Research, Development and Innovation Council

Annexes to the National Research, Development and Innovation Policy of the Czech Republic 2021+

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1 Annex – Evaluation of timeliness and relevance of R&D Priorities

Context of creation of R&D Priorities

Up until 2008, priorities in the area of research and development were formulated as long-term basic directions for research, representing a wide range of almost all the scientific (research) disciplines in the Czech Republic. In 2008, the basic long-term research directions were re-evaluated, resulting in their being updated in 2009 and renamed as Priorities of Applied Research, Development and Innovation of the Czech Republic for 2009–2011.

The Priorities of Applied Research, Development and Innovation of the Czech Republic for 2009–2011 became part of the National Research, Development and Innovation Policy of the Czech Republic for 2009–2015. These priorities were formulated very generally and comprehensively. They lacked a sufficient focus on the areas that would react to the needs of society, in particular the social and economic development of the Czech Republic. The R&D support programmes regularly referred to the current research directions, though in reality they were often only formal relationships. The Priorities of Applied Research, Development and Innovation of the Czech Republic for 2009–2011 were replaced in 2012 by the National Priorities of Oriented Research, Experimental Development and Innovation (hereinafter referred to as "R&D Priorities"), which became part of the Update of the National Research, Development and Innovation Policy of the Czech Republic for 2009–2015 with regard to 2020.

Government Resolution No. 569 of 31 July 2013 approved the implementation of the R&D Priorities, which builds on Government Resolution No. 552 of 19 July 2012, in which the R&D Priorities themselves were approved.

The Act on R&D anticipates the prioritisation in relation to applied research [see Article 2(3) of the cited act]. The requirement for the formulation of the priorities of applied research appeared on the part of the EU in connection with the preparation of the 2014–2020 programme period, but also from the business sector.

Basis for evaluation of timeliness and relevance of R&D Priorities

The purpose of the formulation of R&D Priorities was the strategic targeting of part of the national R&D (particularly applied research, but also partially basic research) to the areas that help resolve the important current and foreseeable future problems and challenges to the Czech Republic. Such targeted research is focused on resolving concrete social and economic goals on the boundary of basic and applied research. That was also the reason for the creation of the priorities of applied research.

According to the implementation of R&D Priorities, they should be used during the preparation of targeted R&D support programmes. They were originally also supposed to form the foundation for the targeting of aid from the EU structural funds in the 2014–2020 programme period. They were, however, prepared at a time when the preparation of the new programme period had not been completed, the operation programmes had not been approved and the preparation of the National RIS3 began as a preliminary condition for drawing on ESIF. In December 2013, the EU Council formally approved the new rules and legal regulations regulating the further round of investments as part of the European Union Cohesion Policy for the 2014–2020 period.

In this connection, the EU came with the concept of national/regional research and innovation strategies for smart specialisations (RIS3). The sense of the concept consists in the creation of strategies that will reflect the concrete conditions and needs of the individual regions. Thus, through RIS3, the EU would like to achieve the financial funds for R&D being sent to competitive areas with a high innovation potential, which will be the driving force for economic growth in the country or region.

With Government Resolution No. 634 of 11 July 2016, the Update of the National RIS3 Strategy was approved. It already contained the priority of applied and oriented research according to the configured National R&D Priorities 2016–2020 and related to the ESIF and selected national R&D support programmes [specifically programmes of the Ministry of Industry and Trade (MIT) and the Technology Agency of the Czech Republic (TACR)]. The purpose of the National RIS3 Strategy is to define priorities for creating competitive advantages on a country-wide and regional level by building research and development capacities that will accommodate the needs of businesses while increasing their competitiveness. Government Resolution No. 24 of 11 January 2019 approved the National RIS3 Strategy – 2018 update. The key areas of the changes include the higher innovation performance of companies, increasing the quality and economic benefits of research, better accessibility of the potential of people for innovative businesses, research and development, development of eGovernment and eBusiness and better use of social capital when resolving societal challenges.

Procedure for the formulation of the priorities of applied research

All of the aforementioned documents are closely related from the perspective of the gradual creation and refinement of the priorities of applied research. The National RIS3 Strategy contains the priorities of applied and oriented research related to competitiveness and in these sections it specifies the general priorities contained in the R&D Priorities.

The approval of the National R&D Priorities 2016–2020 led to the formal introduction of a continual process for determining and evaluating the material needs of companies and other users in the area of applied and oriented research. The National R&D Priorities 2016–2020 contained the first proposal of the priorities of applied and oriented research, which was negotiated for a period of almost two years (the period of 2014–2015) with representatives of the academic and private spheres as part of the sectoral groups created by Office of the Government of the Czech Republic. The first proposal of these priorities became the foundation for the work of the National Innovation Platforms (the “NIP”) under the National RIS3 Strategy, where these initial proposals were further processed in cooperation with the academic and private spheres and used during the completion of the National RIS3 Strategy. The National RIS3 Strategy already contains the priorities of oriented and applied research, which the Office of the Government of the Czech Republic specified with the help of intensive discussions as part of the NIP with representatives of the academic and private sectors. The priorities are the “horizontal goals” of the National RIS3 Strategy (strengthening the R&D capacities of companies; supporting the technical cooperation of companies; improving the quality of research workplaces; improving the cooperation of research organisations and companies; supporting qualified employees from abroad; supporting the use of ICT in business, etc.). The second structural level represents research and the economic specialisation of the National RIS3 Strategy. These are priorities on which the applied and oriented research should focus in the Czech Republic and which it is beneficial to support with regard to the national research and economic performance in a European and global context.

On the basis of the discussions in NIP, the research specialisations of the National RIS3 Strategy were updated or newly identified: knowledge domains (advanced materials; nanotechnologies; biotechnologies; artificial intelligence; security and connectivity; social innovations; etc.) and economic specialisation of the RIS3 Strategy – application sectors (engineering/mechatronics; industrial chemistry; automotive; aerospace industry; digital economics and digital content; sustainable management of natural resources; etc.).

Since the approval of the National RIS3 Strategy, these defined priorities have gradually been incorporated into the support programmes in the areas of applied and oriented research, which therefore corresponds to the demand on the part of the private sector and other users. The priorities of the National RIS3 Strategy (horizontal goals, knowledge domains and application sectors) are not their fixed focus; instead, their clarification and targeting are a constant process based on the implementation of the outputs of the process for discovering business opportunities (i.e. the EDP)[1].

In the 2021–2027 programme period, the importance of the National RIS3 Strategy will grow [the draft general regulation of the European Parliament and of the Council under no. COM(2018)375]. The National RIS3 is gradually becoming a coordination mechanism. Its goal is thus for the Czech Republic to be a prosperous, technologically advanced, digitally-friendly industrial country with an open innovation ecosystem and a good name abroad.

Relationship between Innovation Strategy, National R&D Strategy and National RIS3 Strategy

With the acceptance of the Innovation Strategy, a general multi-departmental document was created that had legislative backing along with demanding goals. The National R&D Strategy represented the strategic overarching document for the area of R&D as well as one of the tools to fulfil the goals in the pillars of the Innovation Strategy. At the same time, the Innovation Strategy also provides its outputs for the National R&D Strategy.

The National R&D Strategy presents a framework of R&D Priorities and the priorities of oriented and applied research contained in the National RIS3 Strategy. The R&D Priorities cover the entire area of R&D (except for basic research) on the level of conception, while the National RIS3 Strategy aims its measures on the support of oriented and applied research targeted at innovation. Thus, the National RIS3 Strategy is an implementation tool of a significant part of the National R&D Strategy, particularly in the area of the support of oriented and applied research through the effective targeting of European, national, regional and private funds into the most perspective areas of research and business. The continual determination of material needs in the individual sectors of the economy is achieved through dialogue. Thus, the National RIS3 Strategy represents a tool for the identification, verification and implementation of the priorities of oriented and applied research.

The R&D Priorities are incorporated into the programmes for R&D support, which are preferentially targeted at the R&D goals contained in the R&D Priorities (e.g. departmental programmes) and these goals comprise the mandatory part of the programme. When announcing public tenders, the providers of support in these programmes demand the selection of specific R&D goals from the R&D Priorities from the applicants for support or the relevant R&D support programme on which their R&D project will be focussed. The R&D

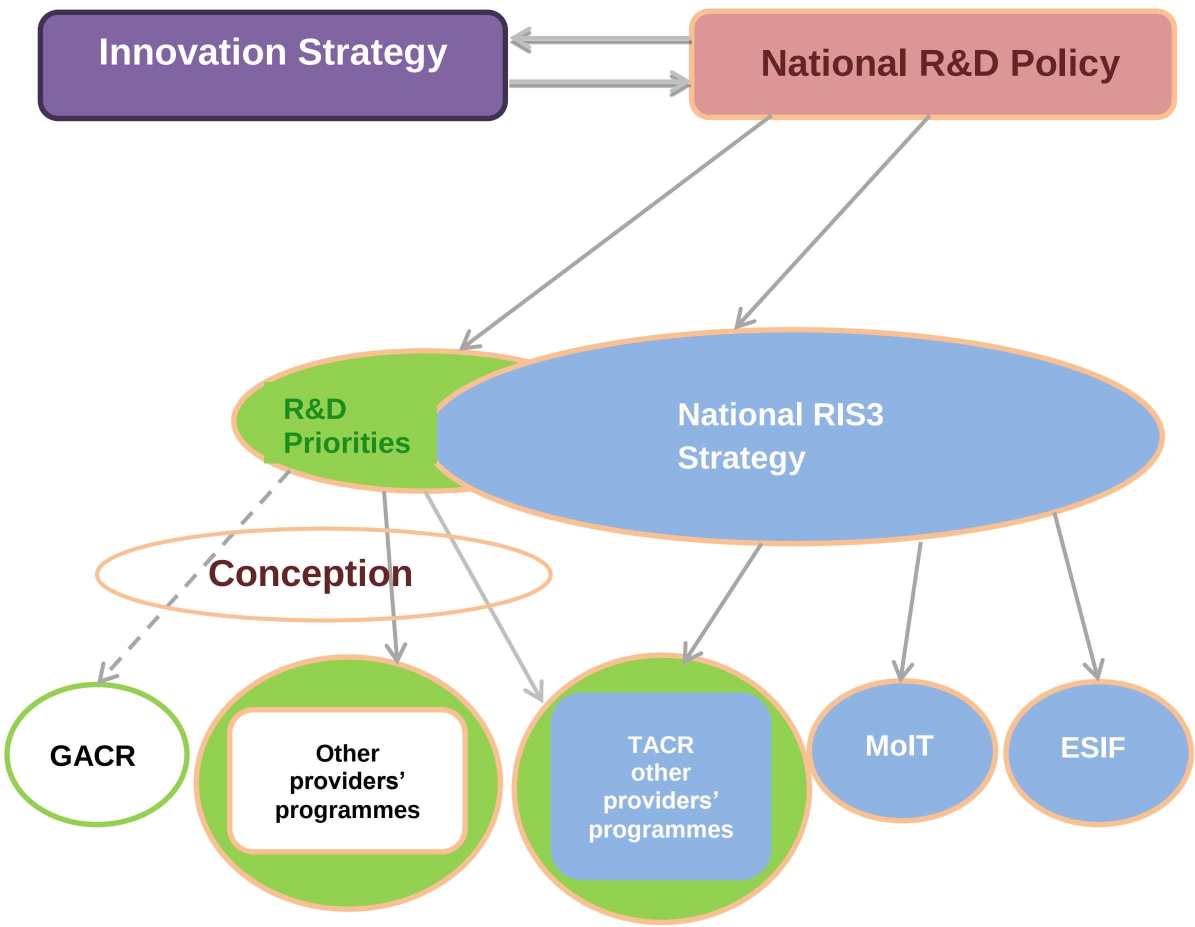
[1] "Entrepreneurial Discovery Process"

Priorities can also be incorporated in the group of grant projects financed from the state budget for the area of R&D. In this case, however, the application of R&D Priorities only applies to basic research, which can be considered to be targeted on the resolution of specific social and economic goals on the boundary of basic and applied research. In the case of the Czech Science Foundation (GACR), the application of a programme or grant scheme for a concrete priority area (or sub-area) in accordance with the Implementation of R&D Priorities is not obligatory, but is based on the focus of specific projects.

The priorities of oriented and applied research under the National RIS3 Strategy are incorporated in the R&D operational programmes financed from ESIF and in programmes for the support of applied research of the relevant providers from the state budget in the area of R&D.

The figure below depicts the mutual relationships between the Innovation Strategy, National R&D Strategy, R&D Priorities and National RIS3 Strategy and their effect on the providers of support in R&D programmes financed from the state budget or ESIF.

Figure 1.1: Relationship between Innovation Strategy, National R&D Strategy, R&D Priorities, National RIS3 Strategy (containing priorities of applies research) and R&D support programmes



Source: own processing

Conclusion

Both the long-term priorities, i.e. R&D Priorities, and the medium-term priorities of oriented and applied research specified in the National RIS3 Strategy will continue to remain valid.

Compliance with the R&D Priorities will continue to be required for support programmes for applied research and departmental R&D support programmes in themes that are not covered by the National RIS3 Strategy.

The priorities in basic research will not be specified since basic research is understood to be a source of general development of knowledge. Oriented research, however, includes GACR grant projects, which can subsequently be used in applied research. This is in compliance with the provisions of Sections 3 and 36 of the Act on R&D, according to which GACR provides support to basic research as part of government-approved groups of grant projects in the form of the financing of grant projects in which the recipient specifies the goals and solution methods in the basic research itself.

Compliance with the priorities of applied and oriented research contained in the National RIS3 Strategy will be required particularly in the area of programmes of targeted support that lead to increased competitiveness of the Czech Republic.

2 Annex – Megatrends in the area of science, technology and innovation

The main social megatrends influencing the future image of the world

On one hand, technical progress can strengthen the destabilisation of the effects of many of the megatrends described below. On the other hand, it has the potential of improving the reaction of humanity to the many global challenges it faces. In any case, technical progress leads to the increased speed of these changes and often to unexpected results.

- **Demography** – the population of the world is continually growing and it is estimated that it will reach 10 billion by 2050. More than half the demographic growth will be caused by demographic developments in Africa. In other countries, the pace of **population aging** will intensify. The proportion of the population surviving past 80 will reach as much as 10% in the middle of the century. Thus, the share of economically active people, for whom it will be difficult to achieve a comparable standard of living, will decrease. International **migration** can, to a certain extent, help overcome this problem. Technologies improving the physical and cognitive abilities of seniors will also extend the economically active phase of life. Another study[2] also shows that population growth in developing countries will reach more than six times the speed of growth in developed countries.
- **Natural resources and energy** – the growing population will produce further pressure on natural resources and ecosystem services. Problems with water sources, just like a lack of food, will probably continue in many parts of the world. The consumption of energy will also rise considerably and will continue to contribute to climate change. Global biodiversity will continue to be threatened.
- **Climate change, environment** – the management of climate change will require the fulfilment of demanding goals connected with a reduction in the production of greenhouse gases, a timely and comprehensive adaptation to climate change, the protection of nature and the landscape as part of the environment and a source of ecosystem services, an increase in the share of recycled waste and a transition to a circular economy. Technological innovation and ecosystem solutions in this area will have to be applied in advanced and developing countries.
- **Globalisation** – the focal point of the international economy will move to the east and to the south. The shift of forces will occur both from a geopolitical perspective and from the perspective of the influence of multinational corporations and non-governmental organisations. The introduction of digital technologies will influence the flows of goods, services, investments, people and ideas. Political instability, armed conflicts and protectionism will remain counteracting powers. The study[3] includes, for example, Mexico, Indonesia, Turkey, South Korea and Nigeria among the rapidly-developing countries with large potential for the future due to their high GDP growth.
- **The role of governments** – governments will be forced to react to great challenges that will arise in the context of growing fiscal pressures, erosion of the public's trust in the

[2] MEGATRENDS: A BIGGER PICTURE FOR A BETTER STRATEGY [online]. Munich: Roland Berger GmbH [cit. 30. 4. 2020]. Available from https://www.rolandberger.com/en/Insights/Global-Topics/Trend-Compendium.html
[3] MEGATRENDS: A BIGGER PICTURE FOR A BETTER STRATEGY [online]. Munich: Roland Berger GmbH [cit. 30. 4. 2020]. Available from https://www.rolandberger.com/en/Insights/Global-Topics/Trend-Compendium.html

government and the continuing transition to a multi-polar world with the subsequent potential for increasing instability.

- **Economy, labour and productivity** – digital technologies will continue to have a significant effect on the economy and society. Digitisation will continue to advance, which will enable products, production processes and deliveries to be highly integrated. Expenses for acquiring ICT will decrease, and open source codes will create an opportunity for companies and individuals to succeed on new markets. The concurrently decreasing expenses for computing power and advances in machine learning and artificial intelligence will continue to transform the labour market.
- **Society** – the concept of family and home life will change. The number of childless families will increase. Access to education and the acquisition of skills will be one of the most important keys to improving the environment. The increase in the number of students on all levels of education will continue and have a significant effect on the job market and family life. The worldwide population will be increasingly urban, while Asia and Africa will contribute to 90% of this increase. **Urbanisation** could bring several advantages to developing countries, including better access to electricity, water and hygienic and sanitation facilities. But the more extensive formation of slums could lead to negative consequences for human health and the environment.
- **Health, inequality and standard of living** – there will be advances in the treatment of infectious diseases affecting the developing world. It is necessary to prepare for solutions to repeated threats with a global impact, such as pandemic diseases like COVID-19 caused by the new type of coronavirus SARS-CoV-2. It is expected that non-communicable and neurological diseases will occur more frequently in accordance with the demographic aging and unhealthy lifestyle. Inequality is growing in many developed countries, just like the level of poverty and the number of people threatened by poverty.

Main technological trends

The prognostic processes implemented in several OECD countries and Russia in 2016 resulted in the identification of more than forty promising technologies that will strongly influence the development of society over the course of the next ten to twenty years. The OECD mapped these technologies and presents a comprehensive overview (see figure 2.1).

- **Internet of Things** – the IoT contains items and devices whose status can be changed over the internet, either initiated by humans or without them. The expansion of interconnected sensors plays a key role in the IoT. It truly is the interconnection and mutual interaction of everything. Big data analysis and cloud computing play a key role. There is huge potential to move humanity forward, but there is also a need to introduce protective and security measures. Healthcare, energy systems, transportation, cities and state administration will all fundamentally impacted.
- **Analyses of big data** – in order to understand the enormous amount of data generated and collected through the expanding Internet of Things, it is necessary to develop and use analytical techniques and tools. Data "mining" uses several techniques to obtain relevant information, e.g. profiling techniques, business intelligence tools, machine learning and visual analysis techniques. Big data analysis will be a key factor for how innovative and competitive a company will be, for how efficient the public sector will be and the wide range of uses that will be found for it in the area of healthcare. The increased availability of

scientific data will enable more effective and productive research. The need to analyse big data places increasing demands on the education and training of workers/specialists, on the modernisation of education systems, on the development of new supercomputers and storage devices, on the introduction of fast and available internet and last, but not least, on international regulations. The great challenge in this area consists in finding a balance between the need for openness and the threat to privacy, security, equality and moral integrity ensuing from the digitalisation of social life.

