013



Left vertical axis: reduction of the corporate income tax for the executed RDI in millions of CZK | Right vertical axis: number of entities that exercised the RDI expenditure deduction | Data source: CZSO according to the administrative data of General Financial Directorate

For international comparison only a limited number of countries can be used, i.e. countries that record the indirect RDI support in the business sector and transfer it into international databases. Besides long time sequences are not available, therefore the comparison is carried out for one year only (2012 or 2011). Figure 1.10 shows that states such as France and also Belgium, Ireland and the Netherlands use mostly the indirect support and its ratio is considerably higher than in the Czech Republic. On the other hand, the direct support in these countries is lower than in the Czech Republic. On the contrary, in the United States of America or in Slovenia the direct support is quite high and at the same time indirect support is used as well. From the point of view of direct support, the Czech Republic is at a level comparable to Austria or Hungary; however, the indirect support in both countries is higher than in the Czech Republic. Norway is showing a similar level of indirect support as the Czech Republic, nevertheless with indirect support being about one third lower. In Germany, Finland, Sweden, Switzerland and also in Slovakia, Poland, Italy or Spain, direct support is lower than in the Czech Republic and indirect support is not used at all or in a very limited manner. The sum of direct and indirect support in the Czech Republic is 0.19% GDP, which is about ten times above the level of Slovakia, but only one fifth less than in Austria or Hungary.

Figure 1.10: Direct and indirect support of RDI in the business sector as % of GDP in an international comparison (reference year 2012)



Data source: OECD (Main science and technology indicators, R&D Tax Incentive Indicators) | To replace the missing data for 2012, data for 2011 were used for some states.

2. FUNDING RDI FROM THE STATE BUDGET

Public domestic resources allocated to RDI execution comprise mostly of the state budget for research, development and innovations, whose draft is annually approved by the Government in a manner defined by Act No. 130/2002 Coll., on Support of Research and Development from Public Funds and on the Amendment to Some Related Acts (Act on Support of Research and Development from Public Funds), as amended. The amount of the support is annually defined by the State Budget Act, e.g. for 2014 by Act No. 475 of 19 December 2013 on the State Budget of the Czech Republic for 2014.

Drafting the state budget expenditures is a continuous and complex process illustratively described in the diagram below. Pursuant to Section 35(2) (k) and (l) of the Act on Support of Research Experimental Development and Innovation, the proposal of state budget expenditures on RDI and their mid-term outlook is managed by the Council for Research, Development and Innovation (R&D Council). The proposal is structured into 11 budget chapters. The chapter on the Office of the Government of the Czech Republic includes costs of the R&D Council activities and funds for material or financial evaluation of extraordinary results. Besides expenditures on activities, funds for public tenders and assessment of projects and expenditures on material or financial evaluation of extraordinary results, other budget chapters contain mostly expenditures to be divided among the particular entities performing RDI.

Two working groups (Budget I and II) were established in 2014 with the aim to precise communication with the particular budget chapters during elaboration of the state budget proposal, coordinated by the Department of Science, Research and Innovation of the Office of the Government of the Czech Republic. Their establishment contributed in creating the budget proposal for 2015. The set, efficient cooperation is ongoing and remains a part of the expenditure drafting for 2016 as well as the mid-term budget outlook for 2017 and 2018.

The state budget resources are distributed to the entities performing RDI through 10 providers (Figure 2.1). The providers use instruments defined by the Act on Support of Research, Experimental Development and Innovation from Public Funds for distribution. Most providers use projects (programme or grant-based, depending on whether they are directed to basic or applied research) as fundamental instruments of special-purpose support and resources for long-term conceptual development of research organizations as the main instrument of institutional support. The instrument for co-financing operational programmes in RDI from the state budget is tied to the structural funds in the sphere of RDI, and therefore it is managed by MEYS and MIT. Moreover, MEYS is responsible for other instruments defined by the Act on Support of Research, Experimental Development and Innovation. This is support aimed at large infrastructures and international cooperation of the Czech Republic in research and development executed under international contracts and support of specific university research. The National Programmes of Sustainability I and II are of special importance as in compliance with the Act on Support of Research, Experimental Development and Innovation they are programmes of special-purpose support; however, they are supposed to help ensure sustainability of infrastructures built in priority axes 1 and 2 of the Research and Development for Innovations Operational Programme, which makes it markedly different from other programmes.

Figure 2.1 shows that the individual groups of beneficiaries can use all instruments of support from the state budget, except for SUR, which is aimed at universities[1]. Multi-source financing from several providers through various instruments presents an advantage to the beneficiaries in the form of the possibility to combine them according to the needs of the entity in compliance with its strategy of RDI execution. However, the situation, when a large proportion of financial resources is comprised of a great number of unparalleled special-purpose supports, causes financial instability of the entities and impedes strategic planning in the area of human resources as well as research objectives. When combining many instruments and different providers, it is also difficult to prevent duplicity in financing.

For strategic planning of state budget expenditures on RDI at the national level it is fundamental, among other things, to differentiate between the respective instruments within the meaning of their potential benefits. The benefits of the particular instruments should be analysed and the outputs used for their optimization. The Act on Support of Research, Experimental Development and Innovation strictly separates special-purpose and institutional financing; however, certain instruments are classed within special-purpose financing, even though in their nature they are closer to institutional financing. From the analytical point of view it would be more suitable to class instruments such as SUR, INFRA and also NPU as instruments of institutional nature. On the contrary, the SPOLUFIN instrument and partly also MEZINAR has a more special-purpose character, as projects selected based on tenders are financed.

The SPECIF, INFRA and NPU instruments have similar effects as ROD, i.e. they support the stability and development of the research base[2]. It is fundamental for their distribution which entity is granted the support. On the other hand, the projects have particular goals, usually field-specific and defined in advance in strategic documents at a national or department level[3] (an exception are projects aimed at support of the so-called horizontal activities, e.g. international cooperation, excellence, competitiveness, etc.). For a project to be successful, it is not crucial who the beneficiary is, but whether the target output is generated and whether the output is beneficial for the particular field of economic activity or the society as a whole.

1) State universities are incorporated into the state budget group in RDI IS, therefore the SUR resources are also directed to the group of state budget beneficiaries.

2) Research base means human resources in the area of RDI and infastructures concentrated in organizations performing research, development, innovation and knowledge transfer.

3) E.g. National priorities of oriented research, experimental development and innovation, department concept of research, development and innovation progress.

Chapter responsibilities, roles of central authority and financial flows (without European financial resources and their co-financing from SB)

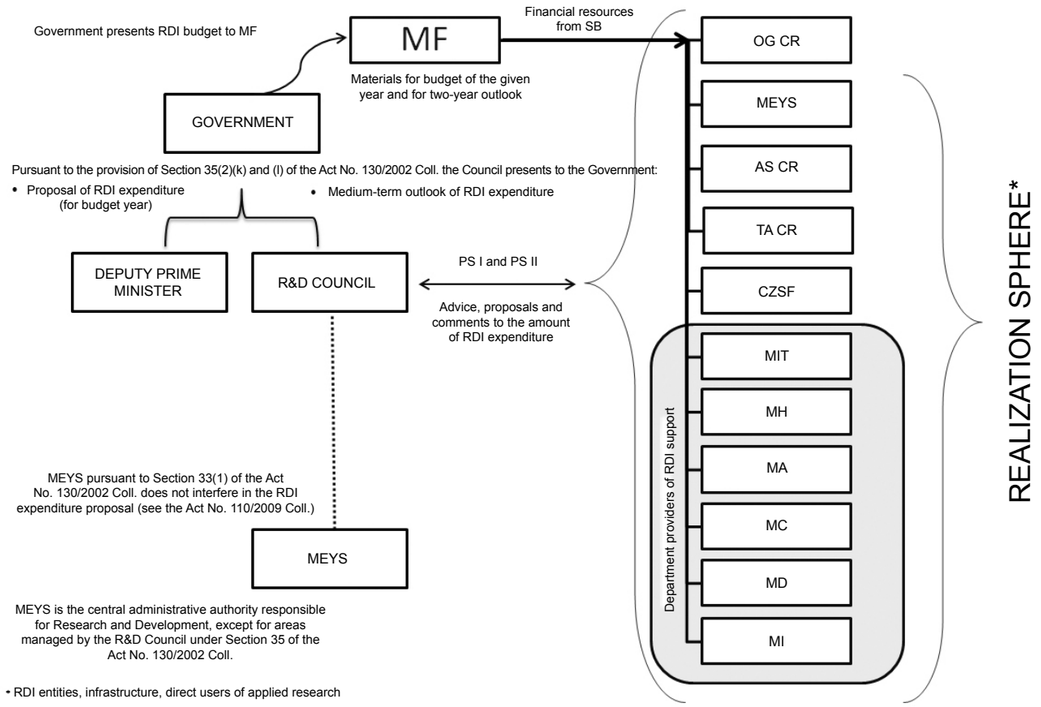
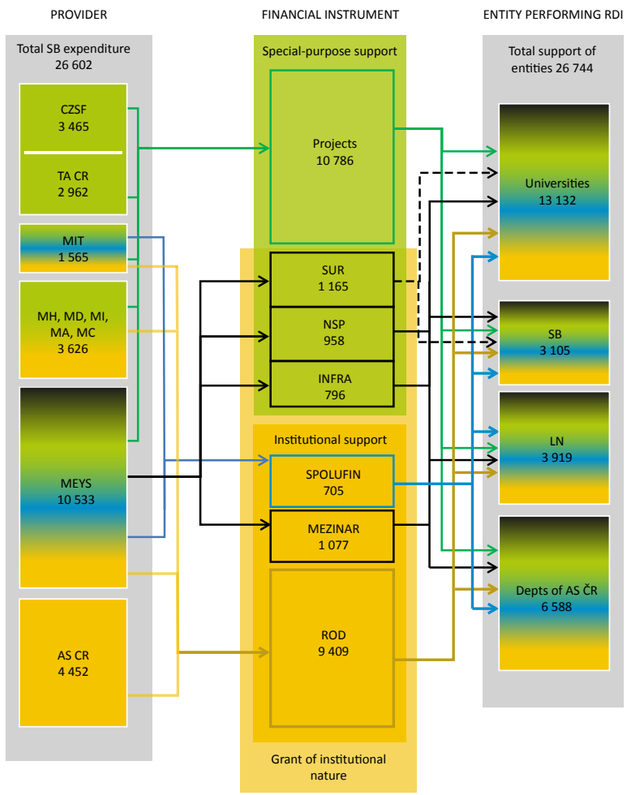


Figure 2.1 also shows quantified financial flows for 2014. It also demonstrates the division into the particular budget chapters (left column; without the chapter on the Office of the Government, which is not a provider) and financial instruments (middle column) in the amount approved by the Act No. 475 of 19 December 2013 on the State Budget of the Czech Republic for 2014 and the actually drawn amounts according to groups of beneficiaries based on the RDI IS data, the CEA and CEP parts (right column). The difference in total state budget expenditures on financial instruments is formed by the resources for the providers' own activities including inspections and finance for evaluating exceptional RDI results. The aggregate state budget resources actually divided among the beneficiaries in 2014 (based on the RDI IS data) for 2014 did not correspond to the approved level; they were increased by approximately CZK 140 million, probably by using the unused expenditures from the previous years at the level of budget chapters.

The particular amounts of institutional and special-purpose support under the Act on Support of Research, Experimental Development and Innovation in 2014 for the respective groups of beneficiaries are specified in Figure 2.2. It seems obvious that in all groups of beneficiaries the special-purpose element comprises a large proportion of the aggregate support.

Whereas with companies its substantial dominance (84 %) can be considered desirable, with public entities it indicates increased risk of year-on-year financing instability. Moreover, the instability is increased by the way of defining the amount of institutional tools, which is a finding presented in the conclusion of the international audit of the RDI system in the Czech Republic[4], carried out in 2011. In 2014 the ratio of special-purpose financing reached 42% with universities and 53 % with budgetary organizations. The departments of the Academy of Sciences of the Czech Republic showed only a slight (60 %) excess of institutional support. The interpretation is affected by incorporation of the institutional tools into the special-purpose support.

Figure 2.1: Diagram of RDI financing from the state budget (Particular amounts of money expended in 2014 are presented.)



The amounts are in millions of CZK, without the chapter on the Office of the Government of the Czech Republic.

The sizes of the fields in the diagram do not exactly correspond to the amounts of money.

The financial resources in the right column (entity executing RDI) do not include:

- *Resources aimed at co-financing SF EU projects of MIT as a provider (approved in the aggregate amount of CZK 350 million), as the data was not handed over by MIT into the RDI IS, even though it is one of the obligations of a provider under Section 31 of the Act on Support of Research, Development and Innovation;*
- *Financial resources aimed at membership fees of international RDI organizations. The amount of CZK 580.6 million was set aside in the budget chapter of MEYS. The above funds cannot be divided based on the RDI IS data into the beneficiary groups, even though pursuant to Section 7(8) of the Act on Support of Research, Development and Innovation, it is a provider's obligation to provide the given resources through the body or organization representing the Czech Republic.*

SB - State budgetary organizations, state organizational units and public research institutions except for the departments of the Academy of Sciences

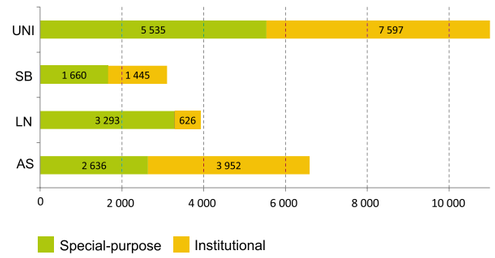
LN – Legal and natural persons outside universities, SB and departments of the Academy of Sciences

The share of the respective providers in financing the groups of beneficiaries from the state budget in 2014 is demonstrated by Figure 2.3. The division of resources to institutional and special-purpose is carried out in Figure 2.3 in compliance with the Act on Support of Research, Experimental Development and Innovation. The special-purpose resources are gained by all groups of beneficiaries from all providers with the exception of the Academy of Sciences, which provides exclusively[5] institutional support to its departments in the amount of CZK 3,002 million.

4) R&D Governance in the Czech Republic, International Audit of Research, Development & Innovation in the Czech Republic, Annex 2 to the Second Interim Report, Brighton, Technopolis Group. http://audit-vav.reformy-msmt.cz/soubory-ke-stazeni/zaverecna-zprava-z-auditu-vaval

5) Apart from the institutional support, the budget chapter of the Academy of Sciences also includes expenditures on activities – namely CZK 1,441 million in 2014 .

Figure 2.2: Amount of resources actually allocated to the groups of beneficiaries in 2014 (in millions of CZK)



Neither financial resources aimed at co-financing ESIF projects of MIT nor financial resources directed as membership fees in international RDI organizations are included (They cannot be divided to groups of beneficiaries based on the data in RDI IS.).

Groups of beneficiaries:

AS – Public research institutions established by the Academy of Sciences of the Czech Republic under the Act No. 341/2005 Coll.;

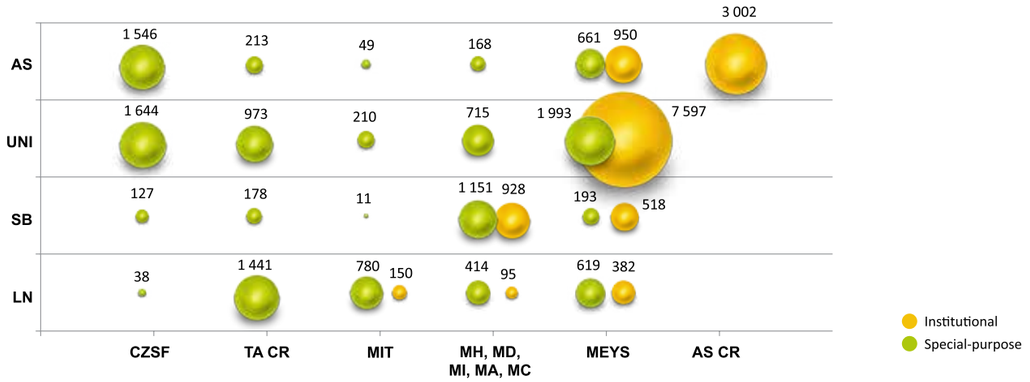
U – Universities (public and private, founded by legal or natural persons);

SB – State budgetary organizations, state organizational units and public research institutions except for the departments of the Academy of Sciences;

LN – Legal and natural persons, individuals and institutions that do not fall into any of the above groups, e.g. a joint stock company, private limited company, public service company, foundation, civic association.

Data source: RDI IS

Figure 2.3: Distribution of state budget resources to the groups of beneficiaries in 2014 by the respective providers (in millions of CZK)



Horizontal axis: providers | Vertical axis: groups of beneficiaries | Resources aimed at co-financing ESIF projects of MEYS are included. | Neither the financial resources aimed at co-financing ESIF projects of MIT nor the financial resources directed as membership fees in international RDI organizations are included (They cannot be divided to groups of beneficiaries based on the data in RDI IS.). | Data source: RDI IS

The resources of the Czech Science Foundation are used mostly by universities (CZK 1,644 million) and the departments of AS CR (CZK 1,546 million). The support of the Technology Agency is directed primarily to businesses (CZK 1,441 million), but significantly also to universities (over CZK 973 million). MIT mostly supports companies, both in a special-purpose (CZK 780 million) and institutional manner (CZK 150 million). MEYS is the largest supplier as far as the volume of distributed resources is concerned; it distributes mostly institutional support to universities (CZK 7,597 million). The special-purpose resources of MEYS are used mostly by universities (CZK 1,993 million), followed by the departments of AS CR (CZK 661 million) and companies (CZK 619 million). Other departments, i.e. MH, MD, MI, MA and MC are focused mainly on the entities whose founders they are (the SB group). They support them both in the institutional manner (CZK 928 million) and in the special-purpose manner (CZK 1,151 million). However, the special-purpose support of these departments is also successfully used by universities (CZK 715 million) and companies (CZK 414 million). The low share of the departments of the Academy of Sciences in drawing the special-purpose support from the Technology Agency and other departments might indicate their focus being directed towards basic research rather than applied research.

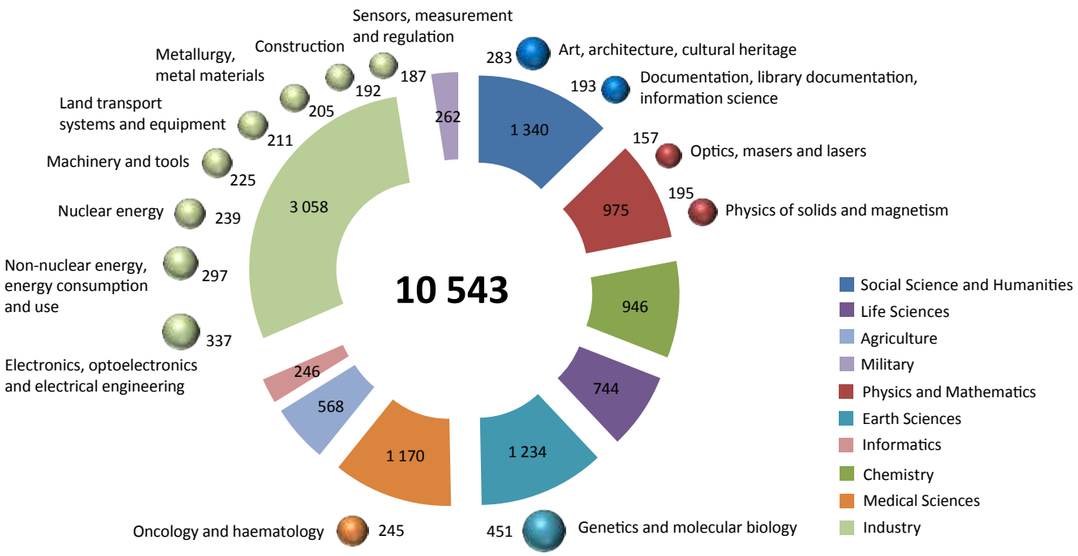
The special-purpose support according to field groups and significant fields in 2014 is depicted by Figure 2.4. Only the financial resources for programme and grant projects (total of 26 programmes and groups of grant projects) are included, moreover excluding projects of large infrastructures and projects funded through the National sustainability programmes (NSP), which are institutional in nature from an analytical point of view. After the adjustment, the amount of support (in millions of CZK) reflects the success of the research teams of the respective field groups and selected RDI fields in tenders concerning public resources. Still, the interpretation is limited by the specific nature of the field division in RDI IS and the focus of certain programmes on supporting horizontal activities (see Table 2.6).

From the point of view of sector focus of the projects, Industry was the most supported group of sectors (CZK 3,058 million) followed by social sciences (CZK 1,340 million), life sciences (CZK 1,234 million) and medical sciences (CZK 1,170 million). Financial support reaching nearly CZK 1 billion was also shown by groups Physics and Mathematics (CZK 975 million) and Chemistry (CZK 946 million).

Among the individual fields, unequivocally the highest support was gained by Genetics and Molecular Biology (CZK 451 million). In the Industry group, the fields of Electronics, Optoelectronics and Electrical Engineering were supported the most (CZK 337 million), Non-Nuclear Energy, Energy Consumption and Use (CZK 297 million) and Nuclear Energy (CZK 239 million). In the group of social sciences the largest support was gained by the fields of Art, Architecture, Cultural Heritage (CZK 283 million out of which CZK 247 million thanks to the support of MC) and Documentation, Library Science, Working with Information (CZK 193 million). In physics and mathematics the support of Physics of Solids and Magnetism prevailed (CZK 195 million), followed by Optics, Masers and Lasers (CZK 157 million). From medical sciences, the largest amount of support went to Oncology and Haematology (CZK 245 million). The example of high proportion of support for the field of Art, Architecture and Cultural Heritage makes it obvious that some fields are preferred by the very focus of the programme. Figure 2.5 demonstrates the division of resources to programme and grant projects to field groups according to the provider. It is obvious that besides MC, Social Sciences are significantly supported also by the Czech Science Foundation and MEYS. Industry is supported mostly by the Technology Agency and the Ministry of Industry and Trade. Life Sciences use mainly the support of the Czech Science Foundation, Physics and Mathematics is significantly supported, besides the Czech Science Foundation, also by MEYS; Medical Sciences are supported mostly by the Ministry of Health.

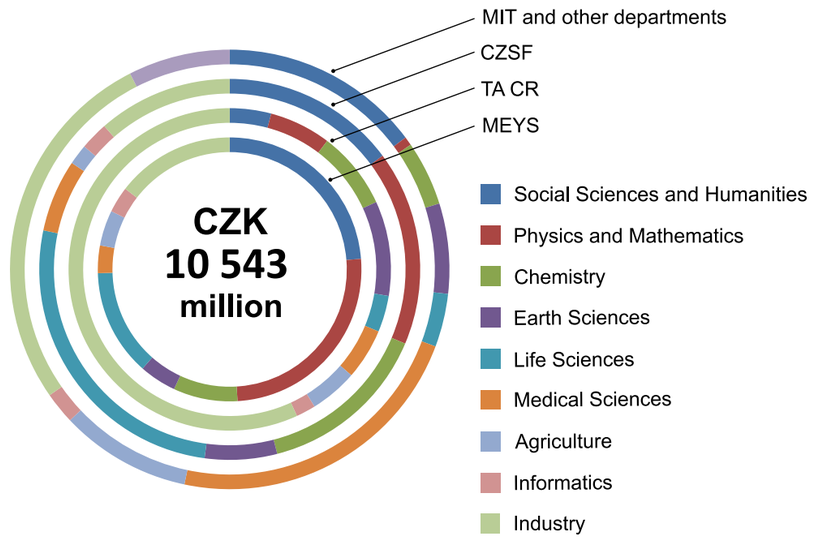
It is currently very difficult to interpret the volume of support in relation to the results and their quality. Scientometric evaluation of the quality of publications is based on global quote databases – mostly from Web of Science – which use different field distinction than RDI IS. The indicator can be transferred into the OECD Fields of Science structure (part of the so-called Frascati Manual), used for statistical surveys (InCites analytical tool distributed by Thomson Reuters based on the Web of Science database includes the transfer). Unification of indicators in the following years would be a considerable advance step towards analyses.

Figure 2.4: Special-purpose support to programme and grant projects from the state budget to field groups and individual fields in 2014 (in millions of CZK)



Zdroj dat: IS VaVaI | *Uvedeny jsou pouze obory, jejichž podpora v roce 2014 překročila 150 mil. Kč.*

Figure 2.5: Special-purpose support to programme and grant projects from the state budget to field groups in 2014 by providers.



Data source: RDI IS

Table 2.6: Main goals of the programmes and groups of grant projects of research, development and innovations funded from the state budget in 2014

Provider	PROGRAMME NAME	GOALS	Aggregate expenditures in 2014 (in thousands of CZK)	Support from the state budget in 2014 (in thousands of CZK)
CZSF	Standard Projects	Support of non-oriented research and development in compliance with the Resolution of the Government of 5 January 2000 No. 16. Standard projects are designed by research workers and evaluated by specialized commission of the Czech Science Foundation.	2 571 399	2 553 713
CZSF	Projects for Support of Excellence in Basic Research	The goal is to support research cooperation in basic research, i.e. cooperation of several top teams from different institutions researching the same or similar areas in which they have recently achieved excellent results.	476 899	476 156
CZSF	International Projects	The activity relates to supporting the participation in international programmes in compliance with bilateral agreements of the Czech Science Foundation with various foreign foundation institutions, mostly in countries such as Korea, China, Germany etc., in compliance with Article 2(3) of the Czech Science Foundation Statute. This activity is proposed by the Czech Science Foundation also due to the fact that MEYS cannot enter into official agreements with non-governmental organizations worldwide, whereas the Czech Science Foundation has this opportunity. Each grant agency in the world has its own separate resources for international research cooperation. Within this activity the Czech Science Foundation will fund parts of the projects dealt with at the departments within the Czech Republic.	49 598	49 598
CZSF	Eurocores	The activity relates to supporting the participation in the international Eurocores programmes coordinated by the European Science Foundation (ESF). Within this activity the Czech Science Foundation will fund parts of the projects dealt with at the departments within the Czech Republic.	543	543
CZSF	Postgraduate Grants	The purpose of postgraduate grants is to stimulate young researchers not to leave academic and educational institutions.	276 083	275 825
MC	Programme of National and Cultural Identity Applied Research and Development (NAKI)	The main objective of the Programme is to facilitate that the public resources invested in applied research and development in the sphere of national and cultural identity bring tangible economic or another kind of social benefit through their realization. The main objective of the Programme is pursued by means of result-oriented targets and milestones related to the main subject priorities, their subordinated subject priorities and determination of applied research and development of national and cultural identity within the Concept.	405 145	405 145
MD	The applied research, experimental development and innovation in defence	The objective of the Programme is a systematic development in the sphere of defence RDI and gaining new experience, its practical use and reaching such level of knowledge that enables to gain, master, maintain and develop specific skills required for ensuring defence as well as specific aspects of national security and reaching operational skills that the Armed Forces of the Czech Republic need to acquire to be able to fulfil the tasks arising out of national and international norms, obligations as well as political and military ambitions of the Czech Republic before 2020.	282 956	282 956
MIT	TIP	New materials and products. New progressive technologies. New information and control systems.	1 746 933	1 049 657
MEYS	COST CZ	To support the multilateral international cooperation in basic research of the research institutions of the Czech Republic with similar institutions of the COST Member States, which cooperate on project solutions within the so-called COST ventures.	110 694	101 325
MEYS	EUPRO II	Enable participation of Czech research institutions in coordination of European research, increasing participation in international research and development programmes and in bilateral activities through the support.	84 130	83 078
MEYS	INGO II	Providing special-purpose support to projects that gained the EUREKA status, support international cooperation in applied research, increased competitiveness of Czech companies and creating new innovated products and services.	226 435	114 362
MEYS	INGO II	Enable the participation of Czech science departments in research programmes carried out by top nongovernmental research organizations and the participation of Czech scientific personalities in the managing bodies of international research organizations.	171 648	165 795
MEYS	KONTAKT II	Support bilateral or multilateral international cooperation of institutions operating within research and development in the area of basic and applied research of the Czech Republic, with emphasis on cooperation with states that are not members of the EU.	165 418	152 284
MEYS	NÁVRAT (“RETURN”)	The main objective is to create good conditions for re-/integration of top RDI workers in the Czech Republic, stimulate their interest in qualified work in the Czech research sphere and also stimulate the interest of Czech research organizations in these personalities. Favourable conditions for further development of the professional skills of these people after their return from abroad must be ensured to enable fast career growth and quality work and material background for their research activities.	69 274	66 641
MEYS	ERC CZ	The main objective of the Programme is to support excellent research in the territory of the Czech Republic in a targeted manner. The Czech Republic will support and realize particular projects that have evaluated within international “peer review” by ERC panels as follows: “The proposal is of good quality and fundable but not retained for funding due to budgetary constrains”.	60 679	60 679
MEYS	Information – basis of research	The development of information infrastructure and infrastructure research services – “Information as a fundamental building block necessary to build anything”, i.e. to create new results in RDI.	325 907	141 116
MI	Safety research for the needs of the state in 2010–2015	The objective of the Programme is to achieve such level of knowledge, technical and technological skills that will enable the public administration bodies fulfilling the tasks in the area of inland safety and security of the citizens of the Czech Republic within their competence to propose legislative and organization measures, new methods and instruments to increase security of the state and its citizens; to develop a modern system of technical means to increase efficiency and effectiveness of crisis management processes and to improve the security of critical infrastructures.	116 020	116 020

