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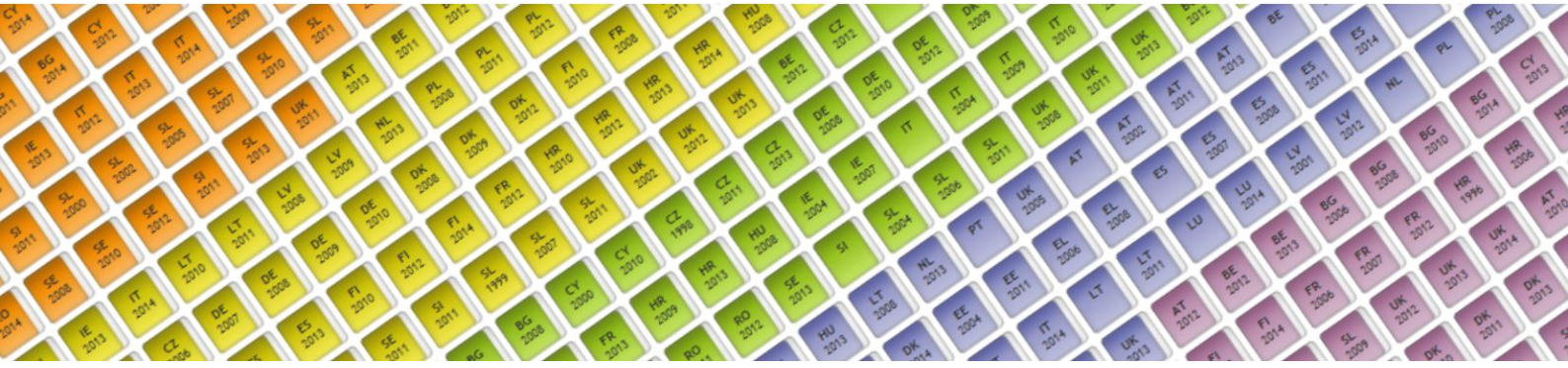

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Abstract

The report offers an analysis of the R&I system in the Czech Republic for 2014, including relevant policies and funding, with particular focus on topics critical for two EU policies: the European Research Area and the Innovation Union. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The report identifies the structural challenges of the Czech research and innovation system and assesses the match between the national priorities and those challenges, highlighting the latest policy developments, their dynamics and impact in the overall national context.

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Executive summary

The objective of the report is to provide an up-to-date overview of the R&D and innovation (RDI) system of the Czech Republic and to assess the evolution of national research and innovation policies in the perspective of the EUROPE 2020 Strategy. The main focus is on developments along the topics central to the EU policies of the European Research Area (ERA) and Innovation Union (IU), including the issues of governance, funding, transnational co-operation, labour market, framework conditions for innovation and market, transfer and circulation of knowledge. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, such as policy documents, statistics and evaluation reports.

Overall, the Reform of the Research, Development and Innovation (RDI) System launched in 2008 and the consequent agenda of the National RDI Policy 2009-2015 are aligned with the EUROPE 2020 Strategy. A number of strategic documents that have been published during the reform highlighted the key problems and stimulated a much needed public debate; however, policy response and implementation have been piecemeal so far. The main success area is the upgrading of research infrastructures, while the progress has been slow in promoting excellence, opening the labour market, reforming the evaluation framework and getting ideas to market.

Despite the economic crisis and major slowdown of economic growth, R&D intensity of the economy in terms of gross domestic expenditure on R&D (GERD) as % of GDP increased from the bottom of 1.24% in 2008 to 1.91% in 2013 (Eurostat, 2014). Since 2011 public funding slightly predominates over the private one. Business and foreign R&D funding, including from the EU Structural Funds, grew rapidly over the recent years, while national public funding of R&D tends to stagnate, which casts doubts about the sustainability of recent R&D investments growth.