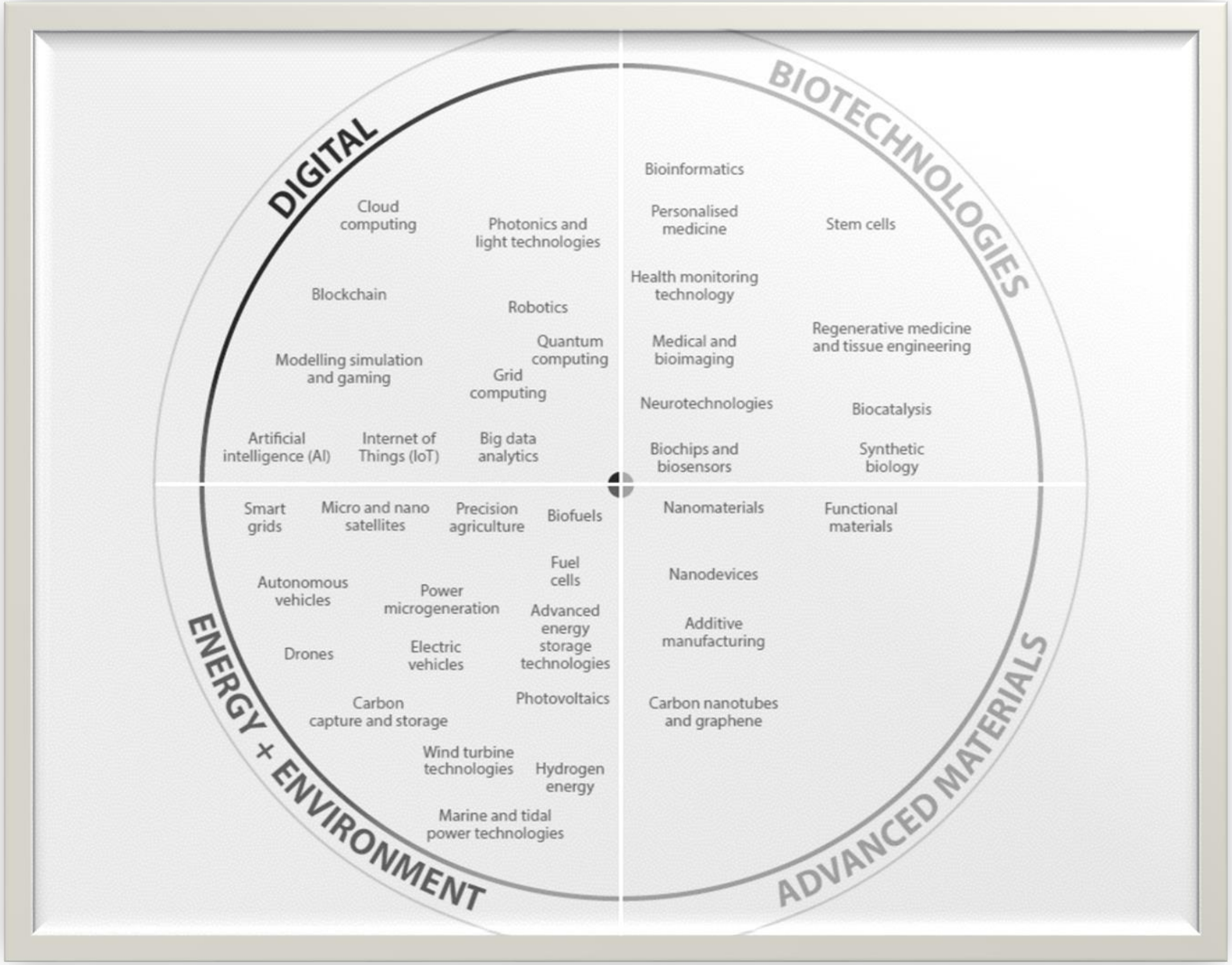
- **Artificial intelligence** – the purpose of artificial intelligence is to equip machines and devices with the ability to reason, with this ability possibly surpassing that of humans in the future. Even though the ultimate impact is difficult to assess, intelligent systems will probably bring a considerable shift in productivity. Systems equipped by artificial intelligence use elements of big data analyses, cloud computing, communication among devices and the Internet of Things for their operations. The systems are capable of collecting data, evaluating it using statistical methods and calculating the probability of the individual phenomena. On the basis of their own experiences, they can adapt their algorithms and procedures, thereby increasing the quality of the output. According to the International Telecommunication Union (ITU), artificial intelligence (AI) will be the main key to achieving the 17 goals of sustainable development as maintained by the United Nations Organisation.[4] Of course, AI can also increase the differences between developed states and developing regions, where a broadband Internet infrastructure has not yet been built. AI is used, for example, for increasing the quality of health, monitoring hygiene and nutrition, conducting nuclear tests, in autonomous automobiles, for language translators, when using satellites, in agriculture and in education. AI is also used in the arms industry (autonomous weapon systems), which could, with the expansion of IT, lead to a security threat in the case of a cybernetic attack. These cannot only breach security, but also human rights and privacy. The development of AI will also have a large effect on the job market, where many people will be replaced by automation. AI is currently running up against many obstacles where, in some cases, human assistance for evaluating the situation is necessary. AI also runs up against current ethical and social/legal shortcomings.
- **Neurotechnology** – neurotechnology is an applied technology in the area of the diagnosis and therapy for healthy aging and the general improvement of the functioning of the human body. Neurotechnology examines, penetrates and manipulates the structure and functionality of the nervous system. Examination of the brain can bring significant progress in the area of medicine. We can find examples in research and the use of these technologies in the areas of optogenetics, neuromodulation technologies, connecting the brain to a computer and nanorobotics. Of course, some forms of neurotechnology raise ethical, legal, social and cultural problems that demand attention.
- **Micro and nano satellites** – the development and production of smaller-sized satellites (up to 50 kg) is increasing, and because they are smaller, they can be built using faster using fewer materials. These small satellites can be combined into larger groups, allowing them to be used for civilian and military purposes. The challenge for future development is to find a compromise between size and functionality and an extension of the period of

[4] SDGs .:. Sustainable Development Knowledge Platform. *Home .:. Sustainable Development Knowledge Platform* [online] [cit. 30. 4. 2020]. Available from https://sustainabledevelopment.un.org/sdgs

functionality. As more satellites are launched, the threat of overcrowding in orbit and the risk of the collision will increase.

- **Nanomaterials** – nanomaterials display unique optical, magnetic and electric characteristics that can find use in various areas, such healthcare, construction, chemical and textile industry and energy technologies. Currently, nanomaterials are predominantly developed and manufactured by multinational companies. Nevertheless, technical limitations and uncertainty regarding the possible danger of their effects on people and the environment restrict their wider use.
- **Additive manufacturing** – additive manufacturing (also 3D printing) is, unlike subtractive and formative manufacturing, a method where the product is made by adding layers, often with the use of a computer-assisted design programme. In the past, additive manufacturing was primarily used when making prototypes; now it is largely used for the production of functional components made of plastic, metal, ceramics and glass. The future development of products produced by the additive method is leading to their use in healthcare, medicine and biotechnologies (in the area of dental and other prostheses or exoskeletons) or for the processing of metal. Additive manufacturing enables the sale of designs instead of physical products, which lowers the expenses for transportation. At the same time, it leads to a decrease of waste that occurs during regular production. Obstacles in the use of this technology are in the limitations of usable materials, lower quality and the speed of processing and non-existing legal regulations, especially from the perspective of property rights.
- **Advanced energy storage technologies** – energy storage technologies are systems that are capable of absorbing and storing energy and releasing it again upon demand. It is necessary to develop new technologies in the area that have higher performance and are integrated into a system with renewable sources of energy, which often provide energy unexpectedly and with interruptions. Technologies for storing large-scale energy are used for the compensation of energy fluctuations. Small, transportable energy storage has commercial use, for example in electric cars. A decrease in the emission of greenhouse gasses is expected from advanced energy-storing systems.
- **Synthetic biology** – synthetic biology is a new branch of biotechnology capable of manipulating DNA. It enables the creation and modification of original biological systems and is applicable primarily in healthcare, agriculture, industry and energy. Of course, this technology runs up against technical, legal and ethical obstacles and biological risks.
- **Blockchain** – a blockchain is a distributed database storing an ever-expanding number of records that are protected against unauthorised interference. The most well-known use of blockchain technology is for financial transactions in the form of cryptocurrencies, though it has potential use for the creation of a decentralised internet and in the area of contractual relations, decentralised social networks, message encryption, ownership verification, medical record storage, notarial practice, tax collection and other applications. Due to technical deficiencies, the sustainability of this technology is a question of the future.

Figure **2.1**: **Forty key and emerging technologies for the future**



Source: OECD Science, Technology and Innovation Outlook 2016

3 Annex – Analysis of developments in the area of R&D

The knowledge intensity of the Czech economy for 2018 is on the level of 1.9%. Compared internationally, the knowledge intensity of the Czech Republic for 2018 was under the EU-28 average and reached a higher value than, for example, the economy of Great Britain. The highest level of knowledge intensity was reached in the European countries of Sweden, Switzerland and Austria.

The innovation performance was analysed on the basis of three composite indicators: the Summary Innovation Index (SII), Global Innovation Index (GII) and Innovation Output Indicator (IOI). The conclusions and recommendations in this material are based on SII and GII; IOI is only mentioned in the text as supplemental to illustrate the overall state of the innovation performance of the Czech Republic and selected countries.

SII

Based on SII, the Czech Republic is classified in the group of "Moderate Innovators". The Czech economy ranked 14th in the EU-28 countries with its SII result. According to SII 2019, the Czech Republic excels in the following areas:

- Employment impacts
- Innovators
- Firm investments

The Czech Republic specifically placed high in the following indicators:

- Employment in fast-growing enterprises of the most innovative sectors
- Medium and high-tech product exports
- SMEs innovating in-house

On the other hand, the following can be considered weaknesses of SII 2019:

- Finance and support
- Attractive research systems
- Intellectual assets

The Czech Republic specifically achieved low marks in the following indicators:

- Venture capital expenditures
- PCT patent applications
- Scientific publications in the top 10% of the most cited publications

GII

According to GII 2019, the Czech Republic ranked 26th out of the 129 evaluated economies. Within the EU-28, the Czech Republic is in 13th place. The highest GII 2019 values were achieved by Switzerland, Sweden, the USA, the Netherlands, Great Britain, Finland, Denmark, Singapore, Germany and Israel.

According to GII 2019, the following are the Czech Republic's strengths (13):

- Ease of resolving insolvency
- Ecological sustainability

- ISO 14001 environmental certificates
- GERD financed by abroad
- High-tech imports
- Utility models by origin
- Knowledge impact
- ISO 9001 quality certificates
- High- and medium-high-tech manufacturing
- High-tech net exports
- Creative goods and services
- Creative goods exports
- Country-code TLDs

According to evaluating GII 2019, the following are the Czech Republic's weaknesses (11):

- Costs of redundancy dismissal
- Ease of starting a business
- Global R&D companies
- Government's online service
- E-participation
- GDP/unit of energy use
- Investment
- Ease of protecting minority investors
- Venture capital deals
- JV-strategic alliance deals
- Printing and other media

IOI

The IOI indicator is understood in this material to be only supplementary for completing the overall view of the innovation performance of the Czech Republic and selected countries. The Czech Republic also ranked 13th within the EU-28 countries in the evaluation according to IOI. The highest rankings in the EU-28 went to Ireland, Sweden and Great Britain.

According to IOI, the following are the Czech Republic's strengths:

- Proportion of medium- and high-tech products in total exports
- Proportion of employment in fast-growing enterprises in innovative sectors

On the contrary, the following are considered to be areas with sufficient room for development:

- Patent applications per billion GDP
- Share of employment in knowledge-intensive business industries
- and the share of knowledge-intensive service exports as a percentage of total service exports.

With regard to the Czech Republic's weaknesses according to the used composite indicators, room for development and progress for the Czech economy in the area of innovation performance can be seen in the number of patents, the export of knowledge-intensive services and employment in knowledge-intensive business industries, venture capital investments and also, for example, the availability of government services over the Internet, expenses for education and JV – strategic partnership deals.

In connection with the statistical survey of innovation activities for 2014–2016, the start of innovation activities can be observed following the economic crisis.

Innovation performance of the Czech economy and its international comparison

Only that, for which the performance can be measured, analysed and evaluated, can be managed (especially effectively). This also applies to innovation performance. For effective interventions in the area of innovation, it is necessary to first analyse and evaluate the current innovation performance. Simple or composite indicators are used for the needs of measuring innovation performance. The advantages of simple indicators, which rely primarily on financial data, include their easy calculation and interpretation or, for example, the possibility of comparing the degree of innovation performance in an international environment. The disadvantages of simple indicators include primarily the limited explanatory power in the area of finding the true causes of the achieved innovation performance. A simple indicator is not independently capable of bringing information on the contribution of individual factors and components to achieving innovation performance. It follows from the above that as part of a comprehensive and objective analysis of innovation performance, simple indicators must be supplemented by composite indicators that make it possible to break innovation performance down into the individual factors and components contributing to the achievement of the degree of performance. Composite indicators can also be comprised of several dozen partial indicators; thus, they are more sophisticated from the perspective of the possibilities of the analysis of the achieved innovation performance into the individual composite parts of the indicator.

This part of the Annex is focused on the innovation performance of the Czech economy and on an international comparison of the innovation performance with selected countries. For comparing the achieved performance of the Czech economy with other economies, both simple and composite indicators were used. In particular, this applied to indicators such as the knowledge intensity, Summary Innovation Index, Global Innovation Index and Innovation Output Indicator. The conclusions of comprehensive indicators of the Summary Innovation Index and Global Innovation Index are crucial for the recommendation and further direction of the Czech Republic's innovation performance (and consequently the National R&D Strategy). The Innovation Output Indicator is only used supplementally. For a detailed comparison of the partial indicators, four EU states were selected: Sweden, Austria, Slovenia and Estonia. In conclusion, the survey of the Czech Statistical Office on innovation activities for 2014–2016 is also presented.

Innovation performance of the Czech Republic based on simple indicators

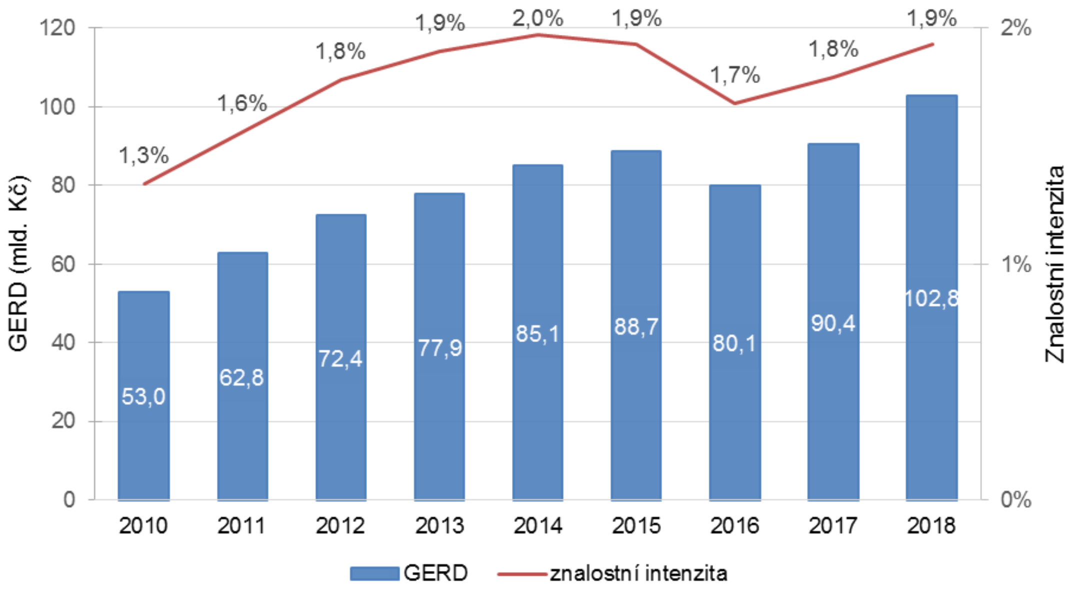
One of the basic and most frequently used simple indicators to determine innovation performance is knowledge intensity. Knowledge intensity is a percentual expression of the ratio of the gross domestic expenditure on research and development (GERD) to gross domestic product (GDP). In some analyses, GERD is also calculated as the amount of expenditure on education. The data required for the calculation of knowledge intensity are reported by most European countries and OECD member states, thus it enables an extensive international comparison.

Figure 3.1 depicts the development of Czech GERD and the knowledge intensity (i.e. GERD in % GDP) in 2010–2018. The knowledge intensity of the Czech economy for 2018 is on the level of 1.9%. In 2010, the knowledge intensity was 1.34%. In the following years, the level of the knowledge intensity rose, culminating in 2014 (i.e. 2.0%). After 2015, the knowledge intensity of the Czech economy decreased, reaching 1.7% in 2016.

For 2010–2018, there was only a decrease in GERD in 2016. While GERD reached CZK 53.0 billion (at current prices) in 2010, during the monitored period GERD hit its maximum in 2018 (CZK 102.8 billion). A year-on-year decrease of CZK 8.6 billion (to the value of CZK 80.1 billion), , i.e. a year-on-year decrease of 9.7%, was noted in 2016. Nevertheless, in 2017 there was once again a year-on-year increase of GERD of CZK 10.3 billion, i.e. a year-on-year increase of 12.9%, and in 2018 GERD increased by CZK 12.4 billion, i.e. a year-on-year increase of 13.7%.

The interim decrease in the course of the monitored period was caused by the transition between two periods of the realisation of EU funds.

Figure 3.1: GERD and the knowledge intensity of the Czech Republic in 2010–2018



Source: ČSÚ, Research and development

GERD (mld. Kč)	GERD (CZK billions)
Znalostní intenzita	Knowledge intensity

Figure 3.2 shows the knowledge intensity of selected countries for 2013 and 2017 (ranked according to 2017). In 2014, the Czech Republic was right behind the EU-28 average. In 2015, the Netherlands got between the EU-28 average and the Czech Republic, and in 2016, the Czech Republic moved even further from the EU-28 average. In 2017, only Slovenia and the Netherlands were between the EU-28 average and the Czech Republic. Great Britain, which was between the Czech Republic and EU28 the previous year, achieved a lower knowledge intensity than the Czech Republic in 2017, while Norway, on the contrary, moved ahead of the EU-28 average.

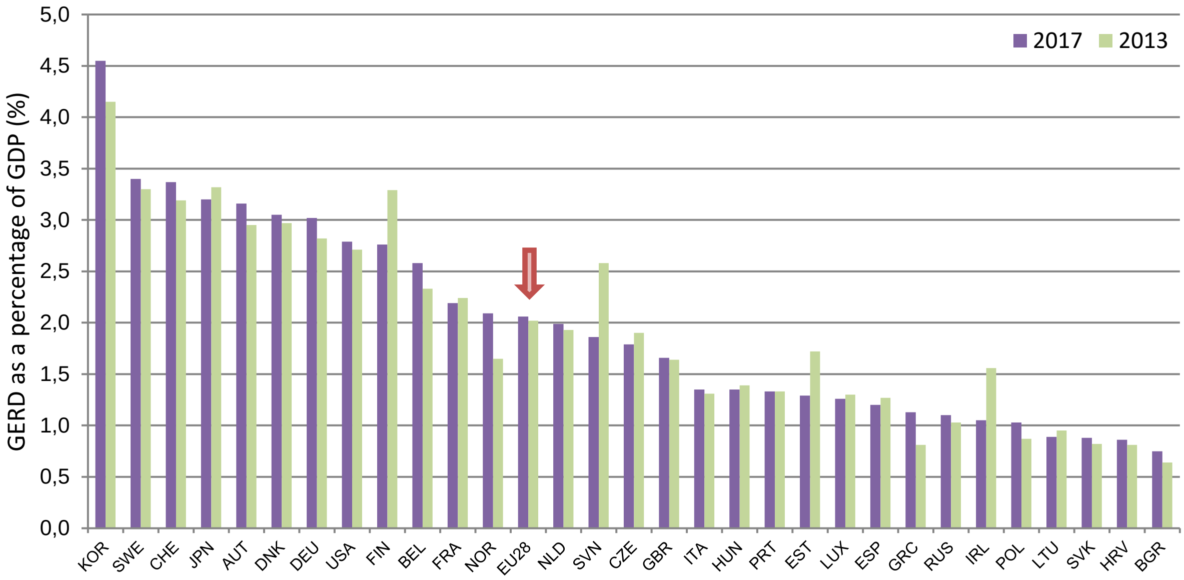
The economies of Italy, Hungary, Russia, Poland and Slovakia, as well as the aforementioned Great Britain, for example, remain behind the Czech Republic. The European countries that achieve the highest knowledge intensity are Sweden, Switzerland, Austria, Denmark and Germany.

When comparing the values from 2013 and 2017, the highest percentual growth was posted by Greece (+40%), Romania (+28%) and Norway (+27%). Conversely, a percentual decrease is evident for Ireland (-33%), Malta (-30%) and Slovenia (-28%).

Thus, it is evident that the knowledge intensity has the greatest percentual growth in countries with a low initial value, and thus an assessment using only an international comparison is not sufficient. As mentioned above, simple indicators do not provide sufficient information about the reasons for year-on-year changes, for example.