Provider	PROGRAMME NAME	GOALS	Aggregate expenditures in 2014 (in thousands of CZK)	Support from the state budget in 2014 (in thousands of CZK)
MI	Security Research Programme of the Czech Republic 2010–2015	The Programme has been designed with the aim to increase the security of the state and its citizens by means of using applied research, experimental development and innovations in the area of identification, prevention and protection against illegal attacks on citizens, organizations, systems, property and infrastructure of the Czech Republic as well as natural and industrial disasters. The results of the Programme will bring new methods, instruments and technologies.	495 252	456 477
MH	Department Research and Development Programme of the Ministry of Health III	To develop new diagnostic methods and processes to be used for as fast and exact disease identification as possible. To gain new knowledge on disease pathogenesis necessary to ensure highly efficient treatment based on EBM with focus on the support of molecular-biological approach. To develop research in the sphere of prevention of infectious diseases and diseases of mass occurrence. To analyze the particular parameters of health care so that the prerequisites for effective treatment linked by the effect on the patient's quality of life are created. To gather data enabling continuous assessment of the progress of the population's state of health and its comparison with the situation in the European Union countries. To use the results of research in continuous training of physicians and other healthcare professionals.	816 429	809 336
MA	Agrarian Sector Research (VAK)	The overall goal of the programme is to support sustainable development of the agrarian sector, development of the country and countryside greening, to enhance competitiveness of small and medium-sized agricultural and processing enterprises. New processes for production and processing of agricultural raw materials into quality and safe foods will be elaborated, the systems of forest management will be modernized, the water management systems will be made more effective and the development of countryside by means of considerate countryside management will be stabilised.	171 694	154 552
MA	Complex Sustainable Systems in Agriculture 2012–2018 "CSS"	By increasing the production potential of agricultural crops and farm animals, to contribute to the food safety of the Czech Republic, i.e. to ensure sufficient production amount of quality and safe domestic foods for healthy diet of the population. By implementing new methods, technological processes and systems, to increase competitiveness of Czech agriculture in the EU conditions and to support sustainable development of the agricultural sector, the countryside and regions of the Czech Republic; thanks to new knowledge and its realization, to contribute to sustainable exploitation of natural resources while minimizing environmental impact and to introduce management systems leading to limiting negative impact of climatic change to the ecosystem functions in agriculture, forest and water management; to increase the potential of non-production functions of agriculture, forest and water management.	273 678	224 000
TA CR	ALFA Programme of Applied Research and Experimental Development Support	The main objective of the programme is a significant increase in the volume and quality of applied research and experimental development in the area of progressive technologies, materials and systems, energy sources, protection and formation of environment and sustainable development of transport, which will be applicable in the form of innovations. This knowledge will later lead to enhanced performance of economic entities, increased competitiveness of Czech economy and society and improved quality of life of the citizens due to development of progressive technologies, materials and systems, increasing environment quality and sustainable transport development.	2 873 273	1 823 239
TA CR	Programme of public contracts in research, experimental development and innovation for public administration needs – "BETA"	Support of research, development and innovation for public administration needs, namely for the needs of those administrative bodies that are not providers of support to research, development and innovations. However, the programme does not exclude those administrative authorities that still are among the research and development public support providers.	51 280	51 280
TA CR	OMEGA Programme aimed at support of applied social research and experimental development	The main objective of the programme is to enhance research activities in the area of applied social sciences and applying the results of these activities to increase competitiveness of CR, to improve the citizens' quality of life and balanced socio-economic progress of the society.	102 223	79 891
TA CR	Competence Centres	The main aim of the programme is to increase competitiveness of the Czech Republic in progressive fields with high potential for applying RDI results in innovations. The targets include: improving long-term cooperation of significant organizations and enterprises in RDI; support of R&D interdisciplinarity; creating conditions for development of RDI human resources, mostly focused on engaging young research workers under 35 including students participating in the project; creating conditions for horizontal mobility of research workers; meet the National Priorities of Oriented Research, Experimental Development and Innovations; sustainability of the strategic research agenda in the centres at least five years after the end of the project.	1 211 963	842 502
TA CR	GAMA Programme of Applied Research, Experimental Development and Innovation	The main aim of the Programme is to support the transformation of the RDI results achieved in RO and/or in cooperation between RO and enterprises and make it much more efficient in the form of a practical application enabling their commercial use and to support their practical implementation this way. The objectives of the Programme include ensuring the creation of R&D results leading to innovations with high commercial potential and thus stimulating innovations in companies (mostly in small and medium-sized enterprises) using the R&D results created with the support of public resources within the research organization.	7 246	7 246
		TOTAL	**13 142 799**	**10 543 416**

The table does not include Large Infrastructure Projects for RDI (Programme code LM) and the National Sustainability Programme I (Programme code LO) due to their institutional nature. | *Data source: RDI IS*

3. RDI SUPPORT IN THE CZECH REPUBLIC FROM EUROPEAN FUNDS

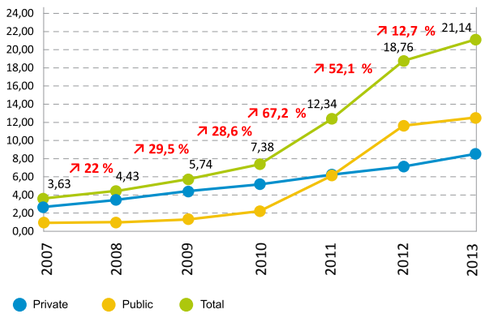
The policy of economic, social and territorial unity of the EU is one of the most significant items of the EU budget. Its objectives are pursued within seven-year cycles with the use of specially created funds. Investment projects are supported by the European Regional Development Fund, social programmes or human resource development projects are supported by the European Social Fund. These two basic funds are complemented by other instruments; however, these support the RDI sphere only to a limited degree. In the programme period 2007–2013 EUR 26.69 billion was allocated for the Czech Republic (ERDF, ESF and Cohesion Fund), in the programming period 2014–2020 it was EUR 23.85 billion for 5 European structural and investment funds (ESI funds, ESIF), which include, apart from ERDF, ESF and the Cohesion Fund, also the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund (EMFF). The last part of the resources in the programming period 2007–2013 needs to be used by the end of 2015, the deadline for using the resources from programming period 2014–2020 being the end of 2023.

The member states are compiling a national strategic document as well as related documents in each period to facilitate the exploitation of these funds. The programming period 2007–2013 it was the National Strategic Reference Framework and Operational Programmes, for the programming period 2014–2020 the Partnership Agreement and Programmes were formed.

Due to a different legal background of the two followed programming periods; it is necessary to appreciate slight differences between the programmes as well, which fall under the responsibilities of a certain institution and are connected between the respective periods. The focus of the respective OP is further specified by the structure of the priority axes, areas of support and target programmes and activities. Apart from boundary determination, the programmes differ mainly in the sources of support (ECOP – ESF, OP RDE ESF / ERDF and OP RDI, OPEI – ERDF) or in the public support rules defined by European laws.

Chart 3.1 shows that the share of foreign resources in aggregate expenditures was growing on a long-term basis between 2007 and 2013. The total amount of foreign expenditures on RD support in 2013, including the resources covered by revenue from the EU and the Norwegian Grants, reached CZK 21.14 billion. The use of financial resources from structural funds in the programming period 2007–2013 in the sphere of R&D strongly contributed to the total increase in R&D expenditures in the Czech Republic. The growth rate of private and public foreign resources varies. The year-on-year growth in foreign resources was relatively constant in the reference period; on the other hand, the year-on-year growth rate of foreign public resources increased markedly after 2010. However, it is to be expected that in 2014 and 2015 there will be a slight year-on-year decrease of the amount of foreign public expenditures, as drawing the resources within the 7th programming period is going to finish in 2015. Furthermore, it can be expected that in 2015 and 2016 there will be growth again and the drawing of financial resources within the programming period 2014–2020 will be "boosted".

Chart 3.1: R&D Expenditures from Foreign Resources in the Czech Republic in 2007–2013 (in billions of CZK)



Data source: CZSO 2013 – Annual Statistical Survey of Research and Development VTR 5-01

The resources from EU funds in the programming period 2007–2013 provided a significant opportunity to update the education system and develop human resources in R&D, to improve the quality of science and research infrastructure in the Czech Republic, to enhance international cooperation and to support innovation activities within the business sector. The programming period 2014–2020 will continue with the positive trends of the preceding period (see Tables 3.2 and 3.3). The Ministry of Education, Youth and Sport, the Ministry of Industry and Trade and the Capital City of Prague remain the managing authorities of OP focused on RDI for the programming period 2014–2020. OP RDE carries on with the theme of OP RDI and ECOP. However, unlike OP RDI, OP RDE will significantly restrict the past mass support of R&D investments; the investments should be directed towards improving infrastructure for research and education. Among the crucial topics are improving international research quality and its results, improving quality of human resources in the sphere of RDI. OP EIC also mostly continues with the preceding activities and focuses on enhancing competitiveness of small and

Table 3.2: Operational Programmes Supporting RDI and Their Structure – Programming Period 2007–2013

Structural funds	RESOURCES PAID TO BENEFICIARIES IN MILLIONS OF CZK								
Operational Programme	OP RDI			ECOP			OPEI		
Priority axis	PA1–PA4			PA2			PA4–PA5		
Support area/target/theme	SC 1.1	European Centres of Excellence	8 340,80	SC 2.3	Human Resources in RDI	4 694,80	SC 4.1	Innovation	11 045,10
	SC 2.1	Regional R&D centres	12 911,20	SC 2.4	Partnerships and networks	2 323,20	SC 4.2	Potential	4 590,50
	SC 3.1	Commercialization	407,10				SC 5.1	Prosperity and cooperation	4 681,80
	SC 3.2	Popularization	3 015,80						
	SC 4.1	University infrastructure	7 948,30						
Governing authority	MEYS						MIT		

Operational Programme	PCOP			PAOP		
Priority axis	PA3			PA1		
Support area/target/theme	SC 3.1	Innovation environment development	1 247,60	SC 1.1	Support of knowledge economy development	864,00
Governing authority	Capital City of Prague					

Note: RDE OP as of 13 March 2015 has been updated
PO1 SC 1 – Improving international research quality and its results
PO1 SC 2 – Building capacities and reinforcing long-term cooperation of research organizations with application sphere
PO1 SC 3 – Improving infrastructure for research and education
PO1 SC 4 – Improving strategic management of research at the national level
PO2 SC 1 – Improving quality of university education and its relevance for the labour market needs
PO2 SC 4 – Setting and development of evaluation and quality system and strategic management of universities
PO2 SC 5 – Improving conditions of education related to research as well as conditions of human resources development in R&D
Data source Table 3.2: RDI IS Yearbook, MRD – Resources Paid to Beneficiaries QMR Q4 2014

Table 3.3: Operational Programmes Supporting RDI and Their Structure – Programming Period 2014–2020

ESIF	INDICATIVE ASSIGNMENT OF OP FINANCIAL RESOURCES TO KEY R&D AREAS (NATIONAL CO-FINANCING) IN EUR									
Operational Programm	OP RDE			OP EIC			OP PPG			
Priority axis	PA1–PA2			PA1, PA2, PA4			PA1			
Support area/target/theme	SC 1.1	Reinforcing research excellence	177 531 818	SC 1.1	Increase innovation performance of enterprises	974 842 633	SC 1.1	Higher rate of intersector cooperation stimulated by regional self-government	62 492 932	
	SC 1.2	Increasing benefits for society		SC 1.2	Increase intensity and efficiency of cooperation in research, development and innovation	339 873 790	SC 1.2	Easier foundation and development of knowledge-intensive businesses		
	SC 2.1	Improving educational infrastructure at universities in order to ensure high quality of education, better attitude to disadvantaged groups and improved openness of universities	105 811 767	SC 2.1	Improve competitiveness of starting and developing SMEs	293 096 703				
	SC 2.4	Setting and developing a system of evaluation and ensuring quality and strategic management of universities		SC 2.2	Increase internationalization of SMEs	27 192 400				
	SC 2.5	Improving teaching conditions related to research and for development of human resources in research and development	9 782 634	SC 2.4	Increase capacity for professional education in SME	4 068 481				
				SC 4.1	Increase coverage of high-speed internet	471 203 877				
				SC 4.2	Increase the use of ICT potential for economy competitiveness	200 885 759				
Governing authority	MEYS			MIT			Capital City of Prague			

Data source Table 3.3: RIS3 – Indicative allocation of financial resources of OP to key areas of R&D (national co-financing)

medium-sized enterprises and support of the business and science and research spheres. OP Prague Competitiveness and OP Prague Adaptability will be developed by OP Prague – Pole of Growth; emphasis will still be laid on inter-sector cooperation and the support of knowledge-intensive economy development will be important.

The state and progress of drawing financial resources from the structural funds and the Cohesion Fund is presented by the Ministry of Regional Development in the so-called Quarterly Monitoring Reports (QMR). The data in the tables (3.4–3.6) are taken over from the chapter "State of Thematic Operational Programmes Objectives 1 and 2" and they inform on the state of structural assistance realization from the respective OP. The total OP RDI allocation is directed exclusively to the RDI sphere and the latest report showed it was about CZK 55.4 billion; the allocation to the RDI sphere in other OP was far from reaching this level (ECOP – 10 billion, OPEI – 32.5 billion, PCOP and PAOP – 2.9 billion.).

Table 3.4: Drawing Financial Resources – MEYS

OP RDI							
Section	Total allocation	Applications submitted			Projects with issued decision		
	(millions of CZK)	Number	Amount (millions of CZK)	Amount (% allocation)	Number	Amount (millions of CZK)	Amount (% allocation)
PO1	18 567,50	33	21 424,60	115,4	8	17 043,80	91,8
PO2	18 197,40	103	43 073,10	236,7	40	17 261,50	94,9
PO3	4 936,60	135	8 911,00	180,5	62	4 407,60	89,3
PO4	11 782,50	82	15 641,20	132,7	65	10 693,40	90,8
OP TOTAL	55 441,00	373	90 712,90	163,6	192	50 768,60	91,6

ECOP							
Section	Total allocation	Applications submitted			Projects with issued decision		
	(millions of CZK)	Number	Amount (millions of CZK)	Amount (% allocation)	Number	Amount (millions of CZK)	Amount (% allocation)
PO2	16 677,30	2 730	46 147,40	276,7	1 067	16 978,70	101,8
PO2-OP 2.3	7 073,30	715	15 026,40	212,4	339	7 500,70	106,0
PO2-OP 2.4	2 947,60	538	12 056,40	409,0	176	2 919,40	99,0
OP TOTAL	43 692,10	23 384	127 986,30	292,9	10 593	46 319,20	106,0

Table 3.5: Drawing Financial Resources – Ministry of Industry and Trade

OPEI							
Section	Total allocation	Applications submitted			Projects with issued decision		
	(millions of CZK)	Number	Amount (millions of CZK)	Amount (% allocation)	Number	Amount (millions of CZK)	Amount (% allocation)
PO4	25 533,80	4 386	64 984,00	254,5	2 284	27 998,90	109,7
PO4-OP 4.1	17 812,20	3 076	44 401,50	249,3	1 630	20 187,90	113,3
PO4-OP 4.2	7 721,60	1 310	20 582,50	266,6	654	7 811,00	101,2
PO5	20 238,10	2 377	38 261,10	189,1	1 607	21 441,70	105,9
PO5-OP 5.1	7 022,20	292	17 408,80	247,9	148	7 908,10	112,6
OP TOTAL	81 957,80	19 985	179 569,30	219,1	11 967	93 805,70	114,5

Table 3.6: Drawing Financial Resources – Capital City of Prague

PCOP							
Section	Total allocation	Applications submitted			Projects with issued decision		
	(millions of CZK)	Number	Amount (millions of CZK)	Amount (% allocation)	Number	Amount (millions of CZK)	Amount (% allocation)
PO3	2 377,80	761	7 320,50	307,9	224	2 510,70	105,6
PO3-OP 3.1	1 785,80	201	5 227,80	292,7	74	1 902,40	106,5
OP TOTAL	6 350,20	1075	15 437,90	243,1	350	6 955,80	109,5

Data source: Quarterly Monitoring Report Q1 2015 – Ministry of Regional Development 2015 [http://www.strukturalni-fondy.cz/cs/Informace-o-cerpani]

3.1. STRATEGIC FRAMEWORK OF RDI SUPPORT FROM ESI FUNDS

The national strategy of intelligent specialization is aimed at efficient direction of all available financial resources to the R&D sphere and the goal of the strategy is to allocate these resources effectively into areas identified as the most perspective ones for exploitation of the knowledge and innovation potential of the Czech Republic. RIS 3 together with other activities should contribute to fulfilling the objectives of the Europe 2020 strategy, mostly to support of national economy competitiveness and to contribute to reducing unemployment rate. RIS 3 represents a prerequisite for ESI funds exploitation for RDI support. The process of the National RIS 3 preparation was initiated in 2013 and it was run by MEYS. After approval by the Government by the Resolution No. 1028/2014 of 8 December 2014, the RIS 3 management was transferred to the Office of the Government of the Czech Republic, Department of Science, Research and Innovation, from 1 January 2015. The wording of RIS 3 approved by the Government of the Czech Republic at the end of 2014 was assessed as not eligible by the European Commission. EC applied complaints with regard to the National RIS 3 strategy mostly in relation to monitoring of objectives, interconnection with public budgets and the institutional arrangements. Therefore the Czech Republic, in compliance with Regulation No. 1303/2013, submitted together with these programmes also the Action Plan of meeting the National RIS 3 prerequisite, which declares gradual completion of the unsatisfactory parts of the document and setting-up implementation so that RIS 3 is regarded as eligible. The updated RIS 3 text will also be presented to the Government for approval at the end of 2015.

To ensure correct RIS 3 implementation the Entrepreneurial Discovery processes were initiated, i.e. continuous defining of needs in the area of RDI and human resources as well as defining objectives from the perspective of the enterprises and researchers, and verticalization, i.e. connecting particular themes to resources from the state budget and the European Funds. Still under the management of MEYS, the National Innovation Platforms were formed. The members of these platforms are representatives of businesses, public institutions performing research and development and support providers. Their most important objective is to facilitate a debate between the representatives of the business and the public (higher education and government) sector under moderation of public institutions. The mutual discussion should lead to the formation of assignment for support providers, so that they could be directed towards RIS 3, i.e. to the particular field-specific topics.

So far there have been two meetings of the National Innovation Platforms (in accordance with Chapter 7 of the National RIS 3 the meetings shall take place every half a year, or more frequently, if necessary). Tangible results arising out of these meetings can be expected in autumn 2015. The list of members of the National Innovation Platforms has not been finalized; alterations are expected to ensure better coverage of field and regional structure.

3.2. THE NEW HORIZON 2020 FRAMEWORK PROGRAMME

The budget of the EU Research and Innovation Framework Programme – Horizon 2020 – was approved by the European Parliament and the Council of Ministers in the middle of 2013, providing over EUR 77.028 billion.1 The H2020 Programme was initiated in January 2014 and is supposed to be the most extensive and significant programme for funding European science, research and innovation for the period of 2014 to 2020. The H2020 Programme builds on the previous research and innovation framework programmes (mostly on the Seventh Framework Programme) declared by the EU, it focuses on scientific excellence and greater innovation support. It emphasises the connection of research and innovations in relation to the market, creating business opportunities, social impact and cooperation between teams inside and outside the EU. It also supports continuity of structural funds and other EU programmes.

The crucial new characteristics of the H2020 Programme include the so-called focus areas. These are areas into

1) The H2020 Programme includes the EURATOM Programme with aggregate budget of EUR 1.603 billion for 2014–2018.

which the financial and human resources across social challenges should be focused, in order to achieve maximum utilization of the existing research capacities, increase the possibilities to reach breakthrough solutions and at the same time to implement crucial political initiatives. Unlike FP7, this Programme also accounts for greater support of the bottom-up approach when formulating research themes, more extensive possibilities for young scientists, more elaborate connection of research and innovation with market principles and for greater emphasis on creating business and work opportunities. There is a greater focus on supporting innovation, namely innovation in small and medium-sized enterprises and the introduction of new credit instruments is expected too. The H2020 Programme incorporates the preceding Competitiveness and Innovation Framework Programme and the European Institute of Innovation and Technology.

The structure of H2020 is formed by three key mutually reinforcing priorities:
1. Excellent Science,
2. Industrial leadership,
3. Societal challenges.

Horizontal areas are supported as well:
- Spreading excellence and widening participation,
- Science with and for Society.

The H2020 budget will also cover:
- Non-nuclear direct activities of the Joint Research Centre,
- European Institute of Innovation and Technology.

Table 3.7 shows the budget outline, Table 3.8 presents an overview of project success rate in H2020 priority areas related to the Czech Republic.

Table 3.7: H2020 Budget

	% from the total budget	(millions of EUR
Excellent science	31,73	24 441
European Research Council	17	3 095
Future and Emerging Technologies	3,5	2 696
Marie Skłodowska-Curie actions	8	6 162
European research infrastructure	3,23	2 488
Industrial leadership	22,09	17 016
Leadership in enabling and industrial technologies	17,6	13 557
Access to risk finance	3,69	2 842
Innovation in small and medium-sized enterprises	0,8	616
Societal challenges	38,53	29 679
Health, demographic change and well-being	9,7	7 472
Food security, sustainable agriculture and forestry,, marine and maritime and inland water research	5	3 851
Secure, clean and efficient energy	7,7	5 931
Smart, green and integrated transport	8	6 339
Climate action, environment, resource efficiency and raw materials	4	3 081
Europe in a changing world – inclusive, innovative and reflective societies	1,7	1 309
Secure societies - Protection freedom and security of Europe and its citizens	2,2	1 695
Science with and for society	0,6	462
Spreading excellence and widening participation	1,06	816
European Institute of Innovation and Technology	3,52	2 711
Non-nuclear direct activities of the Joint Research Centre	2,47	1 903
TOTAL EU CONTRIBUTION	**100**	**77 028**

Data source: Horizon 2020 Brief Information on the Programme, Technology Centre ASCR

Table 3.8: H2020 – Success of the Czech Republic: Project Proposals in Priority Areas of H2020

H2020 – SUCCESS OF THE CZECH REPUBLIC: PROJECT PROPOSALS IN PRIORITY AREAS OF H2020								
Pillar	Priority area	Abbreviation	Number of eligible project proposals	Number of eligible project proposals recommended for funding	Project success rate (%)	Financial support (€) for eligible project proposals	Financial support (€) for project proposals recommended for funding	Financial success rate (%)
Excellent Science	European Research Council	ERC	53	5	9,4	68 410 483,0	7 766 502,0	11,4
	Future and Emerging Technologies	FER	8	0	0,0	3 576 320,0	0,0	0,0
	Marie Sklodowska-Curie actions	MSCA	134	18	13,4	39 002 791,0	4 701 842,0	12,1
	Research infrastructures	INFRA	34	17	50,0	7 030 918,0	2 364 294,0	33,6
	Total: Excellent Science		**229**	**40**	**17,5**	**118 020 512,0**	**14 832 638,0**	**12,6**
Industrial Leadership	Leadership in enabling and industrial technologies	LEIT						
	Information and Communication Technologies	ICT	115	13	11,3	50 584 872,0	4 776 002,0	9,4
	Nanotechnologies, Advanced Materials and Production	NMP	17	0	0,0	2 938 408,0	0,0	0,0
	Advanced materials	ADVMAT						
	Biotechnologiy	BIOTECH	14	1	7,1	1 253 565,0	148 274,0	11,8
	Advanced manufacturing and processing	ADVMANU	29	4	13,8	10 210 379,0	976 129,0	9,6
	Space	SPA	30	5	16,7	9 083 385,0	1 275 776,0	14,0
	Access to risk finance	RISKFINANCE	4	0	0,0	307 019,0	0,0	0,0
	Innovation in SMEs	SME	4	1	25,0	271 081,0	69 300,0	25,6
	Total: Industrial leadership		**213**	**24**	**11,3**	**74 648 709,0**	**7 245 481,0**	**9,7**
Societal Challenges	Health, demographic change and wellbeing	HEALTH	99	13	13,1	32 406 916,0	2 608 132,0	8,0
	Food security, sustainable agriculture and forestry,, marine and maritime research and inland water research	FOOD	39	10	25,6	11 541 202,0	1 482 011,0	12,8
	Secure, clean and efficient energy	ENRGY	77	13	16,9	21 818 749,0	2 719 791,0	12,5
	Smart, green and integrated transport	TPT	53	12	22,6	18 127 047,0	2 427 913,0	13,4
	Climate action, environment, resource efficiency and raw materials	ENV	33	9	27,3	5 266 225,0	814 207,0	15,5
	Europe in changing world – inclusive, innovative and reflective Societies	SOCIETY	47	7	14,9	8 327 225,0	1 274 381,0	15,3
	Secure societies – Protecting freedom and security of Europe and its citizens	SEC	43	2	4,7	16 842 712,0	366 388,0	2,2
	Total: Societal Challenges		**391**	**66**	**16,9**	**114 330 076,0**	**11 692 823,0**	**10,2**
Spreading excellence and widening participation	Teaming of excellent research institutions and low performing RDI regions	WIDSPREAD	26	13	50,0	2 435 310,0	641 412,0	26,3
	Policy Support Facility	PSF						
	Transnational networks of National Contact Points	NCPNET	1	1	100,0	47 500,0	47 500,0	100,0
	Total: Spreading excellence and widening participation		**27**	**14**	**51,9**	**2 482 810,0**	**688 912,0**	**27,7**
Science with and for Society	Develop the governance for the advancement of responsible research and innovation	GOV	2	2	100,0	284 063,0	284 063,0	100,0
	Total: Science with and for Society		**2**	**2**	**100,0**	**284 063,0**	**284 063,0**	**100,0**
Euroatom	Programme EURATOM 2014–2018		35	16	45,7	12 201 157,0	3 470 853,0	28,4
	Total: Euroatom		**35**	**16**	**45,7**	**12 201 157,0**	**3 470 853,0**	**28,4**
	TOTAL		**897**	**162**	**18,1**	**321 967 327,0**	**38 214 770,0**	**11,9**

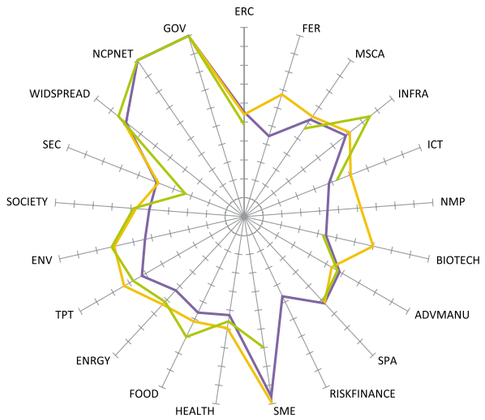
Data source: E-CORDA extraction date: 2015/02/25

The following 2 radar charts compare project success rate and the amount of financial support of the Czech Republic with Austria and the average for countries (ALL), which have become involved in the H2020 Programme to date. So far, all the projects submitted in the area of "Develop the governance for the advancement of responsible research and innovation" (GOV) have been approved and the total financial support amounts to EUR 3,967.4 thousand; the support granted to the Czech Republic was EUR 24.8 thousand lower than that of Austria. Czech Republic and Austria have not yet been active in submitting project applications in the area of "Advanced materials" (ADVMAT), a total of 10 projects have been filed, 2 of which were eligible and the total financial support amounts to EUR 3,488.6 thousand billion. Lack of activity in submitting projects is also demonstrated by Austria in the area of "Transnational networks of National Contact Points" (NPCNET); the Czech Republic, on the other hand, has been 100% successful in this area and the financial support amounts to EUR 47.5 thousand billion. In the area of "Access to risk finance" (RISKFINANCE) the project success rate of both the Czech Republic and Austria is currently 0%; so far the Czech Republic has unfortunately also not been successful in the areas "Future and Emerging Technologies" (FET) and "Nanotechnologies, Advanced Materials and Production" (NMP).

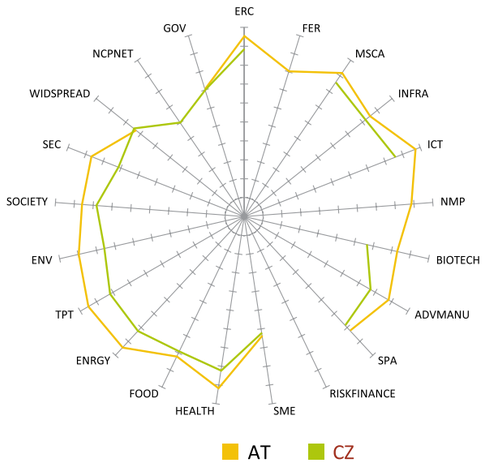
When compared to Austria, the Czech Republic tends to be relatively more successful in project areas such as "Research infrastructures" (INFRA), "Food security, sustainable agriculture and forestry, marine and maritime and inland water research" (FOOD) and "Teaming of excellent research institutions and low performing RDI regions" (WIDSPREAD); the percentage of project success rate of the Czech Republic in these areas is higher than the total average of all participating countries. Nevertheless, when the financial support of projects recommended for funding is compared with Austria, Austria has been granted larger amount of financial support for its projects in all other areas, only in WIDSPREAD the Czech Republic managed to gain higher financial support, the difference being approximately EUR 151 thousand. In the area of "Biotechnology" (BIOTECH) the Czech Republic lacks behind Austria significantly both in project and financial success rate. The interesting fact is that even though the Czech Republic is 75 % less successful in projects as well as granted financial support in the area of "Innovation in SMEs" (SME), the difference in support amounting to EUR 21.1 thousand, the Czech Republic achieves nearly 7 % higher financial success rate than Austria.

Chart 3.9 A and B

Project success rate (%)



Financial support (€)
Project proposals recommended for funding



Data source: Technology Centre ASCR, own draft
Note: Logarithmic data transformation was carried out.

4. HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT

Human resources represent a crucial element of the RDI base within the RDI system. People, not only researchers but also technical and specialized workers in RDI and other supporting staff, such as managers, administrative workers, craftsmen forming a compact team where new findings can originate. The amount and professional as well as personal qualities of human resources determine the intensity and quality of RDI performance as well as the success of transferring new knowledge from the scientific environment to manufacturing practice where they can be turned into real benefits. This is the main reason why RDI management requires attention to be paid to forming, motivating and stabilizing research and development teams, support cooperation of research entities with manufacturers even at the international level.

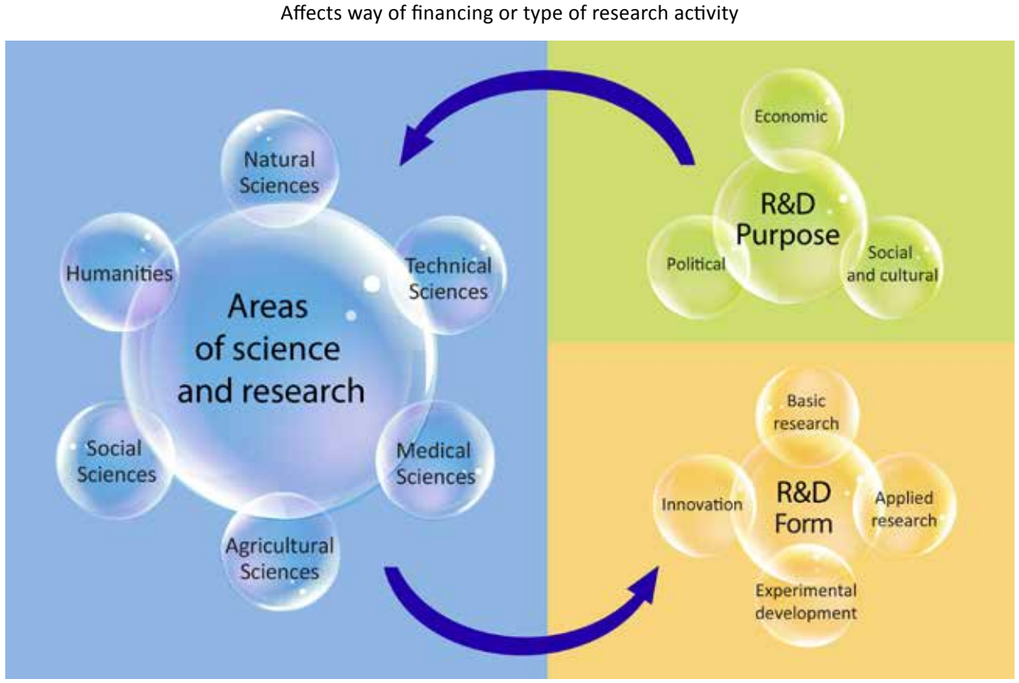
It is advisable to analyse human resources in relation to their expertise, way of working and motivation (Figure 4.1). Expertise of the worker defined by the scientific area should be the basis. The work manner and conditions are largely affected by the purpose of the research or development activity. In most cases the purpose of research a development corresponds to the employer type. The business sphere usually follows the economic purpose, departments and their research facilities focus mostly on the political purpose and universities and the departments of the Academy of Sciences serve the social and cultural purpose. However, as the stated categories can mix at the level of these institutions, it is more suitable to distinguish categories directly reflecting the R&D purpose. Whereas the social and cultural purpose is more related to developing the knowledge base for social utilization, the economic purpose of research and development is focused mainly on achieving manufacturing goals or providing services to customers. As far as the political purpose is concerned, the main aim is to meet the needs of the evidence based policy. Due to a different purpose the requirements of employers in the respective areas concerning the competence of research workers differ too, which may be related to different work organization and culture in the company or its departments. Apart from purpose, human resources are also affected by the RDI forms (basic research, applied research, experimental development, innovation activities), which can be connected to the purpose to a certain degree, though. The RDI form is of primary importance in terms of the way of funding; in the area of human resources its impact on the research workers' motivation can be observed.

The key role of human resources is apparent, among other things, from the body of statistical data collected in relation to human resources. In the Czech Republic it is the CZSO that pays great attention to human resources. In the annual publication "Research and Development Indicators" compiled mostly on the basis of the VTR 5-01 research and development survey, the outputs concerning human resources are presented classified in a number of segments. Besides, the CZSO also focuses on human resources in RDI when evaluating the workforce selection survey. Therefore, this analysis only presents the most significant indicators, trends and international comparisons. The analysis further focuses on areas that are not sufficiently monitored yet, even though they are of great importance for the RDI system management.

As for the total number of R&D employees, the total of individuals (HC) registered as of 31 December 2013 was 92,714. This represents an increase by 5.9 % when compared to the previous year. When converting the data to full time equivalent (FTE indicator), the increase was lower, namely 2.4% and the value amounted to 61,976 in 2013. The majority of the employees are researchers (approximately 55 %), followed by technical workers (about 30 %) and other workers (15 %). This workforce distribution does not demonstrate significant changes even after conversion to FTE and is also consistent year-on-year.

The representation of R&D employees in the respective sectors is shown in Figure 4.2. The most significant sector in terms of total R&D employees is the business sector (45 thousand employees in 2013), with the share in total employment rate increases every year and is gradually approaching 50%. Approximately 35 % of R&D employees work in the higher education sector and their number has also been growing year-on-year (32 thousand in 2013). The number of employees in the government sector is less than half of the number in the higher education sector (15 thousand in 2013) and has been stagnating year-on-year. After conversion to FTE the dominance of the business sector is even more striking (55 % as oppo-

Figure 4.1: Overview of Human Resources in Terms of Their Expertise, Performed Activities and Motivation



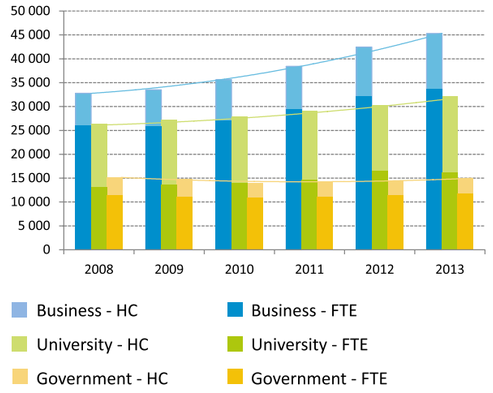
Note: The OECD Fieldsof Science classification (FRASCATI Manual) can be used for classifying scientific areas/fields; the NACE field classification is suitable for economic purpose.

sed to 26 % in the higher education sector and 19 % in the government sector). This is caused by a great difference between the number of registered workers (HC) and the number of full-time workers (FTE). Whereas in the business and government sector the difference after conversion is about 20–25 %, in the higher education sector it is as much as a half (32 thousand employees, 16 thousand FTE). This difference is affected by the conversion methodology[1]; however, it might indicate higher occurrence of part-time contracts in the higher education sector.

The international comparison of R&D employee numbers according to the sectors in which the employees operate is given in Figure 4.3 (data converted to FTE expressed as relative to 1,000 inhabitants). A similar situation as in the Czech Republic, i.e. a slight dominance of employees in the business sector over the public sector after FTE conversion is in countries such as Belgium or France. A slight dominance of employees in the business sector over the public sector is also demonstrated in Hungary and Italy; however, the numbers of employees working in research and development are significantly lower. In countries such as Germany, Austria, the Netherlands or Sweden the dominance of employees in the business sector is even more substantial.

1) The conversion to FTE calculates only with a part of the work capacity devoted to research and development but not other activities, such as teaching.

Figure 4.2: Number of R&D employees in the Czech Republic according to sectors in 2008–2013



Data source: CZSO | Both the number of registered workers (HC) and FTE conversion are presented.

These countries are comparable to the Czech Republic in terms of public sector employees but considerably exceed the Czech Republic in the business sector. Similar numbers of public sector employees and significantly lower representation of employees in the business sector are shown e.g. in Spain, Portugal or Slovakia.

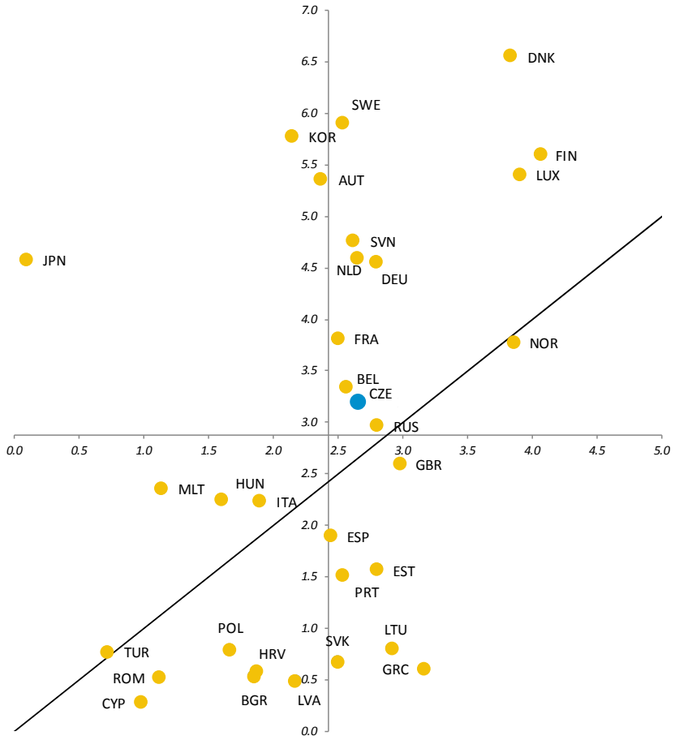
The numbers of research workers in the respective sectors, field areas and groups of scientific fields are presented in Figure 4.4. Figure 4.4 also shows the trends of numbers development in recent years. The most important sector in terms of the number of research workers is the higher education sector, followed by the business sector. The number of research workers in the government sector is less than half the number of employees in the higher education sector, similarly to the total of research and development employees. The number of research workers in the higher education and the business sector has been increasing long-term (Figure 4.5). There was an increase in the higher education sector from 19 thousand in 2008 to 23 thousand in 2013. Thanks to a rapid growth in the last three years, the business sector has almost reached the level of the higher education sector (increase from 15 thousand in 2010 to 20 thousand in 2013). The number of researchers in the government sector is stagnating around 8.5 thousand.

In the higher education sector the number of research workers has been increasing in all types of entities (public universities, university hospitals and private universities); however, after conversion to FTE the trend of research workers of public universities is decreasing in the last year, which causes a slight decrease in their number in the higher education sector as a whole. In the business sector the numbers of research workers have been increasing in small and medium-size enterprises, yet small enterprises saw a decrease in the last year.

From the perspective of area/field2 focus there are large differences between the higher education and the government sectors (Figure 4.4). Whereas within the higher education sector the highest number of research workers perform in technical sciences and medical sciences (probably due to university hospitals), in the government sector there is a distinct dominance of natural sciences followed by human sciences with a substantial gap (probably due to the inclusion of libraries, archives and museums). The status of social sciences is different too. In the higher education sector their significance according to the number of workers is comparable to medical and natural sciences and the number of employees has been increasing, whereas in the government sector the number of employees in social sciences reaches only 10% of the number of employees in natural sciences and moreover there is a decreasing trend. The varied status of social sciences is even more striking when compared to human sciences. Within the government sector the social fields have fewer than half the number of employees when compared to human sciences, in the higher education sector, on the other hand, the numbers within social sciences are almost triple when compared to human sciences. The drop in the number of employees working in technical sciences is shared by both public sectors.
Due to different data records (sector classification in the business sector, field classification in the higher education and government sector) it is complicated to describe the connection between public sectors and the business sector. Besides, there are no data on turnover of research and development workers.

2) In the business sector the information is available in field segmentation (CZ-NACE), whereas in the public sector (higher education and government) these are scientific fields.

Figure 4.3: International Comparison of R&D Employee Numbers According to Sectors (converted to FTE expressed as relative to 1,000 inhabitants)



Horizontal axis: Number of R&D employees in the public (higher education and government) sector (FTE to 1,000 inhabitants). | *Vertical axis: Number of R&D employees in the business sector (FTE to 1,000 inhabitants).* | *The intersection point marks the theoretical EU 28 position.* | *The black diagonal line expresses balanced ratio of employee numbers in public and government sectors.* | *Data source: Eurostat, OECD (Main Science and Technology Indicators); For RUS, JAP and KOR population data from 2012 were used.*

Therefore, it cannot be exactly reported where from and where to they are transferring. However, the decrease in the numbers of employees in technical sciences in the government and mostly in the higher education sector compared to the increase in the processing industry (most significant fields being mechanical engineering and motor vehicle manufacturing) as well as in information and communication technologies, can be considered to be a certain disproportion. This may indicate that technically oriented R&D employees transfer from the public sphere to the business sphere.

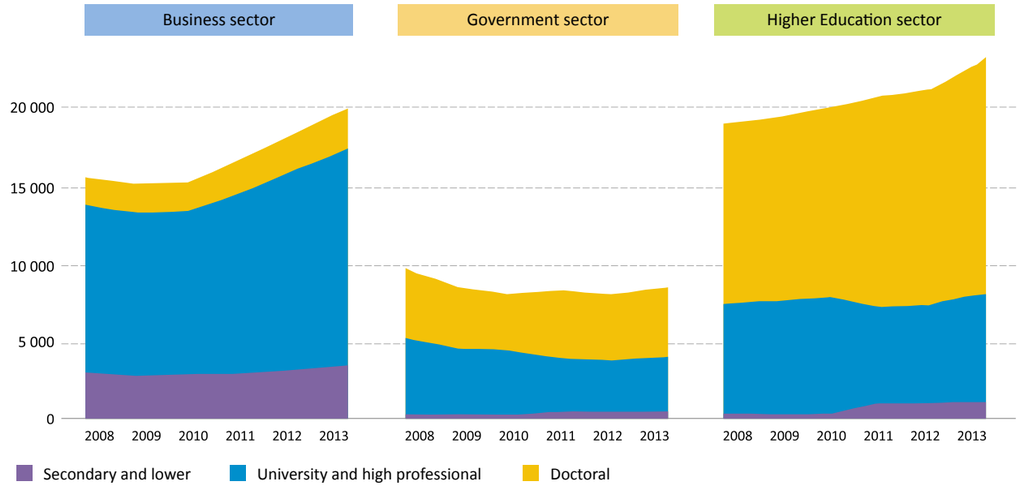
As far as the highest completed level of education of researchers is concerned, Figure 4.5 shows significant differences between the sectors. The higher education sector is unambiguously dominated by researchers with doctorate degree (65 % in 2013) and their number has recently been growing (their proportion in 2008 was 61 %). On the other hand, in the business sector there are approximately 10 % of researchers with doctorate degree and their proportion has not been growing substantially, moreover, there are more researchers with high school education in this sector (17 % in 2013).

Figure 4.4: Numbers of research workers in research and development in the Czech Republic in 2013 and their trends

BUSINESS SECTOR (19 882) ↑↑↑			GOVERNMENT SECTOR (8 413) —↑FTE—				HIGHER EDUCATION SECTOR (22 957) —↑FTE–↑–		
Small enterprises (3 199) ↑↑↓	Medium enterprises (6 703) –↑↑	Large enterprises (9 981) ↑↑↑	AS CR facilities (5 604) ––↑FTE–––	Department research facilities (1 569) ↑↓↑	Libraries, archives, museums (683) –↓–FTE↓–↑	Other facilities (cca 557) ↓––	Public universities (20 177) ––↑FTE–↑↓	University hospitals (2 075) –↓↑	Private universities, high professional schools (705) ↑↑↑
Processing industry (9 833) ↑↑–			Natural Sciences (4 850) –↑↑FTE–↑–				Technical Sciences (5 473) ↓↑↓		
Information and communication activities (3 325) ↑↑↑			Humanities (1 264) –––				Medical Sciences (4 741) –↓↑		
Research and development (2 764) –↑–			Technical Sciences (686) –↓–FTE↓↓–				Natural Sciences (4 601) ↑–↑		
Other services (2 294) –↑↑			Medical Sciences (679) –↓–				Social Sciences (4598) ↑↓↑FTE↑––		
Architectural and engineering activities; technical testing and analysis (1 081) ↑↑↓FTE–↓↑			Social Sciences (496) ↑–↓FTE–↓↓				Humanities (1890) ↓↑↓		
Other industries and construction (501) ↑↑↑			Agricultural Sciences (438) ↑↓↑				Agricultural Sciences (1 654) ↓↑↑		

Registered numbers of employees as of 31 December 2013 are given in brackets | *The arrows show year-on-year HC changes, the first arrow between 2010–2011, second 2011–2012, third 2012–2013; ↑ increase by 5 % or more, – changes under 5%, ↓ decrease by 5 % and more). In case of differences the FTE trend is presented too.* | *Note: The classification of institutions in the government sector corresponds to the data of CZSO. Department PRI are related to MT, MEYS, MLSA, MFA, MA, ME; among other facilities are State governed PRI (State Office for Nuclear Safety and the Czech Office for Surveying, Mapping and Cadastre) and PRI governed by self-government (Statutory City of Liberec, the Municipality of Mšené-lázně, the Region of South Moravia, the Region of Ústí nad Labem)* | *Data source: CZSO*

Figure 4.5: Numbers of research workers in the Czech Republic in the respective sectors in relation to completed education

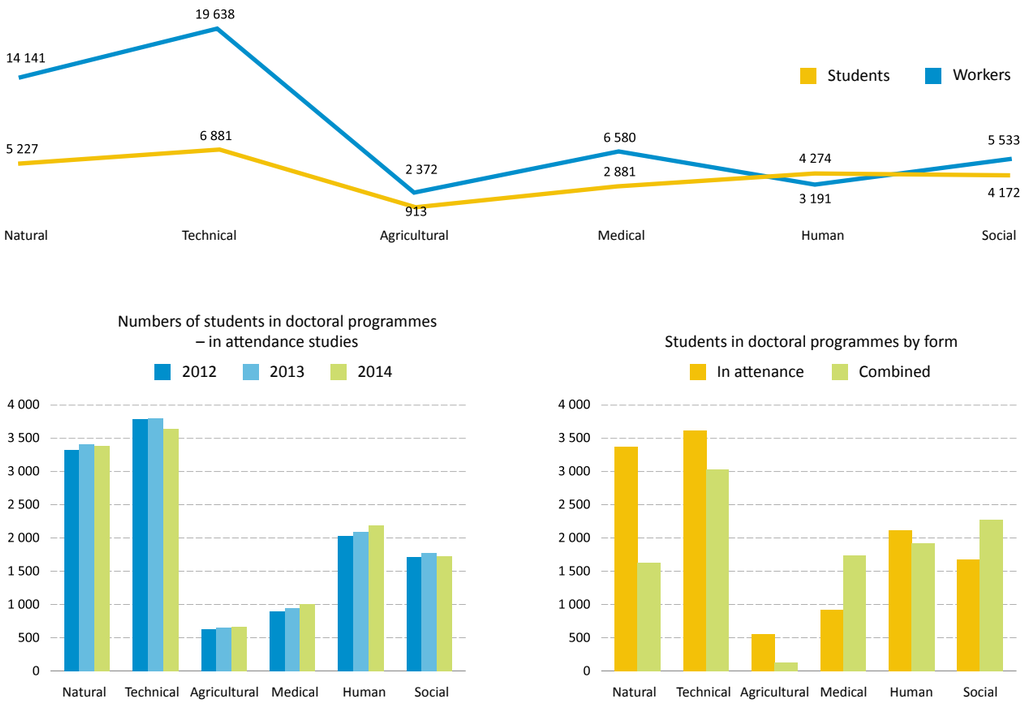


Registered numbers of employees (HC) are presented. | *Data source: CZSO*

In the government sector researchers with doctorate degree account for approximately 53 %. From the above trends one might conclude that the career options for new doctoral graduates are a crucial factor. The majority of researchers remain in the higher education sector, which provided them with professional qualifications or they transfer to the government sector (probably mostly to departments of the Academy of Sciences) where there will not be increased career opportunities in the future according to the trend. The reason for this might be the motivation of young researchers (for example the desire to pursue basic research) or they are pushed by circumstances as they do not have the qualifications required for a career within the business sector. However, no data on the needs of the business sector in the form of open job positions for research workers and qualification requirements that would confirm the above assumption are available. More detailed data on the age structure of researchers are lacking as well, which would enable to better define the potential for accepting new research workers. A considerable prospect in this respect is represented by newly built RDI infrastructures (see Chapter 5 – RDI Infrastructures).

There might be differences among field groups in the relation between education for the purpose of performing research and development and real expertise application at a position of a research worker. There is a substantial imbalance between the numbers of doctoral students in the groups of scientific fields and the numbers in other groups (Figure 4.6). In technical and natural sciences there is a significantly higher ratio of researchers to students (about three times higher). Thus a sufficient space for future careers of graduates is being created. Medical and agricultural sciences have a smaller potential from this perspective.

Figure 4.6: Relation between numbers of researchers and numbers of doctoral students in various field groups



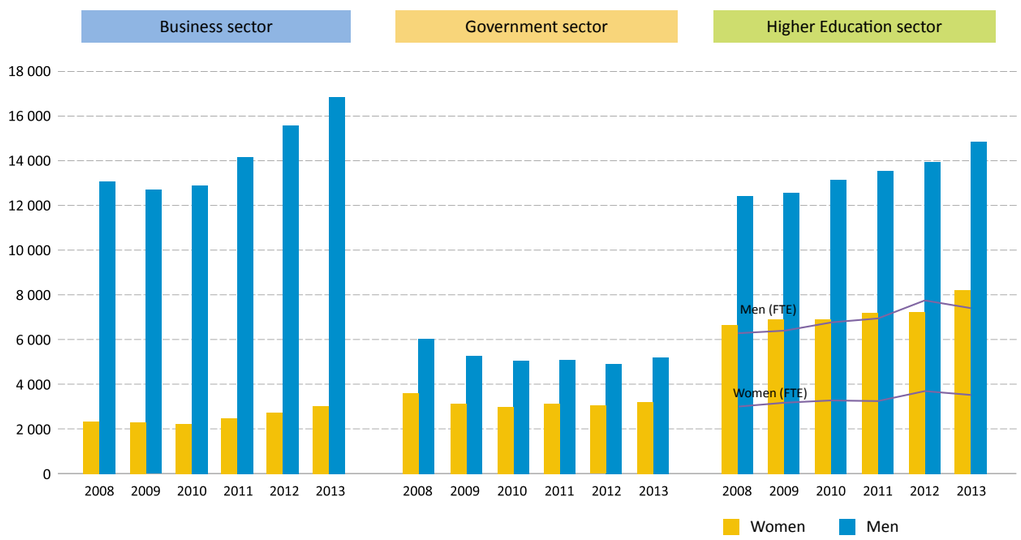
Data source: CZSO (numbers of researchers in 2013), MEYS (numbers of students in 2014)

In social sciences and mostly in humanities the situation is completely reverse than in technical and natural sciences. The current number of doctorate students is nearly at the same level as the number of employees; in humanities it is even higher. Therefore, the potential of students pursuing purely R&D oriented careers is minimal.

Figure 4.6 also presents the time trend of student numbers in the respective groups of scientific fields. Whereas in all other scientific fields the numbers of students have been increasing slightly, there has been an apparent decrease in technical sciences. That can be related to low representation of researchers with doctorate degrees in the business sector (Figure 4.5). There are also some differences between the proportions of students in attendance to distance students (combined studies). In attendance studies prevail in natural, technical and agricultural sciences. This is probably due to the fact that these fields require financially demanding equipment, which can only be used to a limited degree in the distant form of studies. On the other hand, the combined form is more frequently used in fields of social sciences. In medical sciences the dominance of combined studies is even more striking, probably due to the connection to healthcare facilities, where the doctoral students already work as employees.

As for the gender ratio of research workers, there is an obvious imbalance in all sectors. The greatest dominance of men is in the business sector (85 %), the lowest in the government sector (approximately 60 %); in the higher education sector about 65 % of research workers are men. The time trend of the numbers of research workers does not indicate any improvement in this respect. However, the data required for a detailed analysis of the causes are not available.

Figure 4.7: Numbers of research workers in the Czech Republic in 2008–2013 according to gender.



The column charts present registered numbers of employees (HC). | *Data source: CZSO*

5. RDI INFRASTRUCTURES

RDI infrastructure is defined by the European Commission[1] as *"facilities, resources and related services that are used by the scientific community to conduct research in their respective fields and covers scientific equipment or sets of instruments, knowledge-based resources such as collections, archives or structured scientific information, enabling information and communication technology -based infrastructures such as grid, computing, software and communication, or any other entity of a unique nature essential to conduct research. Such infrastructures may be 'single-sited' or 'distributed' (an organised network of resources) in accordance with Article 2(a) of Council Regulation (EC) N°723/2009 of 25.6.2009 on the Community legal framework for a European Research Infrastructure Consortium (ERIC)."*

The RDI infrastructures are areas where all segments of the innovation chain are efficiently connected, places for interaction of entities engaged in education and public research as well as the business sphere with the final effect of goods and services with high added value. From the analytical point of view, RDI infrastructure can be perceived as one of the three key elements of the RDI base (other elements being human resources and financial resources for RDI realization). RDI infrastructures in the Czech Republic are founded, developed and operated by various entities, most often public research organizations (universities, public research facilities); however, they lack legal personality.
Similar as the RDI entities, RDI infrastructures are also funded from multiple sources based on the principles of additionality and complementarity. In compliance with the Act on Support of Research, Experimental Development and Innovation these financial instruments are both special-purpose and institutional. Special-purpose resources used for RDI infrastructure support are reviewed in Table 5.1. Since 2005 total resources amounting to nearly CZK 84 billion have been expended, over CZK 34.5 billion coming from the state budget.
The greatest source for the first investment related to building and further development of RDI infrastructures were the resources from ESF and the most important resource for further infrastructure development in the programming period 2014–2020 will probably be ESIF. Within priority axes 1 and 2, OP RDI supported the foundation or extension of the total of 48 RDI centres (8 European centres of excellence and 40 Regional centres of research and development) by the total amount exceeding CZK 41 billion. According to the total amount of support to the respective centres the projects are divided into large, whose support has exceeded EUR 50 million and regular (small)2. The following projects are among the large centres (also highlighted in Figure 5.2 presenting the total amount of support):

- **Priority axis 1 – European Centres of Excellence:**
  - ELI: EXTREME LIGHT INFRASTRUCTURE,
  - Biotechnology and Biomedicine Centre of the Academy of Sciences of the Czech Republic and the Charles University in Prague
  - CEITEC – Central European Institute of Technology
  - St. Anne's University Hospital in Brno – International Clinical Research Centre
  - IT4Innovations – Centre of Excellence
- **Priority axis 2 – Regional Research and Development Centres**
  - SUSTAINABLE ENERGETICS.

Further development of these centres will be enabled by the Operational Programme Research, Development and Education, which is discussed in detail in Chapter 6. As for the SUSEN and ELI centres, the projects will be divided into stages due to material changes in the solution schedule, i.e. the projects will be divided into two immediately following operational programming periods 2007–2013 and 2014–2020. The phasing will enable the projects initiated from OP RDI and from the resources of OP RDE to be completed.

However, in the last ten years, building and improvements of RDI infrastructure capacity has also been enabled by the programmes of special-purpose support funded mostly from the state budget. Since 2005 there have been three programmes provided by the

1) Commission Regulation (EC) No. 651/2014 of 17 June 2014, by which in compliance with Article 107 and 108 of the Contract certain support categories are declared compatible with the internal market.

2) The division to large and small projects is of a purely administrative character. In compliance with this document, it is utilized for separating certain projects that are used for certain analyses as pilot projects.