Governance coordination issues, the revision of evaluation methodologies and generally more efficient allocation of public research funding are flagged as the top policy priorities. Structure of the public RDI system was revised early in the reform. The Council for R&D and Innovation (CRDI) has become the central policy actor, the Technology Agency of the Czech Republic (TA CR) has been established and the funding flows have been streamlined. Nevertheless, the governance reform has slowed down significantly after the initial push and many of the changes remain half-baked due to disagreements among the main stakeholders, in particular over allocation of institutional funding.

New research centres and infrastructure projects that have been constructed with subsidies from the EU Structural Funds represent a great promise for boosting the research output. According to preliminary estimates, however, their operating expenses may account for as much as one fifth to one third of the current public R&D budget. Unless the amount of public R&D outlays is significantly expanded, which is not expected in the medium-term outlook, public research organisations, including the newly build projects,

may end up being underfunded. National program sustainability I and II have been enacted to at least partly alleviate the lack of funds for the launch of the new facilities but how they are managed, staffed, and integrated into the system remains to be seen.

One aim that has been repeatedly stressed in the policy documents is to increase the quality of human resources in research. Unfortunately, higher education reform ended up in doldrums. Despite initially ambitious plans, the reform agenda in this domain has been significantly watered down, as the result of which resolving the core problems, such as rigid recruitment practices, are not under consideration anymore. Horizontal mobility of academic staff is low, competition for posts weak and inbreeding widespread. Gender inequality issues are not systematically tackled. Research internationalization is very limited in the public sector. Much remains to be done in improving the labour market for researchers.

Given the historical separation of science and business, improving public-private circulation, collaboration and transfer of scientific knowledge is a constant policy challenge. New measures were introduced that are shifting the focus of public subsidies to promoting joint public-private projects. Another major policy shift is from a support system to innovation traditionally based on direct subsidies to firms towards a wider portfolio of measures, including tax credits, loan guarantees and provision of support services. But many public-private linkages are informal, technology transfer services are weak and the absorptive capacity of firms is insufficient. Governance of public-private collaboration in research institutions remains underdeveloped.

A major policy shift has been from a system traditionally focused on science towards more attention devoted to boosting innovation. But the success has been at best partial so far. Structurally, the business sector appears sound; the high- and medium-high-technology sector is large. However, there is a lingering gap in innovation performance, as the business sector is specialized in low value added segments of value chains. Foreign affiliates are poorly integrated in the national innovation system, access to venture capital is limited and path-breaking innovation is rare. Innovation activities performed by enterprises are focused on the absorption of technologies new to the firm and experimental development rather than research.

Generally speaking, the policy mix aims to tackle the main challenges. For the first time, the strategic reform documents that were released from 2008 onwards outlined the RDI policy in a coherent, manner and there seems to be emerging consensus on the way forward. In recent years, the Czech RDI system embarked on a catching up trajectory with advanced European countries. Yet many IU indicators have not reached the EU28 average and the lag behind innovation leaders remains quite significant. No doubt progress has been made, but in many respects the progress towards meeting the ERA's objectives and IU commitments has been painstakingly slow and a number of the objectives outlined in the National RDI Policy 2009-2015 and its mid-term update from 2013 are not likely to be satisfactorily achieved.

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1. Overview of the R&I system

1.1 Czech Republic in the European RDI landscape

The Czech Republic is a medium size Central European country with an area of 78.9 thousands square kilometres and population of 10.5 million people, accounting for, respectively, 1.8% and 2.1% of the EU28 total. In 2013, gross domestic product (GDP) per capita in purchasing power standards reached €20,600, 80% of the EU28 average. After real GDP dropped in the peak of the crisis by 4.5% in 2009, the economy slowly recovered by 2.5% in 2010 and 1.8% and 2011; however, this positive trend did not last and the GDP dropped by 1.0% in 2012 and 0.9% in 2013 (Eurostat, 2014).