In 2017, the total GERD expenditure for the EU-28 was EUR 317.1 billion. The countries that contributed to most to this amount are Germany (EUR 99.1 billion; 31.3%), France (EUR 50.2 billion; 15.8 %) and Great Britain (EUR 38.9 billion; 12.3%). The Czech Republic's share in the EU-28 GERD is EUR 3.4 billion, i.e. 1.1%, Austria EUR 11.7 billion, i.e. 3.7%, Slovenia EUR 0.8 billion, i.e. 0.3%, Sweden EUR 16.1 billion, i.e. 5.1%, and Estonia EUR 0.3 billion, i.e. 0.1%.

Figure 3.2: Knowledge intensity of the Czech economy and its international comparison



Axis y GERD as a percentage of GDP in %; for CHE the data is given for 2012 and 2015 and for RUS for 2015

Source: Eurostat; OECD – MSTI database

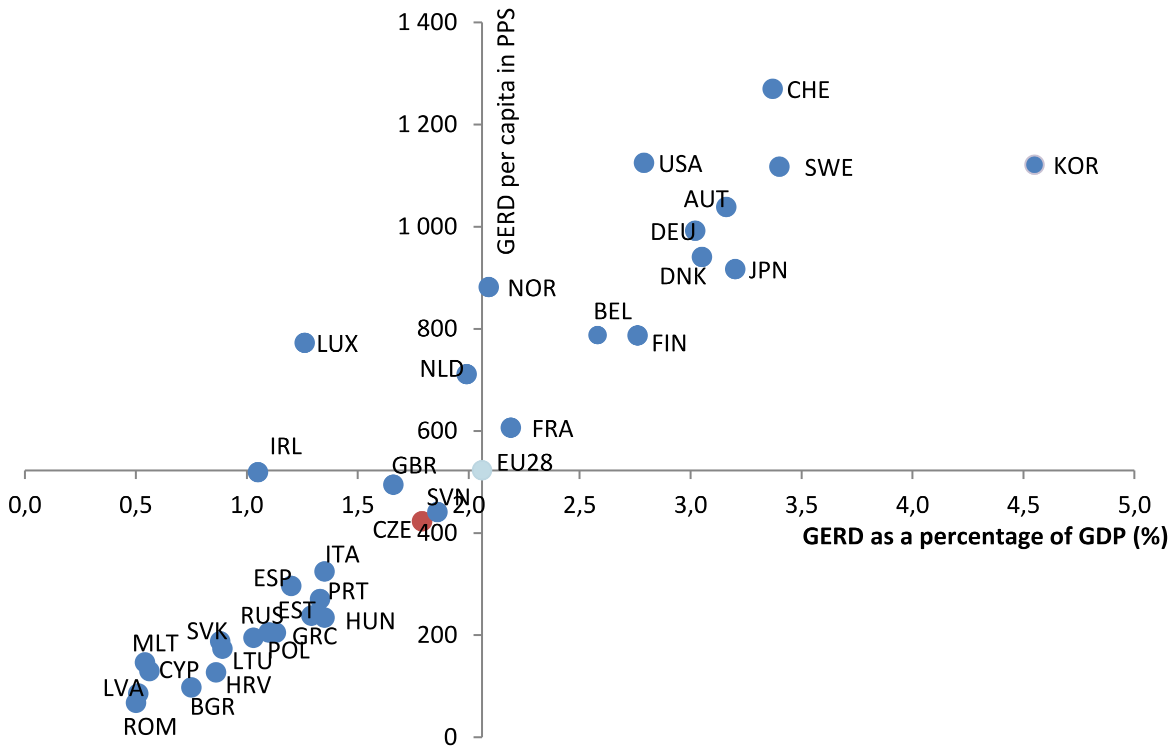
The knowledge intensity does not testify to the differences in the achieved level of production or to the structure of R&D according to the areas of financing. A solution for increasing the explanatory power of the knowledge intensity could be, for example, its comparison with the amount of R&D expenditure per capita in the purchasing power standard (PPS). The comparison of the countries according to GERD as a percentage of GDP and according to R&D expenditure per capita for the 2017 is depicted in figure 3.3. PPS is expressed per capita in 2005 prices.

In absolute terms, in 2015, the Czech Republic achieved 427.7 on the level of expenditure per capita in PPS, in 2016 just 381.1 and in 2017 once again a value of 422.8. Within the EU-28, Sweden achieved the highest values.

The Czech Republic reports roughly the same amount of R&D expenditure per capita in PPS as Slovenia and 1.8 times higher than Estonia. On the other hand, in comparison with Austria and Sweden, the Czech Republic reaches approximately 2.5 times lower R&D expenditure per capita in PPS.

According to figure 3.3, it is evident that from the monitored countries, the highest value of knowledge intensity as well as GERD per capita in PPS is achieved by South Korea, followed by Switzerland and Sweden. The Czech Republic is slightly below the EU-28 average in the degree of knowledge intensity adjusted per capita in PPS. Slovenia and Great Britain have the closest values to the Czech Republic in knowledge intensity and also expenditure per capita in PPS.

Figure 3.3: Comparison of the countries according to GERD as a percentage of GDP and according to expenses for R&D per capita (2017)



Source: own processing according to Eurostat and OECD – MSTI Database

Note: Axis Y – GERD per capita in PPS (RUS data from 2014, CHE data from 2015, USA, JPN and KOR data from 2016); Axis X – GERD as a percentage of HDP (CHE and RUS data from 2015).

Innovation performance based on composite indicators

The following are primarily the most frequently used composite indicators of innovation performance:

- Summary Innovation Index (SII)
- Global Innovation Index (GII)
- Innovation Output Indicator (IOI)

The recommendations and conclusions are formulated on the basis of SII and GII indicators, IOI is solely for completing the overall view of the innovation performance of the Czech Republic and selected countries.

Summary Innovation Index (SII)

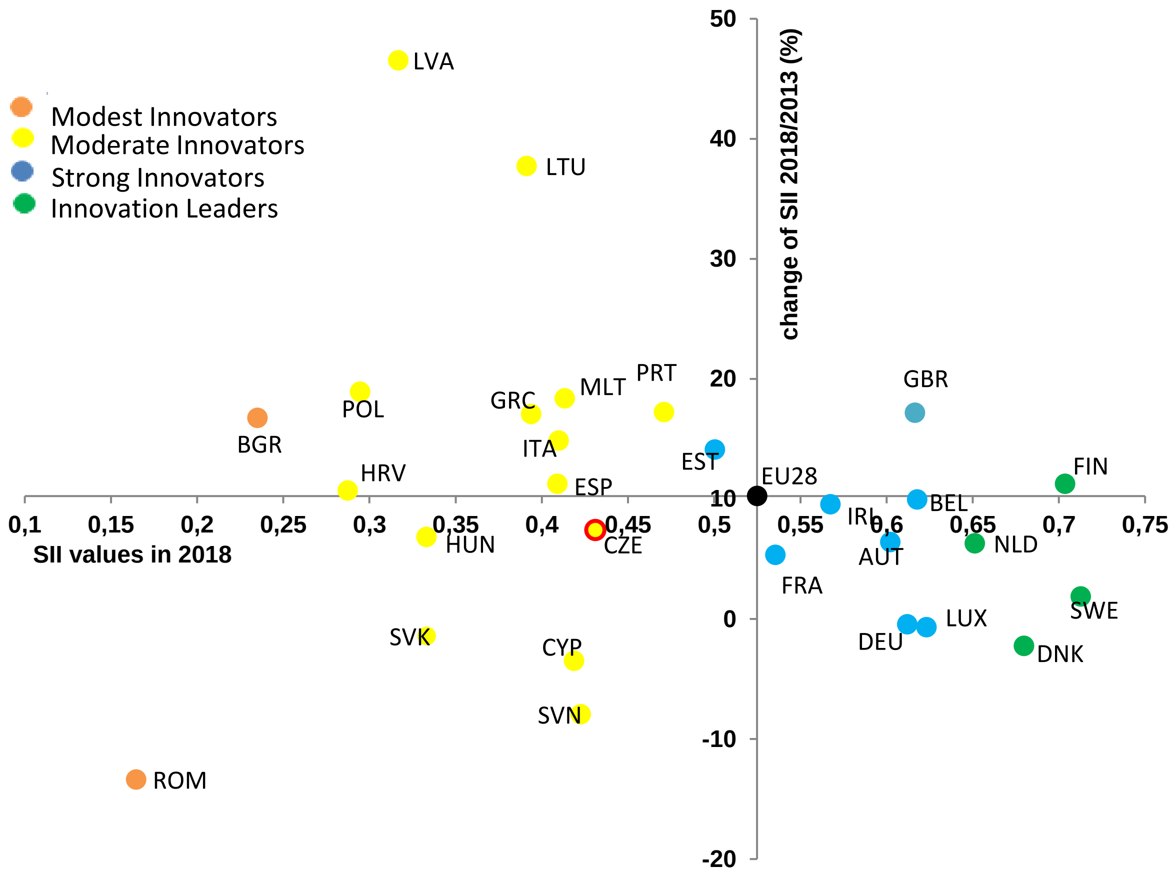
The European Innovation Scoreboard (EIS) enables the comparison of the innovation of EU member states and selected third countries. EIS 2019 is comprised on the basis of data from 2018 and is the seventeenth release of the respected methodology in recent years. In EIS, the innovation performance is measured using the Summary Innovation Index (SII) composite indicator. SII is comprised of four areas of indicators: General Conditions, Innovation Activities, Investment and Impacts. These areas are divided into ten partial innovation groups and are comprised of 27 indicators, which are given various weights. According to the achieved SII values, the evaluated countries are divided into four groups: Innovation Leaders, Strong Innovators, Moderate Innovators, Modest Innovators.

Figure 3.4 depicts the SII value of the EU Member States for 2018 and the relative change between 2013 and 2018. The division of the countries into the four aforementioned groups is also evident from the diagram.

There was movement between the individual groups by some of the states as part of the SII evaluation for 2018. Estonia was a Moderate Innovator in the previous evaluation and is currently in the Strong Innovators category. Luxembourg and Great Britain were formerly Innovation Leaders and in the last evaluation were categorised as Strong Innovators. Slovenia was a Strong Innovator and is momentarily, like the Czech Republic, a Moderate Innovator.

Romania and Bulgaria, which achieved the lowest SII values for 2018, belong in the Moderate Innovators group (Romania also had the lowest relative change between 2013 and 2018). The counties of the Modest Innovators group are far from achieving the average of the EU's innovation performance.

Figure 3.4: SII of EU member states for 2018 and the relative change between 2013 and 2018



Source: own processing according to EIS 2018; colour differentiation of countries corresponds to division according to SII

The Czech Republic ranks in the largest Moderate Innovators group, where it reached the highest SII level in previous years (in the Moderate Innovators category), but in the 2018 evaluation, Portugal had the highest values. The highest relative change between 2013 and 2018 in this group and in SII overall was achieved by Latvia (from a value of 0.2 to 0.3). Slovenia, which ranked among the Strong Innovators last year, dropped into the Moderate Innovators group. The innovation performance of the Moderate Innovators group does not reach the EU average.

Eight of the EU-28 countries (Belgium, Germany, Estonia, Ireland, France, Luxembourg, Austria and Great Britain) are ranked in the Strong Innovators category. Six EU-28 countries were in this category in the SII evaluation for 2017 (Slovenia, France, Austria, Belgium, Ireland and Germany). The innovation performance of the Strong Innovators exceeds or approaches the EU average.

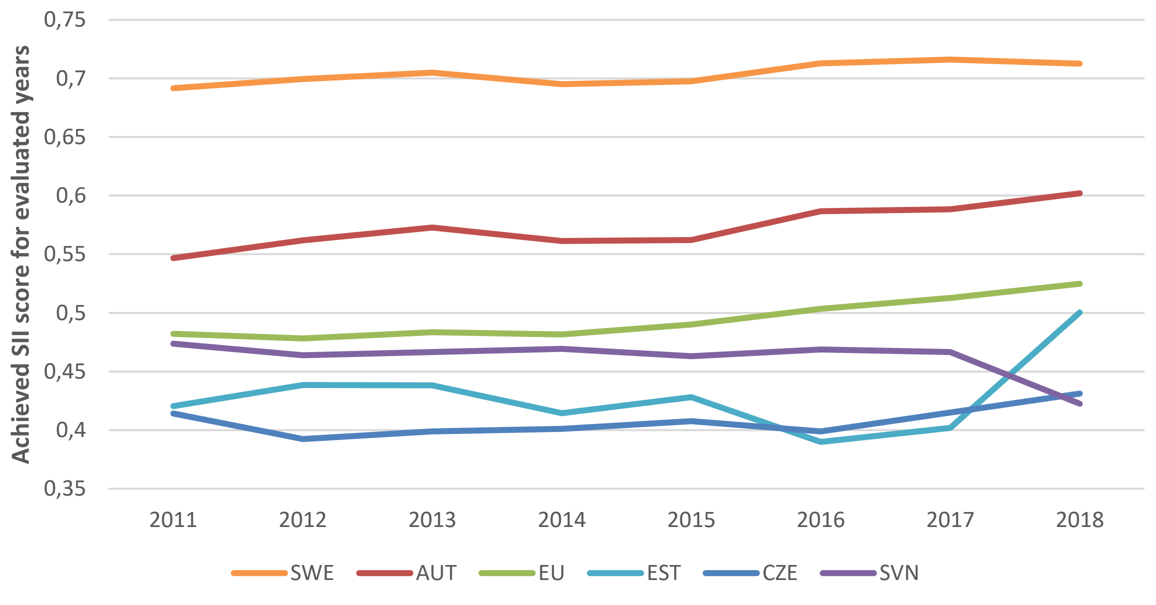
Four of the EU-28 countries rank among the leaders in the area of innovation (the Innovation Leaders): Denmark, the Netherlands, Finland and Sweden. There were six countries in this category the year before (Great Britain, Luxembourg, Finland, the Netherlands, Denmark and Sweden). The Innovation Leaders countries significantly exceed the EU's innovation performance average.

As follows from the conclusions of EIS 2019, the innovation performance of the EU continues to rise at a stable rate and the progress of recent years is and will remain faster. In the EU states, of course, the progress is distributed quite unequally. From a global innovation performance perspective, the EU-28 surpassed the USA but remains behind Japan, Canada, South Korea and Australia. The EU continues to lose ground in comparison to Japan and South Korea and the differences in performance are expected to expand in the coming years. The EU has improved its position in comparison with Australia, Canada and the USA. The innovation performance of China is growing twice faster than the EU and China is gradually catching up to the EU. On the other hand, the EU is gradually widening their lead in front of Brazil, India, Russia and South Africa.

Figure 3.5 shows the development of the value of SII from 2011 to 2018 for the Czech Republic, Austria, Sweden, Slovenia, Estonia and the EU. As was explained above, Sweden stably achieves the highest SII values. The Czech Republic is below the EU average.

In the base year of 2011, the Czech Republic achieved an SII value close to Estonia; in the following year a decrease in the SII can be seen for the Czech Republic and an increase for Estonia. The Czech Republic showed higher SII values than Estonia in 2016 and 2017. In 2018, a considerable increase in the SII value can be seen for Estonia and a significant decrease for Slovenia. Thus, in 2018 the Czech Republic achieved a higher SII value than Slovenia, but a lower value than Estonia. The sub-areas of SII are depicted in the following diagrams.

Figure 3.5: Development of SII between 2011 and 2018 in the Czech Republic and other selected countries



Source: own processing pursuant to EIS 2019

Figure 3.6 shows the value of SII for 2018 and its sub-areas for the Czech Republic, Austria, Slovenia, Sweden, Estonia and the EU. Sweden has achieved considerably higher values than the other selected countries in most of the sub-areas. Sweden only shows lower values in the area of Innovators (Austria has the highest value), Linkages (Austria has the highest value) and Sales impacts (the EU and Czech Republic have the highest values). The greatest difference between Sweden and the other selected countries is in the area of Innovation-friendly environment.

The Czech Republic achieved the lowest value of the monitored countries in the areas of Human resources (the potential of people), Attractive research systems, Innovation-friendly environment, Linkages and Intellectual assets. Estonia shows the lowest values for the areas of Firm investments and Sales impacts, Slovenia in the area of Financing and support and Innovators and Austria achieves the lowest value from the selected countries for Employment impacts.

Figure 3.7 shows the individual SII indicators for 2018 for the Czech Republic, Austria, Slovenia, Sweden and Estonia.

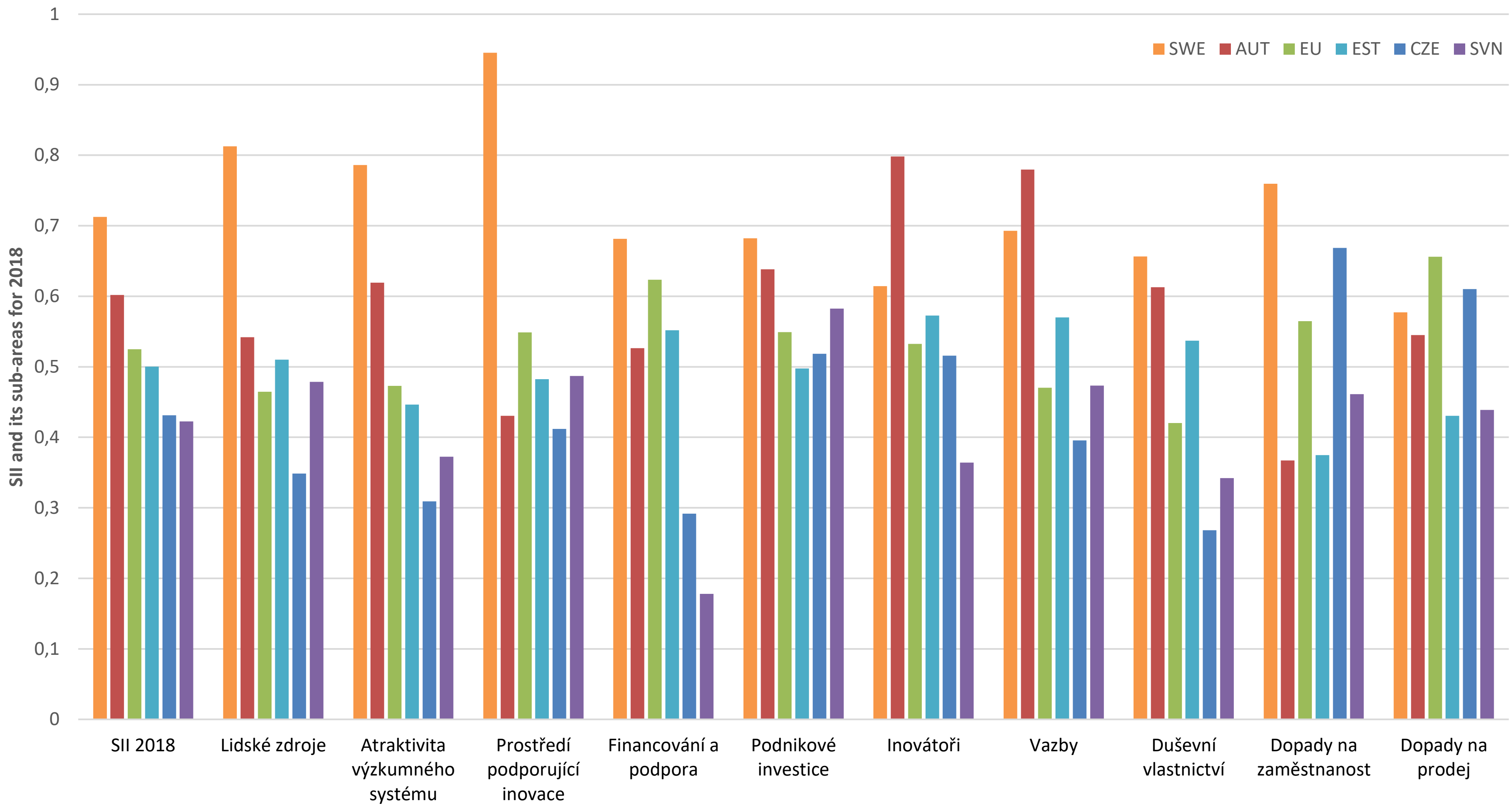
Three areas of indicators (of which there are a total of eight) fall under General conditions. The Czech Republic achieved the lowest values from the monitored countries for 5 of the indicators of General conditions (Population with tertiary education, Lifelong learning, International scientific co-publications, Most cited publications and Broadband penetration). On the other hand, Sweden achieved the highest values in all the indicators of the General conditions.