Table 5.1: Financial instruments for support of RDI Infrastructures in the Czech Republic in 2005–2014 (including ongoing financial instruments to be completed in the following years)

Provider	Programme code in RDI IS	Name of financial instrument / programme	Objectives related to RDI infrastructure support	Start	End	Aggregate costs of the total execution time (thousands of CZK)	Support from SB throughout execution (thousands of CZK)	Number of projects
Operational Programmes co-financed from SB								
MEYS	ED*	The Operational Programme Research and Development for Innovations – priority axes European Centres of Excellence and Regional Research and Development Centres	The global aim of OP RDI is to enhance the research, development and innovation potential of the Czech Republic, which will contribute to increasing competitiveness and creating high qualification jobs so that the regions in the Czech Republic become significant areas where these activities would be concentrated within Europe. OP RDI is one of the key operational programmes that contribute to the growing competitiveness of the country and focus on economy based on knowledge. The Programme comprises of the priority axes European Centres of Excellence (PO 1) and Regional Research and Development Centres (PO 2), Commercialization and Popularization of RDI, Infrastructure for University courses related to research and Technical assistance. PO 1 – Centres whose impact, equipment, unique structure and crucial size will contribute to the connection and deeper integration of leading RDI teams to the international level. PO 2 – Centres focused on applied research and cooperation with the application sphere; they should contribute to enhancing regional, economic and technical specializations.	2008	2015	41 320 257	6 185 709	48
Programmes of special-purpose support and groups of grant projects focused on building infrastructures and their further development								
MEYS	1M	Research centres (National Research Programme)	To support cooperation of top scientific centres in the Czech Republic in order to improve their competitiveness in the European Research Space and to contribute to the education of young specialists.	2005	2011	6 723 072	5 931 731	36
MEYS	LC	Basic Research Centres	To support cooperation of top scientific centres in the Czech Republic in order to improve their competitiveness in the European Research Space and to contribute to the education of young specialists.	2005	2011	4 071 613	3 163 562	51
MEYS	LR	Information – basis of research	Development of information infrastructure and infrastructure research services – "Information as a fundamental building block necessary to build anything", i.e. to create new results in RDI.	2013	2017	1 951 526	1 017 120	9
CZSF	GB	Projects for Support of Excellence in Basic Research	The goal is to support scientific cooperation in basic research, i.e. cooperation of several top teams from different institutions researching the same or similar areas in which they have recently achieved excellent results.	2012	2018	3 334 237	3 330 460	37
TA CR	TE	Competence Centres	The main aim of the programme is to increase competitiveness of the Czech Republic in progressive fields with high potential for applying RDI results in innovations. The targets include: improving long-term cooperation of research organizations and enterprises in RDI; support of R&D interdisciplinarity; creating conditions for development of RDI human resources, mostly focused on engaging young research workers under 35 including students participating in the project; creating conditions for horizontal mobility of research workers; meeting the National Priorities of oriented research, experimental development and innovation; sustainability of the strategic research agenda in the centres at least five years after the end of a project.	2012	2019	8 845 331	6 024 948	33
Financial instruments focused on supporting operation of RDI infrastructure and ensuring their sustainability								
MEYS	LM	Projects of Large Infrastructures for RDI	To provide financial means to the base of excellent research and thus enhance the competitiveness of Czech R&D.	2010	2017	6 204 812	4 059 954	35
MEYS	LO	National Sustainability Programme I	The aim of the Programme is continuous development of research infrastructure of the Centres built in the Czech Republic in 2007–2013/15 with the financial contribution of the European Regional Development Fund, to support social and economic development of the regions where these Centres operate, continually create and apply quality R&D results, maintain or increase the numbers of created job positions in the Centres, mostly for research workers.	2013	2020	11 391 940	4 840 670	40
MEYS	LQ	National Sustainability Programme II	Ensuring long-term sustainable funding of centres equipped with modern and unique infrastructure, producing outstanding research results including practically applicable results and creating strong partnerships with prestigious research facilities both in the Czech Republic and abroad.	2016	2020	N/A	N/A	N/A
Total						**83 842 788**	**34 554 154**	**289**

*For financial instruments ongoing after 2014, data from RDI IS as of 15 May 2015 are presented. | In case of programmes that have not been completed yet, planned realization expenses related to initiated projects are taken into account too (allocated resources for 2015 and planned for the following years). Data source: RDI IS | * The Operational Programme Research and Development for Innovations only data related to priority axes 1 and 2 are presented.*

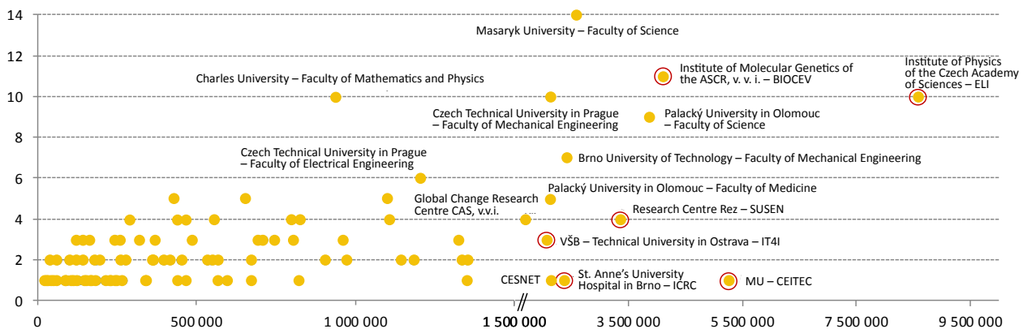
Ministry of Education, Youth and Sports (MEYS) and one programme provided by the Czech Science Foundation and the Czech Technology Agency each (List of titles including information on their objectives is presented in Table 5.1.).

The most significant RDI infrastructures are supported from the state budget for RDI through MEYS chapter as the so-called Large RDI infrastructures projects approved by the government. Evaluation of large infrastructures was carried out in 2014 under the auspices of MEYS based on the principles of informed international peer-review.

The evaluation output are 58 RDI infrastructures recommended by the international evaluating commission for funding, divided into 4 groups marking the priority of their funding. 42 have been recommended by the commission to be funded as high priority. The large projects ELI, IT4I and significant parts of the CEITEC and BIOCEV projects as well as regular (small) projects Centre for Research of Toxic Substances in the Environment, Centre for Global Change Research (Czech-Globe) and Biomedicine for Regional Development and Human Resources have been among those built from OP RDI evaluated as high priority.
In compliance with the development of the European Research Space and in relation to the activities of the European Strategic Forum on Research Infrastructures in the form of the ESFRI Roadmap the Roadmap of large Czech RDI infrastructures was created in 2010. It includes RDI infrastructures that were supported as projects of large infrastructures. In 2015 the Roadmap will be updated. It is expected to be extended to 58 RDI infrastructures in relation to the results of the above mentioned international evaluation. MEYS expects that the operational costs of RDI infrastructures included in the Roadmap will be paid from the state budget within the limits defined by the approved state budget expenditure on research, development and innovation for 2016 and its mid-term outlook for 2017 and 2018 as large infrastructure projects.

To ensure sustainability of RDI infrastructures built from OP RDI the government approved NSP I (having been executed since 2013) and II (will be executed by 2016).

Figure 5.2: Beneficiaries of support for RDI infrastructures in the Czech Republic in 2005–2014



Horizontal axis: Total support of RDI Infrastructures from public special-purpose resources (including grant from OP RDI) in thousands of CZK | *Vertical axis: Number of projects solved in 2005–2014 (including unfinished projects)* | *For projects that are ongoing after 2014 the amounts allocated for 2015 and planned financial resources for the following years of realization are included.* | *For universities the projects are assigned to their organizational units.* | *For collaborative projects the projects are assigned to the coordinating beneficiary.* | *Red marks beneficiaries (or coordinating beneficiaries) of the so-called large projects from OP RDI (projects with total support exceeding EUR 50 million).* | *The figure does not express the number of infrastructures in the Czech Republic as the principles of complementarity and additionality are applied for their funding. One RDI infrastructure can be financed gradually or simultaneously from more projects. On the other hand, one large OP RDI project comprises of supports to more RDI infrastructures.* | *Data source: RDI IS (data export on 15 May 2015)*

It serves as support to the centres mostly in the first years of operation after their construction, when different ways of funding can only be applied in a limited manner. Large infrastructure projects as well as the National sustainability projects are special-purpose support under the Act on Support of Research, Experimental Development and Innovation, even though their focus on particular RDI infrastructures is closer to institutional support.

Figure 5.2 summarizes the special-purpose resources expended to support RDI infrastructures in the Czech Republic from 2005 to 2014 for the respective beneficiaries or their organizational units. All programmes named in Table 5.1 are included (except for the National Sustainability Programme II, which will be executed till 2016). Figure 5.2 thus documents all special-purpose resources (including grants from OP RDI) used in the given years for building RDI infrastructures as well as for their further development and operation, i.e. total of CZK 83.84 billion for 289 projects related to RDI infrastructures.

It is apparent that in terms of both the number of projects and the financial volume, the dominant support beneficiaries in the Czech Republic are entities / divisions focused on natural sciences, technical and medical sciences. Among beneficiaries with the highest number of projects with support exceeding CZK 1.5 billion at the same time are the Faculties of Science of the Masaryk University and of the Palacký University in Olomouc as representatives of universities and from the departments of the Academy of Sciences it is the Institute of Molecular Genetics of the ASCR, v. v. i. and the Institute of Physics of the Czech Academy of Sciences. In the sphere of industrial sciences, the category with a high number of projects and at the same time great volume of financial resources includes most importantly the Faculty of Mechanical Engineering, Czech Technical University in Prague and the Faculty of Mechanical Engineering, Brno University of Technology. A considerable number of projects was also dealt with at the Faculty of Mathematics and Physics of the Charles University in Prague and the Faculty of Electrical Engineering of the Czech Technical University in Prague. In the sphere of medical sciences among RDI infrastructures the major position is held by the Faculty of Medicine and Dentistry of the Palacký University in Olomouc. Interpretation of Figure 5.2 is affected by the financially significant, so-called large projects from OP RDI. The coordinating beneficiaries of these projects (e.g. the Institute of Molecular Genetics of the ASCR for BIOCEV and the Masaryk University in relation to CEITEC) demonstrate seemingly the highest amounts of financial resources, but in reality the support has been divided among several recipients and the built infrastructures are operated by several entities (for BIOCEV six ASCR departments and two university faculties, for CEITEC four universities and two public research institutions).
Apart from the above instruments the operating entities can fund the activities of RDI infrastructures from institutional resources aimed at long-term conceptual development of research organizations. In the future it might prove beneficial for this source to cover the majority of operational costs of those RDI infrastructures that will not be funded by the Ministry of Education, Youth and Sports as projects of large infrastructures. With regard to the legal determination of the financial resources distribution, it cannot be used for newly created RDI infrastructures as long as the resources are distributed based on points for value of results (mostly publications) achieved in the previous five years. When initiating new research activities by newly created research teams in new infrastructures it is necessary to account for some time lag before the results can be published or legally protected (patents, utility models) and therefore before they are included in the evaluation. This time lag can extend, depending on the field, to about two to ten years. Many infrastructure operators are forced to rely mostly on finance allocated for the results of different organizational units in this period.
Another funding resource are public foreign resources in the form of collaborative projects at the international level within grant schemes, such as 7FP, Horizon 2020 or EEA Grants and Norway Grants, which are partly realized in the particular RDI infrastructure. For RDI infrastructures with applied focus the major source of finance are business resources. The state budget resources for support of long-term conceptual development of research organizations together with business resources should essentially replace the ESIF resources aimed at further development of research infrastructures after the end of the programming period 2014–2020. The costs related to the execution of particular RDI tasks should partly cover regular operational costs of RDI infrastructures.

The issue of funding RDI infrastructures in relation to meeting the objectives and benefits can be demonstrated by the example of large centres built from the OP RDI resources. Figure 5.3 shows the potential to fulfil sustainability through indicators in the area of own construction, human resources (new employees), financial resources, creating research outputs and education. Based on the indicator values achieved in 2014 it is obvious that the IT4I, ICRC and CEITEC centres in the target year 2015 will most probably meet the indicators in the area of human resources and number of publications (CEITEC has already considerably exceeded the target values). The probability of meeting the indicators is lower in centres ELI, BIOCEV and SUSEN, which is also given by a later date of approval. All above centres perceive meeting the indicator on contractual research volume as problematic as this indicator was probably overestimated at the time of project preparation. However, this is not a mistake as at the time of project preparation the restrictions related to the approach of the European Commission[3] concerning the determination of economic and non-economic activities performed by research organizations and RDI infrastructure were not known. Lower amount of acquired private resources in the form of payments for performed contractual research will probably result in increased requirements of centre operators on public resources mostly from the state budget, most importantly in the first years after initiation of RDI activities that the centres were built for.

Expenditures planned in 2015–2020 in relation to the operation of six large centres built from the RDI resources are shown in Figure 5.4. These data have been obtained directly from centre operators. They represent the first estimates obtained in the first quarter of 2015, i.e. at the point of finishing the construction of the centres, which will be made more accurate in the following years. The estimates indicate that the total costs will probably increase to approximately CZK 3.5 billion per year. About 30 % of these costs will be running costs that need to be expended without any research going on in the centre. Running costs together with research costs will probably stabilize by 2018 at approximately CZK 2.5 billion per year. In later years probably only the costs of investment renewal will increase up to about CZK 900 million per year.
Figure 5.4 also shows which financial instruments will likely be used to cover the costs. Operational costs can be covered mostly by financial instruments of institutional nature, e.g. Projects of large infrastructures, National Sustainability Programmes I and II and support of long-term conceptual development of research organizations. These costs can partially be covered by resources for own research, both from public and business sources.

Figure 5.3: Sustainability indicators of selected RDI infrastructures built from OP RDI in 2008–2015

Data of the so-called large centres are given, i.e. those whose project financial allocation exceeded EUR 50 million.
At the time of data provision all stated projects were in the realization stage before completion of construction work.
The projects differ from each other in the number and type of sustainability indicators with regard to project focus and classification within the priority axes (the SUSEN project is a regional research and development centre funded from priority axis 2, the other ones are European centres of excellence funded from priority axis 1): If the indicator has not been set in the particular centre, the line in the figure is interrupted (e.g. in ICRC the construction of new capacities is missing as it concerns the extension and reconstruction of the existing RDI infrastructure).
Data source: Data provided by MEYS from the MONIT 7+ information system in February 2015

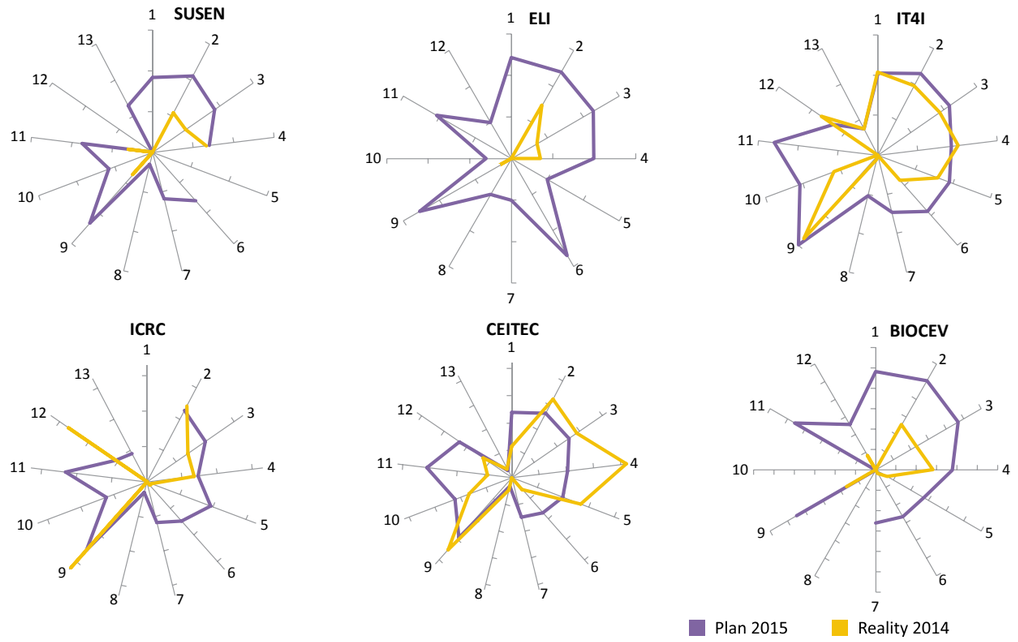
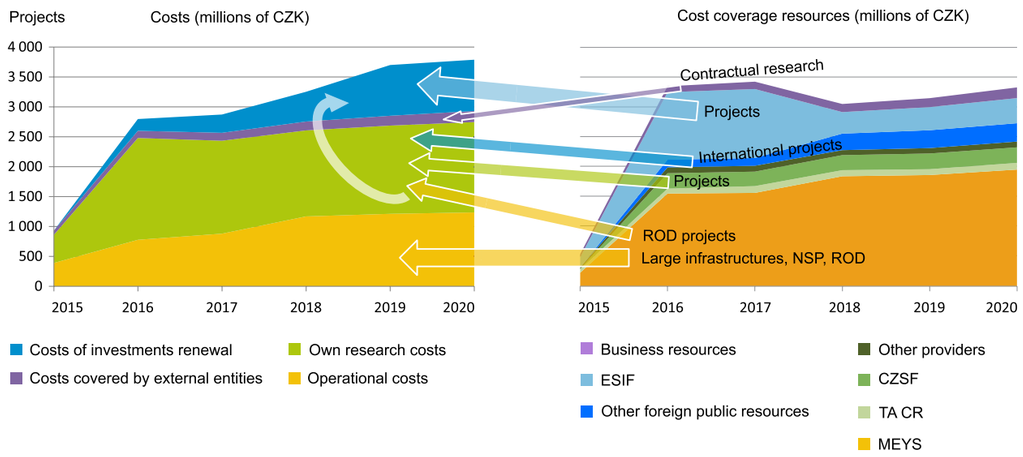


Figure 5.4: Summary estimate of future costs of six large centres built from OP RDI and the resources for their coverage in 2015–2020



Vertical axis: amount of financial resources in millions of CZK | These are estimates that will be gradually made more accurate. | Operational costs are expenses required for the centre to be prepared in a situation when there is no research going on in the centre – so-called fixed costs. | The data for 2015 are affected by unfinished construction phase of the projects; in compliance with the projects, the centres will be operating from 2016. | Data source: own survey within the Budget III working group carried out in the first quarter of 2014

3) inder Commission Regulation (EC) No. 651/2014 of 17 June 2014, which, pursuant to Articles 107 and 108 of the Contract, declares certain support categories to be compatible with the internal market and the Commission Communication – Framework for state aid for research and development and innovation (2014/C 198/01-29)

The costs of own research expect coverage from special-purpose resources of the Czech Science Foundation, the Technology Agency and other providers in year-on-year stable amount around CZK 0.5 billion. Special-purpose resources from MEYS will be used too. Own research can also be funded from the Development of Research Organizations. The estimated share of foreign public resources of special-purpose nature (e.g. H2020, EEA Grants / Norway Grants) is relatively low, about CZK 100 million in 2016 with gradual increase to about CZK 300 million in 2020. However, at the time of forming the estimate the centres were not running yet, therefore it was very difficult to quantify future success in international tenders. The ESIF resources (mostly OP RDE) amounting up to CZK 1.2 billion a year are accounted for covering the costs of future development of the centres. The estimate of the centre operators expects culmination of ESIF resources in 2017; however, with regard to the programme settings the maximum drawing will probably occur afterwards. The resources from Development of Research Organizations will also be used to cover reinvestments. The expected level of contractual research is relatively low (about 5 %), which does not correspond to the estimate at the time of OP RDI project approval. This is due to the focus of the centres, which is predominantly on basic research (except for SUSEN) as well as the restrictions related to the regulations imposed by the European Commission.

Multi-source financing of the RDI infrastructure operation is necessary in the existing system mainly to ensure their long-term sustainability with a high-level machine equipment, which together with stabilization of research and development teams represents a potential for performing quality RDI leading to economic and social benefits. However, a large amount of resources for funding infrastructures also places heavy demands on control activities that are to prevent funding duplicity, i.e. covering costs of the same activity from several sources at once. The fact that some RDI infrastructures are operated by several entities makes it more difficult to compile analyses focused on efficiency and economy of funding RDI infrastructures. Therefore, RDI infrastructures cannot be separated when evaluating the benefits and have to be assessed as an integral part of institutions performing RDI in the whole range of their activities.

6. RESULTS OF RESEARCH AND DEVELOPMENT

Results are important pieces of evidence of performing research and development activities. Depending on the type of executed activity (basic or applied research, development, innovation activities) and its objectives, different types of results are created. In the Czech Republic there are defined types of results[1] collected at the central level in the Research, Development and Innovation Information System (RDI IS). According to their nature, these results can be divided to a group of publication and non-publication results, which is further divided to applied and other results[2] (Figure 6.1).
Publication results, i.e. J results – reviewed article, B – specialized book, C – chapter in a specialized book and D – article in a collection, are usually connected mostly to basic research, even though also new applied research findings tend to be published. As far as publication results are concerned, those who are at level with the world's top results are prized the most.
As for non-publication applied results, their creation is usually related to applied research and experimental development. This group includes the following types of results: P – patent, Z – pilot operation, tested technology, variety or breed, F – utility model or industrial design, G – prototype or functional sample, H – result reflected in regulations and strategic materials, N – certified methodology, treatment, heritage process, or specialized map, R – software, V – research report and also previously defined results of type S – umbrella category for other applied results used before 2007 and T – umbrella category for other applied results used before 2006. For the majority of these results their practical utilization is expected as well as commercialization opportunities; this is the reason why the creation of such results in particular is stressed in strategic RDI documents.[3] Based on the results the evaluation of research organizations in the Czech Republic is carried out. From the perspective of efficient finance utilization it is necessary to follow mainly the share of particular types of results and their quality, or their potential for practical usage. With articles in periodicals, the quality of publication results can be derived from the level of such periodicals (defined by registration and rating of the journals within renowned global databases, e.g. impact factors of periodicals indexed in Web of Science) and by the frequency of the articles being quoted, which usually provides evidence of the presented findings being used by other authors in related research and development activities. There is no such indicator of quality for monographs and articles in collections. The quality of applied results is not evaluated, the significant aspects are the benefits of such results in the form of practical usage. For patents the benefits can be derived from financial resources earned by selling licences; however,

1) The definitions are given in the document Methodology of Evaluation of the Results of Research Organizations and Results of Finished Programmes (in force for 2013–2015).
2) For the purposes of evaluating research organizations the results are categorized differently according to the Methodology of Evaluation of the Results of Research Organizations and Results of Finished Programmes (in force for 2013–2015). Patents are separated outside applied results as an individual category and the results included in the Other category in Figure 6.1 are classified as applied, even though they are not assessed on the point basis.

3) E.g. Update of the National Reseach, Development and Innovation Policy of the Czech Republic for 2009 to 2015 with Outlook to 2020 approved by the Government Resolution of 24 April 2013 No. 294 and National priorities of oriented research, experimental development and innovation, approved by the Government on 19 July 2012 No. 552.

Figure 6.1: Types of Results of Research and Development Defined in the Czech Republic

<table>
<tr><th>PUBLICATION RESULTS</th><th colspan="4">NON-PUBLICATION RESULTS</th></tr>
<tr><td rowspan="2">(J, B, C, D)</td><td colspan="3">Applied</td><td rowspan="2">Other
(A, M, W, E, O)</td></tr>
<tr><td>Patents (P)</td><td>Utility models and industrial designs (F)</td><td>Other applied
(Z, G, H, N, R, V, S, T)</td></tr>
</table>

results with special legal protection

Codes of results defined in Annex No. 2 of the Methodology of Evaluation of the Results of Research Organizations and Results of Finished Programmes (in force for 2013–2015) are given in brackets.

licence sale is not always the goal of patent protection, often it reflects an effort to protect a unique process or technology in order to be able to further use it in the originating institution.

The data on the results from RDI IS provide a complex overview of RDI productivity in the Czech Republic. In relation to the nature of the support to performed RDI (special-purpose or institutional, for details see Chapter 2 – Funding RDI from the State Budget) financial instruments can be evaluated in a partial manner. However, the fundamental restrictions related to using information on results need to be taken into account too:

- *Transferring data on results of research and development into RDI IS is a statutory obligation under the Act on Support of Research, Experimental Development and Innovation applying solely to beneficiaries obtaining funds from public RDI resources. Thus the information on results in the business sphere is greatly limited.*
- *Most of the above types of results cannot be interpreted as results in the strict sense as the aim of the performed research, both basic and applied, is not the creation of a publication, but acquiring new knowledge. Publication thus represents a form of releasing a finding, i.e. its spreading. Similarly a patent, utility model or industrial design is not the primary goal of applied research or experimental development, but a way of protecting new findings. From an analytical point of view these are fundamental indicators providing evidence on the level of research performance; however, they cannot be used directly to measure the performance of research and development activities.*
- *The actual benefit of research and development comes only when the new knowledge, published or legally protected is used, not the creation of publications, patents, industrial designs and utility models as such.*

6.1. TYPES OF RESULTS AND TIME TREND OF THEIR NUMBERS

Creation of results in the Czech Republic demonstrates a long-term increasing trend, based on the RDI IS data. The total of results in the last decade has increased by approximately one third (from 42,000 in 2005 to 60,000 in 2014).

Figure 6.2 shows that the upward trend applies to both publication and applied results. The positive motivation causing this upward trend might have been affected by the implementation of research organization evaluation by results. The maximum of publication and applied results was reached in 2012 (in total more than 63,000 results), a slight decrease followed in the next two years. The described trend seems to indicate that the maximum results under the current valid definitions which the RDI system in the Czech Republic is able to produce has already been reached.

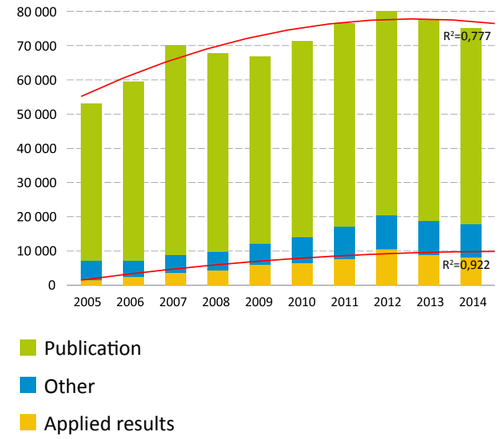
In the long run there has been a low proportion of applied results in the total number of results. Although their number and proportion has increased more than five times since 2005, applied results currently constitute only less than 11 % of all results reported in RDI IS.

As far as the types of publication results are concerned (Figure 6.3), in recent years there has been a prevalence of specialized articles (type J). Since 2005 their number has increased by approximately one third and they currently represent about 55 % of publication results. On the other hand, the number of articles in collections has dropped (type D). In 2007 articles in collections were the most numerous type of publication results; however, they were gradually replaced mostly by reviewed articles. The increasing proportion of reviewed articles within publication results indicates an increasing quality of publications. This was probably caused by the changesy[4] in the approach to evaluating research organizations, as a greater emphasis is now laid on publications in quality periodicals. In 2013 the peer-review evaluation of results was introduced. In 2012–2015 the individual national System of Efficient Evaluation and Funding of Research, Development and innovations, coordinated by MEYS, whose outputs should contribute to optimization of the way entities performing research are evaluated and the manner of spreading knowledge. The numbers of results correspond to quality mostly in natural science (for details see Chapter 6.3).

4)Based on the Resolution from the 305th RVVI Meeting, item "Outputs of the IPn Methodology Project will be one of the materials for creating the Evaluation 2017+" model.

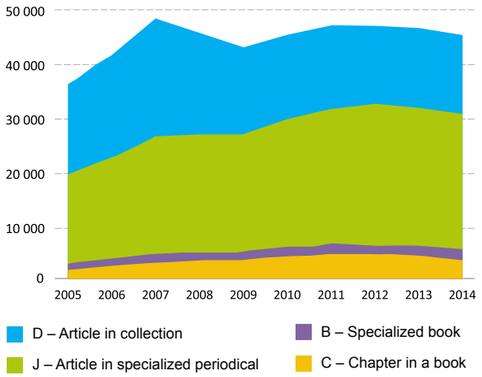
There were also changes in the structure of the respective types of applied results in 2005–2014 (Figure 6.4). The major share in applied results in 2014 was comprised by research reports (type V) and prototypes or functional samples (type G), whereas in 2012 it was certified methodologies (type N). The number of research reports has increased since 2012, when the so-called Summary research reports providing an overview of applied research project results were included, whereas in the previous years the reports taken into account were only the classified research reports. The proportion of results with special legal protection, i.e. patents (type P) and utility models and industrial designs (type F) has been very low in the whole reference period. Low patent production in the Czech Republic is also apparent from the international comparison (see Chapter 7 – Innovation Performance of Czech Economy and Its International Comparison, Figure 7.9; the Czech Republic is lacking behind the international average, e.g. Austria demonstrates more than double values).

Figure 6.2: Numbers of publication, applied and other types of results in the Czech Republic in 2005–2014

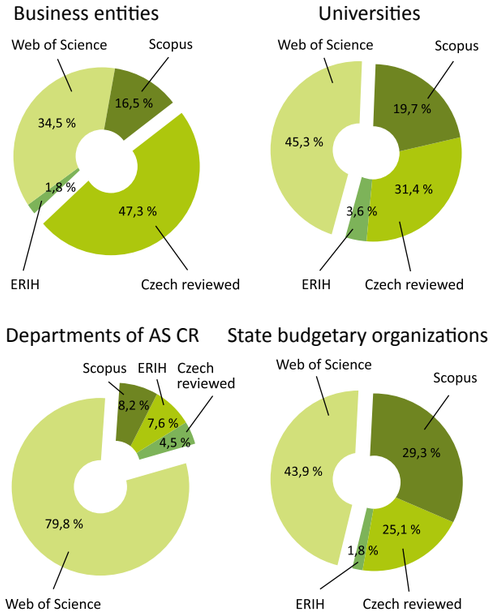


The numbers of results for 2014 are not final as at the time of processing the verification and elimination of results was not finished. The final number of results will probably differ only slightly. Data source: RDI IS

Figure 6.3: Types of publication results and their numbers in the Czech Republic in 2005–2014



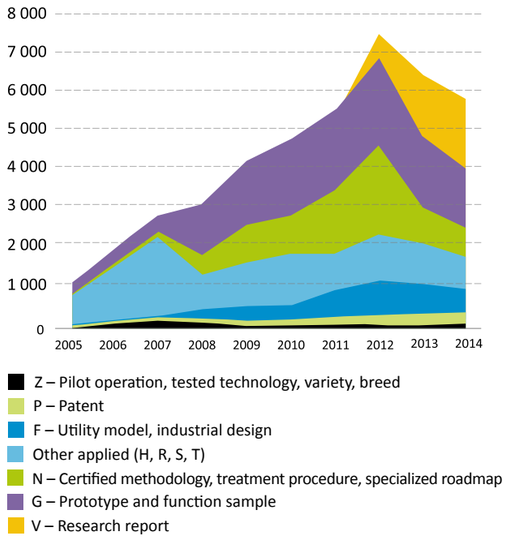
Structure of type J results according to the periodical occurrence



Structure of type J results includes data from evaluation of results of research organizations in 2013, i.e. results applied in 2008–2012. | *The numbers of results for 2014 are not final as at the time of processing the verification and elimination of results was not finished. The final number of results will probably differ only slightly.* | *Data source: RDI IS*

Changes in shown numbers of the respective types of applied results are probably related to the modifications of evaluating research organizations based on their results. For instance, results of types N (certified methodologies, treatment and heritage processes, specialized maps) and F (utility models, industrial designs) were evaluated by points in the past. The point-based evaluation of this type of results started in 2007 and this was probably the cause of their increase in the following period. Since 2013, with the exception of results of type P (patent) and some results of type Z (variety and breed), which are still evaluated by points, applied research is evaluated based on the financial amounts of contractual research; points are no longer granted for certified methodologies, utility models and industrial designs. This is probably the reason why their numbers have been decreasing recently. The stated facts might indicate undesirable pragmatics in creating results in direct relation to the way of evaluation. The created applied results thus probably reflect the needs of manufacturing practice only very little.