1.2 Main features of the R&I system

Despite the sluggish economy, gross domestic expenditure on R&D (GERD) as % of GDP increased from the crisis bottom of 1.24 % in 2008 to 1.91% in 2013, getting significantly closer to the EU28 average of 2.02%. In 2013, the business sector financed 38% of GERD, of which 97% was spent by the firms themselves testifying to their weak link to the rest of the system. Business expenditure on R&D (BERD) as % of GDP expanded to 1.03% in 2013 compared to 0.96% in 2012 and 0.86% in 2011, hence catching-up with the EU28 average of 1.29%. In 2013, the government sector financed 35% and foreign sources – a combination of EU Structural Funds and foreign business funds - accounted for as much as 27% of GERD going up from only 9% in 2008, which makes the latter by far the most dynamic source (Eurostat, 2014).

On one hand, there is clearly a catching up trend in research productivity with the EU28 average. On the other hand, however, the research and innovation system as a whole still lags behind the EU28 average in terms of research outputs per capita or per GDP (European Commission, 2014a).As far as high-quality R&D outputs, such as internationally recognized scientific publications and triadic patents, are concerned, there are several high-profile fields that stand out, including organic chemistry, nuclear physics, medical sciences, textile materials, machine tools, electrical engineering, combustion engines and vehicles in general.

1.3 Structure of the national research and innovation system and its governance

At the heart of the public research sector is (i) the Academy of Sciences of the Czech Republic (ASCR), consisting of 54 formally independent public research institutes, and (ii) 26 public, 2 state and 44 private higher education institutions. Unlike in Western Europe, a large part of research activities are under the umbrella of the ASCR, the primary mission of which is to conduct basic research, while the higher education sector has been traditionally

less research-oriented and more focused on teaching. Nevertheless, this has been changing in recent years, as the ASCR tends to get more involved in applied research and the higher education sector significantly expands its research activities.

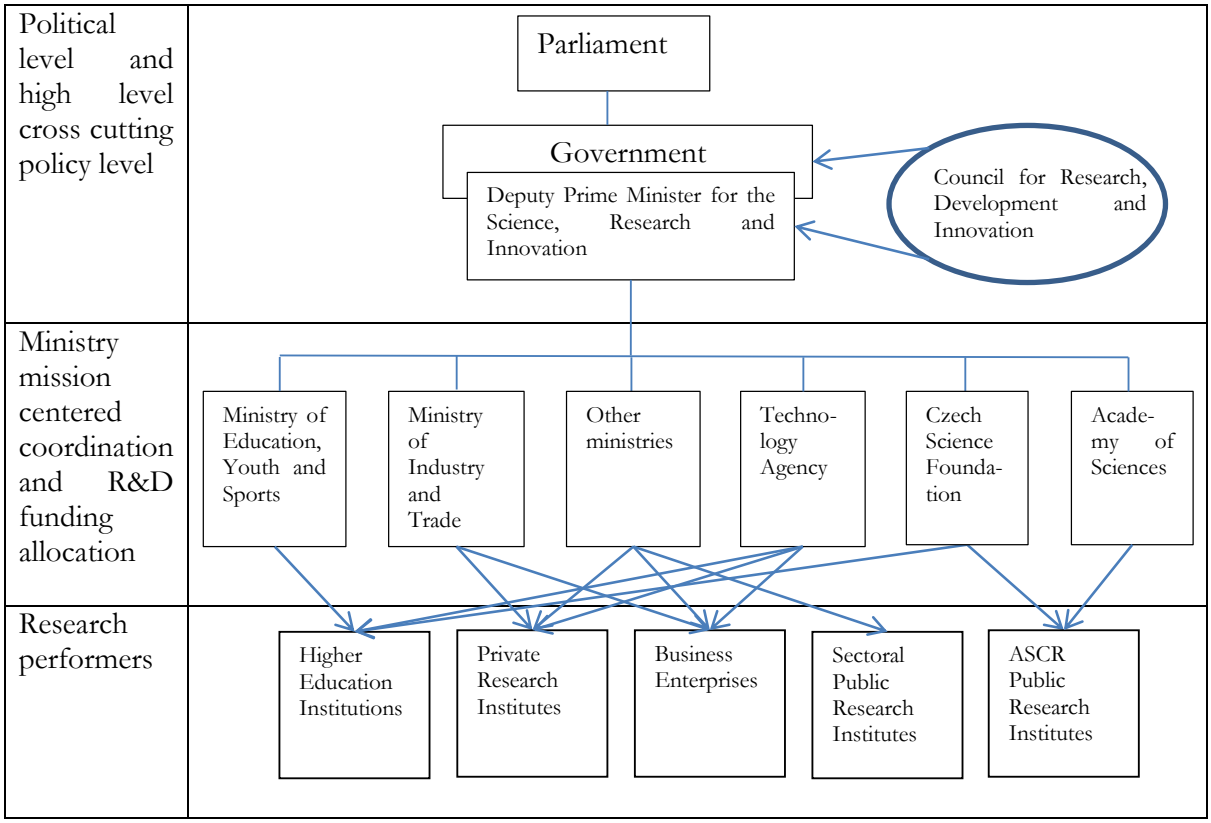
The private research sector consists of about 2,300 actors that perform R&D activities, of which about 25% are foreign affiliates and 80% are small and medium size enterprises. The main R&D performing sectors are the automotive, machinery, electronics and information and communication industries with about 50% share in both R&D employment and expenditure, respectively (CZSO, 2014a). By far the largest single private R&D performer is well-known to be the carmaker Škoda Auto, a part of the Volkswagen Group, which maintains a large research facility and its own private university. Other major business R&D performers include, for example, Bosh, Honeywell, Škoda Transportation, Visteon-Autopal and Zentiva. Private research institutes that are specialized in applied research are organized under the umbrella of Association of Research Organizations (AVO), which has about 80 members. Association of Innovative Entrepreneurship (AIE) consists of 30 organizations representing about 84,000 self-employed persons and 1,100 corporations.