The second category is Investment, in which there are two areas of indicators, of which there is a total of five. The Czech Republic achieves average values in most of these indicators. Compared to the EU-28, the Czech Republic is only significantly behind in the Venture capital expenditures indicator. Most of the Czech Republic's values are close to Slovenia's values.

The third area is Innovation Activities, which contains 9 indicators divided into 3 groups. In the Intellectual Assets group, the Czech Republic achieves the lowest values from the monitored countries for the PCT patent applications and Trademark applications. Only Slovenia is behind the Czech Republic in the group's last indicator.

The last area is Impacts, which contains 5 indicators divided into 2 groups. The Czech Republic achieved the highest score from the monitored countries on one indicator in both of these groups. In the Employment impacts group, the Czech Republic is the best from the monitored countries in the Employment in fast-growing enterprises of the most innovative sectors indicator (Austria achieved only 30% of the Czech Republic's value). In the other hand, it achieved the worst result in Employment in knowledge-intensive activities. In the Sales impacts group, the Czech Republic reported the highest value from the monitored groups in the Import of medium- and high-tech products indicator (Estonia only achieved 58% of the Czech Republic's value).

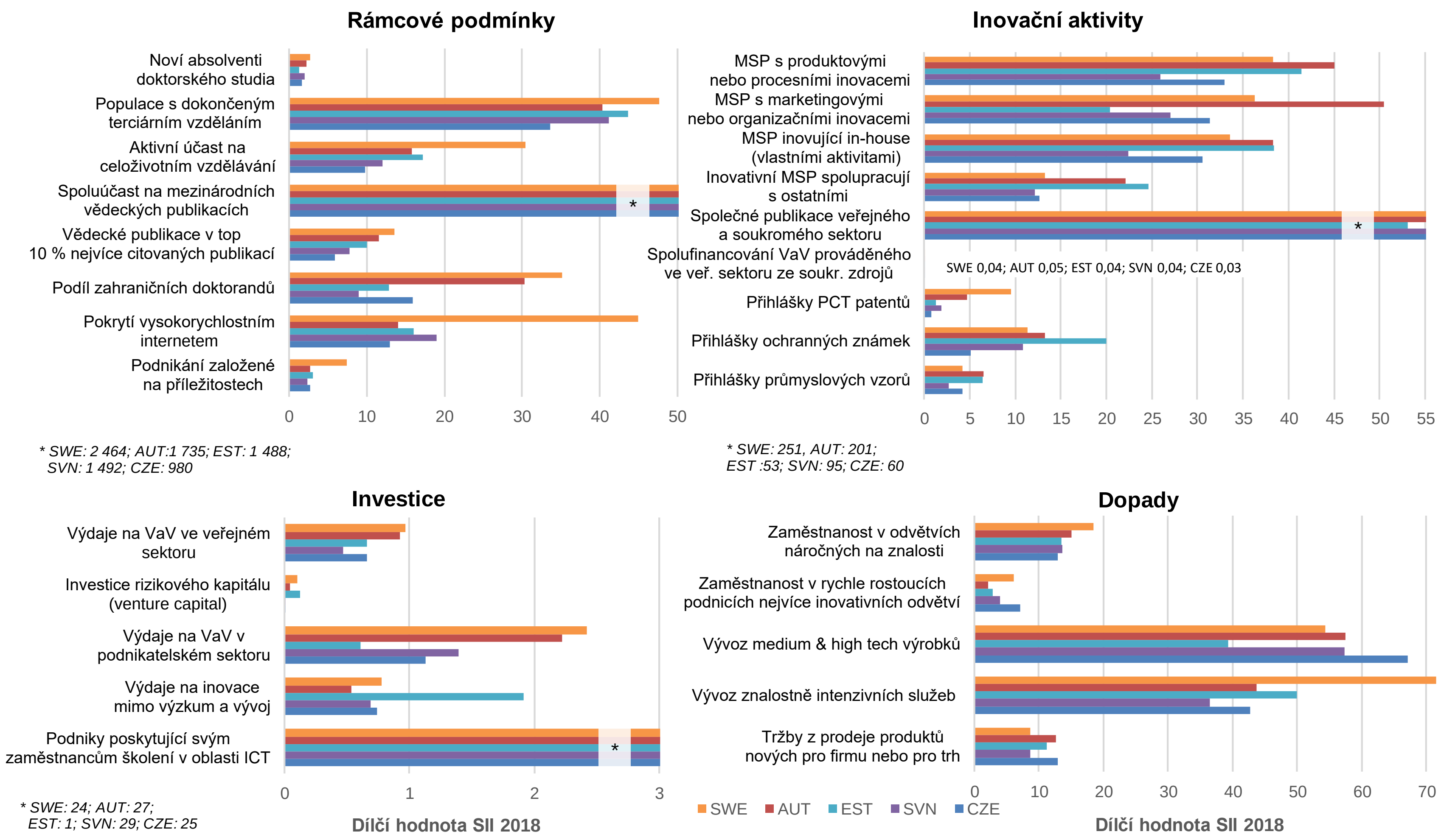
Figure 3.6: SII for 2018 and its sub-areas comparing the Czech Republic and selected countries



Source: own processing pursuant to EIS 2019

Lidské zdroje	Human Resources
Atraktivita výzkumného systému	Attractive research systems
Prostředí podporující inovace	Innovation-friendly environment
Financování a podpora	Finance and support
Podnikové investice	Firm investments
Inovátoři	Innovators
Vazby Duševní vlastnictví	Linkages Intelectual assets
Dopady na zaměstnanost Dopady na prodej	Employment impacts Sales impacts

Figure 3.7: Break-down of SII for 2018 comparing the Czech Republic and selected countries



Source: own processing pursuant to EIS 2019

General conditions	Innovation activities
New doctorate graduates	SMEs product/process innovations
Population with tertiary education	SMEs marketing/organizational innovations
Lifelong learning	SMEs innovating in-house
International scientific co-publications	Innovative SMEs collaborating with others
Most cited publications	Public-private co-publications
Foreign doctorate students	Private co-funding of public R&D exp.
Broadband penetration	PCT patent applications
Opportunity-driven entrepreneurship	Trademark applications
	Design applications

Investment	Innovation activities
R&D expenditure in the public sector	Employment in knowledge-intensive activities
Venture capital expenditures	Employment fast-growing enterprises
R&D expenditure in the business sector	Medium and high-tech product exports
Non-R&D innovation expenditures	Knowledge-intensive services exports
Enterprises providing ICT training	Sales of new-to-market/firm innovations
Partial values of SII 2018	Partial values of SII 2018

Even though the innovation performance of the Czech Republic is increasing, it is evident from table 3.1 that the Czech Republic is not keeping up with the EU's innovation performance. The performance of the Czech Republic in 2018 is only significantly higher than the performance of the EU-28 in the indicators Employment in fast-growing enterprises of the most innovative sectors and Import of medium- and high-tech products. On the contrary, the Czech Republic achieved the worst values in the Venture capital expenditures indicator, where it achieved only 5% of the EU-28's value from 2018. The Intellectual assets group of indicators, on the other hand, can generally be considered to be an unsatisfactory area of performance.

The second part of table 3.1 shows the position of the selected countries according to the SII 2019 evaluation within the EU-28 and the development of the performance between 2013 and 2018. From the red arrows, which depict a negative change of more than 5 percentage points (pp) between 2013 and 2018, it is apparent that the Czech Republic has worsened in the fewest number of indicators from the selected countries. On the contrary, the position of the Czech Republic in the individual indicators puts the Czech Republic into the second half of the EU-28 rankings. The Czech Republic achieved the best ranking (4th place) in the Import of medium- and high-tech products indicator. The Czech Republic achieved its worst ranking (26th place) in the EU-28 for the Venture capital expenditures indicator.

Table 3.1: Relative performance of the Czech Republic and selected countries according to SII

	Relativní výkonnost ČR k EU 2018	Relativní výkonnost ČR k EU 2011		Pořadí v EU 28 dle SII za rok 2018 a změna mezi roky 2013 a 2018									
				ČR		Švédsko		Rakousko		Slovinsko		Estonsko	
	2018	2011	2018	Δ	pozice	Δ	pozice	Δ	pozice	Δ	pozice	Δ	pozice
SOUHRNNÝ INOVAČNÍ INDEX	**82,2**	**85,9**	**89,4**	↑	14	↗	1	↑	9	↓	15	↑	12
Lidské zdroje	**75,0**	**73,4**	**91,7**	↑	19	↗	2	↑	9	↗	13	↑	11
Noví absolventi doktorského studia	77,8	84,6	112,9	↘	15	↓	3	↘	9	↗	12	↑	20
Populace s dokončeným terciárním vzděláním	61,3	45,5	73,1	↑	24	↑	6	↑	17	↑	16	↑	11
Aktivní účast na celoživotním vzdělávání	88,8	92,7	90,6	↘	13	↗	1	↑	8	↓	10	↑	6
Atraktivita výzkumného systému	**65,3**	**48,8**	**73,6**	↑	18	↑	4	↑	8	↑	16	↑	13
Spoluúčast na mezinárodních vědeckých publikacích	91,0	73,8	132,3	↑	16	↑	2	↑	8	↑	11	↑	12
Vědecké publikace v top 10 % nejvíce citovaných publikacích	43,8	37,3	48,0	↑	20	↗	5	↗	11	↑	18	↑	13
Podíl zahraničních doktorandů	78,1	50,2	74,7	↑	12	↑	7	↑	8	↓	21	↑	15
Prostředí podporující inovace	**75,1**	**84,3**	**118,6**	↑	22	↑	3	↓	20	↓	17	↑	18
Pokrytí vysokorychlostním internetem	72,2	88,9	144,4	↑	22	↑	1	↑	20	↑	14	↑	18
Podnikání založené na příležitostech	78,1	81,2	101,1	↑	16	↓	3	↓	15	↓	19	↘	12
Financování a podpora	**46,7**	**84,6**	**51,1**	↓	18	↓	5	↑	12	↓	23	↓	11
Výdaje na VaV ve veřejném sektoru	96,0	70,1	88,8	↓	10	↓	2	↑	5	↓	18	↓	9
Investice rizikového kapitálu (venture capital)	5,0	101,7	6,5	↘	26	↑	11	↗	19	↓	27	↑	8
Podnikové investice	**94,4**	**104,6**	**112,6**	↑	9	↑	3	↑	5	↓	6	↓	11
Výdaje na VaV v podnikatelském sektoru	82,8	64,0	94,9	↑	10	↑	1	↑	2	↓	8	↓	19
Výdaje na inovace mimo výzkum a vývoj	89,3	134,6	104,3	↑	13	↑	10	↑	19	↑	15	↑	1
Podniky poskytující svým zaměstnancům školení v oblasti ICT	110,5	113,3	140,0	↑	13	↑	14	↓	8	↑	5	↑	23
Inovátoři	**96,9**	**105,4**	**88,0**	↘	16	↓	12	↑	3	↓	20	↓	14
MSP s produktovými nebo procesními inovacemi	94,9	99,0	92,1	↑	17	↓	11	↑	5	↓	20	↗	7
MSP s marketingovými nebo organizačními inovacemi	82,9	120,1	70,7	↓	17	↓	14	↑	2	↓	20	↓	23
MSP inovující in-house (vlastními aktivitami)	112,6	97,0	101,4	↑	15	↓	13	↑	7	↓	20	↑	6
Vazby	**84,1**	**71,5**	**87,3**	↑	14	↘	4	↑	1	↓	12	↑	9
Inovativní MSP spolupracují s ostatními	107,1	101,1	114,4	↑	12	↓	10	↑	5	↓	13	↑	1
Společné publikace veřejného a soukromého sektoru	73,0	71,4	85,6	↗	15	↑	2	↑	3	↓	11	↑	16
Spolufinancování VaV prováděného ve veřejném sektoru ze soukromých zdrojů	71,2	49,8	68,3	↑	14	↘	8	↑	5	↓	7	↑	9
Duševní vlastnictví	**63,8**	**50,7**	**62,1**	↗	20	↘	4	↓	7	↓	15	↑	8
Přihlášky PCT patentů	23,2	21,1	21,1	↘	19	↗	1	↓	6	↓	13	↓	17
Přihlášky ochranných známek	69,1	71,4	76,9	↓	22	↑	8	↘	5	↑	9	↑	4
Přihlášky průmyslových vzorů	100,0	64,3	92,2	↑	11	↓	10	↓	4	↓	19	↑	5
Dopady na zaměstnanost	**118,4**	**114,6**	**123,6**	↑	7	↘	4	↓	25	↑	18	↑	24
Zaměstnanost v odvětvích náročných na znalosti	84,7	84,6	92,3	↗	17	↑	4	↑	11	↓	14	↑	16
Zaměstnanost v rychle rostoucích podnicích nejvíce inovativních odvětví	144,6	136,3	146,3	↑	6	↓	9	↓	27	↑	19	↘	23
Dopady na prodej	**93,0**	**105,4**	**95,8**	↘	7	↗	10	↗	13	↘	19	↘	21
Vývoz medium & high tech výrobků	128,2	127,2	138,3	↑	4	↑	12	↗	7	↑	8	↓	23
Vývoz znalostně intenzivních služeb	49,3	41,1	50,9	↗	20	↘	8	↘	19	↗	25	↑	16
Tržby z prodeje produktů nových pro firmu nebo pro trh	100,0	153,4	97,0	↓	9	↗	18	↑	10	↓	19	↓	14

Note: Performance – dark green: standardised performance above 120% of EU value; light green: standardised performance between 90 and 120% of EU value; yellow: standardised performance between 50 and 90% of the EU value; orange: standardised performance under 50% of the EU value. Red values indicate a decrease in performance compared to the 2010 values;

Position – green background colour position 1–14, red background colour position 15–28;

Change – a positive change of more than 5 pp is indicated with a green arrow, a yellow arrow indicates a change smaller than 5 pp, a negative change greater than 5 pp is indicated with a red arrow.

Source: own processing pursuant to EIS 2019

Relative performance of CR to EU 2018	Relative performance of CR to EU 2018	Order in EU-28 according to SII for 2018 and change between 2013 and 2018				
2011	2011 | 2018	CR position	Sweden position	Austria position	Slovenia position	Estonia position

SUMMARY INNOVATION INDEX
Human resources
New doctorate graduates
Population with tertiary education
Lifelong learning
Attractive research systems
International scientific co-publications
Most cited publications
Foreign doctorate students
Innovation-friendly environment
Broadband penetration
Opportunity-driven entrepreneurship
Finance and support
R&D expenditure in the public sector
Venture capital expenditures
Firm investments
R&D expenditure in the business sector
Non-R&D innovation expenditures
Enterprises providing ICT training
Innovators 97.0 90.7 86.7
SMEs product/process innovations
SMEs marketing/organizational innovations
SMEs innovating in-house
Linkages
Innovative SMEs collaborating with others
Public-private co-publications
Private co-funding of public R&D exp.
Intellectual assets
PCT patent applications
Trademark applications
Design applications
Employment impacts
Employment in knowledge-intensive activities
Employment fast-growing enterprises
Sales impacts
Medium and high-tech product exports
Knowledge-intensive services exports
Sales of new-to-market/firm innovations

Global Innovation Index (GII)

The Global Innovation Index (GII) is another of the most widely-used composite indicators of innovation performance. This indicator is focused on the influence of innovation-oriented policies on economic growth and development. GII is comprised of innovation inputs and innovation outputs. The areas of Institutions, Human capital & research, Infrastructure, Market Sophistication and Business sophistication are evaluated for innovation inputs. The area of innovation outputs is comprised of Knowledge & technology outputs and Creative outputs. The GII value is given by the average of innovation inputs and innovation outputs. In the case of the ratio between innovation inputs and innovation outputs, an Innovation efficiency indicator can be determined, which indicates how much innovation output produces one unit of innovation input.

According to GII 2019, which was calculated on the basis of 2018 data, 129 countries were evaluated. Just as in the previous year, the highest GII values were achieved by Switzerland, followed by Sweden, the USA, the Netherlands, Great Britain, Finland, Denmark, Singapore, Germany and Israel. In the GII evaluation, the Czech Republic is in 26th place (in GII 2018 the Czech Republic was in 27th place and according to GII 2017 in 24th place). The absolute value of the Czech Republic’s score in the previous evaluation of GII 2018 was 48.8 and according to the GII 2019 evaluation the Czech Republic’s score is 49.4 (Switzerland is first with 67.2, Yemen the last with 14.5). The other selected countries reached the following positions: 2nd Sweden (a score of 63.7), 21st Austria (a score of 50.9), 24th Estonia (a score of 50.0) and 31st Slovenia (a score of 45.3).

With regards to the Innovation Input Sub-index, Singapore placed first followed by Switzerland, the USA and Sweden. The Czech Republic took 29th place (Sweden 4th, Austria 19th, Estonia 27th, Slovenia 33rd). In the Innovation Output Sub-index indicator, Switzerland is once again in first place, followed by the Netherlands, Sweden and Great Britain. The Czech Republic is in 21st place (Sweden 3rd, Estonia 19th, Austria 25th, Slovenia 30th).

Table 4.2 shows the rankings of the selected countries within EU28 according to GII 2019 in the individual pillars and sub-pillars and the change between GII 2019 and 2013. The green arrow depicts a positive change greater than 10% and a red arrow, on the contrary, a negative change greater than 10%. For some indicators, it was not possible to calculate the changes between the years, because the composition of GII 2013 and GII 2019 changed slightly.

For the Czech Republic, 13 of the monitored indicators were evaluated as strengths and 11 as weaknesses. The Czech Republic achieved first place within the EU-28 in several areas: High-tech imports; Utility model applications by origin; High-tech exports; Creative goods exports. In fact, in two indicators (High-tech exports, Creative goods exports), the Czech Republic is evaluated as the best of all 129 evaluated countries.[5] On the contrary, the Czech Republic achieved unsatisfactory rankings in these areas: Females employed with advanced degrees; Information and communication technologies (ICTs); Government´s online service; Online e-participation; Cost of redundancy dismissal; ICT access; GDP per unit of energy use; Venture capital deals; GERD financed by business enterprise. The Czech Republic is in last place

[5] For the Applied tariff rate indicator, all the EU states (except for Croatia) achieved the same values, i.e. and also the same order. Thus, the order for this indicator is not indicative.

among the EU-28 for three of these areas (Information and communication technologies, Government´s online service, Online e-participation).