Figure 6.4: Types of applied results and their numbers in the Czech Republic in 2005–2014



The numbers of results for 2014 are not final as at the time of processing the verification and elimination of results was not finished. The final number of results will probably differ only slightly. The S and T type results are umbrella categories used for results of applied research till 2006 and 2007, respectively. | *Data source: RDI IS*

6.2. FIELD STRUCTURE OF RESULTS AND ITS CHANGES IN TIME

Figure 6.5 presents the numbers of results divided by field groups[5]. Figure 6.5 also demonstrates the time dynamics by comparing two consecutive five-year periods, i.e. 2005–2009 and 2010–2014. Definitely the greatest amount of results originate from Social and human sciences; besides, they demonstrate the most substantial increase in numbers out of all field groups. The second most significant field group from the perspective of amount of results is Industry; however, a slight decrease has been noticed here. This is probably affected by the way of data collection to RDI IS; due to the connection to the public support of research and development, data on research and development results funded solely from business resources are missing. Medical sciences are represented relatively high and showing increase in the amount of results, as well as Physics and Mathematics.

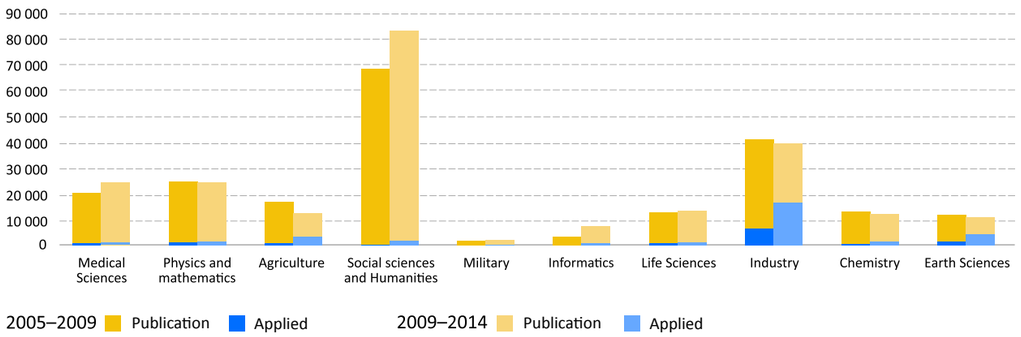
The field structure of the numbers of results is highly affected by the financial allocation of state budget resources for research, development and innovation. The resources for long-term conceptual development of research organization divided to field groups can be deduced from the point allocation defined by the evaluation methodology since 2010[6].

The largest point allocation is assigned to Chemical Sciences (15.8 %), Physical Sciences (15 %) and Biological Sciences (12 %). They are followed by Medical Sciences (10.7 %), Earth Sciences and Agricultural Sciences (total of 10 %). Technical Sciences including Informatics and Mathematics have been allocated over 20 % points (Informatics was originally assigned to Mathematics, since 2013 it has been incorporated in the joint field group with Technical Sciences). The remaining 15 % are allocated to Social Sciences and Humanities. However, the given allocations are executed at the level of providers who divide them to the entities according to the same mechanism (except for the Academy of Sciences, which uses a different way of evaluation). It is not completely obvious how the allocated resources are further distributed within the organizational structure of the entities (e.g. to respective faculties and university departments). Therefore, the point allocation does not have to correspond to the real support for field groups. The distribution of resources to the particular fields within the field groups is unknown as well. Moreover the field groups defined for the purpose of evaluation do not correspond to the field groups for reporting results in RDI IS.

More precise field comparison is enabled by special-purpose support distribution (see Figure 2.4 in Chapter 2 – Funding RDI from the State Budget). The numbers of results in Agricultural Sciences are comparable to Life

5) According to the first letter of the field code used in RDI IS records
6) Methodology of Evaluation of the Results of Research Organizations and Results of Finished Programmes (in force for 2013–2015)

Figure 6.5: Creation of publication and applied results in the Czech Republic according to field groups and their changes in time



The numbers of results for 2014 are not final as at the time of processing the verification and elimination of results was not finished. The final number of results will probably differ only slightly, in the order of %. | *Data source: RDI IS*

Sciences, Chemistry and Earth Sciences; the special-purpose support of research and development in these field groups varies considerably. In Life Sciences and Chemistry it is approximately double the support of Agriculture Sciences, in Earth Sciences it is almost one half higher.

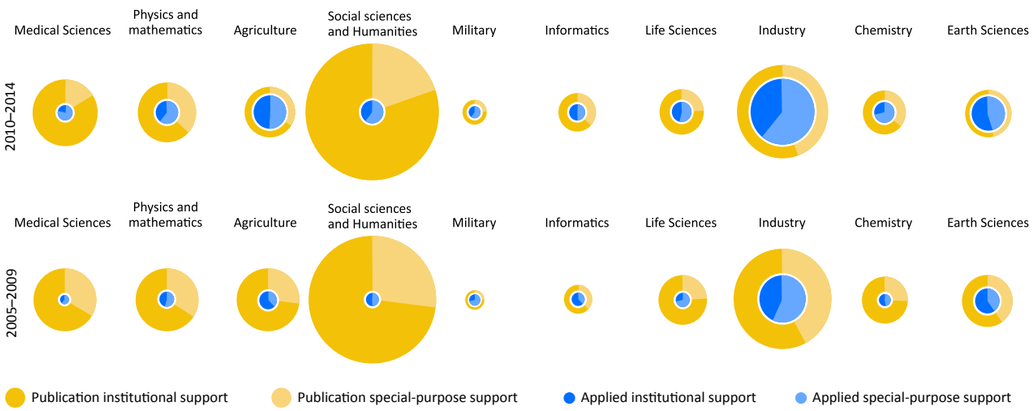
The proportion of applied results to publications in all field groups has increased, but it still remains low. In Industrial fields the ratio of applied results is more significant; however, even here it does not reach 50 %. Among the other field groups the relatively highest proportion of applied results is in Earth Sciences (39 %) and in Agricultural Sciences (27 %), on the contrary it is almost zero in Medical Sciences, it is also very low in Life Sciences, Informatics and Chemical Sciences (10–12 %).

An interesting comparison is provided by the field groups of results in relation to the type of public support (special-purpose and institutional) presented in Figure 6.6. Institutional support exceeds special-purpose support in publication results in all field groups. This dominance is the most striking in Social Sciences and Humanities, which are the most significant as for the number of results, as well as in Medical Sciences, and it has been increasing over time. It is the case for most fields that the proportion of special-purpose support in applied results exceeds the significance of the same support in publication results. Two exceptions are Informatics and Earth Sciences, where the proportion of special-purpose support in both result groups is comparable at a level close to 50%. From time perspective, most fields have shown increase in the significance of special-purpose support for the creation of applied results. In Social Sciences and Humanities as well as in Medical Sciences where the difference is most substantial (proportion of publications created with special-purpose support is less than quarter the amount, whereas the absolute majority of applied results has been created with special-purpose support); however, relatively lowest numbers of applied results are created. In Agriculture and Industry, where relatively the most applied results originate, this difference is less marked.

The above information confirm the assumption that institutional support more probably results in creating publications, whereas special-purpose support is more likely to generate applied results, most notably in recent years. However, it is not known to what degree the applied results are practically used.

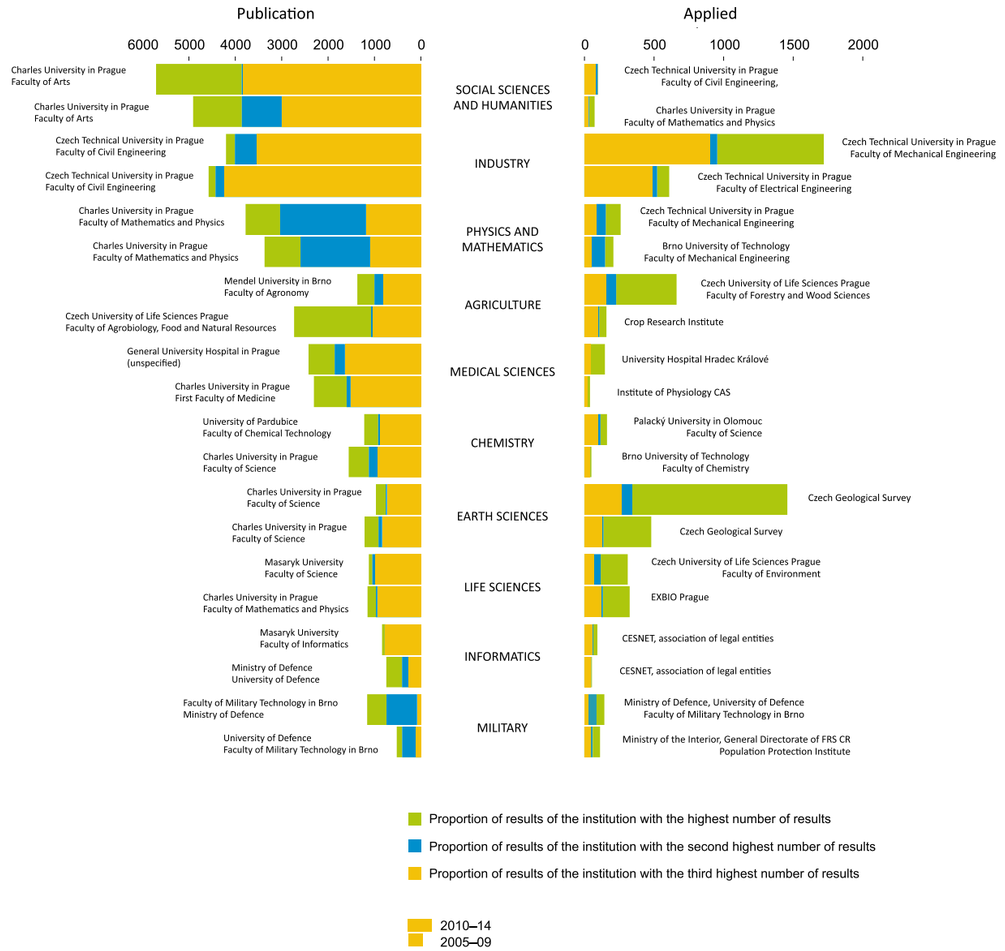
From the point of view of the institutions/organizational units and their share in the number of results in the

Figure 6.6: Creation of publication and applied results in the Czech Republic in relation to the type of public support – field group comparison.



The numbers of results for 2014 are not final as at the time of processing the verification and elimination process was not finished. The final number of results will probably differ only slightly, in the order of %. | *The size of the colour field corresponds to the number of results created with the given type of support; If the result was created with institutional as well as special-purpose support, it was counted twice – the image thus shows the ratio of both types of support but not the exact ratio of applied results to publication ones, which is presented in Figure 6.5.* | *Data source: RDI IS*

Figure 6.7: Institutions in the Czech Republic with the highest numbers of results in the respective field groups



respective field groups, the highest number of results are produced at universities (Figure 6.7 and for details see Annex No. 1[7]), mostly at universities with technical and scientific focus (with the exception of Social Sciences and Humanities, dominated by publication activity of the Faculty of Arts of the Charles University). The facts stated below as interpretations of Figure 6.7 and the figures in Annex No. 1 relate solely to the number of results and do not account for quality. Therefore, they are related mostly to the size of the institution (e.g. to the number of researchers and their fields of expertise – see Chapter 4 – Human Resources in Research and Development, Figure 4.4) and to the amount of public support (Chapter 2 – Funding RDI from the State Budget, Figures 2.2 and 2.3), not to their actual research and development performance. Faculty of Mechanical Engineering of the Czech Technical University produces the highest number of applied results in total and at the same time in the past it was one of the three most prominent creators of applied results in industrial fields as well as in Physics, Mathematics and Medical Sciences. Faculty of Civil Engineering of the Czech Technical University in Prague is among the institutions producing the most publication and applied results in Industrial Sciences. In Chemical Sciences, the largest number of publication results is created by Faculty of Chemical Technology of the University of Pardubice. In Earth Sciences, the largest producer of publication results is the Faculty of Science of the Charles University (also creates the most publications in Life Sciences); however, applied results in this field are produced mostly by the Czech Geological Survey. The highest number of results in Social and Human Sciences are produced by the Faculty of Arts of the Charles University.

7) The first figure in Annex No. 1 – Dendrogram presentst helists of ten institutions witht he highest number of publication and applied results and of three institutions witht he highest numbers in there spective fields. Italsopresents a comparisonofperiods 2005–2009 and 2010–2014. The second figure in Annex No. 1 concentrates on theentities/organizationalunitsthatcreatethelargestnumbers in morefields (horizontal axis showingthenumberofdendrogramoccurences, vertical axis showingthenumberofresults)

6.3. QUALITY OF RESULTS AND THEIR INTERNATIONAL COMPARISON

In terms of the quality of created publications a more detailed classification of reviewed articles by indexation in global databases is important on top of monitoring the proportions of the particular types. RDI IS does not facilitate such classification as it does not include the information on whether and in which global database (Web of Science, Scopus, or ERIH for human sciences) the publication is located. This piece of information can be obtained based on the process of evaluating the results of research organizations. Figure 6.3 presents the division by information from the latest completed evaluation from 2013, which contains results for 2008–2012. The highest number of highly appreciated articles indexed by Web of Science is created at universities. However, this results from the fact that universities in total produce the highest number of reviewed articles (and also employ the highest numbers of research workers). However, if one focuses on the proportion of publications in Web of Science in all reviewed articles produced by the given group of entities, the departments of the Academy of Sciences exceed universities substantially (80 % of articles in Web of Science for the ASCR departments as opposed to 45% for universities). Universities, similarly to state budgetary organizations and business entities, tend to publish more in Czech reviewed periodicals and in the Scopus database. This can be related to the effort of these entities to spread the results of research into practice, as mostly the Czech reviewed journals might be more accessible and more widely used by domestic experts, the public and manufacturers, in a way similar to conference collections. However, it can also indicate an effort to publish only partial or less interesting research results in an easier way and the entities might be motivated to do so by the current system of evaluating research organizations. There is not enough information on further use of the publications by the operating entities to differentiate whether the effect is positive (spreading knowledge into practice) or negative (efforts to publish at all costs) with all the consequences (fragmentation of knowledge into a higher number of publications with less of a response, impeding intellectual property protection etc.).

If we look at the quality of articles in the Web of Science periodicals measured by citation count in the international context, the Czech Republic is showing a positive trend here too. In some fields the Czech publications are above the world average and the numbers of quality publications grow year-on-year. Figure 6.8 presents the changes in the numbers of articles of Czech authors and co-authors in 2009–2013 and also their citation response (determined in the middle of 2015). The greatest increase in citation count in Web of Science was in Medical Sciences (by nearly 60 %); however, most fields show an increase (except for Other Agricultural Sciences). The most important fields with regard to the number of articles by Czech authors are the fields of Biological Sciences, Chemical Sciences, Physical Sciences and Astronomy and Clinical Medicine. In Clinical Medicine and Physical Sciences the publications in question are also substantially cited, above average (normalized citation impact 1.5 for Clinical Medicine and about 1.4 for Physics and Astronomy). Among industry-oriented fields, the highest citation count is demonstrated by Environmental Engineering, Material Engineering and Mechanical Engineering; however, the citation index does not reach the global average. The citation count of publications in Computer Science and Informatics, Electrical and Electronic Engineering as well as in Humanities is even lower; Mathematics is more markedly below the global average and the increase of publication numbers has been only very insignificant. This is affected by different publication routines of the respective fields; e.g. in Mathematics and Social Sciences and Humanities it is usual to publish in the form of monographs, whereas in Informatics articles within collections are more usual. Agricultural Sciences are slightly above average as far as the citation count is concerned; Earth Sciences are slightly below average.

When evaluating the quality of publications, it is also useful to concentrate on the structure of publications with regard to the citation response of the periodicals and the related publication strategy, which can vary between fields. E.g. in the field of Sociology in the Czech Republic the proportion of publications in the upper tertile of most cited periodicals is minimal (Figure 6.9), considerably lower when compared to countries such as Belgium, Denmark, the Netherlands or Austria and at the same level as Slovakia or Poland. Therefore, it seems plausible that the quality of most Czech publications is not very high. On the other

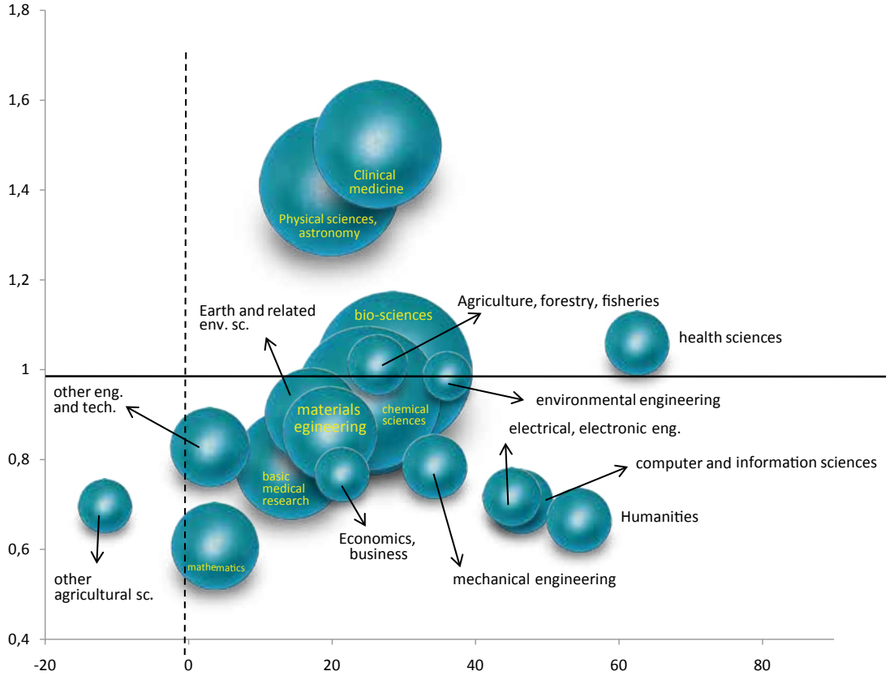
hand, for instance the field of Physics of Solids shows a considerable proportion of works in the most cited periodicals, comparable e.g. to Belgium, higher than in Estonia or Poland (Figure 6.9). That confirms the high quality of the fields of Physics in the Czech Republic derived from the total number of citations, which is above global average (Figure 6.8). It should also be considered whether in the particular field impact (indexed by Web of Science) journals are released in the Czech Republic and whether the citations from other journals originate in the Czech Republic or abroad. For instance in the field of Economics four impact journals are issued in the Czech Republic and they are highly mutually cited. This results in low citation response of Czech publications in this field when compared to the global average (Figure 6.8).

The given facts implied by Figure 6.8 partially correspond to the financial allocation of special-purpose support to field groups and the particular fields (Figure 2.4 in Chapter 2). Strong support of Biological Sciences, Medical Sciences, Physics and Chemistry was demonstrated by large representation of these sciences among quality publications (Figure 6.8). As for the Social Sciences and Humanities as well as Industrial Sciences it seems that the financial allocation of special-purpose support does not correspond with the quality of results. It is possible that this is the way to balance the relatively low allocation of points for setting institutional support within evaluation of research organizations. Within industrial sectors, the most supported ones were Electronics and Optoelectronics, Electrical Engineering, Non-Nuclear and Nuclear Power Engineering; however, higher-quality publications were compiled in Environmental and Material Engineering. However, the information can be distorted by different sector coding in RDI IS and in the global citation databases (for details see Chapter 2), or the publications might be results of activities funded institutionally, while relevant data are missing for sector determination of financial allocation.

Another significant measure of publication quality is the performance of Czech authors in international authorial teams of scientific publications. At the same time it is one of the indicators of research internationalization. As shown by Figure 6.10, in the last five years the proportion of quality publications in international authorial team has increased when compared to exclusively Czech publications. Whereas in 2008 45 % of the total 8.4 thousand publications were international, in 2013 it was more than 50% of the total 11.2 thousand publications. The structure of foreign countries Czech scientists cooperate with within publication activities has also changed slightly. The highest number of international publications created by Czech authors in 2013 was in cooperation with authors from the United States of America, whereas in 2008 it was with authors from Germany. The significance of cooperation with European countries that publish with less success is decreasing as well, this applies for example to Slovakia and Poland and the cooperation activities are moving towards more successful countries, such as United Kingdom, France, Austria and Switzerland. The above facts might be the reason for increasing quality of publications by Czech authors.

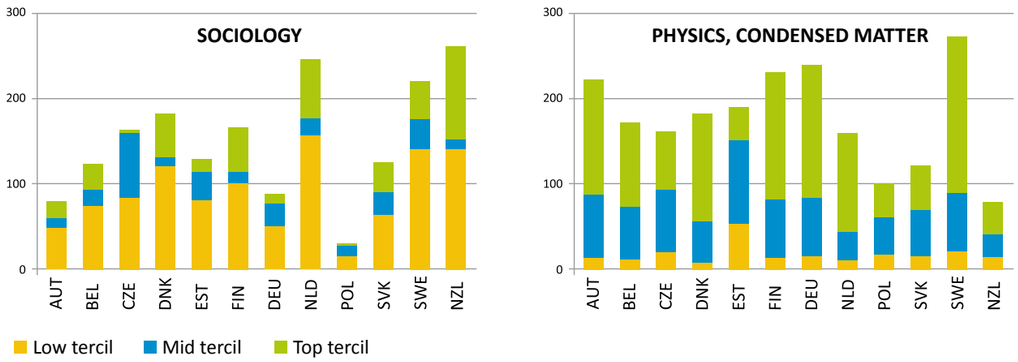
In an international comparison of collaborative publications, the Czech Republic with its 50 % international publications from the total number of articles in the Web of Science database lacks slightly behind the European average and also the growth rate of this parameter in the last five years (about 12 %) is slightly slower when compared to the European average (Figure 6.11). The Czech Republic is at a level comparable to Germany and Great Britain, slightly exceeding Italy and Spain. The Czech Republic lacks more markedly behind countries such as Denmark, Belgium, Austria or Switzerland where the ratio of collaborative publications reaches 60 to 70 %. Poland and the United States are among the countries with the lowest ratio (about 35 %).

Figure 6.8: Numbers of publications by Czech authors in Web of Science in the most significant fields and their citation counts



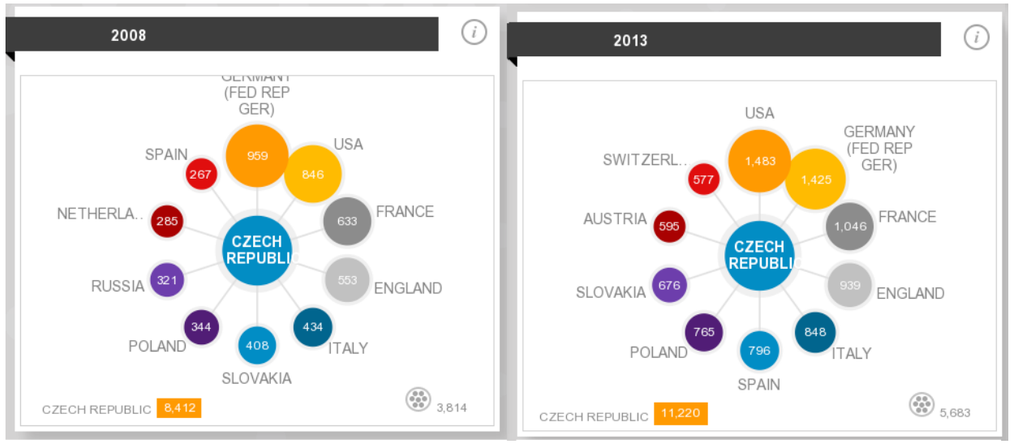
Only field groups with at least 1,000 publications in the reference period are included. | *Horizontal axis: Index of change in number of publications between 2009 and 2013: (2013-2009)/2009 in %* | *Vertical axis: Normalized Citation Impact as of 29 May 2015 (normalized at the level of particular fields with subsequent index aggregation; if the publication belongs to several fields, the arithmetic mean is used); value y = 1 represents the global average* | *The size of the bubbles expresses the number of publications in 2009–2013* | *The Humanities group includes mostly Philosophy, Ethics and Religion, Languages and Literature, History and Archaeology* | *Data source: Web of Science, included publication types are article and review for 2009–2013 in the periodicals Web of Science Core Collection, field classification according to OECD Fields of Science (Frascati Manual); included publications are those with at least one author's address stating "Czech" (co-authorship is not taken into account)*

Figure 6.9: International comparison of publications quality in the fields of Sociology and Physics – Condensed Matter according to the citation response of periodicals



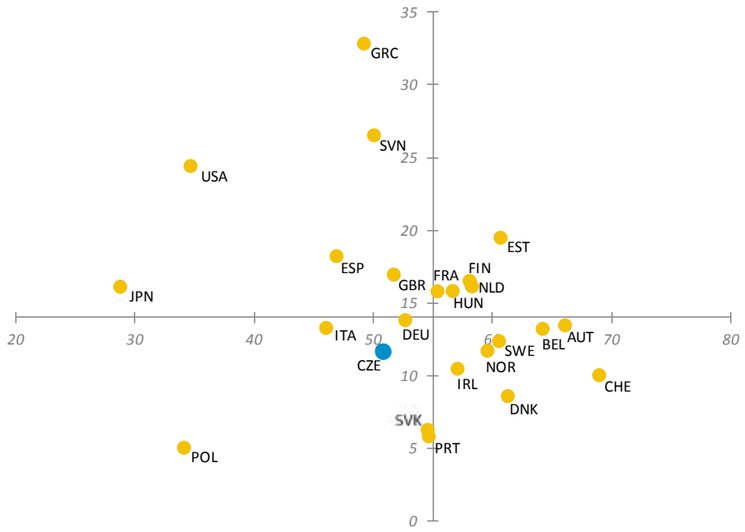
Numbers of articles are presented according to the field tertiles of the AIS values (Article Influence Score) for 2010–2011. These are the numbers of Articles stated in the Web of Science where at least one of the authors' addresses states "Czech". Therefore, the numbers do not account for co-authorship. If Web of Science classifies a journal to more fields, such result is counted in each of these fields. | *The international comparison was based on data from other medium-sized countries, with English not being the mother tongue (except for New Zealand). The numbers for these other countries have been normalized to the population of the Czech Republic (i.e. so that e.g. the number of articles for Estonia corresponds to the production of this country, if its population was the same as the population of the Czech Republic, i.e. 10.3 million).* | *The comparison does not account for different levels of RDI support in the respective areas and therefore does not express R&D productivity; neither does it reflect the significance of impact journals issued in the Czech Republic.* | *Data source: Web of Science*

Figure 6.10: Publications by Czech authors created in cooperation with foreign partners – comparison of 2008 and 2013



The bubbles show the numbers of publications created in the particular year, where the authorial team includes a Czech author with an author from the particular country. | *Data source: Web of Science, publication type – article, letter, review*

Figure 6.11: Proportion of scientific publications created by international authorial teams in EU and OECD countries.



Horizontal axis: Proportion of publications with at least one foreign author in the total number of publications of a particular country in 2013 (in %). | *Vertical axis: Increase in proportion of international publications between 2008 and 2013 (in %)* | *The intersection point marks the theoretical EU 28 position* | *Data source: Web of Science, exported through InCites, publication type – article, letter, review*

7. INNOVATION PERFORMANCE OF CZECH ECONOMY AND ITS INTERNATIONAL COMPARISON

Innovation performance is assessed based on several different approaches, using simple indicators as well as indicators composed of up to several tens of partial indicators. The advantage of simple indicators, usually based on financial inputs, is their easy interpretation and the possibility of international comparison with a wide range of countries. The disadvantage of simple indicators is their inability to grasp the true cause of the innovation performance level and therefore their unsuitability for innovation management. The need to specify economy innovation and its causes and impacts contributed to the formulation of more sophisticated indicators of innovation of a composite nature.