In 2008, the Reform of the Research, Development and Innovation (RDI) system was launched. The reform profoundly changed the governance of RDI policy. Competences of particular governmental bodies are given by the Act No. 130/2002 Coll. on the Support of Research and Development from Public Funds and by the Reform amendment Act. no 211/2009 Coll. The main players in RDI policy making are as follows:

- Deputy Prime Minister for the Science, Research and Innovation is a member of the government responsible for RDI policy supported by the Section for Science, Research and Innovation at the Office of the Government.
- Council for Research, Development and Innovation (CRDI) is an advisory government body for RDI policy with 17 members chaired by the Deputy Prime Minister for the Science, Research and Innovation. At the political level, the CRDI plays the main strategic and coordinating role.
- Ministry of Education, Youth and Sports (MEYS) is the central administrative authority for R&D programmes in the public sector, particularly institutional funding for public universities, and for promoting international research collaboration. MEYS coordinates the EU Structural Funds through the Operational Programme Research and Development for Innovation (OP RDI) and the Operational Programme Education for Competitiveness (OP EC).
- Ministry of Industry and Trade (MIT) administers policies in the domain of business RDI. MIT coordinates the EU Structural Funds through Operational Programme Enterprise and Innovation (OP EI).
- Technology Agency of the Czech Republic (TA CR) provides competitive funding for applied research, experimental development and innovation.

- Czech Science Foundation (GA CR) provides funding for competitive grants in basic research.
- Academy of Sciences of the Czech Republic (ASCR) is a major funding provider and as the whole the single most important research performer.

Figure 1. Czech RDI governance system



RDI policy making is fairly centralized. Regional authorities, the self-governing regions at the NUTS3 level, do not have any legally binding responsibilities in this respect. At the regional level, the role of RDI policy is limited to the implementation of national programmes and the implementation of regional development policies. Nonetheless, the law does not prevent the regional authorities from launching their own RDI policy initiatives, though only a very few have done so.

Main changes in 2014

The National RIS Strategy was released.

Nine out of sixteen members of the CRDI council were replaced.

Pavel Bělobrádek was appointed the Deputy Prime Minister for the Science, Research and Innovation and the Chairman of the CRDI.

The MEYS signed under the IPN METODIKA project a contract with Technopolis Group to design a new system of evaluation of research organisations and allocation of institutional funding.

TA CR started funding the GAMA and DELTA programmes and announced the EPSILON programme.

MIT shut down the project Seed Fund to launch a public-private venture capital fund.