Table 3.2: Position of the Czech Republic and selected countries according to GII 2019 in EU-28

		Pořadí v EU28 dle GII 2019 a změna GII 2013 a 2019									
		ČR		Švédsko		Rakousko		Slovinsko		Estonsko	
	Indicator	Δ	pozice	Δ	pozice	Δ	pozice	Δ	pozice	Δ	pozice
	Global Innovation Index	↗	13	↗	1	↘	10	↘	18	↘	12
	Innovation Efficiency Ratio	↘	22	↘	26	↓	5	↓	10	↘	20
	Innovation Input Sub-index	↗	15	↗	1	↗	8	↗	19	↗	13
	Innovation Output Sub-index	↗	12	↗	2	↘	15	↓	19	↘	10
	Index										
1.	Institutions	↗	16	↗	4	↘	7	↗	10	↗	13
1.1.	Political environment	↘	16	↘	3	↘	7	↗	13	↘	12
1.1.1.	Political stability and absence of violence/terrorism	↘	13	↘	3	↘	7	↘	13	↗	7
1.1.2.	Government effectiveness	↗	16	↘	3	↘	7	↑	13	↗	14
1.2.	Regulatory environment	↗	20	↘	5	↘	3	↘	16	↗	8
1.2.1.	Regulatory quality	↘	13	↘	3	↘	10	↓	25	↗	7
1.2.2.	Rule of law	↗	15	↘	2	↘	5	↘	16	↗	12
1.2.3.	Cost of redundancy dismissal	↗	26	↗	17	↗	1	↗	10	↗	11
1.3.	Business environment	↑	15	↗	8	↗	16	↑	5	↑	18
1.3.1.	Ease of starting a business	↗	24	↗	3	↗	25	↘	10	↗	2
1.3.2.	Ease of resolving insolvency	↑	8	↗	10	↓	13	↑	6	↑	19
2.	Human capital and research	↘	16	↘	4	↗	5	↘	14	↓	17
2.1.	Education	↗	11	↘	4	↘	7	↓	10	↓	19
2.1.1.	Expenditure on education	↑	6	↑	2	↘	9	↘	14	↗	13
2.1.2.	Government funding per secondary student	-	11	-	12	-	5	-	10	-	24
2.1.3.	School life expectancy	↘	12	↗	5	↓	16	↓	10	↓	19
2.1.4.	Assessment in reading, mathematics, and science	↗	16	↗	12	↑	14	↑	3	↑	1
2.1.5.	Pupil-teacher ratio, secondary	↘	18	↓	23	↗	10	↘	12	↗	6
2.2.	Tertiary education	↘	10	↓	11	↑	1	↘	16	↑	6
2.2.1.	Tertiary enrolment	↓	18	↓	19	↗	5	↓	8	↘	11
2.2.2.	Graduates in science and engineering	↘	16	↗	8	↑	2	↑	13	↑	7
2.2.3.	Tertiary level inbound mobility	↓	6	↓	17	↓	4	↓	26	↘	16
2.3.	Research and development (R&D)	↓	19	↑	1	↗	9	↑	13	↓	20
2.3.1.	Researchers	↑	14	↑	2	↑	4	↑	9	↗	15
2.3.2.	Gross expenditure on R&D (GERD)	↘	10	↘	1	↗	2	↓	9	↓	15
2.3.3.	Global R&D companies, average expenditure top 3	-	20	-	5	-	13	-	15	-	20
2.3.4.	QS university ranking average score top 3 universities	↓	14	↓	5	↘	12	↑	22	↑	17
3.	Infrastructure	↑	17	↗	1	↑	11	↑	21	↑	10
3.1.	Information and communication technologies (ICTs)	↑	28	↑	6	↑	15	↑	20	↑	10
3.1.1.	ICT access	↑	26	↘	8	↗	6	↑	13	↑	10
3.1.2.	ICT use	↑	17	↑	2	↑	16	↑	23	↑	7
3.1.3.	Government's online service	↑	28	↑	6	↑	14	↑	18	↗	13
3.1.4.	Online e-participation	↑	28	↑	8	↑	18	↑	20	↑	12
3.2.	General infrastructure	↑	5	↑	1	↑	3	↗	17	↑	8
3.2.1.	Electricity output	↓	5	↓	1	↓	8	↓	7	↓	3
3.2.2.	Logistics performance	↑	12	↑	2	↑	4	↗	18	↑	19
3.2.3.	Gross capital formation	↑	2	↑	4	↑	5	↑	20	↑	3
3.3.	Ecological sustainability	↓	12	↘	8	↑	19	↘	25	↘	14
3.3.1.	GDP per unit of energy use	↓	25	↘	19	↓	12	↓	23	↘	27
3.3.2.	Environmental performance	↗	21	↑	4	↑	7	↗	22	↑	27
3.3.3.	ISO 14001 environmental certificates	↓	3	↓	6	↘	22	↓	13	↗	1
4.	Market sophistication	↗	15	↓	4	↓	13	↓	27	↗	14
4.1.	Credit	↘	17	↓	4	↓	16	↓	26	↓	9
4.1.1.	Ease of getting credit	↗	6	↓	18	↓	18	↘	23	↘	6
4.1.2.	Domestic credit to private sector	↘	22	↘	4	↓	12	↓	24	↓	16
4.1.3.	Microfinance institutions' gross loan portfolio	-	-	-	-	-	-	-	-	-	-
4.2.	Investment	↑	17	↓	4	↑	18	↑	21	↑	8
4.2.1.	Ease of protecting minority investors	-	20	-	5	-	5	-	3	-	25
4.2.2.	Market capitalization	-	-	-	-	↑	12	↓	18	-	-
4.2.3.	Venture capital deals	↓	26	↓	10	↓	17	↓	20	-	9
4.3.	Trade, competition, & market scale	-	11	-	10	-	9	-	22	-	25
4.3.1.	Applied tariff rate, weighted mean	↘	1	↘	1	↘	1	↘	1	↘	1
4.3.2.	Intensity of local competition	↘	8	↘	12	↘	6	↗	16	↗	5
4.3.3.	Domestic market scale	-	12	-	9	-	11	-	23	-	26

		Pořadí v EU28 dle GII 2019 a změna GII 2013 a 2019									
		ČR		Švédsko		Rakousko		Slovinsko		Estonsko	
	Indicator	Δ	pozice	Δ	pozice	Δ	pozice	Δ	pozice	Δ	pozice
5.	Business sophistication	↘	14	↑	1	↑	11	↗	15	↘	16
5.1.	Knowledge workers	↓	15	↑	1	↗	9	↑	11	↓	13
5.1.1.	Employment in knowledge-intensive services	↑	18	↑	2	↑	16	↑	11	↑	8
5.1.2.	Firms offering formal training	↓	2	-	1	-	-	↘	7	↓	9
5.1.3.	GERD performed by business enterprise	↘	11	↘	1	↗	2	↓	8	↓	19
5.1.4.	GERD financed by business enterprise	↘	25	↗	5	↑	10	↑	1	↘	17
5.1.5.	Females employed with advanced degrees	-	27	-	6	-	19	-	12	-	3
5.2.	Innovation linkages	↗	16	↑	1	↑	8	↓	21	↘	18
5.2.1.	University/industry research collaboration	↓	14	↘	5	↗	9	↘	17	↓	18
5.2.2.	State of cluster development	↘	16	↗	5	↗	7	↗	17	↘	24
5.2.3.	GERD financed by abroad	↑	3	↓	25	↑	9	↑	18	↑	13
5.2.4.	Joint venture/strategic alliance deals	↑	22	↑	2	↑	13	↓	25	↘	10
5.2.5.	Patent families filed in at least two offices	↓	17	↑	1	↓	8	↓	15	↓	16
5.3.	Knowledge absorption	↗	11	↑	4	↑	13	↗	16	↗	19
5.3.1.	Intellectual property payments	-	19	-	6	-	20	-	23	-	26
5.3.2.	High-tech imports	↗	1	↓	15	↓	13	↘	26	↓	9
5.3.3.	ICT services imports	-	20	-	3	-	8	-	17	-	11
5.3.4.	Foreign direct investment, net inflows	↑	11	↑	14	↑	28	↑	13	↑	20
5.3.5.	Research talent in business enterprise	-	13	-	1	-	3	-	4	-	21
6.	Knowledge and technology outputs	↑	9	↑	1	↘	16	↓	22	↗	17
6.1.	Knowledge creation	↗	12	↗	1	↗	10	↑	14	↓	16
6.1.1.	Patent applications by origin	-	15	-	5	-	8	-	6	-	19
6.1.2.	PCT international applications by origin	-	21	-	1	-	7	-	13	-	16
6.1.3.	Utility model applications by origin	-	1	-	-	-	8	-	15	-	7
6.1.4.	Scientific and technical publications	↑	9	↗	4	↑	12	↑	2	↗	6
6.1.5.	Citable documents H index	↘	16	↓	6	↓	10	↘	18	↗	21
6.2.	Knowledge impact	↑	6	↘	14	↗	19	↓	25	↗	7
6.2.1.	Growth rate of GDP per person engaged	↑	8	↑	21	↑	14	↑	9	↑	6
6.2.2.	New business density	↓	16	↓	8	↓	28	↓	22	↑	1
6.2.3.	Total computer software spending	↑	16	↑	8	↘	12	-	26	-	24
6.2.4.	ISO 9001 quality certificates	↓	3	↓	24	↓	23	↘	8	↘	7
6.2.5.	High-tech and medium high-tech output	↑	3	↘	7	↘	8	↓	19	↓	22
6.3.	Knowledge diffusion	↑	11	↑	3	↓	21	↓	25	↑	17
6.3.1.	Intellectual property receipts	-	16	-	1	-	14	-	18	-	25
6.3.2.	High-tech exports	↑	1	↗	13	↑	11	↑	18	↑	9
6.3.3.	ICT services exports	↓	17	↑	4	↑	12	↓	25	↑	7
6.3.4.	Foreign direct investment, net outflows	↓	14	↘	7	↓	27	↓	20	-	23
7.	Creative outputs	↓	12	↘	5	↓	15	↘	14	↘	6
7.1.	Intangible assets	↑	17	↑	10	↑	16	↑	12	↗	6
7.1.1.	Trademark application class count by origin	-	11	-	14	-	17	-	2	-	8
7.1.2.	Industrial designs by origin	-	10	-	16	-	7	-	12	-	11
7.1.3.	ICTs and business model creation	↑	21	↗	3	↗	15	↑	17	↘	11
7.1.4.	ICTs and organizational model creation	↑	13	↑	1	↑	15	↑	20	↑	4
7.2.	Creative goods and services	↓	3	↓	9	↓	16	↓	14	↓	7
7.2.1.	Cultural and creative services exports	-	24	-	14	-	12	-	17	-	6
7.2.2.	National feature films produced	↓	15	↓	10	↓	14	↓	5	↗	2
7.2.3.	Entertainment and media market	-	14	-	2	-	3	-	-	-	-
7.2.4.	Printing, publications & other media output	↓	23	↗	14	↘	11	↗	7	↗	5
7.2.5.	Creative goods exports	↗	1	↓	11	↓	20	↓	19	↓	16
7.3.	Online creativity	↓	16	↓	3	↓	12	↓	15	↓	8
7.3.1.	Generic top-level domains (gTLDs)	↑	19	↓	9	↓	11	↓	17	↓	24
7.3.2.	Country-code top-level domains (ccTLDs)	↓	9	↘	5	↓	7	↓	18	↓	11
7.3.3.	Wikipedia yearly edits	-	11	-	2	-	13	-	7	-	1
7.3.4.	Mobile app creation	-	12	-	5	-	15	-	10	-	4

Note: Position – green background colour position 1–14, red background colour position 15-28; Change – positive change of more than 10% indicated by a green arrow, a yellow arrow indicates a change less than 10%, a negative change greater than 10% is indicated by a red arrow.

Source: own processing pursuant to GII report 2019

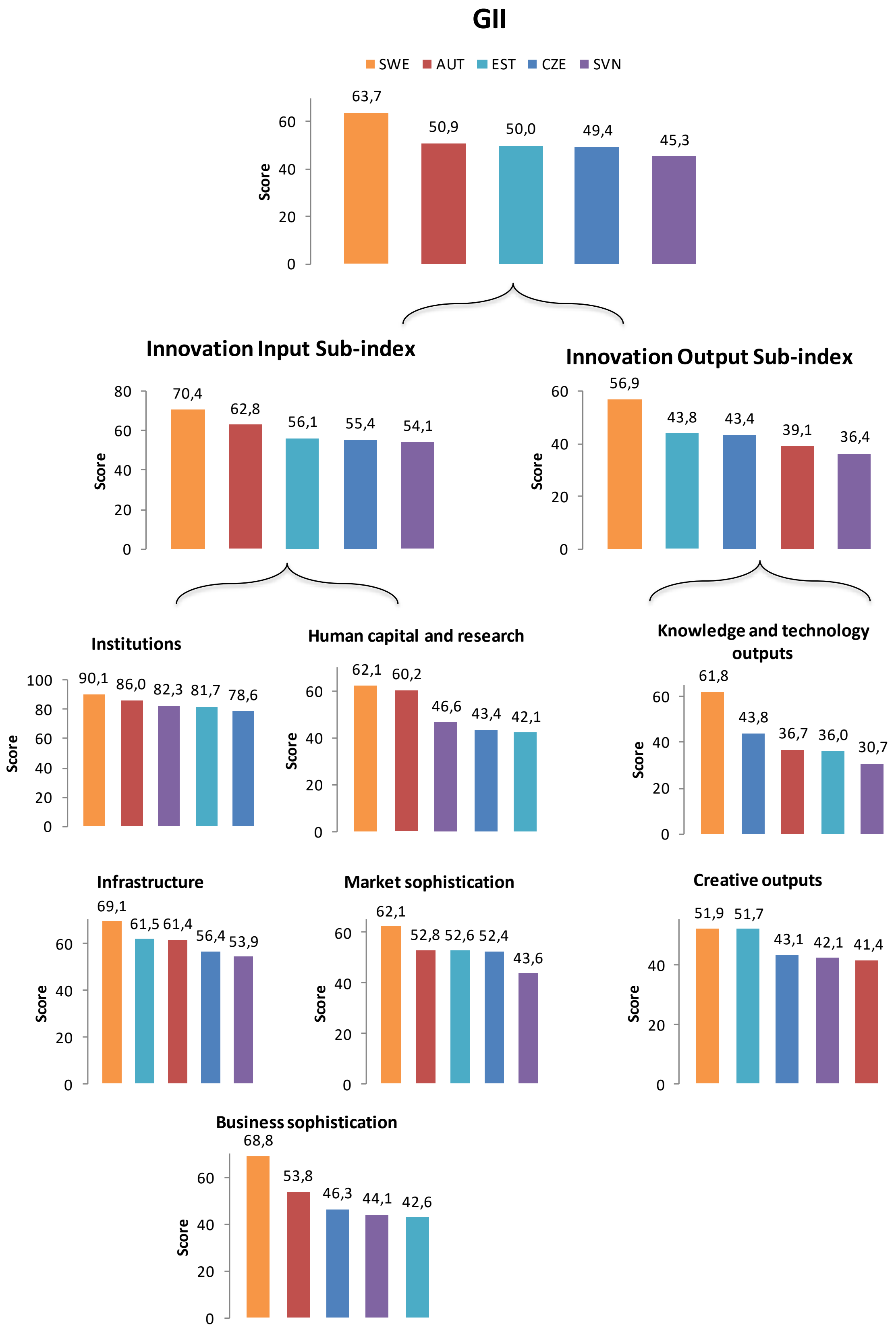
Order in EU-28 according to GII and change between GII 2013 and 2019				
CR position	Sweden position	Austria position	Slovenia position	Estonia position

Figure 3.8 shows GII 2019 broken down into the individual pillars and the values of the Czech Republic and other selected countries are recorded here. In the GII indicators, the Czech Republic achieved a value of 49.4 (26th out of 129 evaluated countries). Sweden placed 2nd, Austria 21st, Estonia 24th and Slovenia 31st.

For the Innovation Input Sub-index, the Czech Republic obtained a score of 55.4 (i.e. 29th position), the other selected countries, except for Slovenia, placed before the Czech Republic. In the Innovation Output Sub-index, the Czech Republic achieved a score of 43.4 (i.e. 21st position). From the selected countries, Sweden and Estonia placed higher, Austria and Slovenia received a lower score.

It is clear from the diagram that the Czech Republic achieved the best ranking from the selected countries in the area of Knowledge and technology outputs (only Sweden placed higher). The Czech Republic placed last from the selected countries, on the contrary, in the pillar of Institutions.

Figure 3.8: Break-down of GII 2019 for Czech Republic and selected countries



Source: own processing pursuant to GII report 2018

Supplementary composite indicator: Innovation Output Indicator (IOI)

The Innovation Output Indicator (IOI) attests to the degree of the ability of ideas from innovation sectors to achieve utilisation on the market, thereby contributing to the more qualified jobs and increasing the competitiveness of the analysed economy. The European Commission introduced IOI in 2013. It is a composite indicator that is comprised of four basic components. The first component of IOI (PCT) is the degree of technical innovation that is measured with the use of patents. The second component (KIABI) is comprised of employment in knowledge intensive business industries (the percentage of overall employment). The third component of IOI (COMP) is the competitiveness of goods (GOOD) and services (SERV), which demands a high degree of knowledge and the last component (DYN) is the level of employment in fast-growing enterprises in innovative sectors.

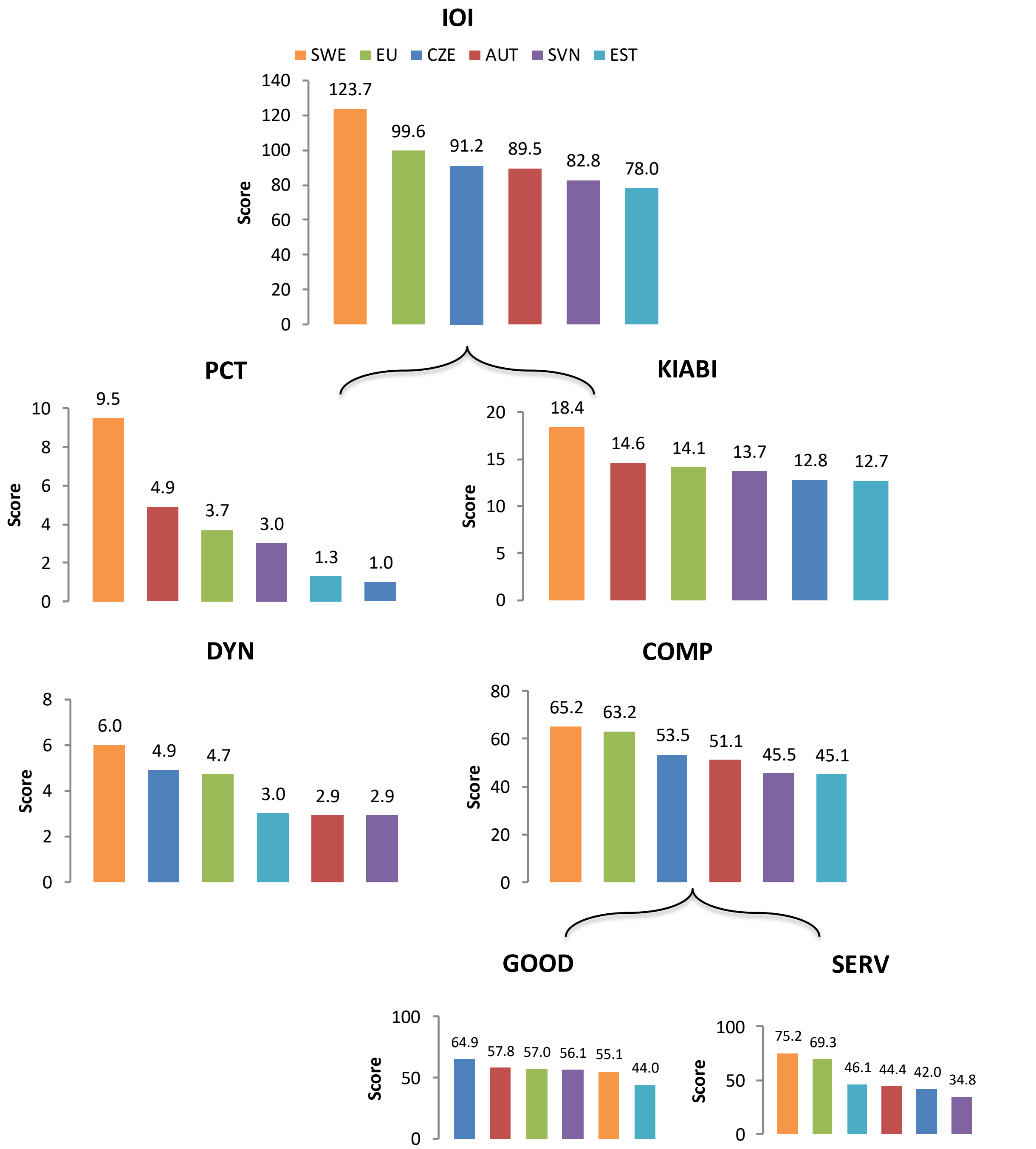
Figure 3.9 depicts the comparison of the results of the IOI 2017 indicators (the data are predominantly from 2016, in some cases 2015 and 2014) for the Czech Republic, Austria, Slovenia, Estonia and the EU-28. Sweden achieved the best result from the selected indicators, while Estonia posted the lowest values. The Czech Republic was far behind in the number of patents per billion GDP in PPS. While the Czech Republic achieved only one patent per billion GDP in PPS, in Sweden this value was 9.5, in Austria 4.9 and in the EU-28 it is 3.7.

For the second component of IOI (the share of employment in knowledge-intensive business industries), only Estonia showed a lower value than the Czech Republic from the selected economies.

The Czech Republic achieved a better evaluation in the share of employment in fast-growing enterprises in innovative sectors. Here the Czech Republic achieved the second-best result of the monitored economies (highest score – Sweden).