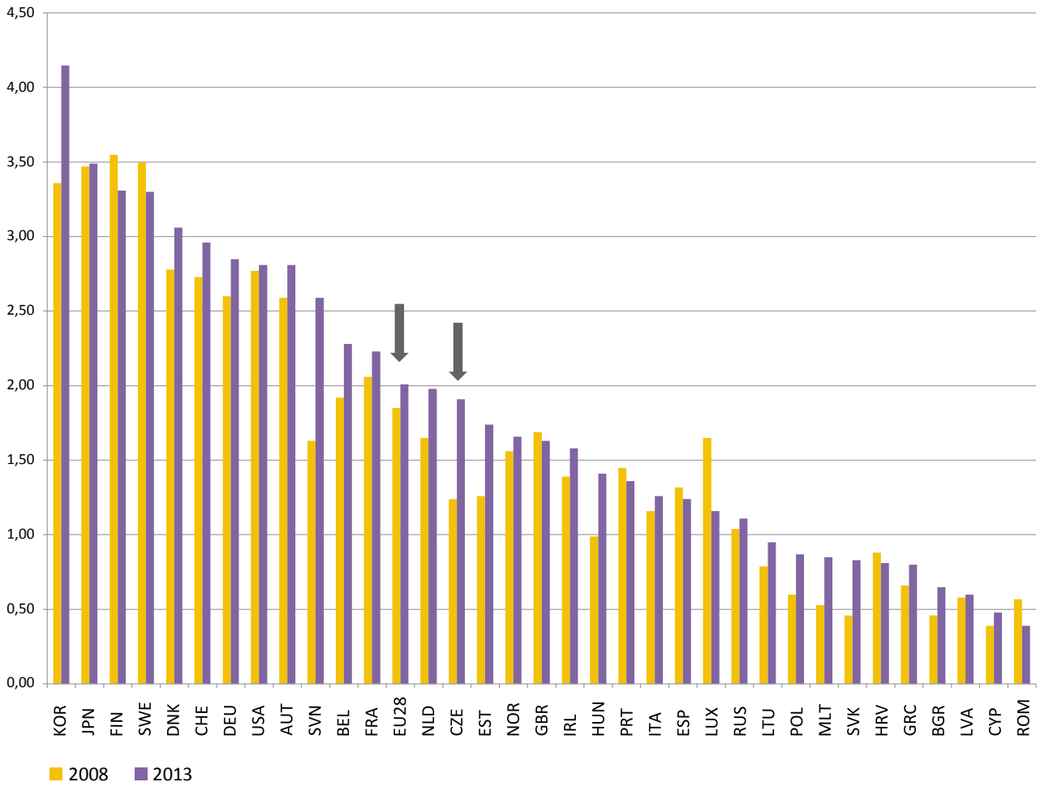
7.1. INNOVATION PERFORMANCE BASED ON SIMPLE INDICATORS

Due to easy interpretation and the possibility of international comparison the Knowledge Intensity indicator is frequently used. Knowledge Economy can be expressed as the ratio of aggregate science and research expenditure to Gross Domestic Product. It is statistically evaluated in the majority of European countries and OECD Member States, therefore, it enables a broad international comparison. In 2013 GERD in the Czech Republic reached 1.91 % (2 % of GDP before National Account review). When compared to 2012 there was an increase in GERD by 0.12 %, the R&D expenditure reaching 1.88 % of GDP (1.79 % before National Account review). Since 2008 the ratio of R&D expenditure to GDP has increased on average by 0.67 percentage points (Figure 7.1).

In 2013 the total R&D expenditure in the European Union countries (EU 28) reached EUR 271.6 billion, with the largest proportion shown by Germany, namely 29.5 %. The share of the Czech Republic in the total expenditure was 1.1 % (i.e. EUR 2.99 billion), which is about twice as much as Hungary, five times more than Slovakia, but 2.5 times less than Denmark and 3 times less than Austria and 0.2 % less than Poland.
Knowledge Intensity of the economy is only a gross indicator; it indicates the amount of R&D investments related to the total economy production but it does not reflect significant differences in the achieved production level. Improving the information value in the sense of assessing the rate of investments into the formation of new knowledge can be achieved by comparing Knowledge Intensity to the amount of R&D expenditure converted to a value per capita in PPS . The expenditure per capita in PPS in the Czech Republic in 2013 was 2.85 times higher than in Poland, 1.9 times higher than in Hungary, Germany and in Austria, on the other hand, it was about 2.2 times higher than in the Czech Republic (Source: Eurostat). Further specification is brought by the decomposition of R&D expenditure structure by funding resources and performance sectors (for details see Chapter Financial Flows).

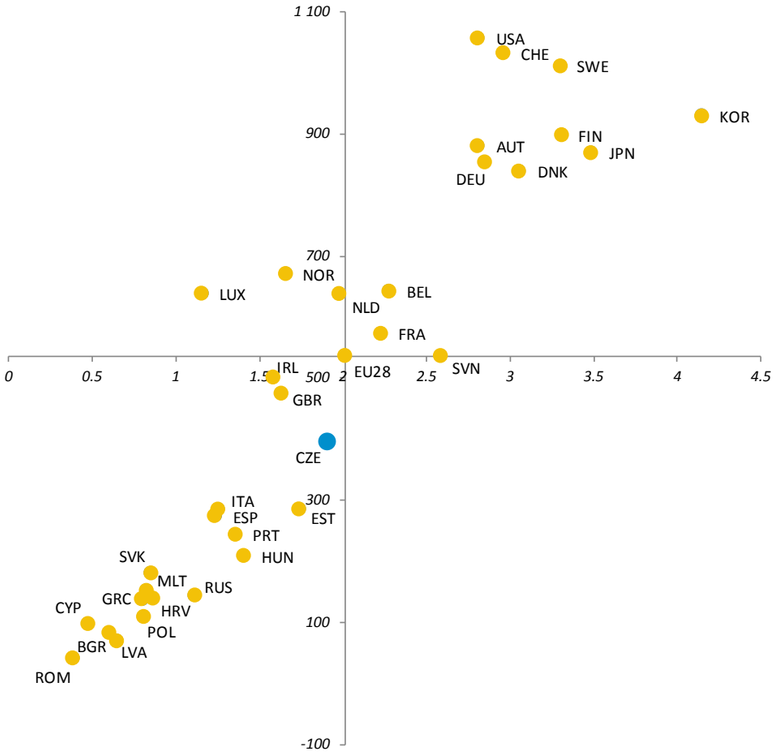
Figure 7.2 depicts that the value of Knowledge Intensity of the economy of Norway and the Czech Republic is almost the same but after conversion of R&D expenditure to a value per capita, this indicator for Norway is more than double when compared to the Czech Republic. For instance, the value of knowledge intensity of South Korea is significantly higher when compared to Germany, Austria or Finland. This difference is caused by the relatively low GDP value in the South Korean economy. After conversion to a value per capita, Germany, Austria and Finland are nearly at the same level as South Korea.

Figure 7.1: Knowledge intensity of Czech economy in international comparison



(*)Y Axis GERD/ GDP in %; for CHE, USA, IRL data for 2012 are shown | Data source: Eurostat – Science and technology database; OECD – MSTI database

Figure 7.2: Comparison of countries by GERD per GDP and by R&D expenditure per capita, 2013



(*)X Axis GERD/ GDP in %; the data for CHE, USA, IRL are for 2012, Y axis GERD per capita in PPS (the EU 28 value is in euros). The data related to CHE, USA, IRL and RUS are for 2012 and those related to JPN and KOR for 2011.
Data source: Eurostat – Science and technology database

7.2. INNOVATION PERFORMANCE BASED ON COMPLEX INDICATORS

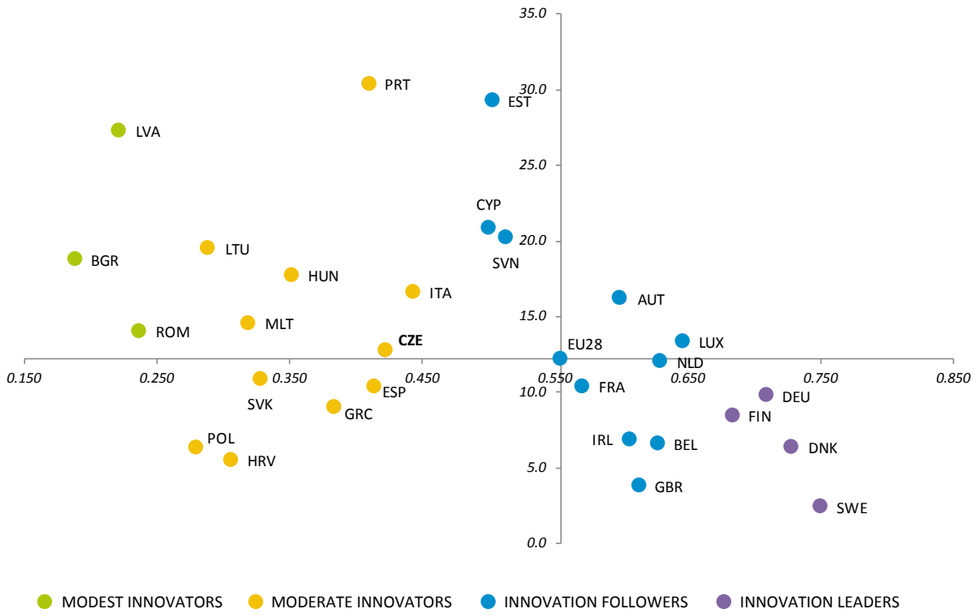
The most widely respected and frequently used complex indicators of innovation performance include above all:

- Summary Innovation Index (SII)
- Innovation output indicator

In Europe currently the most widely used indicator of economy innovation is the SII indicator published annually in the Innovation Union Scoreboard Yearbook, which is based on publicly available data as well as its own IUS surveys. It comprises of 25 partial indicators in eight areas significant for innovation (human resources, research systems, finance and support, corporate investments, relations and business, intellectual property, innovators, economic effects) with different weight.

Based on the SII values the EU Member States are divided into 4 groups according to the level of economy innovation – Innovation Leaders, Innovation Followers, Moderate Innovators and Modest Innovators. The Czech Republic falls into the group of "Moderate Innovators". In this group the SII of the Czech Republic reaches the second highest value and is at approximately the same level as Spain and Portugal. Throughout the years the position of the Czech Republic has not changed much, since 2006 the SII of the Czech Republic has grown by approximately 13% of the initial value (from 0.374 in 2006 to 0.422 in 2013). According to the latest data from 2013 the Czech Republic took the position before Spain and Portugal; there have been exchanges in the positions between these countries in the previous years.

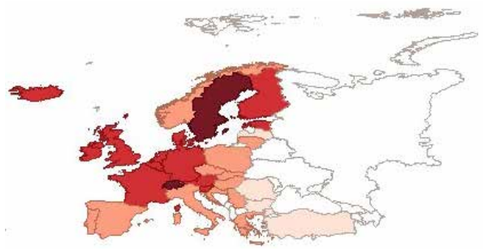
Chart 7.3: Position of CR according to SII in 2013 and SII growth in 2006–2013



(*)X axis SII in 2013, y axis percentage of SII change between 2013 and 2006
Data source: own calculation based on the IUS data (2014)

An interesting comparison is that of the Czech Republic with Slovenia and Estonia, which also have a past of centrally planned economy. Both of these countries joined the second highest category of "Innovation Followers" in 2013. However, these two countries together with Cyprus fell into the category of medium-innovative economies, same as the Czech Republic. The reason for this might be the substantial increase in the values of the composite indicator caused by drawing European resources, reflecting in a material change in innovation input values and some processes (see the example of Estonia). When comparing the Czech Republic to the economies with the highest level of economic performance (Denmark, Germany, Austria, Sweden etc.) according to SII, this comparison provides a similar picture as in the case of knowledge intensity.

Figure 7.4: Innovation index value in CR and its year-on-year dynamics compared to Austria

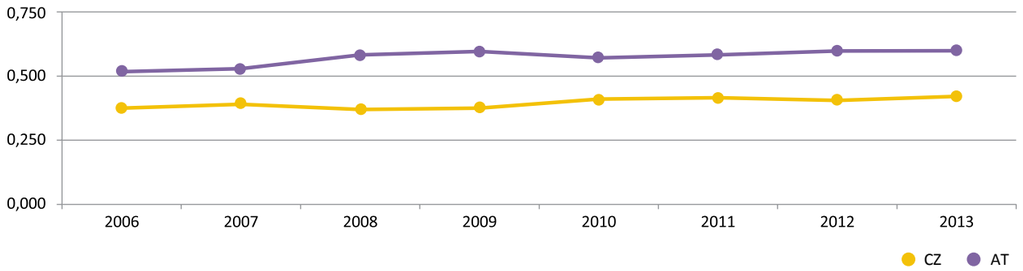


Data source: IUS

Compared to Austria, which falls into the upper half of the "Innovation Followers" group, the Czech Republic lacks behind significantly (Figure 7.3). Although the innovation index in the Czech Republic has been showing an upward trend since 2006, the same growth rate is demonstrated in Austria, so the SII difference between the two countries is nearly constant. A more detailed analysis of the individual partial indicators and their development trends (Figure 7.7) it is apparent that 12 out of the 25 indicators demonstrate a year-on-year increasing trend, while 13 indicators are stagnating or decreasing in the long run. It can be traced that there has been a plunge in the risk capital and innovation in small and medium-size enterprises as well as in the cooperation among these enterprises in implementing innovations. Moreover, the Czech Republic has been suffering from long-term low numbers of international patent applications and the numbers of young people with high school education have dropped as well.
When comparing the partial indicators with Austria (Chart 7.9) it stands that the Czech Republic currently lacks mostly in the number of international patent applications. In the Czech Republic this indicator reaches less than 50 % of the EU average, while in Austria it is over 100 %. The RDI expenditure in the business sector in the Czech Republic reaches approximately 75 % of the EU average and 150% in Austria. Other significant differences are in risk capital investments (less than 25 % of the EU average in the Czech Republic, 50 % in Austria) as well as in the area of international (common international publication indicator) and national cooperation (cooperation of innovative small and medium-size enterprises, joint publications of public and business entities).

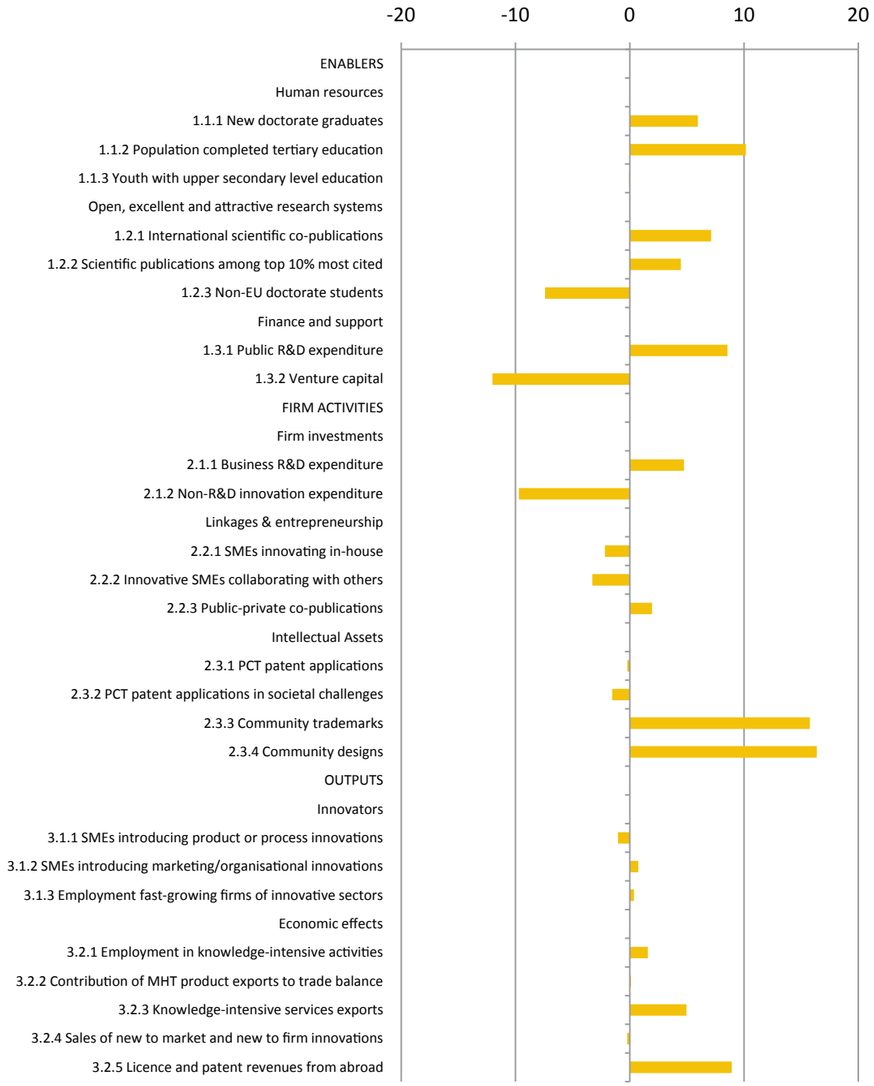
When we focus on the trends in both countries (Chart 7.10), the Czech Republic falls behind Austria mainly in risk capital investments (more substantial year-on-year decrease than in Austria), the number of international patents and cooperation among innovating

Chart 7.5: Innovation index value in CR and its year-on-year dynamics compared to Austria



Data source: IUS

Chart 7.6: Partial indicators of the Innovation Index in CR and their progress in time (average change in 2002–2012 in %)



Data source: IUS

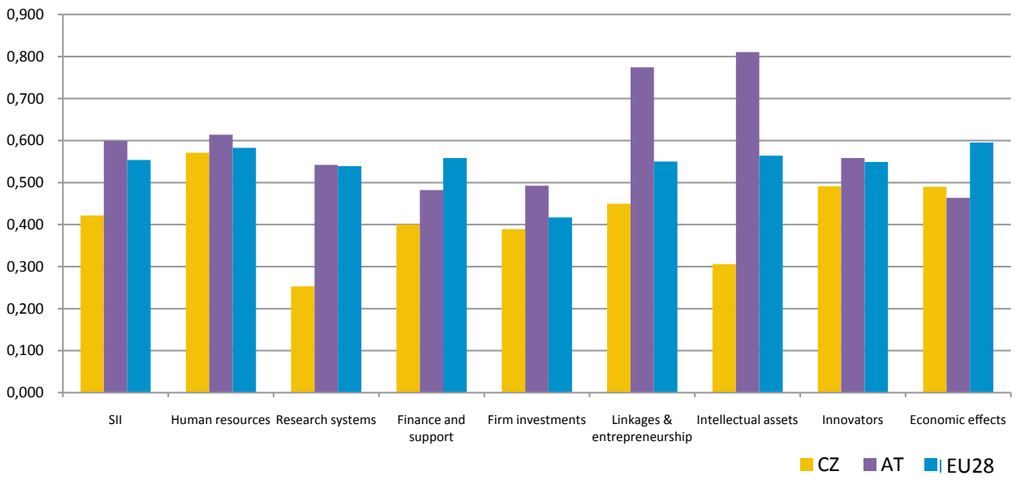
Figure 7.7: Partial indicators of the Innovation Index in the Czech Republic and their progress in time (2002–2012)

	Trend	Growth 2002-2012
ENABLERS		
Human resources		
1.1.1 New doctorate graduates		5,96%
1.1.2 Population completed tertiary education		10,16%
1.1.3 Youth with upper secondary level education		-0,05%
Open, excellent and attractive research systems		
1.2.1 International scientific co-publications		7,11%
1.2.2 Scientific publications among top 10% most cited		4,47%
1.2.3 Non-EU doctorate students		-7,41%
Finance and support		
1.3.1 Public R&D expenditure		8,55%
1.3.2 Venture capital		-12,01%
FIRM ACTIVITIES		
Firm investments		
2.1.1 Business R&D expenditure		4,75%
2.1.2 Non-R&D innovation expenditure		-9,71%
Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house		-2,17%
2.2.2 Innovative SMEs collaborating with others		-3,27%
2.2.3 Public-private co-publications		1,95%
Intellectual Assets		
2.3.1 PCT patent applications		-0,21%
2.3.2 PCT patent applications in societal challenges		-1,53%
2.3.3 Community trademarks		15,77%
2.3.4 Community designs		16,36%
OUTPUTS		
Innovators		
3.1.1 SMEs introducing product or process innovations		-1,03%
3.1.2 SMEs introducing marketing/organisational innovations		0,74%
3.1.3 Employment fast-growing firms of innovative sectors		0,37%
Economic effects		
3.2.1 Employment in knowledge-intensive activities		1,58%
3.2.2 Contribution of MHT product exports to trade balance		0,11%
3.2.3 Knowledge-intensive services exports		4,96%
3.2.4 Sales of new to market and new to firm innovations		-0,22%
3.2.5 Licence and patent revenues from abroad		8,92%

Data source: IUS

SMEs (decrease in the Czech Republic, increase in Austria). The RDI expenditure in the Czech Republic (both public and business) is growing much more rapidly, on the other hand. From the perspective of the Innovation Index, the Czech Republic holds a position in the group of "Moderate Innovators".
Based on year-on-year development no striking improvement of this situation or the potential move to the group of "Innovation Followers", e.g. to the level of Austria, is to be expected. The situation of the Czech Republic is caused mainly by deficiencies in the area of risk capital investments and protection of intellectual property by means of international patents, partly also in the area of human resources (young people with high school education). Besides, the growth rate of research internationalization and cooperation is slow. To improve the position of the Czech Republic, the discussed areas need to be optimized.

Chart 7.8: Composite SII indicators



Data source: IUS

Chart 7.9: Partial indicators of the Innovation Index in the Czech Republic compared to Austria in 2013 →

The values are presented in % of the EU average (100 = EU 28)
Data source: IUS

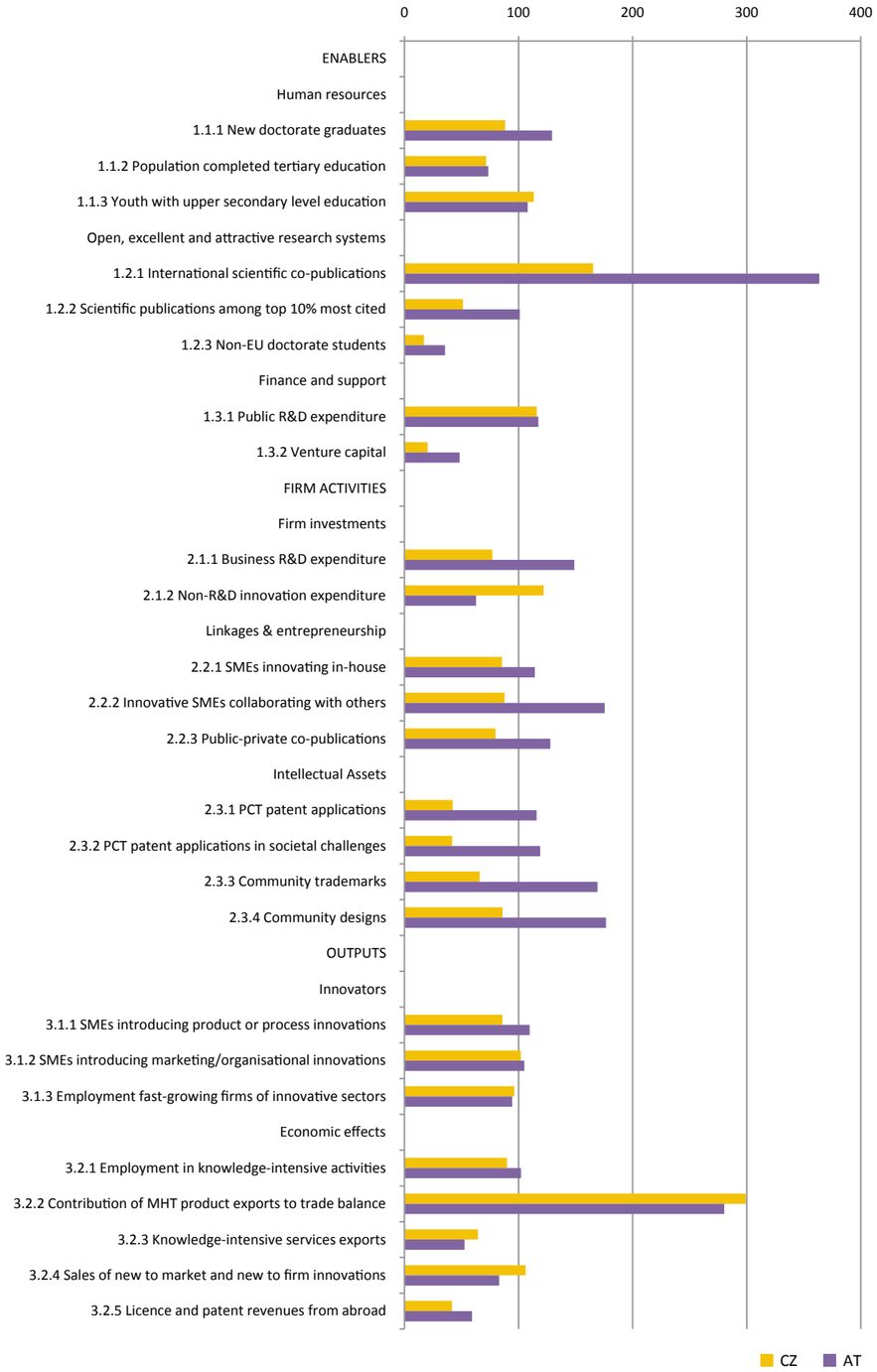
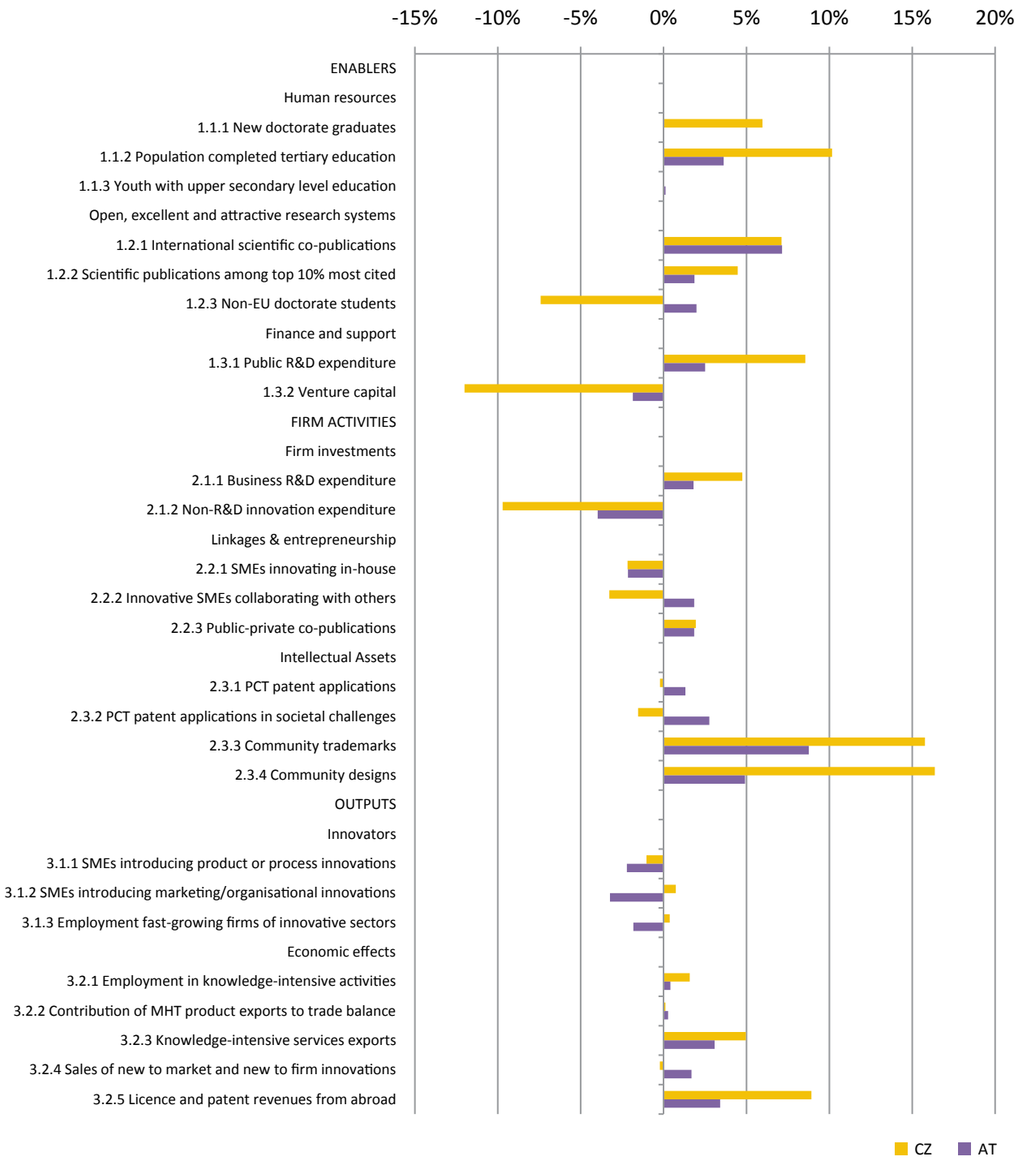


Chart 7.10: Changes in partial indicators of the Innovation Index in CR compared to Austria (average year-on-year change in 2002–2012 in %)



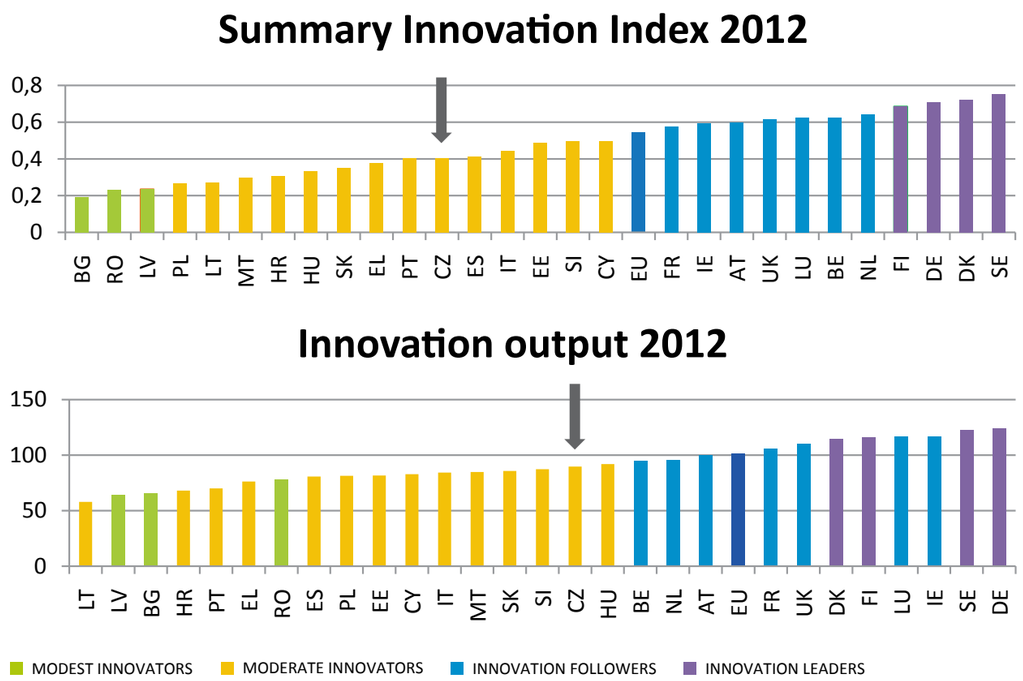
Data source: IUS

The Innovation Output Indicator was introduced by the European Commission in 2013 and is used mostly for comparing national innovation policies. This composite indicator contains 4 indicators related to innovation activity outputs (Figure 7.12):

1) Technological innovation measured by the number of PCT patent applications per one billion GDP in PPS;
2) Employment rate in knowledge-intensive fields measured as total employment rate percentage;
3) Innovation in fast growing enterprises measured as weighted employment average;
4) Combination of two partial indicators expressing export of products and services of knowledge-intensive fields.