In the share of medium- and high-tech products in total exports, the Czech Republic posted the highest value. The opposite is the case for the share of knowledge-intensive service exports as a percentage of total service exports (Sweden reached the highest evaluation, only Slovenia was behind the Czech Republic). In the overall evaluation of the share of technically-advanced products and services, the Czech Republic had a better result than Austria, Slovenia and Estonia, though the Czech Republic remained behind Sweden and the EU-28 average, of course.

Figure 3.9: IOI 2017, Czech Republic, selected countries and EU



Source: own processing according to The Innovation Output Indicator 2017, Dániel Vértesy, JRC Technical Reports (http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108942/jrc108942_ioi_2017_report_final.pdf)

PCT = Number of patents per billion GDP (PPS); data for 2014; KIABI = Share of employment in knowledge intensive business industries; data for 2016; DYN = Employment share in fast-growing enterprises in innovative sectors; data for 2014; COMP = Component; GOOD = Share of medium- and high-tech products in total exports; data for 2016; SERV = Knowledge intensive service exports as share of total service exports; data for 2015.

Innovation in the Czech Republic

Since 2002, the Czech Statistical Office (CzSO) has been performing surveys of the innovation activities of enterprises in regular two-year intervals. The last valid survey is TI 2016, which is oriented on the innovation activities for 2014–2016. For the unification of the methodology for the measuring of Innovation, the CzSO uses the classification of innovation pursuant to Eurostat. Enterprises with innovation activities are thus classified as enterprises with technical or non-technical innovations. Enterprises with technical innovations can be product, procedural or continuing or suspended innovation activities. Enterprises with non-technical innovations post activities in the area of marketing or organisational innovations. The basic population in the TI 2016 statistical survey amounts to 25 103 enterprises, of which 6 638 were sent the survey (i.e. the coverage of the basic population is 26.4%) and the net return reached 84.7% (the highest of all the surveys performed to date).

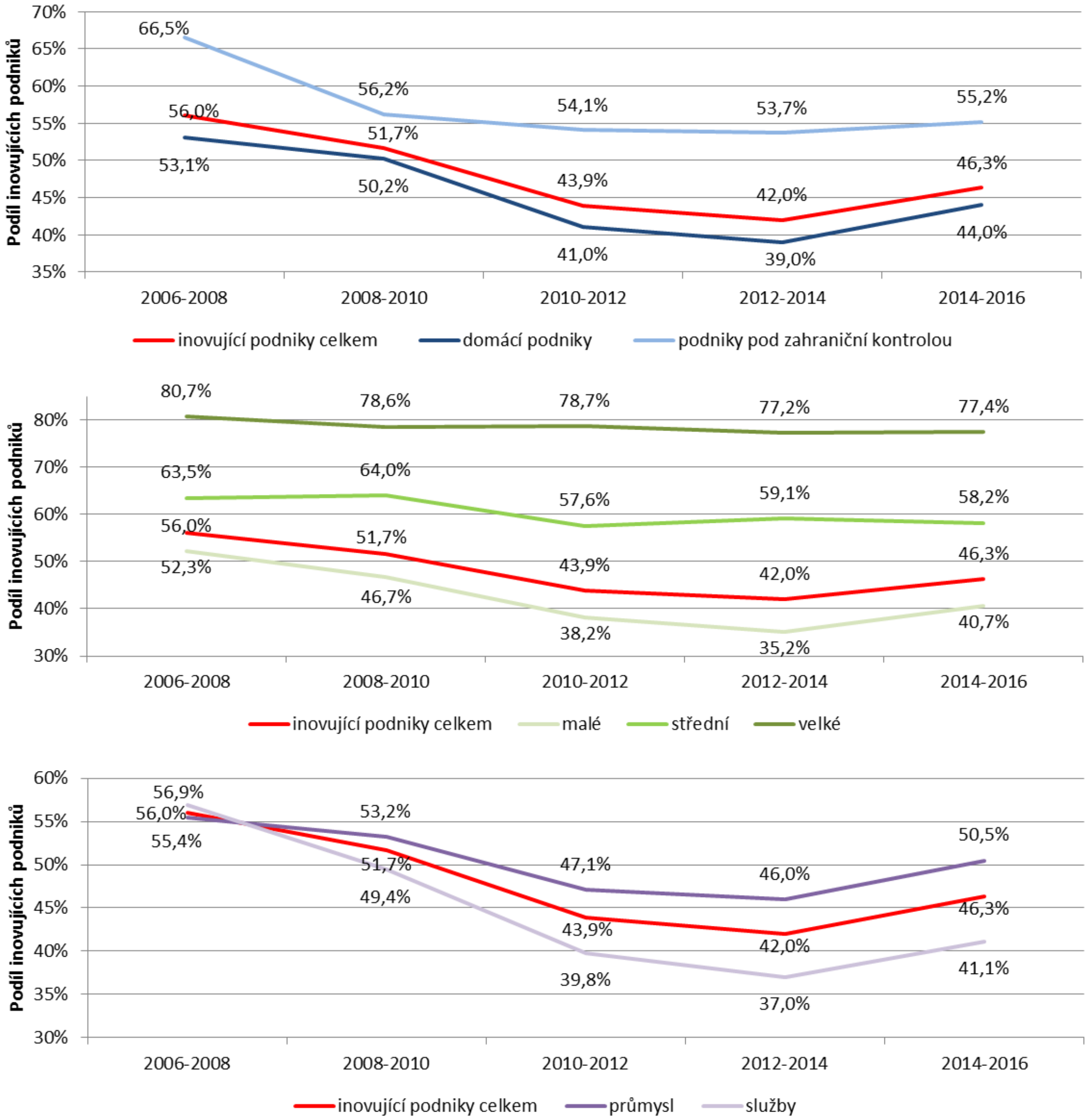
The aforementioned survey points to a reversal in the decreasing trend in the framework of innovation activities and can be seen as the start-up of innovation activities in the period following the economic crisis.

The basic information from the performed survey is given in figure 3.10. As is evident from the upper part of the diagram, the share of innovating enterprises dropped from the period of 2006–2008 to the last monitored period (2014–2016), in which an increase of 4 percentage points compared to the previous period was noted. The share of innovating enterprises was 46.3% in the period of 2014–2016. The trend of the overall share of innovating enterprises copies the domestic enterprises (innovating domestic enterprises 44.0%). Enterprises under foreign control show the same trend with a slightly different size of the changes (innovating enterprises under foreign control: 55.2%).

The next part of the diagram depicts the shares of innovating enterprises in relation to the size of the enterprise. The smallest share of innovating enterprises is traditionally in the category of smaller enterprises (40.7%). This group copies the trend of total innovating enterprises. The trend of the development of innovating enterprises differs for medium-sized enterprises (58.2%). In the category of large enterprises, the share of innovating enterprises changed just marginally. While in the period of 2006–2008 this share was 80.7%, in the following two periods it was 78.6% and 78.7%, and in the next two periods 77.2% and 77.4%.

The last part of the diagram depicts the share of innovating enterprises according to the area of their activity divided into two groups: industry and services. Both groups show a similar trend in the share of innovating enterprises. In the first monitored period (2006–2008), the group of enterprises in the areas of industry and services posted similar values, but since then the values of the share of innovating enterprises have continued to widen. While the share of innovating enterprises in the area of industry is 50.5%, in the area of services this value is 41.1%.

Figure 3.10: Basic information on innovations in the Czech Republic according to categories of enterprises



Source: own processing according to CzSO Innovation Activities of Enterprises in 2014–2016

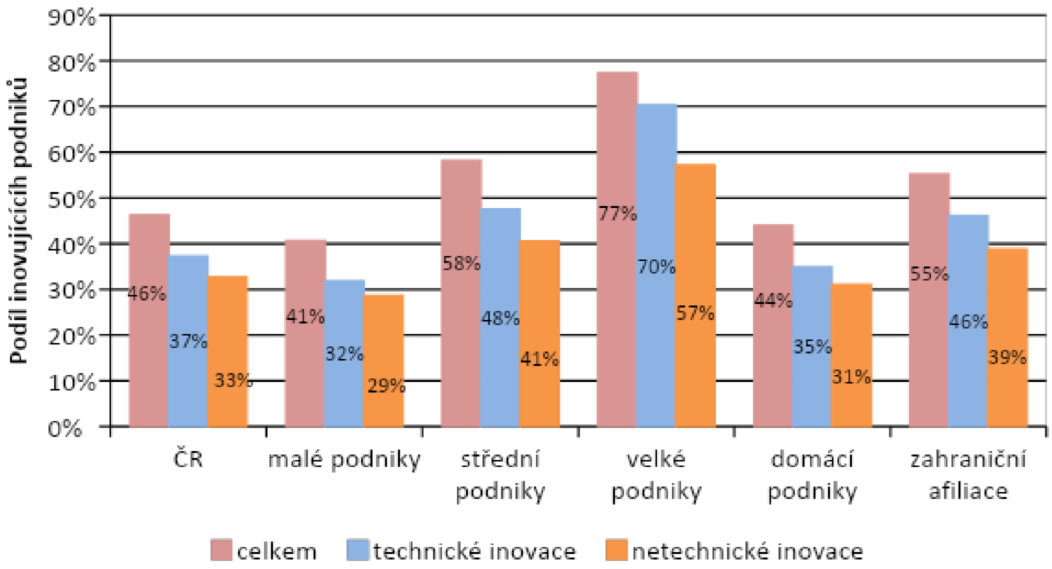
Proportion of innovating enterprises Total innovating enterprises	Domestic enterprises		Enterprises under foreign control
Proportion of innovating enterprises Total innovating enterprises	Small	Medium	Large
Proportion of innovating enterprises Total innovating enterprises	Industry	Services	

Figure 3.11 depicts the share of innovating enterprises broken down by the type of innovation, i.e. technical and non-technical. In the Czech Republic, technical innovations (37.3%) prevail over non-technical (32.7%). It can be said that this also applies to the breakdown according to the size of the enterprises and according to the characteristics of the enterprises. The

difference in the percentage points between technical and non-technical innovations are lowest for small enterprises, where non-technical innovations are smaller by 3 percentage points. In the second category, the ratio of technical and non-technical innovations for domestic enterprises (a difference of 4 percentage points, the difference in foreign affiliations is 7 percentage points).

In technical innovations, procedural innovations predominate in all categories. The difference between product and procedural innovations are not that marked. In the Czech Republic, 37.3% of the enterprises show activities in technical innovations, 27.7% are procedural innovations and 25.7% are product innovations. There is roughly a difference of 1–2 percentage points between product and procedural innovations in all the monitored categories (always in favour of procedural innovations).

Figure 3.11: Proportion of innovating enterprises according to type of innovation (2014–2016)



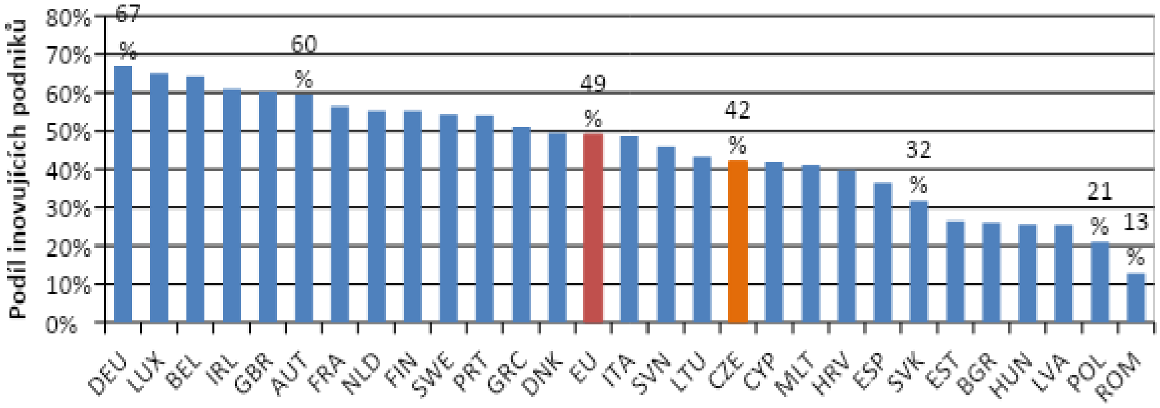
Source: own processing according to CzSO Innovation Activities of Enterprises in 2014–2016

Proportion of innovating enterprises				
Small enterprises	Medium-sized enterprises	Large enterprises	Domestic enterprises	Foreign Affiliations
total	technical innovations		non-technical innovations	

Figure 3.12 depicts the share of innovating enterprises in the EU-28 countries in the last currently available period, i.e. 2012–2014. Germany has the greatest share of innovating enterprises at 67%, followed by Luxembourg (65.1%) and Belgium (64.2%). Romania (12.8%) and Poland (21.0%) are on the other end of the scale from first-place Germany. The EU-28 average is on the level of 49.1% and the share of innovating enterprises in the Czech Republic is below average at 42.0%. Data for international comparison for the period of 2014–2016 currently is not available. It is possible to expect that the value for the Czech Republic for the period of 2014–2016 (i.e. 46.3%) should approach the EU-28 average. In the previous text, the Czech Republic was compared with Austria from the perspective of innovation

performance. In the share of innovating enterprises, the Czech Republic lags far behind Austria (by 18 percentage points).

Figure 3.12: Proportion of innovating enterprises in EU countries (2012–2014)



Source: own processing according to CzSO Innovation Activities of Enterprises in 2014–2016

Proportion of innovating enterprises

The share of technically innovating enterprises in the Czech Republic is slightly behind the EU-28 average. The Czech Republic reached a level of 35.7% in this area; the EU-28 reached 36.8%. Only Lithuania is between the Czech Republic and the value of the EU-28. The lowest share can once again be seen in Romania (6.5%), while the highest share of innovating enterprises in the area of technical innovations is in Belgium (52.9%), Germany (52.6%) and Ireland (48.8%).

Analysis of potential increase in protection of intellectual assets

Analysis of SII from perspective of protection of intellectual assets

The comprehensive SII Index is comprised of sub-indexes containing various innovation activities of the states, with one of these sub-indexes being Intellectual assets.

It is evident from the graph in figure 3.13 and table 3.3 that while the total SII value in the Czech Republic in 2018 was in the middle of the compared countries, specifically in 14th place overall, in the value of the Intellectual assets sub-index it is considerably worse, specifically in 20th place among the compared countries. This is a long-term situation.

Figure 3.13: Intellectual assets sub-index

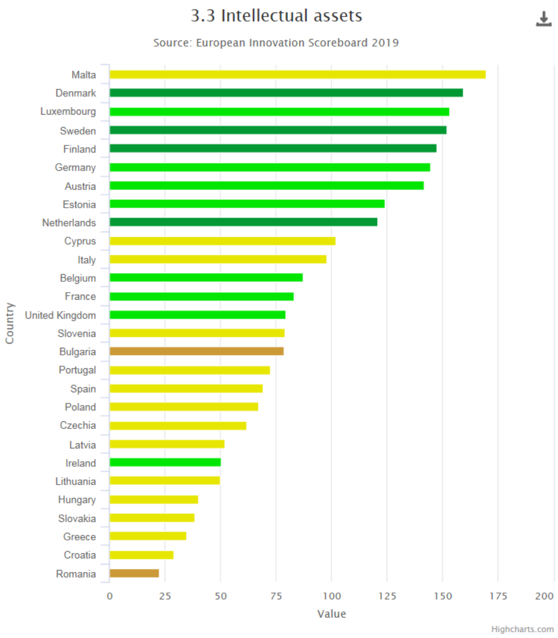


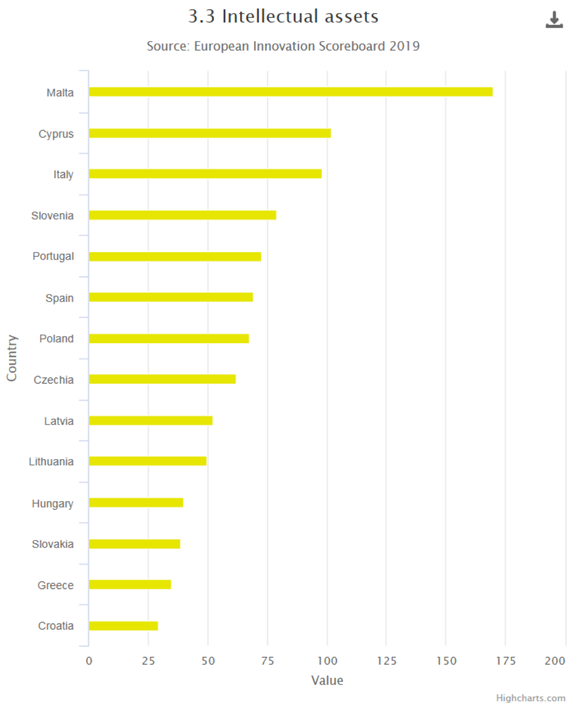
Table 3.3: Overall order of the Czech Republic according to SII and the Intellectual Assets Sub-index

ROK	2011	2012	2013	2014	2015	2016	2017	2018
EIS/pořadí	15	16	16	15	15	13	13	14
EIS - Intellectual Assets/pořadí	21	19	20	21	22	21	20	20

YEAR
EIS/order
EIS – Intellectual Assets/order

The comparison of the Intellectual assets sub-index between the states in the "Moderate Innovators" category is given in Figure 3.14, which shows that the Czech Republic is worse, according to the given sub-index, than Malta, Cyprus, Italy, Slovakia, Portugal, Spain and Poland. With regard to the overall state of the given economies and the economy of the Czech Republic, it should be possible to surpass these countries in the Intellectual assets sub-index.

Figure 3.14: Comparison of Intellectual assets sub-index among states in Moderate Innovators category



Analysis of GII from perspective of protection of intellectual assets

In the “Patent application by origin (6.1.1)” sub-index, the Czech Republic is in 35th place, while in the “PCT patent application by origin (6.2.2)” sub-index, the Czech Republic is once again in 35th place. In the “Intellectual property receipts (6.3.1)” sub-index, the Czech Republic is in 33rd place. In the “Intangible assets (7.1)” sub-index, the Czech Republic is in 39th place overall. All of these sub-indexes evaluate the treatment of intellectual assets. The placement of the Czech Republic according to all these sub-indexes is beneath the overall placement of the Czech Republic.

Expert estimate of causes of under-utilisation of protection of intellectual assets in Czech Republic

The goals of tools specified for the support of the protection of intellectual assets in the Innovation Strategy was specified according to the estimate of the employees of the Industrial Property Office. The estimate was based on the following claims based on long-term communication with foreign partners and actors of the public and private spheres. Some of the following claims on the possible causes of the under-utilisation of industrial asset rights cannot be supported by explicit data, though the given theory on the possible causes of the under-utilisation of industrial asset rights are accepted in the professional community.

The following are the Possible causes of the under-utilisation of industrial asset rights:

- Insufficient awareness of the protection of intellectual assets in the education system (elementary schools, high schools and universities – the absence of information in educational programmes, the absence of support from teachers, the absence of specialists in intellectual assets in academic titles)

- Insufficient awareness of the protection of intellectual assets in the application sphere - the insufficient use of intellectual assets for commercial potential
- Insufficient use of protection of intellectual assets in science and research
- Existing public support of protection of intellectual assets without the subsequent support for subsequent commercial use in the form of licenses
- Insufficient motivation of scientific workplaces to establish motivation rules for scientists so that there is no illegal transfer, insufficient motivation to use of license policy
- Lack of use of patent information when formulating scientific, research and innovation plans
- Lack of use of patent information when assessing programmes and projects supported from public funds
- Absence of goals and measures supporting the protection of intellectual assets in strategic and conceptual documents
- Absence of specialists in intellectual assets when formulating conditions of support for protection of intellectual assets from public sources
- Persisting conviction of some companies or businessmen that they will not be able to finance the expenses of patent protection
- Czech originators are behind several “non-Czech” patents. This fact may be given by the policy of multinational companies, where their headquarters manages intellectual assets and submits a patent application in a country other than the Czech Republic. It can also be due to the fact that the human resources are not working in the Czech Republic. Another factor could be an illegal transfer
- Analysis of European Innovation Scoreboard (EIS) Intellectual assets sub-index documents that the Czech Republic lags in the frequency of the protection of intellectual assets. The state most likely does not invest as much in the activities connected to the protection of intellectual assets as in the activities assessed in the other sub-indexes. An analysis of the state’s investments in correlation with the EIS sub-indexes is not available.

The professional competence encompassing the knowledge of intellectual assets, which is available in the Intellectual Property Office (IPO) is not sufficiently utilised. The IPO currently deals primarily with the fulfilment of tasks ensuing from the legislation for the protection of intellectual rights. The IPO pays excess revenue to the budget. If required by the state, the IPO would have the potential for expanding the capacity for spreading awareness of intellectual assets, cooperation with the other actors of the private and public spheres.

Gender equality in the Czech Republic and international comparison

In 1999, the European Commission released the first report on the theme of women and science, and the Helsinki Group on Women and Science was established at the European Commission’s General Directorate for Research and Technology. There is an evident shift from the measures that aimed at the individual support of women and efforts for women to fully adapt to the demands that work in the area of R&D places on them towards institutions that stand behind these demands and thus behind increasing gender inequality. A cultural and structural change is mentioned in this context. This is based on the idea that a mere change in the behaviour of women is not sufficient. For a truly just environment, a change to the entire R&D system is required. This means supporting gender equality in the area of the professional fulfilment and careers, but also the development of the institutions themselves. The aforementioned cultural and structural change should be built on gender action plans, which arise in individual institutions and are built on internal analyses. The goal of gender action plans is the removal of obstacles connected with the hiring of new female employees, the motivation of the retention of women in the area of R&D, their career development and ultimately, of course, the removal/minimisation of gender inequality. The institution should also support the sustainability of scientific careers by improving the conditions for balancing the professional and family life. Pressure on decreasing gender inequality does not only affect institutions performing R&D. Specifically in the area of R&D, the efforts also affected the actual providers of public support, which are directed to the suitable configuration of the criteria and processes for the evaluation of projects that contribute to the implementation of cultural and structural changes.

The state's approach to the question of gender equality in R&D is closely connected to the configuration of the R&D system, the management style and the acceptance of political decisions, the behaviour of the private and public sector and with many other variables.

The following text describes the basic information related to the issue of gender equality in the area of R&D and an international comparison of the Czech Republic with other EU states.

The number of employees can be reported in two indicators. The first is Head Count (HC), i.e. the number of physical employees who are involved full- or part-time in R&D (there is no conversion of the number of employees to 1.0 working hours). This reporting indicator does not correspond to the real number of employees fully involved in R&D. Many employees, especially in the university and government sectors, have their working hours in multiple subjects at the same time, and thus the HC indicator is heavily overvalued. Compared to this, the Full-Time Equivalent (FTE) indicator calculates the number of employees working full time and completely dedicated to R&D activities. FTE reporting is suitable for international comparisons. The FTE indicator also is not completely accurate. Many employees' full time exceeds 1.0.

In table 3.4, the number of employees in R&D is given for 2010, 2016 and 2017. In 2010, 2016 and 2017, Germany has the greatest number of employees in R&D from the EU-28 expressed as FTE and HC. It is followed by countries such as France, Great Britain, Italy, Spain and the Netherlands. The Czech Republic is in the middle position in the EU-28 rankings. In 2016, 99 875 people were employed in R&D in the Czech Republic and according to FTE, it was 65 783 full-time employees. In 2017, there were already 107 734 people employed in R&D in the Czech Republic, i.e. 69 736 full-time employees.

Table 3.4: Total number of employees in research and development (2010, 2016, 2017)

	2010		2016		2017
	FTE	**HC**	**FTE**	**HC**	**FTE**
Germany	548 723	777 327[1]	657 894	915 857[4]	681 552
France	397 756	523 648	428 643[4]	575 830[3]	428 643[4]
Great Britain	350 766	524 333	417 390	695 925	424 510
Italy	225 632	348 215	290 040	435 283	291 516
Spain	222 022	360 229	205 873	341 809	205 873[5]
Netherlands	100 544	127 154	132 867	187 750	138 292
Poland	81 843	129 792	111 789	171 610	121 358

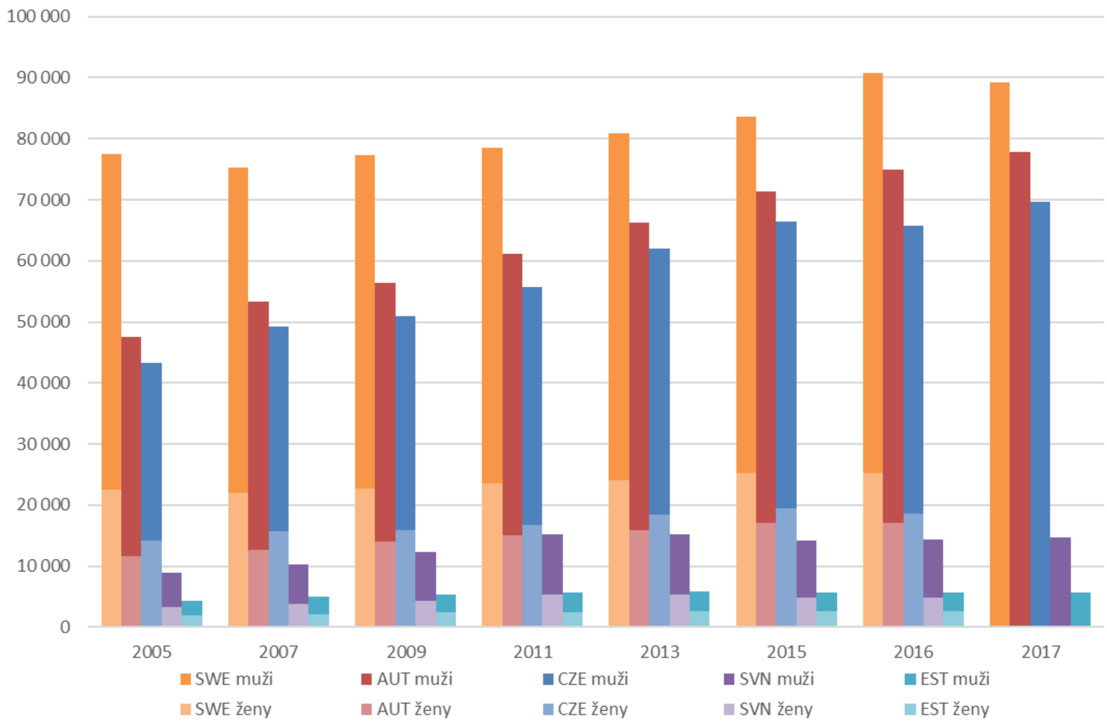
	2010		2016		2017
	FTE	HC	FTE	HC	FTE
Sweden	77 418	116 209[1]	90 690	138 620[4]	89 268
Belgium	60 075	88 803	79 109	113 576[4]	83 441
Austria	59 923	96 502[1]	74 897	126 171[4]	77 880
Denmark	56 623	84 562	62 869	87 491	62 911
Finland	55 897	79 979	47 429	72 387	48 999
Czech Republic	52 290	77 903	65 783	99 875	69 736
Portugal	47 616	91 917	50 406	103 680	54 091
Greece	36 913[2]	70 229[2]	41 790	96 018[4]	48 226
Hungary	31 480	53 991	35 757	54 636	40 432
Romania	26 171	39 065	32 232	44 386	32 586
Ireland	19 722	33 630	36 027	49 236[4]	30 316
Slovakia	18 188	28 128	17 768	33 252	19 011
Bulgaria	16 574	20 823	25 060	32 306	23 290
Slovenia	12 940	17 972	14 403	20 022	14 713
Lithuania	12 315	18 913	10 924	22 355	11 491
Croatia	10 859	18 459	11 197	18 133	11 853
Latvia	5 563	9 174	5 120	11 028	5 378
Estonia	5 277	10 074	5 772	9 234	5 772[5]
Luxembourg	4 972	5 749[1]	5 312	6 505[4]	5 322
Cyprus	1 302	2 628	1 356	3 091	1 485
Malta	1 102	1 807	1 505	2 408	1 481

Note: [1]information for 2009; [2]information for 2011; [3]information for 2014; [4]information for 2015; [5]information for 2016

Source: Eurostat

Figure 3.15 shows the number of employees in R&D and the number of women (FTE) in selected countries. The values for the representation are not yet known for 2017, thus the absolute number of employees in R&D in 2017 is reported only as male representation. There has been a positive trend in the Czech Republic since 2005 with regard to the number of employees in R&D. The absolute number of women employed in R&D has also increased, only in 2016 was a year-on-year decrease by 756 women recorded. None of the selected countries achieved a balanced ratio of men and women, the closest of the selected countries to this was Estonia.

Figure 3.15: Number of employed in R&D and the number of women (FTE)

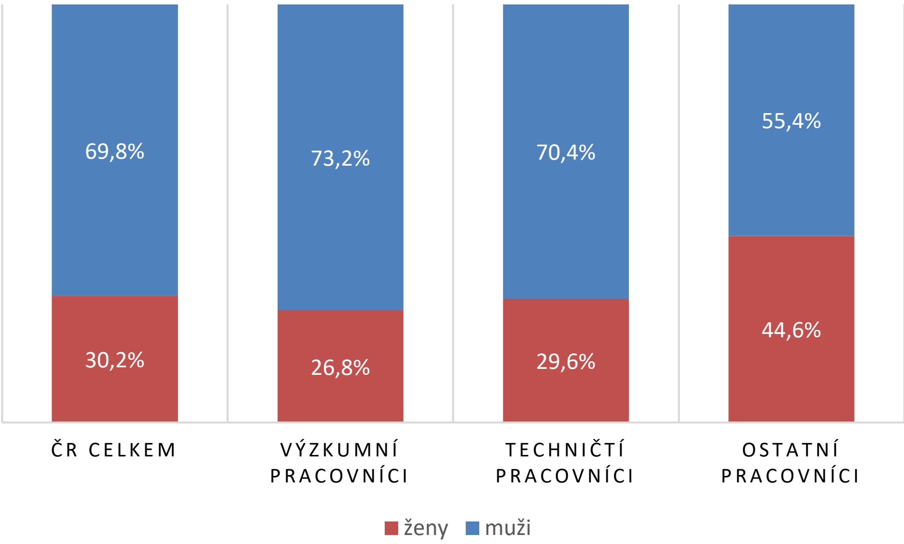


Note: the value of the number of women in Austria 2005 is from 2006, the value of the number of women in Austrian and Sweden 2016 is from 2015, the value of the number of women in Estonia 2017 is from 2016; the values of the number of women in 2017 are not available.

Source: own processing according to CzSO, Research and development indicators

SWE men	AUT men	CZE men	SVN men	EST men
SWE women	AUT women	CZE women	SVN women	EST men

Figure 3.16: Structure of employees in research and development by gender in 2017 (HC)



Source: own processing according to Position of women in Czech science, Monitoring report from 2017 (NKC – gender and science)

TOTAL CR	RESEARCH EMPLOYEES	TECHNICAL EMPLOYEES	OTHER EMPLOYEES
	women	men	

In 2017, 107 733 people were employed in R&D (HC). Figure 3.16 depicts the structure of employees in R&D by gender for 2017 expressed in HC. The representation of women was 30.2% (i.e. in absolute terms 32 576 women). The development of the number of employees in R&D has a positive trend, the percentual representation of women does not change much (the change is only in tenths of percentage points per year).

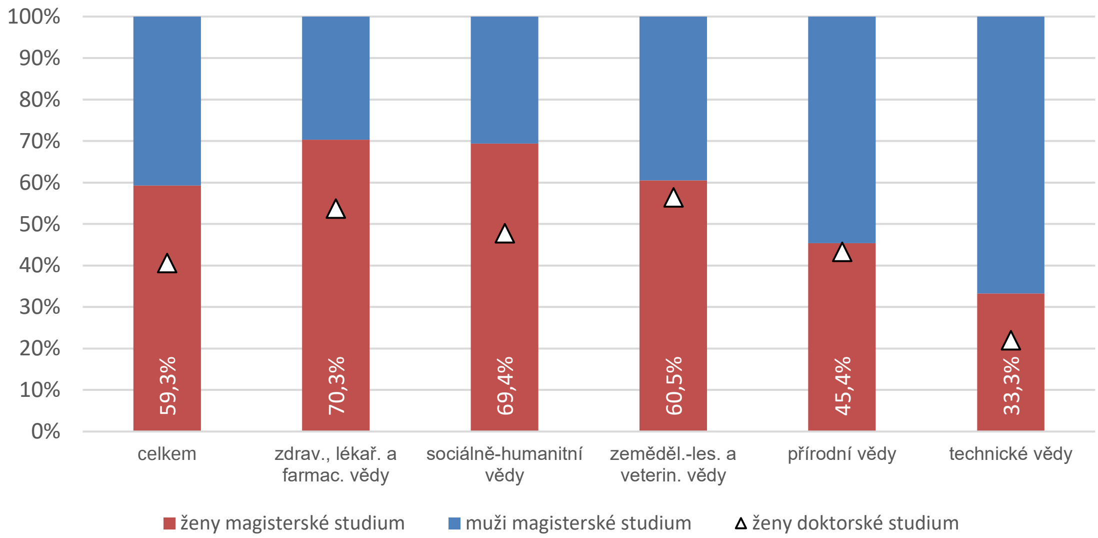
From the employees in R&D, research employees had the greatest representation, with 55.5% in 2017 (i.e. 59 789 HC employees, according to FTE, 39 181 full-time employees). The contribution of women in this category of employees was only 26.8%. From the perspective of time, a decreasing trend in the representation of women in the category of researchers can be seen since 2005. In 2005, the ratio of women was 28.8%, in 2010 it had dropped to 28.1% and in 2016 to 26.7% (i.e. a year-on-year positive change in 2017 to a level of 0.1 percentage points). From a comparison of the female researchers according to the expression of HC and FTE, it follows that the majority of the female researchers are employed part-time and the average amount of the time per female researcher is 0.65 (20 826/32 193), which corresponds to the average amount of the time worked for each researcher (0.66).

Women in the group of technical employees have a slightly higher ratio (29.6%). Of course, women do not reach the same representation of men in the category of other employees, either (women 44.6%).

In 2017, 105 299 people were studying on the master's level, from which 59.9% were women and 40.1% men. From the perspective of time, this is almost a stable number, with the exception of 2010 and 2011, when approximately 126 000 people were studying on the master's level. The representation of women among those studying on the master's level has exceeded the number of men over the long term (60% women). There is also a predominance of women among the graduates of master's studies (more details below). In 2017, there were 22 031 people registered in doctoral studies (45% women). Compared to the master's level of studies, there was a larger number of men than women in doctoral studies and men also outweigh women in the category of graduates of doctoral studies (female graduates of doctoral studies 40.6%).

Figure 3.17 depicts the ratio of graduates of master's studies according to scientific fields and the representation of female graduates of doctoral studies for 2017. There were 59.3% of women from the overall number of graduates of master's studies. Women have even greater representation in healthcare, medicine and pharmaceutical sciences (70.3% women), social/humanitarian sciences (69.4% women) and agriculture/forestry and veterinary sciences (60.5% women). On the contrary, there is a lower share of female graduates in natural sciences (45.4%) and technical sciences (only 33.3%). The ratio of female graduates at the doctorate level of studies is lower than the ratio of female graduates in the master's level in all groups of sciences. The closest ratio of graduates in both levels of study is for natural sciences (master's studies 45.5% and doctoral studies 43.3%).

Figure 3.17: Master's and doctorate degree holders by gender in 2017



Source: own processing according to Position of women in Czech science, Monitoring report from 2017 (NKC – gender and science)

total	healthcare, med and pharm. sciences	social/humanitarian sciences	agro/forestry and veterinary sciences	natural sciences	technical sciences
women in master's studies		men in master's studies		women in doctoral studies	

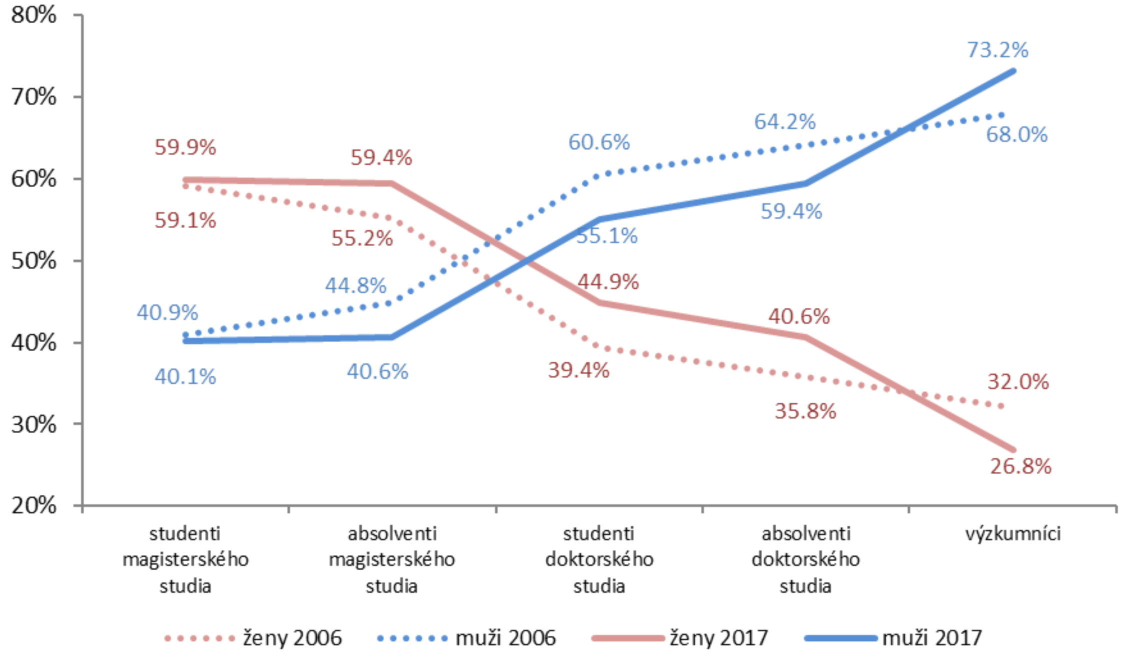
Growing trends in the representation of women among students and graduates of master's and doctoral studies are not reflected in research. The idea that the representation of women in science compared to men would balance out through natural developments over time has not yet been fulfilled from a long-term perspective.

Even in spite of the growth in the number of people working in R&D, the representation of women among researchers has a long-term decreasing character (the growth of men in R&D is faster). Nor is the situation any different from the perspective of scientific fields. In fact, in technical sciences, the development of the representation of women among researchers has more of a decreasing tendency, while for the other scientific fields there is more long-term stagnation.

Figure 3.18 depicts the representation of women and men for the individual levels of an ideally typical path from master's studies and doctorate studies to scientific activities (in % HC for 2006 and 2017). The divergence between the representation of women and men is evident at first glance. While the number of students and graduates of master’s studies have a greater representation of women, men clearly outnumber women in the number of students and graduates of doctoral studies. There is an even greater difference in the representation of men and women in scientific activities.

From the perspective of the number of researchers, the most significant are technical and natural sciences, in which two-thirds of all Czech scientists work. From the perspective of women in the individual scientific areas, the greatest gulf between men and women is in technical sciences. Only 13.2% of women (and 86.8% men) work in technical sciences and 25.1% in natural sciences. The representation of women in humanitarian, agricultural and social sciences is around 41%. The greatest share of women is in medical sciences, where 48.2% working in 2017 were women (51.8% men).