Same as with knowledge intensity of economy and SII, based on this indicator, the Czech Republic reaches values one third to one half lower than the countries that regularly take the top places in innovation and competitiveness charts. Due to the fact that the IOI calculation emphasizes the innovation output indicators, one-off investments of the public sector in R&D and education cannot distort the IOI values. The difference in composition of partial indicators between IOI and SII will affect the sequence of the countries. To compare the position of the Czech Republic, the values of both composite indicators in 2012 can be used: In the rating based on IOI, the Czech Republic is always four places higher and exceeds Italy (Chart 7.12); however, still lacks behind countries such as Austria, Belgium or the Netherlands based on IOI.

Chart 7.11: SII and IOI comparison in 2012



Data source: DG Research and Innovation and IUS

Figure 7.12: Innovation performance of the Czech Republic based on the Innovation Output Indicator (IOI) in 2012 compared to Austria and the EU average

PCT = Numberof PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensiveactivities in business industries as % oftotalemployment.
DYN = Innovativenessofhigh-growthenterprises (employment-weightedaverage).
COMP = Combination of sub-components GOOD and SERV, usingequalweights.
GOOD = High-tech and medium-high-techproducts exports as % total exports
SERV = Knowledge-intensive services exports as % of total service exports.
Data source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies

8. SECTORS OF NATIONAL ECONOMY IN RELATION TO RDI

The objective of resources expended on RDI should be an evident economic and social effect. The Czech economy is driven by enterprises manufacturing products with high added value and in this respect they invest great amounts of financial resources in their own research, development and innovations. One of the instruments that should contribute to efficient RDI management at the national and regional level should be the RIS 3 Strategy, whose aim is to ensure efficient direction of financial resources (European, national and private) to activities leading to enhancing innovation capacity and to prioritize perspective areas. The important sectors of national economy represent environments in which the scientific knowledge is valorised and transformed into economic and social benefits. The sectors with high RDI expenditure have the potential to use these resources for meaningful and efficient research and development in cooperation with public research entities (universities, public research institutions), using modern infrastructures built with the support from ESIF.

The following description of national economy used aggregated data provided by CZSO, namely data from the Annual Report on Research and Development survey in combination with the Annual National Accounts[1]. Figure 8.1 describes the structure of national economy according to the Classification of economic activities, particularly according to the main economic activity of entities, in the effort to identify significant sectors of Czech economy both from the point of view of gross added value share and from the point of view of RDI performance measured by expended financial resources.

1) The principles of providing confidential statistical data from CZSO to external users are based on the legal reguations of the EU and the Czech Republic, in particular on the Act No. 89/1995 Coll. on the State Statistical Service, as amended, Act No. 101/2000 Coll., on the Protection of Personal Data and on Amendment to Some Acts, as amended, and the Regulation of the European Parliament and of the Council (EC) No. 557/2013 of 17 June 2013. Although CZSO collects and processes individual data primarily for statistical purposes, it is allowed to, under Section 17 Provision of Confidential Statistical Data, Act No. 89/1995 Coll. on the State Statistical Service, provide confidential statistical data for the purpose of scientific research as well. The data are provided in a form that does not enable direct determination of the reported unit that the provided data relate to (for more information see https://www.czso.cz/csu/czso/zasady-a-podminky-poskytovani-mikrodat-pro-ucely-disertacnich-praci).

Figure 8.1 reports the situation in 2013 and average changes in 2007–2013. Based on the R&D data in the business sector there are two apparent, well segregated field groups. Group I contains sectors exceeding CZK 1,500 million in RDI expenditure. At the same time these are predominantly sectors that are relatively significant for the national economy with respect to GVA. The largest amount of expended resources has been shown by fields of professional, scientific and technical activities that include Architecture and Engineering Activities; Technical Tests and Analyses, and mainly the field of Research and Development; i.e. entities with prevailing R&D activities regardless of their orientation. There have been significant resource expenditures directed to this sector from the state budget for RDI (CZK 1.7 billion in 2013), therefore, the group in Figure 8.1 is on the far right on the horizontal axis. From industrial sectors, group I includes Motor vehicle manufacturing (except for motorcycles), trailers and semitrailers, Manufacture of machinery and equipment, Information technology and computer service activities, Manufacture of electrical equipment and Repair and installation services of machinery and equipment, which also demonstrate an increasing trend of R&D expenditures and an increasing share in GVA. Group I also includes the sector of Manufacture of computer, electronic and optical products. The proportion of RDI expenditure has been decreasing year-on-year but the share in GVA has been increasing year-on-year.

Group II, which shows RDI expenditure below CZK 1,300 million per sector, includes Manufacture of fabricated metal products, Manufacture of rubber and plastic products and Electricity, gas, steam and air conditioning supply. Among the less significant industrial sectors from the perspective of total RDI expenditure and GVA share that belong to Group II are: Manufacture of basic pharmaceutical products and pharmaceutical preparations, Petrochemical, chemical and pharmaceutical industry, Manufacture of other non-metallic mineral products, Manufacture of food products, Manufacture of textiles, Manufacture of basic metals, casting and foundry. This group also includes sectors that are of great importance to national economy outside industry, such as Public administration and defence

services, Compulsory social security, Education, Wholesale and retail trade, Real estate activities, Financial and insurance activities, Construction, Healthcare, Agriculture, forestry and fishing.

INTERPRETATION RESTRICTIONS

- **RESTRICTIONS RELATED TO CZ-NACE CLASSIFICATION:**
  - ▹ *The classification does not have to follow the current trends as based on progressive development of RDI sectors, e.g. nanotechnologies, biotechnologies, culture and creative industries, completely new sectors can emerge.*
  - ▹ *The classification of an entity to a particular sector is decided based on the prevailing activity in the given year; other activities are not taken into account, even though they can be of nearly the same importance and can cause a year-on-year transfer to a different sector (e.g. companies such as IBM or Alza fall into the sector of Wholesale and retail trade based on their main economic activity, yet they might be perceived as significant entities in the area of information and communication technologies).*
  - ▹ *The Research and Development sector includes all entities that concentrate on research and development, regardless of its focus.*
  - ▹ *The classification does not cover the whole segment of subcontractors that are often linked to the sector.*
- **Restrictions related to the selection of indicators:**
  - ▹ *Newly emerging entities such as start-ups and spin-offs are not taken into account but they will affect GVA several years after their foundation, moreover, at the beginning of their existence they do not show high RDI expenditure.*
  - ▹ *Entities (in particular among SME) that are important in a given sector, e.g. due to high added value of products on the basis of new RDI findings, intensity of innovation implementation, even at the international level, do not have to be included if their financial flows within the sector are minor and cannot affect the position of the sector.*

Apart from the above mentioned interpretation drawbacks in relation to using aggregated data to define the significant sectors of national economy, the Czech Republic demonstrates other specific features:

- ▹ *The structure of the Czech economy demonstrates a relatively high number of enterprises that are among the global or international leaders within a specific niche;*
- ▹ *Another strategic meaning apart from the financial one – employment in the region, tradition, tourism, e.g. in the case of energetics, metallurgy, steel industry and foundry or in the so-called traditional cultural and creative industries;*
- ▹ *Newly emerging industries based on latest technologies, while they are one of the innovation drivers of established or long-term industrial sectors.*

The Office of the Government – the RDI Department has put together sector platforms comprising of the representatives of significant active entities in the sector (see Table 8.2) based on external indicators, with the aim to gain the following information from selected entities:

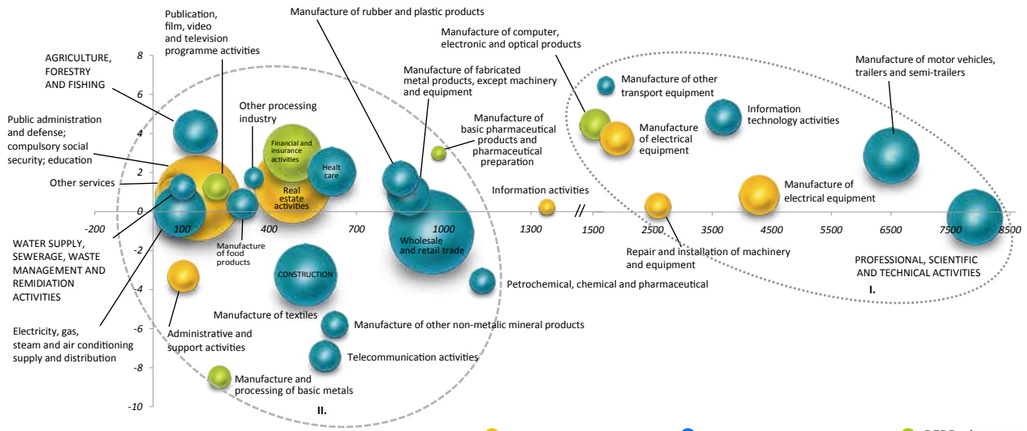
- ▹ *RDI priorities by sector;*
- ▹ *Trends of progress within the sectors;*
- ▹ *Outlook of key long-term RDI themes.*

Two methodology approaches were selected for compiling sector platforms and initiating the dialogue:

1) *Consideration of R&D expenditure within the business sector;*
2) *Consideration of strategic relations or use of latest technologies.*

So far the RDI management was not able to work with information concerning which scientific findings (in relation to sector classification) are necessary for sector development and thus for competitiveness and increasing economic benefits. It is probable that the majority of industry sectors use scientific knowledge across scientific fields, while the relation between the sector and the scientific fields cannot be determined from statistical data. Table 8.2 below presents an overview of Sector platforms; the orange coloured platforms are those where negotiations have already taken place.

Figure 8.1: R&D expenditure and ratio of selected sectors of national economy in gross value added according to CZ-NACE classification



Horizontal axis: business R&D expenditure in 2013 (BERD) in millions of CZK | Vertical axis: mean value of year-on-year change in the gross value added ratio (GVA) in 2007–2013 in % | Bubble size: GVA share in 2013 | Colour range: mean value of year-on-year BERD change in 2008–2013 | Data source: CZSO

Sector platforms are currently being transformed into working groups in order to provide inputs to decision-making processes related to the activities of the Council for Competitiveness and Economic Growth (RVKHR) and R&D Council. At the same time they are connected to the National Innovation Platforms operating within RIS 3 by means of human resources.

Working groups and the National Innovation Platforms offer important feedback on providing public RDI support in the Czech Republic and at the same time provide relevant inputs in the form of defining long-term research sector themes and themes in the area of human resources. These defined and widely discussed sector priorities become the base for RIS 3 verticalization. The aim of the whole process is to get an idea about long-term needs of sectors with significant proportion of private RDI investments, in order to set national policies to create conditions for further development.

Annex No. 2 presents key research themes necessary for further development of defined sectors. This is an initial, unfinished list, which can be extended within the ongoing Entrepreneurial Discovery Process, similarly as the number of working group members.

Table 8.2: List of sector platforms coordinated by the RDI Department

CZ-NACE	SECTOR	SECTOR PLATFORM						
		NAME	CHARACTERISTICS					
			BERD share in %	Number of entities performing R&D (average for 2009–2012)		GVA share in %	Total number of employees in %	Number of enterprises
				Total	SME			
72	Research and Development	This sector includes research institutions the RDI Dept. engages with in a different way.	13,90 %			0,65 %	0,57 %	998
582, 62, 631, 26	IT activities, Manufacture of computer, electronic and optical products	DIGITAL ECONOMY	16,10 %	327	305	4,51 %	2,95 %	28 446
29	Automotive industry – Manufacture of motor vehicles	AUTOMOTIVE	15,43 %	61	31	4,45 %	3,70 %	1 209
28, 331	Engineering – Manufacture of machinery and equipment	PRECISION ENGINEERING	10,28 %	319	246	4,52 %	5,41 %	15 516
18, 32, 332	Other manufacturing industries	MACHINE TOOLS	6,87 %					19 291
71	Architectural and engineering activities; Technical testing and analysis	**ENGINEERING & TESTING**	4,41 %	146	140	1,39 %	1,33 %	36 218
27	Electrical Engineering – Manufacture of electrical equipment	ELECTRICAL ENGINEERING	4,47 %	118	88	1,84 %	2,17 %	14 753
30	Manufacture of other transport equipment	RAIL AND ROLLING STOCK AERONAUTICS INDUSTRY SPACE RESEARCH	4,07 %	36	21	0,51 %	0,51 %	584
21	Pharmaceutical industry	BIOTECHNOLOGIES	2,33 %	25	17	0,44 %	0,23 %	88
35-39	Manufacturing electricity, gas, steam and air conditioning supply; water supply; sewerage, waste management	POWER ENGINEERING	0,45 %	18	16	5,27 %	2,03 %	12 374
13-15	Textile, clothing and footwear industry	TRADITIONAL CULTURAL AND CREATIVE INDUSTRIES[1]	They contribute to GDP by about 1.9 % (together with new cultural and creative industries, forming the so-called culture account compiled by CZSO). They contribute significantly to the development of other sectors as well as to social progress. The entities have been selected based on detailed quality mapping of the Czech Republic[2].					
16-17, 31	Timber and paper industry							
23	Industry of glass, ceramics, plastics and building materials							
05-09	Mining and quarrying	METALLURGY, STEEL INDUSTRY, FOUNDRY	2,66 %	159	104	4,48 %	5,49 %	45 343
24	Metallurgical industry – Manufacture of basic metals, metal processing, foundry							
25	Manufacture of fabricated metal products							
23.2	Manufacture of refractory products							
Newly emerging industries		NEW CULTURE AND CREATIVE INDUSTRIES[2]	They contribute to GDP by about 1.9 % (together with new cultural and creative industries, forming the so-called culture account compiled by CZSO). They contribute significantly to the development of other sectors as well as to social progress. The entities have been selected based on detailed quality mapping of the Czech Republic[28].					
Sector groups with extensive overlap between particular fields		NANOTECHNOLOGIES						

← *2) According to the definition the traditional cultural and creative industries – CCI – are all sectors based on individual human creativity, human skills and talent. At the same time they are sectors with potential to create wealth and jobs mostly by using intellectual property.*

Cultural industries are economic sectors and industries whose aim is to provide all consumers with cultural and new experience, spread information and knowledge and to contribute to protection and maintaining cultural and natural heritage. They develop the distribution of cultural goods and services arising out of individual human creativity, skill and talent. Cultural industries include: Transfer and sharing of fine art, performing arts, cultural heritage (museums, galleries, libraries), Film, video, television and radio, computer games, music and audio, books and press.

Creative industries are economic sectors and industries whose aim is to provide consumers with functional goods and services that offer new uses with elements of individual human skill and talent. Creative industries include: Design, fashion, architecture, urban planning, landscape management, advertising industry, arts and crafts, development and sale of functional SW, development and innovation activities, conceptual activities.

The mapping was using quantitative data of CZSO; partial lists of CCI entities in the Czech Republic were created based on the NACE classification of economic activities. The CZSO data were adjusted so that active entities were selected and the relation of their specialized activity to traditional industry or craft focus in the particular region was taken into account, including social and cultural relevance of the entities within the region and the potential to increase the value of the area.

This resulted in samples of the following entities:

▹ From business sphere, sector of creative industry: groups Craft, Design, Fashion, Architecture and Engineering Activities, Manufacture of clothes and related activities;

▹ Culture industry: groups Publishing of books, periodicals and other publishing activities;

-▹ Areas of non-industrial character (culture sector): Art secondary specialized, secondary and higher education, memory institutions (museums and folk museums), galleries,

▹ Currently active creative incubators, co-working centres, hubs, start-ups and VTP

In the effort to improve the application of human potential, cultural heritage and efficient use of cultural infrastructure it is necessary to sensitively differentiate between supporting creation as the base and source of creativity, which makes it possible for industries to thrive, and support of culture industries and creative economy, which supports business. This kind of support should always be managed in compliance with the logic of the development chain: project – realization/production – representation/maintenance.

9. RDI DATA SOURCES

Each empirical analysis should be based on current and relevant data. The objective followed while compiling this document was to use such statistical and mathematical instruments to enable not only the evaluation of past and present situation and RDI development, but also to predict future development or evaluate interventions. However, a quality data base is required for the use of these sophisticated methods. It has been proved that for RDI analyses the aggregated data are insufficient as to perform complex evaluation it is necessary to analyze individual data on the particular RDI entities.

Table 9.1 briefly summarizes the data sources exploitable for RDI analysis in the Czech Republic. The data sources can basically be divided into national and foreign ones. The R&D Council and CZSO are the important national institutions administering primary RDI statistics. The R&D Council is the administrator of RDI IS and the information system is operated by the Office of the Government of the Czech Republic; RDI IS ensures the collection, processing, provision and use of data related to RDI supported from public resources. The objectives and content of RDI IS as well as the rights, obligations and process of handover, classification, processing and provision of data are defined by the Act on Support of Research, Experimental Development and Innovations, and also by the Government Resolution No. 397/2009 Coll., on Information System for Research, Experimental Development and Innovation, specific legislation and the RDI IS operating regulations. The RDI IS database includes data on projects since 1994, data on results since 1998 and data on research projects since 1998 as well. CZSO monitors the R&D characteristics by means of direct statistical survey and processes data provided by other institutions. The long-term goal of CZSO is to create complex picture of R&D development in the Czech Republic by statistical tools, information and analytical activities in the context of other macroeconomic and structural indicators. Namely since 1995 the VTR 5-01 questionnaire survey is executed annually.

Eurostat and OECD are among the principal foreign institutions operating databases providing RDI information. After the Czech Republic joined the EU, the obligation arose to keep records, control project realization progress and monitor the progress of drawing financial resources from Structural Funds and the Cohesion Fund. This reporting obligation is fulfilled mostly by MRD. During the programming period 2007–2013 the MSC2007 information system was being used. Later the new MS2014+ system was launched, which is intended for monitoring European Structural and Investment Funds (the so-called ESI Funds) in the programming period 2014–2020.

Table 9.1: RDI Data Sources →

	DATA			NOTE
NATIONAL	R&D COUNCIL (OG CR)	RDI IS	CEA	Information on RDI support providers, on RDI programmes and RDI entities (since 2010)
			VES	Information on public tenders in RDI (since 2000)
			CEP	Information on RDI projects (since 1994)
			CEZ	Information on research plan (since 1998)
			RIV	Information on RDI results (since 1998)
	CZSO	Research and Development Indicators		Regular annual questionnaire survey (VTR 5-01)
		Indirect R&D support in CR		Metadata from GFD – MF
		Statistical survey on innovation		The latest published survey (TI2012) deals with the period of 2010 to 2012. The data are collected by means of harmonized EU Community Innovation Survey (CIS) questionnaire.
		Bibliometry		Metadata from citation index: Thomson Reuters/(in-Cites)
		Patent statistics		IPO CR and EPO metadata
		Licence		Regular annual statistical survey (Lic 5-01)
		State budgetary R&D expenditure and grants		RDI IS metadata and department statistics
		Foreign high-tech goods trade		Foreign trade database and Eurostat metadata
		Technological balance of payments – Foreign trade with technology services		Quarterly Report on service import and export (ZO 1-04) and metadata from CNB
	MRD	MSC2007		Serves for material and financial monitoring of all programmes and project financed from ESI funds.
		MS2014+		Slouží pro věcný a finanční monitoring všech programů a projektů hrazených z ESI fondů.
	Other statistics of providers or departments and other organizations*			
	DATA			NOTE
FOREIGN	EUROSTAT			Government budget appropriations or outlays on R&D statistics
	Community innovation survey			
	High-tech industry and knowledge-intensive services statistics			
	Patent statistics			
	Statistics on Human Resources in Science & Technology			
	OECD			Research and Development Statistics
	Cordis			Information on Framework Programme projects
	E-CORDA	External Common Research DAta Warehouse		Enables to process FP participation statistics (database of grant agreements and database of project proposal and applicants).
	Thomson Reuters	Web of Science		Citation indexes
	Thomson Reuters	Journal Citation Reports		
	Elsevier	Scopus		
	European science foundation	ERIH		
	Other statistics and studies**			

** E.g. Register of public research institutions; Database of accredited study programmes*

*** E.g. Innovation Union Scoreboard*

Due to the current needs it would be suitable to complement the statistics with records of institutional resources according to RDI sectors that have been granted support, and further record RDI support at the national level in accounting classification as direct and indirect costs of particular financial instruments. The number codes of sectors used in the Czech Republic have not yet been adjusted to the structure defined by OECD – Fields of Science both at the level of RDI IS records (field groups CEP&CEZ&RIV) and sector groups for evaluation in compliance with the Methodology of Evaluation of Results, Annex No. 7). Statistics on result usage should be followed and available at the national level. In the sphere of Human Resources, it would be suitable to connect the data with the data from the labour market sphere and extend them by gender statistics.

Data source: Own draft

STRATEGIC RECOMMENDATIONS

Based on the performed analyses, the Research and Development Council recommends the following strategic measures (arranged by the chapters of this document), which should contribute to stabilization of well-functioning parts of the RDI system and to optimization of the lower performing elements. Certain areas require more detailed analyses, as there are frequent restrictions due to missing data. This is the reason why some measures are directed to the area of the data base.

Measures:

- Prepare the RDI system, in particular to set national public resources, for the period after 2020 when the ESIF funds are not available.
- Perform detailed analysis of financial flows originating in the business sector and the resources available to enterprises from public sources, in the form of direct research support and indirect support.
- Reinforce the long-term institutional element of the state budget against the special-purpose element.
- Analyze the benefits of particular instruments of financial support and use the outputs from analyses for their optimization.
- Ensure records of institutional resources according to RDI sectors that have been granted support.
- Record the RDI support at the national level in accounting classification as direct costs (labour costs, material, services) and indirect costs for the respective financial instruments, in particular the institutional ones.
- Adjust the codes of scientific fields and sector groups used in the Czech Republic according to the OECD Fields of Science structure (part of the Frascati Manual), which would enable to analyze the relation between financial resources and results on a field-specific basis in the future.
- Connect the data from CZSO surveys and RDI IS with the labour market data (social security registers) and their extension by gender statistics. Perform more detailed analyses of RDI Human Resources based on new data and approaches.
- Create virtual platforms focused on particular research and development themes necessary for improvements in the competitiveness of significant sectors of national economy, in which the RDI infrastructures will play a key role.
- Reinforce the element of institutional support directed to long-term conceptual development of research organizations in funding operation and further infrastructure development.
- Map the possibilities of using infrastructures in applied research for the needs of significant sectors of national economy and define their role within the system of performing and supporting applied research in the Czech Republic.
- Implement measures motivating research organizations to perform applied research, which should demonstrate by increase in the ratio of applied results to publication results.
- Introduce measures to support improvements in quality of publication outputs, in particular in basic research.
- Optimize the manner of evaluating organizations for research and spreading knowledge in a way accounting for the quality of created results in compliance with international RDI standards and recommendations while respecting the specifics of the Czech Republic.
- Ensure records of information on using the results at the national level.

- Analyze the main barriers of innovation progress in the Czech Republic in the form of low risk capital investments, insufficient exploitation of intellectual property protection by means of international patents, deficiencies in the area of human resources (young people with high school education) and to introduce measures leading to their gradual elimination.

- In field-specific analyses, work with the individual input data relevant to research and development in the business sector, e.g. from CZSO statistical surveys, and use these data to create specific aggregates, which will not jeopardize the anonymity of the individual data.

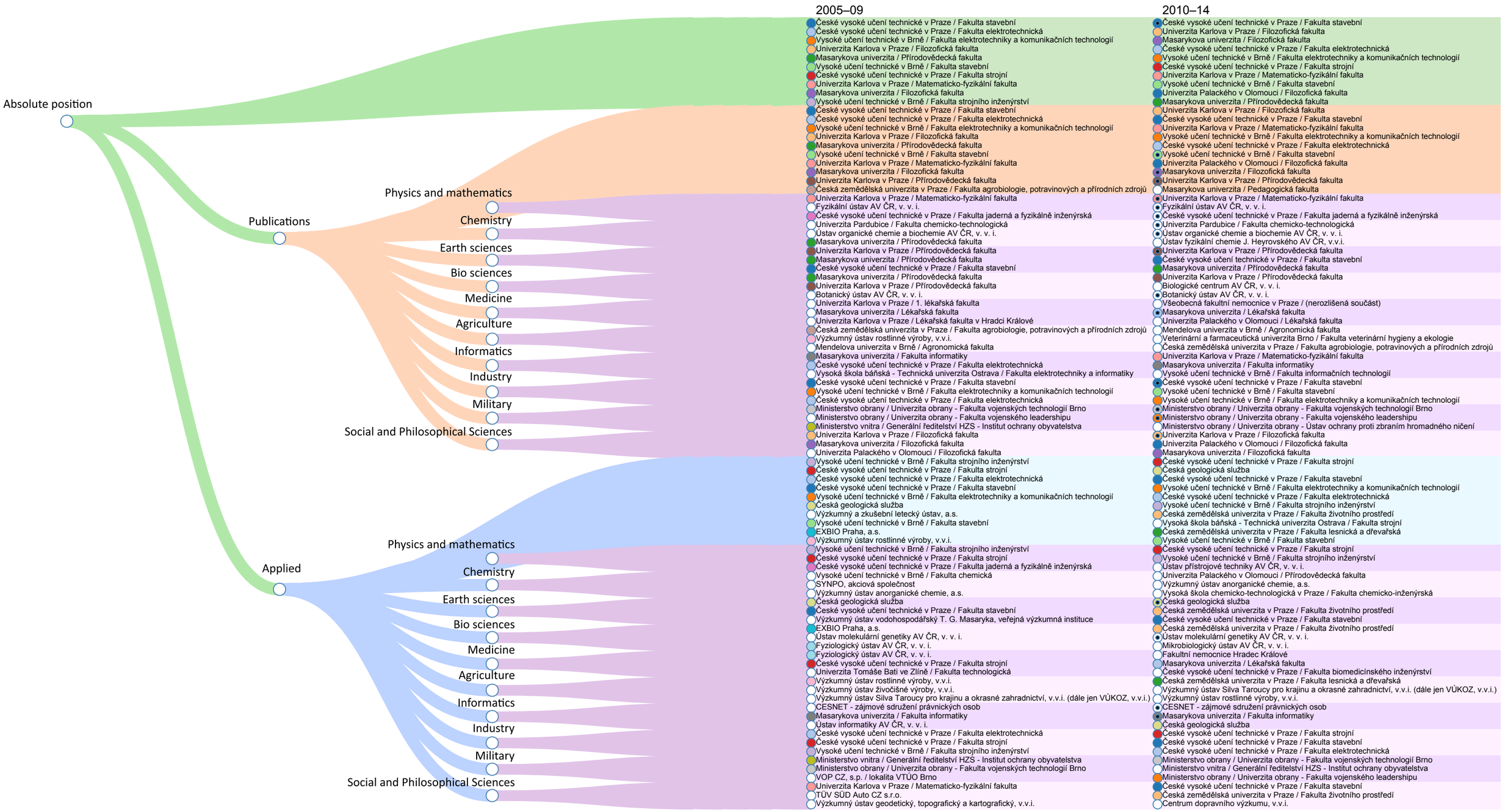
- Further enhance and extend strategic discussions on the priorities of the respective sectors of national economy and discuss these widely within the National Innovation Platforms.

- Map in detail the basic macroeconomic variables according to the respective sectors in relation to applied research, and compare these variables year-on-year.