Figure 3.18: Representation of women and men in individual levels of an ideal scientific path (HC %)



Source: own processing according to Position of women in Czech science, Monitoring report from 2017 (NKC – gender and science)

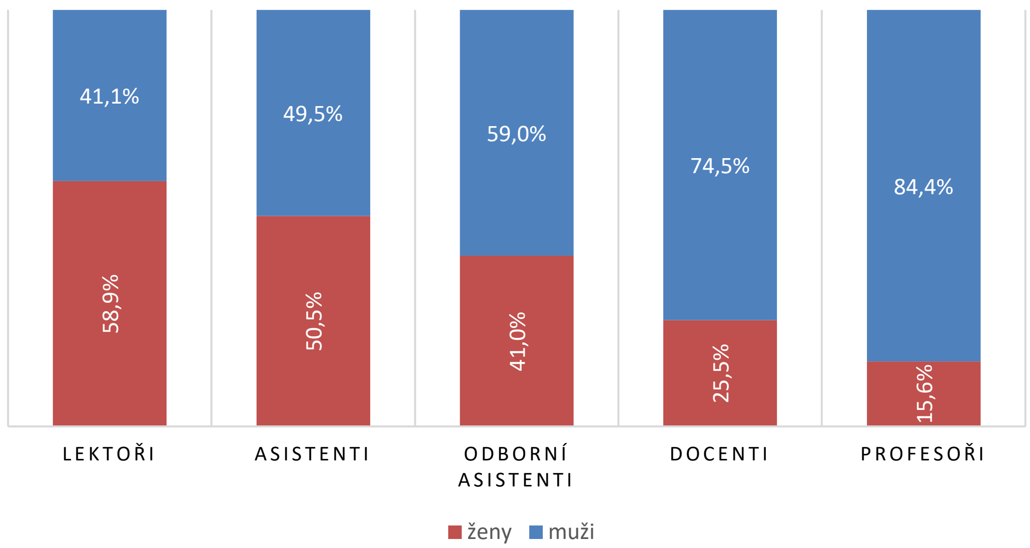
Master's students	Master's degree holders	Doctoral students	Doctorate degree holders	Researchers
women 2006 men 2006 women 2017 men 2017				

More than 80% of all researchers in the Czech Republic work in the university and business sectors. Specifically, 41.8% of all the researchers in the university sector, 40.1% in the business sector, 17.7% in the government sector and 0.4% in the private non-profit sector. Once again, the representation of women from the perspective of the individual sectors is unsatisfactory. The smallest representation of women researchers is in the business sector (1.5% women). In the university sector, 34.5% of the researchers are women. In the private non-profit sector, this number is 38.4% and in the government sector, where the greatest percentage of women researchers work, this number is 40.8%.

The situation of academic employees in universities is also interesting. The greatest representation of full-time employees (FTE) in the academic field is for expert assistants (53.7%), followed by associate professors (23%), professors (11.9%), assistants (7%) and lecturers (4.3%).

Figure 3.19 shows the share of women in connection with the qualification levels of academic employees in universities in 2017 (FTE). The decreasing representation of women as the qualification level increases is evident. While women outnumber men in lecturer positions, the numbers become more or less equal for assistant positions. After this, men outnumber women. In other words, the higher the qualification level, the lower the ratio of the representation of women. In the category of expert assistants, only 41% are women. In associate professor positions, this figure is 25.5% and in the group of professors it is only 15.6%.

Figure 3.19: Ratio of women according to qualification level of academic employees in universities in 2017 (FTE %)



Source: own processing according to Position of women in Czech science, Monitoring report from 2017 (NKC – gender and science)

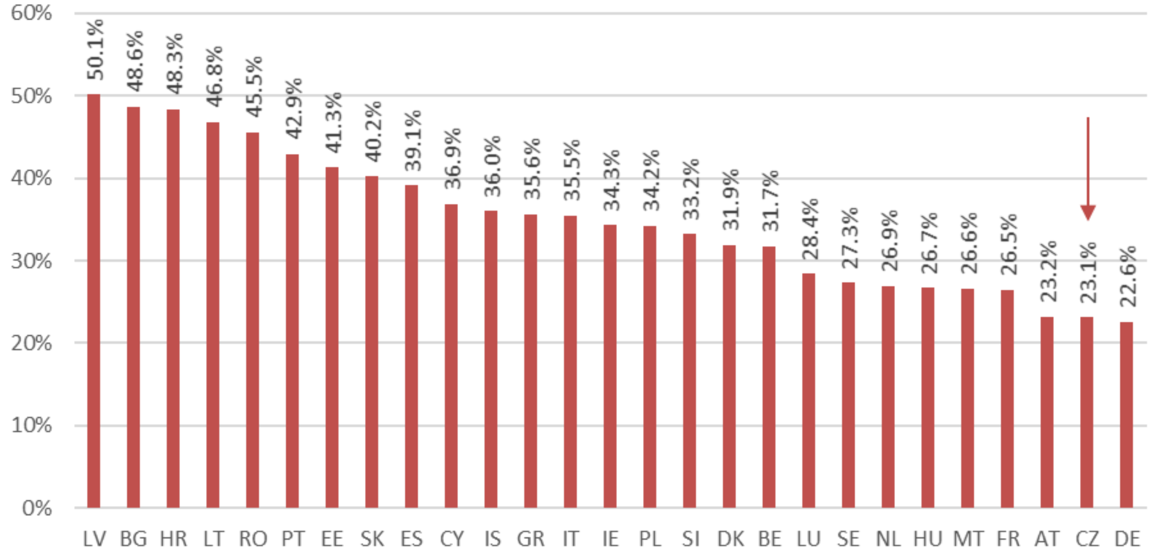
LECTURERS	ASSISTANTS	ASSISTANT PROFESSORS	ASSOCIATE PROFESSORS	PROFESSORS
women		men		

The relative size of gender wage differences shows how many percentage points female workers have a lower average wage than their male colleagues. In the academic world, these differences are evident in all qualification levels. In 2017, these differences were always to the detriment of women (6% in the position of professors, 12.3% in the position of associate professors, 11.6% in the position of expert assistants, 9.6% in the position of assistants and 10.6% in the position of lecturers). Thus, it cannot be said, like in figure 3.19, that the gender wage difference would increase the higher the qualification level is. Personal bonuses are not included in the aforementioned data, and thus it is possible to assume that the real differences in the wages of academic employees will be even greater.

Figure 3.20 shows the international comparison of the ratio of women among scientific employees in 2016 expressed in FTE in %. It is apparent that the representation of women was the highest in the Baltic countries such as Latvia (50.1%), Lithuania (46.8%) and Estonia (41.3%) as well as in some of the Balkan countries, such as Croatia (48.3%), Bulgaria (48.6%) and, for example, Romania (45.5%). The Czech Republic is almost in last place (23.1%). Only Germany (22.6%) is below the Czech Republic. Some studies show that the low representation of women in R&D is connected to the idea that men are predominantly attracted to this area in countries with higher expenditures on R&D and higher wages. In countries with low expenditures for R&D, on the contrary, women predominate. Compared with other countries of the former East Bloc, the Czech Republic has considerably higher expenditures for R&D.

If figure 3.20 was expressed in HC, then Germany would pass the Czech Republic and only France and the Netherlands would be behind the Czech Republic.

Figure 3.20: International comparison of the ratio of women among research employees in 2016 (FTE %)



Source: own processing according to Position of women in Czech science, Monitoring report from 2017 (NKC – gender and science)

Link of SII and GII sub-indexes to strategic goals of National R&D Strategy 2021+

Table 3.5: Link of SII and their sub-indexes to strategic goals of National R&D Strategy 2021+

		Relative performance of CR to EU 2018	Relative performance of CR to EU 2011		defined National R&D Strategy 2021+ goals and their relation to SII				
					Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
		2018	2011	2018					
SII	**SUMMARY INNOVATION INDEX**	**82.2**	**85.9**	**89.4**					
1	**Human resources (potential of people)**	**75.0**	**73.4**	**91.7**		**x**			
1.1	New doctorate graduates	77.8	84.6	112.9		x			
1.2	Population with tertiary education	61.3	45.5	73.1		x			
1.3	Lifelong learning	88.8	92.7	90.6		x			
2	**Attractive research systems**	**65.3**	**48.8**	**73.6**			**x**		
2.1	International scientific co-publications	91.0	73.8	132.3			x		
2.2	Scientific publications in the top 10% of the most cited publications	43.8	37.3	48.0			x		
2.3	Foreign doctorate students	78.1	50.2	74.7		x	x		
3	**Innovation-friendly environment**	**75.1**	**84.3**	**118.6**					**x**
3.1	Broadband penetration	72.2	88.9	144.4	-	-	-	-	-
3.2	Opportunity-driven entrepreneurship	78.1	81.2	101.1	x				x
4	**Finance and support**	**46.7**	**84.6**	**51.1**	**x**				
4.1	R&D expenditure in the public sector	96.0	70.1	88.8	x			x	
4.2	Venture capital expenditures,	5.0	101.7	6.5					x
5	**Firm investments**	**94.4**	**104.6**	**112.6**	**x**			**x**	**x**
5.1	R&D expenditure in the business sector	82.8	64.0	94.9	x				x
5.2	Non-R&D innovation expenditures	89.3	134.6	104.3	x				x
5.3	Enterprises providing ICT training	110.5	113.3	140.0	-	-	-	-	-

		Relative performance of CR to EU 2018	Relative performance of CR to EU 2011		defined National R&D Strategy 2021+ goals and their relation to SII				
					Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
		2018	2011	2018					
6	**Innovators**	**96.9**	**105.4**	**88.0**					
6.1	SMEs product/process innovations	94.9	99.0	92.1					x
6.2	SMEs marketing/organisational innovations	82.9	120.1	70.7					x
6.3	SMEs innovating in-house	112.6	97.0	101.4					x
7	**Linkages**	**84.1**	**71.5**	**87.3**					
7.1	Innovative SMEs collaborating with others	107.1	101.1	114.4				x	x
7.2	Public-private co-publications	73.0	71.4	85.6				x	
7.3	Private co-funding of public R&D exp.	71.2	49.8	68.3				x	
8	**Intellectual assets**	**63.8**	**50.7**	**62.1**	**x**			**x**	**x**
8.1	PCT patent applications	23.2	21.1	21.1				x	x
8.2	Trademark applications	69.1	71.4	76.9				x	x
8.3	Design applications	100.0	64.3	92.2				x	x
9	**Employment impacts**	**118.4**	**114.6**	**123.6**		**x**		**x**	**x**
9.1	Employment in knowledge-intensive activities	84.7	84.6	92.3		x		x	x
9.2	Employment in fast-growing enterprises of the most innovative sectors	144.6	136.3	146.3		x		x	x
10	**Sales impacts**	**93.0**	**105.4**	**95.8**					**x**
10.1	Medium- and high-tech products exports	128.2	127.2	138.3					x
10.2	Knowledge-intensive services exports	49.3	41.1	50.9					x
10.3	Sales of new-to-market/firm innovations	100.0	153.4	97.0					x

Source: own processing

Table 3.6: Link of GII and their sub-indexes to strategic goals of National R&D Strategy 2021+

Rank in EU=28 according to GII 2019 and the change of GII 2013 and 2019	
Indicator	position
Global Innovation Index (GII)	13
Innovation Efficiency Ratio	22
Innovation Input Sub-index	15
Innovation Output Sub-index	12

Rank in EU=28 according to GII 2019 and the change of GII 2013 and 2019			Defined National R&D Strategy 2020+ goals and their relation to GII				
			Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
1.	**Institutions**	**16**					
1.1	Political environment	16					
1.1.1.	Political stability and absence of violence/terrorism	13					
1.1.2.	Government effectiveness	16	X				
1.2.	Regulatory environment	20	X				
1.2.1.	Regulatory quality	13	X				
1.2.2.	Rule of law	15					
1.2.3.	Cost of redundancy dismissal	26					
1.3.	Business environment	15	X				x
1.3.1.	Ease of starting a business	24					x
1.3.2.	Ease of resolving insolvency	8					
2.	**Human capital and research**	**16**		**x**			
2.1.	Education	11					
2.1.1.	Expenditure on education	6					
2.1.2.	Government funding per secondary student	11					
2.1.3.	School life expectancy	12					
2.1.4.	Assessment in reading, mathematics, and science	16		x			
2.1.5.	Pupil-teacher ratio, secondary	18					
2.2.	Tertiary education	10					
2.2.1.	Tertiary enrolment	18					
2.2.2.	Graduates in science and engineering	16					
2.2.3.	Tertiary level inbound mobility	6					
2.3.	Research and development (R&D)	19	X				
2.3.1.	Researchers	14	X				
2.3.2.	Gross expenditure on R&D (GERD)	10	X				
2.3.3.	Global R&D companies, average expenditure top 3	20				x	x
2.3.4.	QS university ranking average score top 3 Universities	14					
3.	**Infrastructure**	**17**					
3.1.	Information and communication technologies (ICTs)	28					

Rank in EU=28 according to GII 2019 and the change of GII 2013 and 2019			Defined National R&D Strategy 2020+ goals and their relation to GII				
			Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
3.1.1.	ICT access	26					
3.1.2.	ICT use	17					
3.1.3.	Government's online service	28					
3.1.4.	Online e-participation	28					
3.2.	General infrastructure	5					
3.2.1.	Electricity output	5					
3.2.2.	Logistics performance	12					
3.2.3.	Gross capital formation	2					
3.3.	Ecological sustainability	12					
3.3.1.	GDP per unit of energy use	25					
3.3.2.	Environmental performance	21					
3.3.3.	ISO 14001 environmental certificates	3					
4.	**Market sophistication**	**15**					
4.1.	Credit	17					
4.1.1.	Ease of getting credit	6					
4.1.2.	Domestic credit to private sector	22					
4.1.3.	Microfinance institutions' gross loan portfolio	-					
4.2.	Investment	17					
4.2.1.	Ease of protecting minority investors	20					
4.2.2.	Market capitalization	-					
4.2.3.	Venture capital deals	26					x
4.3.	Trade, competition, & market scale	11					x
4.3.1.	Applied tariff rate, weighted mean	1					
4.3.2.	Intensity of local competition	8					x
4.3.3.	Domestic market scale	12					
5.	**Business sophistication**	**14**					
5.1.	Knowledge workers	15		x		x	x
5.1.1.	Employment in knowledge-intensive services	18		x		x	
5.1.2.	Firms offering formal training	2					
5.1.3.	GERD performed by business enterprise	11				x	x
5.1.4.	GERD financed by business enterprise	25				x	x
5.1.5.	Females employed with advanced degrees	27		x			
5.2.	Innovation linkages	16					x
5.2.1.	University/industry research collaboration	14	X			x	
5.2.2.	State of cluster development	16					
5.2.3.	GERD financed by abroad	3			x		
5.2.4.	Joint venture/strategic alliance deals	22					x
5.2.5.	Patent families filed in at least two offices	17					x
5.3.	Knowledge absorption	11			x	x	x
5.3.1.	Intellectual property payments	19			x	x	x
5.3.2.	High-tech imports	1					x
5.3.3.	ICT services imports	20					

Rank in EU=28 according to GII 2019 and the change of GII 2013 and 2019			Defined National R&D Strategy 2020+ goals and their relation to GII				
			Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
5.3.4.	Foreign direct investment, net inflows	11					
5.3.5.	Research talent in business enterprise	13		x			x
6.	**Knowledge and technology outputs**	**9**					
6.1.	Knowledge creation	12					
6.1.1.	Patent applications by origin	15				x	x
6.1.2.	PCT international applications by origin	21			x	x	x
6.1.3.	Utility model applications by origin	1			x		x
6.1.4.	Scientific and technical publications	9		x	x		
6.1.5.	Citable documents H index	16		x	x		
6.2.	Knowledge impact	6			x		
6.2.1.	Growth rate of GDP per person engaged	8					
6.2.2.	New business density	16					
6.2.3.	Total computer software spending	16					
6.2.4.	ISO 9001 quality certificates	3					
6.2.5.	High-tech and medium high-tech output	3					
6.3.	Knowledge diffusion	11				x	
6.3.1.	Intellectual property receipts	16					
6.3.2.	High-tech exports	1					
6.3.3.	ICT services exports	17					
6.3.4.	Foreign direct investment, net outflows	14					x
7.	**Creative outputs**	**12**					
7.1.	Intangible assets	17					
7.1.1.	Trademark application class count by origin	11					
7.1.2.	Industrial designs by origin	10					x
7.1.3.	ICTs and business model creation	21					
7.1.4.	ICTs and organizational model creation	13					
7.2.	Creative goods and services	3				x	x
7.2.1.	Cultural and creative services exports	24				x	x
7.2.2.	National feature films produced	15				x	x
7.2.3.	Entertainment and media market	14					
7.2.4.	Printing, publications & other media output	23					
7.2.5.	Creative goods exports	1					
7.3.	Online creativity	16					
7.3.1.	Generic top-level domains (gTLDs)	19					
7.3.2.	Country-code top-level domains (ccTLDs)	9					
7.3.3.	Wikipedia yearly edits	11					
7.3.4.	Mobile app creation	12					

Source: own processing

4 Annex – Summary overview of core documents

- OECD Science, Technology and Innovation Outlook 2016, https://www.rolandberger.com/en/Insights/Global-Topics/Trend-Compendium.html
- Perspektiven des deutschen Wissenschafts systems, Wissenschaftsrat, 12.7.2013, Braunschweig
- Empfehlungenzur Zukunft des Forschungsratings, Wissenschaftsrat, 25.10.2013, Mainz
- Open Innovation. Strategie für Österreich – Ziele, Maβnahmen & Methoden (2025), Bundesministerium für Wissenschaft, Forschungs und Wirtschaft, Bundesministerium für Verkehr, Innovation und Technologie
- Österreichischer Forschungs – und Technologie 2017. Lagesberichtgem.§ (1) FO Güberdie aus Bundesmittelngeförderte Forschung, Technologie und Innovation in Österreich
- Agenda 2030 and Sustainable Development Goals
- The European Union's 9th framework programme for research and innovation "Horizon Europe"
- A New Strategic Agenda 2019–2024, European Council, June 2014
- National Research, Development and Innovation Policy of the Czech Republic for 2016–2020, Government Resolution No. 135 of 17 February 2016
- Report on Evaluation of Fulfilment of Measures of National Research, Development and Innovation Policy of the Czech Republic for 2016–2020, Government Resolution No. 115 of 8 February 2019
- Innovation Strategy of the Czech Republic 2019–2030, Government Resolution No. 104 of 4 February 2019
- System for Management and Coordination of Innovation Strategy of the Czech Republic 2019–2030, Government Resolution No. 935 of 16 December 2019
- National Research and Innovation Strategy for Smart Specialisations of the Czech Republic 2014–2020 (National RIS3 Strategy), 2018 update, Government Resolution No. 24 of 11 January 2019
- National Research and Innovation Strategy for Smart Specialisations of the Czech Republic 2021–2027
- Implementation of Agenda 2030 for Sustainable Development (Goals of sustainable development) in the Czech Republic, Government Resolution No. 670 of 17 October 2018
- 2019 National Reform Programme of the Czech Republic
- National Artificial Intelligence Strategy of the Czech Republic, Government Resolution No. 314 of 6 May 2019
- National Priorities of Oriented Research, Experimental Development and Innovation, Government Resolution No. 552 of 19 July 2012
- National Concept of Cohesion Policy Implementation in the Czech Republic after 2020
- National Action Plan on Adaptation to Climate Change, Government Resolution No. 34 of 16 January 2017
- Strategy on Adaptation to Climate Change in the Czech Republic 2021+ (under preparation)

- Global Megatrends for the Updated Strategic Framework for Sustainable Development, Prague 2016, ISBN: 978-80-7440-161-9
- Government Strategy for Equality of Women and Men in the Czech Republic for 2014 – 2020, Office of the Government of the Czech Republic, 2014
- Strategy for Equality of Men and Women for 2021–2030 (under preparation)
- Akademici a akademičky 2018: Návrhy opatření na podporu rovnosti ve výzkumném a vysokoškolském prostředí [Male and Female Academics 2018: Proposal for Measures to Support Equality in Research and the University Environment]; Institute of Sociology of the Czech Academy of Sciences, Prague, 2018
- Postavení žen v české vědě (monitorovací zpráva za rok 2017) [Status of Women in Czech Science (Monitoring Report for 2017)], Institute of Sociology of the Czech Academy of Sciences, Prague, 2019
- Action Plan for Human Resources Development and Gender Equality in Research and Development in the Czech Republic for 2018–2020, Government Resolution No. 8 of 3 January 2018
- Interim evaluation of the fulfilment of the measures of the Action Plan for Human Resources Development and Gender Equality in Research and Development in the Czech Republic for 2018–2020, Ministry of Education, Youth and Sports, 2019 (supplemented in April 2020)
- Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad in 2018
- The Czech Republic National Strategy of Open Access to Scientific Information for 2017–2020, Government Resolution No. 444 of 14 June 2017
- Action Plan for the Czech Republic National Strategy of Open Access to Scientific Information for 2017–2020, Government Resolution No. 289 of 29 April 2019
- Data from the R&D system, Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad
- Data from the Czech Statistical Office, Eurostat, database of Thomson Reuters Web of Science, OECD, European Innovation Scoreboard, European Semester: Commission’s Diagnosis of the Czech R&D System, evaluation reports, statistics of the European Research Council and other relevant sources