LIST OF ABBREVIATIONS

AS	Public research institutions established by the Academy of Sciences of the Czech Republic under the Act No. 341/2005 Coll.
AS CR	Academy of Sciences of the Czech Republic
AT	Austria
BERD	Business Enterprise Expenditure on R&D
BIOCEV	Biotechnology and Biomedicine Centre of the Academy of Sciences of the Czech Republic and the Charles University in Prague
BIOMEDREG	Biomedicine for Regional Development and Human Resources
CCI	Cultural & Creative Industry
CEA	Central Register of Research Activities
CEITEC	Central European Institute of Technology
CEP	Central Register of Research, Experimental Development and Innovation Projects
CETOCOEN	Centre for the Study of Toxic Substances in the Environment
CEZ	Central Register of Research Plans
CIS	Community Innovation Survey
CNB	Czech National Bank
COMP	Combination of partial indicators of goods and services using the same weight
CR	Czech Republic
CZ-NACE	Classification of economic activities
CZSF	Czech Science Foundation
CZSO	Czech Statistical Office
DYN	Innovation in fast growing enterprises measured as weighted employment average
EC	European Commission
EC	European Community
ECOP	Education for Competitiveness Operational Programme
EGSE	Electrical Ground Support Equipment
ELI	Extreme Light Infrastructure
EPO	European Patent Office
ERDF	European Regional Development Fund
ERIC	European Research Infrastructure Consortium
ESF	European Social Fund
ESFRI	European Strategy Forum on Research Infrastructures
ESIF	European Structural and Investment Funds
EU	European Union
EU 28	All EU Member States since July 2013 (including Croatia)
Eurostat	Statistical office of the EU
FP	Framework Programmes for Research and Technological Development
FP7	Seventh Framework Programme for Research and Technological Development
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
GFD	General Financial Directorate
GOOD	Export of High-tech and Medium-high-tech goods as % of total goods export
GOVERD	Government Expenditure on R&D
GVA	Gross Value Added
H2020	Horizon 2020 – Research and Innovation Framework Programme
HC	Headcount
HERD	Expenditure on R&D in Higher Education Sector
ICRC	St. Anne's University Hospital in Brno – International Clinical Research Centre
ICT	Information and Communication Technologies
IGBT	Insulated-gate bipolar transistor
INFRA	Projects of Large Infrastructures
IOI	Innovation Output Indicator
IPn	Methodology Effective System for Assessing and Funding Research, Development and Innovation
IPO CR	Industrial Property Office of the Czech Republic
IT4I	IT4Innovations Centre of Excellence
ITS	Intelligent transportation systems
IUS	Innovation Union Scoreboard
KIA	Employment rate in knowledge-intensive fields measured as total employment rate percentage
LED	Light-Emitting Diode

Lic 5-01	Annual Licence Report
Lic 5-01	CZSO Survey – Annual Licence Report
LN	Legal and natural persons outside universities
MA	Ministry of Agriculture
MC	Ministry of Culture
MD	Ministry of Defence
MEMS	Micro-Electro-Mechanical Systems
MEZINAR	International cooperation of the Czech Republic in Research and Development executed under international contracts
MF	Ministry of Finance
MGSE	Mechanical Ground Support Equipment
MIT	Ministry of Industry and Trade
MRD	Ministry of Regional Development
MS2014+	Monitoring system of EU Structural Funds and Investment Funds (ESIF) for the programming period 2014–2020
MSC2007	Monitoring system of Structural Funds
MSTI	Main Science and Technology Indicators, OECD
MEYS	Ministry of Education, Youth and Sports
MH	Ministry of Health
MI	Ministry of the Interior
NSP	National Sustainability Programmes I and II
OECD	Organization for Economic Cooperation and Development
OG CR	Office of the Government of the Czech Republic
OGSE	Optical Ground Support Equipment
oLED	Organic light-emitting diode
OP	Operational Programme
OPEI	Operational Programme Enterprise and Innovations
OP EIC	Operational Programme Enterprise and Innovations for Competitiveness
OP RDE	Operational Programme Research, Development and Education
OP RDI	Operational Programme Research and Development for Innovation
PCT	Patent Cooperation Treaty
PPS	Purchasing Power Standard; reference currency unit for measuring the purchasing power of the currency unit in question
PRI	Public Research Institution
R&D	Research and Development
RDI	Research, Experimental Development and Innovation
RDI Dept.	Department of Science, Research and Innovation
RDI IS	Research, Experimental Development and Innovation Information System
RES	Renewable energy source WG Working Group
RIS 3	National Research and Innovation Strategy for intelligent specialization of the Czech Republic
RIV	Information Register of R&D results
RO	Research Organizations
ROD	Research Organization Development
SB	State Budget
SB	State budgetary organizations (SBO), state organizational units (SOU) and public research institutions (PRI) except for the departments of AS CR
SBO	State budgetary organizations
SERV	Export of knowledge-intensive services as % of total services export
SF	Structural Funds
SII	Summary Innovation Index
SME	Small and Medium-Sized Enterprise
SOU	State Organizational Unit
SPOLUFIN	Co-financing of Operational Programmes from the State Budget
SUSEN	Sustainable energetics
SUR	Specific university research
TA CR	Technology Agency of the Czech Republic
TC AS	Technology Centre of the Academy of Sciences of the Czech Republic
TI2012	CZSO survey on innovation in the business sector
TiO2	Titanium dioxide
UNI	University (state, public, private, business organization)
VES	Register of Public Tenders in Research, Experimental Development and Innovation
VTOL/STOL	Vertical and/or Short Take-Off and Landing
VTP	Science and Technology Park
VTR 5-01	CZSO survey – Annual Report on Research and Development
ZO 1-04	Quarterly Report on service import and export


2005–09
2010–14
Absolute position
Publications
Applied
Physics and mathematics
Chemistry
Earth sciences
Bio sciences
Medicine
Agriculture
Informatics
Industry
Military
Social and Philosophical Sciences
České vysoké učení technické v Praze / Fakulta stavební
České vysoké učení technické v Praze / Fakulta elektrotechnická
Vysoké učení technické v Brně / Fakulta elektrotechniky a komunikačních technologií
Univerzita Karlova v Praze / Filozofická fakulta
Masarykova univerzita / Přírodovědecká fakulta
Vysoké učení technické v Brně / Fakulta stavební
České vysoké učení technické v Praze / Fakulta strojní
Univerzita Karlova v Praze / Matematicko-fyzikální fakulta
Masarykova univerzita / Filozofická fakulta
Vysoké učení technické v Brně / Fakulta strojního inženýrství
Univerzita Karlova v Praze / Přírodovědecká fakulta
Česká zemědělská univerzita v Praze / Fakulta agrobiologie, potravinových a přírodních zdrojů
Fyzikální ústav AV ČR, v. v. i.
České vysoké učení technické v Praze / Fakulta jaderná a fyzikálně inženýrská
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Ústav organické chemie a biochemie AV ČR, v. v. i.
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Masarykova univerzita / Lékařská fakulta
Univerzita Karlova v Praze / Lékařská fakulta v Hradci Králové
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Masarykova univerzita / Fakulta informatiky
Vysoká škola báňská - Technická univerzita Ostrava / Fakulta elektrotechniky a informatiky
Ministerstvo obrany / Univerzita obrany - Fakulta vojenských technologií Brno
Ministerstvo obrany / Univerzita obrany - Fakulta vojenského leadershipu
Ministerstvo vnitra / Generální ředitelství HZS - Institut ochrany obyvatelstva
Výzkumný a zkušební letecký ústav, a.s.
EXBIO Praha, a.s.
Vysoká škola chemicko-technologická v Praze / Fakulta chemicko-inženýrská
Výzkumný ústav vodohospodářský T. G. Masaryka, veřejná výzkumná instituce
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Univerzita Karlova v Praze / Přírodovědecká fakulta
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Univerzita Karlova v Praze / Matematicko-fyzikální fakulta
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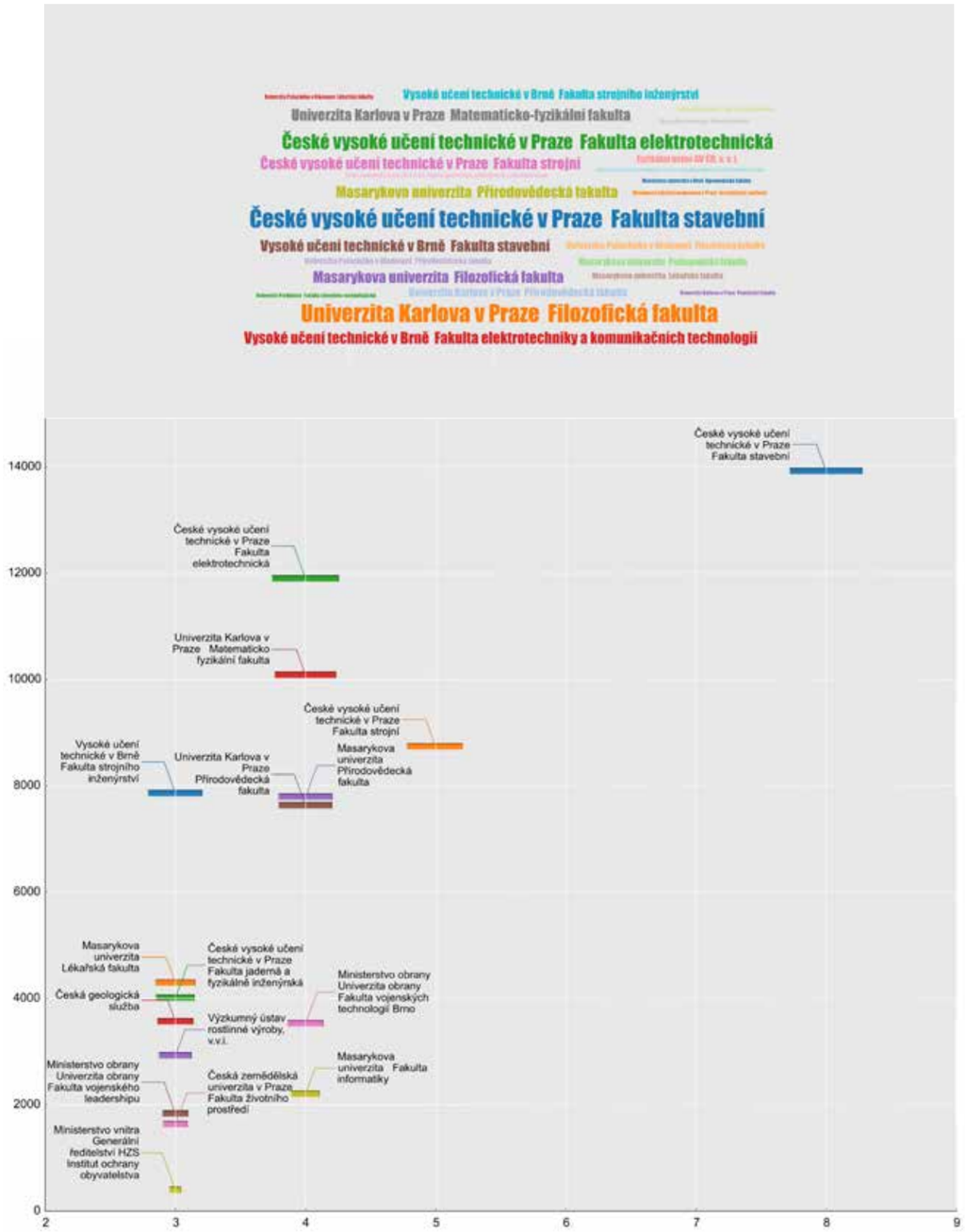
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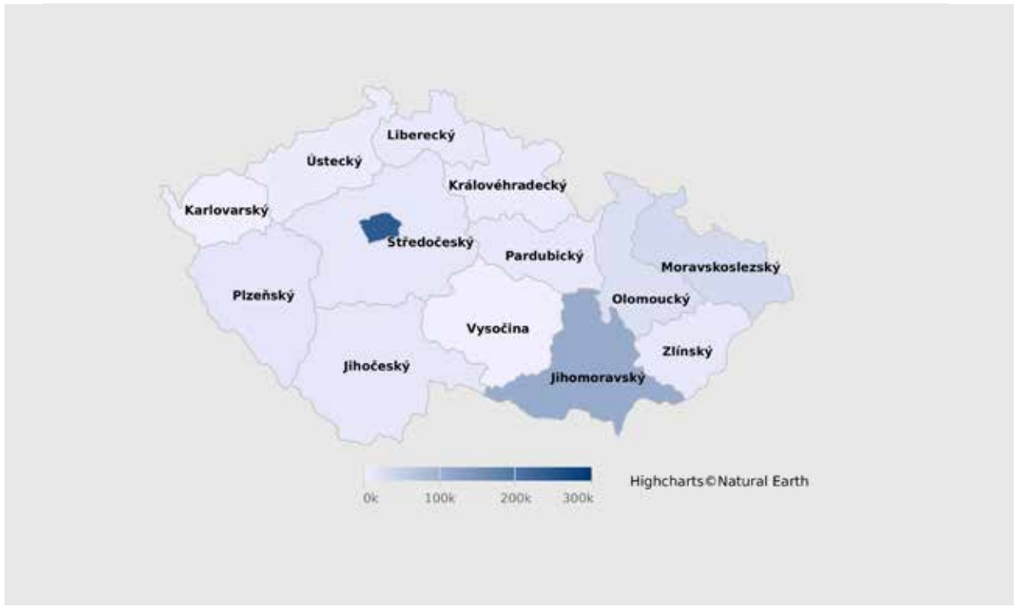
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KEY RESEARCH THEMES THAT ARE CRUCIAL FOR FURTHER DEVELOPMENT OF DEFINED SECTORS

This represents an initial and open list which may be, similar to the number of participants in working groups, extended within the framework of the current Entrepreneurial Discovery Process.

SECTORAL PLATFORM - DIGITAL ECONOMY

- Internet security
- Data (open data, development of new algorithms and analytical instruments for big data, instruments enabling work with the Czech language in ICT, etc.)
- 3D visualizations and rapid prototyping (3D printing…)
- Development of new digital solutions and services (e-commerce, digital content and its technological interfaces, Internet of Things[1], development of assistive technologies, digitalization of distribution and transmission grids / smart grids …)
- Digital skills and knowledge (education in all stages of education system; lifelong education; education of teachers in the area of modern technologies and their use …)

SECTORAL PLATFORM - AUTOMOTIVE

- Driving unit and fuels
  - Fossil fuel and biofuels of the 1st and the 2nd generation internal combustion engines with improved efficiency, flexible combustion engines in innovative driving units using synthetic fuel and higher generation biofuels, materials and components in alternative driving units, alternative fuels and operational liquids in internal combustion engines and electromobiles
- Safety
  - Components improving active and passive vehicle safety, optimisation of vehicles in terms of their integrated safety, supporting measures improving safety of road transport
- Chassis systems
  - New chassis concepts with advanced driving units and integrated controls improving vehicle dynamic conditions, active safety and comfort, as well as reducing noise, application of smart power components, lightweight bodies and frames, exterior and interior aerodynamics of vehicles.
- Electric and electronic equipment in vehicles
  - Vehicular communication systems, adaptive and predictive control of driving unit parameters, integrated and hierarchic vehicle control systems, incl. automation of routine processes, electric system components aiming to reduce input power and price, components improving system robustness and high functional reliability with the objective of improving safety, reducing energy intensity, resolving EMC problems and noise levels, diagnostic tools ensuring reliability of integrated control systems with new appliances.
- ITS, mobility and infrastructure
  - Cooperative systems for on-line sharing of information between vehicles and other types of transport units, and between vehicles and its surroundings, systems ensuring optimum use of data about roads / traffic and on possibility to re-charge electric and hybrid vehicles
- Virtual development
  - Research into simulation techniques and virtual reality (VR) techniques for parametric optimisation of products, for conceptual optimisation of higher order innovations, VR built to speed up production phase preparations within production chain, use of VR in designing production lines, applications facilitating designs of "Digital production plants"
- Material processing, production processes
  - Nano-technologies for multifunctional materials, advanced metal, plastic and composite materials, application of modern material cutting and joining methods, methods facilitating increased productivity incl. Design4x, R&D of production processes optimisation and flexibility improvement, and liquidation methods

Note: Abridged version, for full version please refer to the Strategic Research Agenda for the Technology platform "Vehicles for sustainable mobility", II. edition, February 2013

1) Internet of Things (IoT) relates to all that is called "Industrie 4.0" (the fourth industrial revolution) in Germany, which is a vision / economic model, which is to be achieved through use of high-tech informatization strategies and other future modernizations of economy and industry. This represents a strategically important area, which should be given special attention within the Digital Economy Development Strategy, or which should dealt with separately alongside the six existing areas.

SECTORAL PLATFORM – PRECISION ENGINEERING

- Metals
  - Mechanical properties of materials – increasing durability, reducing weight and ensuring the required operating life
  - Limits - weight, price, operating life
  - Minimising internal tension in metals, minimising thermal expansion
  - R&D of metal-based materials (powder) for additive manufacturing, injecting technology
  - R&D into perspective metal materials and their subsequent heat or combined chemical and heat treatment
- Surface finish
  - R&D focusing on surface finishing aiming to minimize its influence on dimension / nano-coating
  - Surface finishing developed to stop component contamination
  - Jet nozzle design proving uniform spraying
  - Limits – price of application, environmental issues, operational life, mechanical properties
- Technologies
  - R&D focusing on drive trains = electric engines, hydro-motors, gearboxes, mechanical components, power and control electronics
  - Movement of precise mechanisms during large temperature changes
  - New and very precise tooling technologies
  - Damping solutions for fine mechanical metering equipment – active feedback
  - Use of hardenable high-quality stainless steel for mechanical components in semiconductor industry equipment
  - New technologies facilitating production of low friction components
  - Use of new material – carbon fibre – Kevlar, ceramics
  - New principles, Rapid Prototyping
  - Precise tooling of titan-based alloys, invar, less usual materials similar to ultem
  - SW optimisation for component design
- Plastics and composites
  - R&D focusing on plastic and composite materials for injection technologies, additive manufacturing
  - Research onto special polymers using suitable additives
  - Research of polyamide matrices having higher chemical resistance, especially against acids
  - Limits - price of granulate product, operational life
- Glues and sealants
  - R&D into glues and sealants, non-deforming component joining

SECTORAL PLATFORM – TOOLING AND FORMING MACHINERY

- Improving precision – increased geometrical precision of machinery work, geometrical and dimensional precision of resulting product and tooled surfaces
- Improving quality – increased quality of surfaces, targeted positive influencing of corrugation, abrasiveness, appearance and other properties related to surface integrity
- Improving production output – increased short-term and long-term machinery output
- Improved reliability – increased reliability of machinery and all its functions, ensuring reliability of production process, respectively long-term preservation of product quality
- Improved economy – minimisation of unit cost per machine, standby time, cost of operation, but also minimisation of machinery production cost and operation cost
- Reducing negative impact on the environment – minimisation of negative impacts of machinery production processes on the environment, energy intensity solutions
- New metering systems, management focusing on increased prevision and reliability
- Ecological design of machinery and economic use of machinery in production
- Maximisation of output and quality of cutting processes
- Virtual tooling for optimisation of machines and technologies
- Optimum machinery design and its automation
- New tooling machinery concepts and their drive trains, new technologies (Emerging Technology)
- Unconventional materials used in construction of tooling machinery
- New design concepts for forming / moulding machinery and innovation of existing designs
- Damping and reduction of vibrations in tooling machinery
- Interaction between machinery and operators and their environment

SECTORAL PLATFORM – ELECTRONICS

- Automation, robotics, mechatronics, metering
- Industry 4.0 (cyber-physical systems and links to ICT)
- Drive trains and their controls
- Energy sources and quality of electricity
- Smart society, smart buildings
- Identification systems, associated services
- Electronics used in medical applications
- Safety and reliability with respect to all above areas

SECTORAL PLATFORM – RAILWAYS AND OTHER RAIL TRANSPORT

- Products
  - Development and application of synchronous engines and generators using permanent magnets for traction (high efficiency, low weight)
  - Optimised solutions for vehicles and their track performance
  - Strength of rail vehicle components
  - Ventilation, heating and air-conditioning
  - High-quality hybrid bearing for traction motors with extended lubricating interval
  - Development of modern low-rise bodies for trolleybuses and electro-buses
- Materials
  - Monitoring developments in magnet development using rare soils, high-output semiconductors based ion SiC
  - Development of new materials (high-strength, ultra-light, operating in very low temperature -55 °C, modern isolation materials) and sophisticated main node structures
  - Research into plastic substitutes for metals parts
  - Modern semiconductors, especially IGBT transistors, high electric parameters
- Emission / Noise
  - Reducing electromagnetic and noise emissions
- Energy
  - Development of electricity accumulation systems
  - CES (central energy source) – reducing weight, high-frequency sources
  - Power management for vehicles / electrobuses and hybrid buses
  - Infrastructure and transport systems focusing on electromobility
  - Traction lithium batteries – high capacity, fast smart charging, low weight, high number of charging cycles
  - Condensers having high capacity for application in traction converters
- Management systems / electronics
  - Sensor-less management of traction engines
  - Development of active sophisticated management system for rail vehicles
  - Development of artificial intelligence and advanced mechatronic systems
  - Development of integrated safety structures and systems
  - Development of advanced testing, computing and simulations methods in the area of rail vehicle development
- Aerodynamic effects
  - Research of aerodynamic effects – primarily effects and impacts of side wind on the stability / movement of trains
- Other themes
  - New methods of cleaning and renovation of metal parts
  - Metering methods in technical controls

SECTORAL PLATFORM – AVIATION INDUSTRY

- Aerodynamics, thermo-mechanics, flight mechanics
  - SW for aerodynamic computing, aerodynamic profiles, drag management, efficient lift mechanization, active aircraft aerodynamic control elements, analyses of dynamic flight conditions, flight properties and performance, simulation of icing impacts and its elimination, predictions of internal cabin conditions, optimum aerodynamic designs for VTOL/STOL aircraft, optimisation of hydrodynamics for seaplanes and flying boats, thermodynamics of sub-orbital aircraft, optimisation of turbine engines flow channels, optimisation of turbine engine blades, optimisation of aerodynamic propeller designs
- Aero-elasticity
  - Simulation or aero-elastic conditions in various environments
- Noise
  - Noise prediction, measures reducing external and internal noise levels
- Strength and operational life
  - Evaluation of airframes with respect to bearing capacity, fatigue and operational life, critical states and methods of airframe breaches, fatigue breaches, making predictions of remaining operational life more precise. Research of construction, material or technology changes on airframe breaches, increasing operational life of aircraft
- Materials
  - Materials with new properties (anti-corrosion protection, temperature resistance, flammability etc., new types of smart materials)
- Production technologies
  - New composite technologies, joining of construction parts, production of integrated constructions, alternative methods of assembly and fitting, casting of airframe parts from aluminium and magnesium alloys, incl. computer simulations, volume and planar moulding of unconventional materials, high-strength steel and nonferrous alloys, modern surface protection of materials, effective technologies for 3D metrology
- Safety, Reliability
  - Passive safety of aircrew and passengers, reducing burned on pilots, "anti-terrorist" elements, airframe safety and reliability analyses, evaluation of aircraft damage, monitoring, metering and assessments of stress and deformation of airframe parts during operation / flight, aircraft with reduced crew and pilot-less equipment, advanced flight decks / cockpits, low-cost construction elements in aircrafts, efficient use of aircraft interior, transfers and sharing of large volume construction data between remote sites / users, virtual reality in design, advanced de-frosting systems, lightning protection
- Propulsion
  - Optimised propeller and ventilator design, dynamic simulations of regulating and control systems in turbine engines, modelling and optimisation of thermodynamic processes in combustion chambers, restorable rocket propulsion, design and optimisation of high-speed gearboxes, electrical propulsion units, hydrogen fuel cells
- Aircraft systems
  - Integration of system sets (hydraulics, fuel, air-conditions), optimisation of automatic movement control (autopilot), secure data communication, integrated electric source distribution system, increased precision of low-cost inertial aircraft metering / measurement units using GPS and magnetometers, particle filters, identification and control algorithms of dynamic system, integrated satellite navigation receivers, automated control systems, integrated stabilized aircraft optical systems
- Space flight
  - Sensors and instrument technology (accelerometer, altimeter, radar, LIDAR, magnetometer etc.), ground testing equipment (EGSE, MGSE, OGSE), microcomputers for satellite systems, satellite on-board and SW systems, automatic and robotic systems, open and secured communication protocols, MEMS technology, enhanced materials for use in space, structural and thermal analysis, simulations of aero-thermo-elastic effects

Note: Abridged version, for full version please refer to the Strategic Research Agenda for the Czech Aviation and Space Industry 2025 / Implementation Action Plan (March 2013)

SECTORAL PLATFORM - BIOTECHNOLOGIES

- Use of modern biologic methods in agriculture (plant cultivation, livestock farming)
- Use of modern biotechnologies in environmental protection
- Modern vaccination methods not only against infections in human and veterinary medicine
- Diagnostics of human and veterinary diseases
- Development of new biopolymers that may be used in medicine and in technical sectors
- Tissue and cell therapy, biological treatments
- Bio-technological development of new antimicrobial substances
- Production of recombination molecules
- Biotechnological production of active crop substances without genetic modifications
- Use of modern biotechnologies in food processing industry
- Biotechnological production of substances from sustainable sources
- R&D biotechnological products and services with high added value, especially those based on application of molecular genetic approaches

SECTORAL PLATFORM – ENERGY SECTOR

- Analyses of potential and limits of energy sector development in the Czech Republic in different time horizons
- Technology in energy sector and its application in practice

- Generation of electricity and heat in nuclear sources – safety / security, long-term economical operation, reliable economic operation, nuclear fuel cycle, radioactive cycle, advanced 4th generation systems, SMR
- Fossil sources used in electricity generation – new operational regimes incl. requirements placed on ordinary pollutants
- Generation and distribution of heat / coolants based primarily on fossil fuel – improved efficiency of existing district heating systems, heat accumulation, small-scale cogeneration and micro-generation technology, producing coolants and tri-generation
- Generation of electricity and heat from renewable sources (RES) and secondary sources – biomass + waste, water, solar energy, heat pumps, power-to-gas using RES
- Electric grids including electricity accumulation – perspectives in developing transmission and distribution grids, grid management, infrastructure for development and use of hybrid and electric vehicles, cyber-security
- Energy in transport – new biofuel types, infrastructure for plug-ins and electromobiles, hydrogen and fuels cells in transport
- Energy consumption and savings – energy savings in industry, efficiency of energy distribution systems, saving technologies in consumption, smart homes, smart cities and regions

- New technologies and processes with potential significant impact on the energy sector

SECTORAL PLATFORM – TRADITIONAL CULTURAL AND CREATIVE INDUSTRIES

- Glass-making
  - Development of glass products from the perspective of safety and responsibility toward the environment (unleaded glass, internal tension, protective surface coating – nano-paint)
  - Surface finishing of glass products reflecting commercial and legislative trends (protective and anti-adhesive paint)
  - Integration of glass products into final products (fixation tube, telescopic suspension systems)
  - Technologies integrating glass and luminescence (nano-paint, light sources such as LED, oLED technologies or energy-saving light bulbs)
- Porcelain manufacture
  - Colour glazing, glazing properties and effect of oxides
  - Development of granulate product
- Textile industry
  - R&D, production of and use of nano-fibres and nano-fibre structures in textile products, application of nano particles for special effects
  - Development of composite structures containing inorganic fibre and textile reinforcements, smart textile products
  - Use of optical filaments and materials with memory form for technical products
  - Textile sensors and sensors suitable for use in textile products
  - Modification and development of technologies for processing new materials, ecological aspects of new technologies
- Wood processing
  - Technologies for joining wood-base materials
  - Mathematical simulations of wood construction strength
  - Development of materials based on wood having high resistance against biotic elements and fire
  - Glued lamellar wood and its use in wooden house architecture
  - Ecological aspects related to wood processing and processing of wood-based materials
- Other processing industries
  - Musical acoustics and technical physics (research of acoustic qualities of musical instruments and their balanced performance)
  - Modification and development of technologies for processing of new materials

Note: Scientific themes in this sector are linked to scientific themes in associated Convergence and Competitiveness Instrument (CCI) sectors

SECTORAL PLATFORM - METALLURGY, STEEL INDUSTRY, FOUNDRY INDUSTRY

- Development of new sophisticated products, responding to customer requirements
- New and enhanced steel products; development of new steel categories with combined properties (strength, malleability, tensile strength, energy absorption, reduced weight, resistance against thermal impacts etc.)
- Optimisation of production cost and increased energy efficiency of metallurgy processes
- Reduced material intensity of metallurgy processes
- Optimisation of qualitative parameters of metallurgy products incl. improved control and management of production processes (mechatronics)
- Development of new and improvement of parameters of existing auxiliary materials (chemicals, oils etc.)
- New types of heat-resistant materials incl. their surface coating for casting new types of alloys
- Sophisticated control / management systems
- Development of artificial intelligence and advanced systems
- New techniques and technologies for processing and increased quality of final metallurgy products
- Advanced testing, computing and simulation methods specifically used in development
- Light alloys, cellular materials and composites
- Bio-compatible metallurgy
- Coating and surface protection
- Powder metallurgy
- Recycling, refinement and repeated use of critical and highly valuable metals

SECTORAL PLATFORM - NEW CULTURAL AND CREATIVE INDUSTRIES

- Technology as a initiator of European innovations
- Nanotechnology and design
- Use of advanced materials
- Research of life cycle of materials and products made from such materials
- Use of laser light in audio-visual art
- Research of spatial sound / acoustics and interactive technologies
- Immersive spaces and radical technologies in art and its presentation

Note: Scientific themes in this sector will be discussed with sector representatives and subsequently amended

SECTORAL PLATFORM - NANOTECHNOLOGIES

- Textile production
  - Nano-fibre barrier textiles (protection against allergens, bacteria and viruses)
  - Nano-fibre materials for industrial applications (filtration systems)
  - Nano-fibre membranes and special textiles for functional clothing
- Chemical industry
  - Nano-technological surface protection
- Ecology
  - Nano-particles of zero-potency iron and its application in sanitation of surface and subsoil water technologies
  - Filtration materials (polymer nano-fibre membranes) – for water and air cleaning technologies without using chemicals through the use of membrane separation technology
  - Photo-catalytic paints with TiO2 nano-particles
- Energy sector
  - Research of graphene (artificial form of carbon) and possibilities of its application (graphene super condenser)
  - Use of nano materials in battery construction (3D batteries)
- Medicine, pharmaceutics
  - Nano-fibre structures (regenerative medicine, tissue engineering, targeted distribution in nano-capsules)
  - Micro and nano technology processes aiming to facilitate change in physical properties of food complements or medicines (increasing their efficiency, reducing toxicity and side effects)
- Other
  - Nano-structured polymers, electro-active polymers, thermo-set and thermo-plastics composites, polymer composites for medicine, architecture of matter in nano dimensions, 2D and 3D nano -structures

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