GA CR did not issue a new call for postdoc projects but started a new programme of junior projects.

R&D tax credits were extended to purchase of external R&D services from research organisations.

Main Changes in 2013

Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 re-confirmed the reform track.

Metodika 2013 provided a medium-term modification of the formulae-base evaluation of research organisations and allocation of institutional funding.

Higher education reform ended up in doldrums.

The centre-right coalition government collapsed, early elections were held, and a new centre-left government was formed.

National programs sustainability I. and the prospective National program sustainability II. were put in place to sustain financing of the new research centres and infrastructures.

Main changes in 2012

National Priorities of Oriented Research, Experimental Development and Innovation started to guide the design of new support programmes.

The number of R&D budget providers was halved to 11 in the multi-annual budget plan.

TA CR starts funding BETA, OMEGA and Competence Centres programmes.

The TIP programme of the MIT was defunded in medium-term.

Regional governments started to implement innovation voucher programmes.

Main changes in 2011

Strategy of International Competitiveness addressed framework conditions affecting innovation performance.

National Innovation Strategy outlined goals for innovation policy.

TA CR starts funding projects in the first programme ALFA.

Main Changes in 2010

The Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic paved the way for their construction.

A new centre-right coalition government took office after regular parliamentary elections.

1. Recent Developments in Research and Innovation Policy and systems

2.1 National economic and political context

Real GDP growth was high for nearly a decade, annually on average about 4.5% over 2000-2008, which was well above the EU28 average. However, the slump in export demand during the global economic crisis hit the economy hard and GDP dropped by 4.5% in 2009; despite the fact that the domestic financial sector did not face major difficulties thanks to the clean-up about a decade ago. In 2010 and 2011, the economy recovered at a slow pace with GDP growing by 2.5% and 1.8%, respectively, however only to plunge into a double dip recession with GDP declining by 1.0% in 2012 and by 0.9% in 2013 (Eurostat, 2014).

The center-right coalition government collapsed in June 2013. Early elections took place in October 2013 and a new centre-left coalition government is in place since early 2014. Pavel Bělobrádek, leader of the junior coalition partner the Christian Democratic Union – Czechoslovak People's Party, has been appointed the Deputy Prime Minister for the Science, Research and Innovation, a newly created position in the RDI governance system, and the Chairman of the CRDI. Over the summer 2014, nine out of sixteen members of the CRDI council have been replaced, hence significantly changing the composition of the main policy body. So far there has not been a major shift in RDI policies.

Pavel Bělobrádek, the Deputy Prime Minister for the Science, Research and Innovation, has been allocated about €4m in the public RDI budget in 2015 to build a new section under the Office of the Government, which ultimately may form the basis of an Office for Science, Research and Innovation and even a full-fledged Ministry of Science, Research and Innovation. A "big" novella of the Act No. 130/2002, on Support for Research, Experimental Research and Innovation is accordingly under preparation at the new department that besides other issues should clarify its status and that hence has the potential to fundamentally reform governance of the RDI system.

2.2 National R&I strategies and policies

The main priorities in the area of science, research and innovation as outlined in the Policy Statement of The Government of The Czech Republic that took office early in 2014 are to: i) Increase motivation within the private and public sectors to use RDI results; ii) Revise evaluation and funding of research institutions and projects to reflect their real contribution to the development of the Czech Republic; iii) Improve the functioning of the CRDI, promote mobility of RDI staff and PhD students and strengthen doctoral disciplines in applied fields; iv) Increase support for involvement in international projects, applied research, technology transfer and the use of venture capital; v) Support new growth sectors of the digital economy, cultural and creative industries; vi) Formulate new

incentives to stimulate projects with high added value, high proportion of R&D and strategic services; and vii) Submit proposed amendments of higher-education legislation.

The CRDI implements a medium term modification of the evaluation methodology of research outputs for the period 2013-2015, the so-called Metodika 2013 (CRDI, 2013b), on the base of which institutional funding is supposed to be allocated until 2016. Pillar I remains the same as before using formulae-based procedure of assigning points to publications. Pillar II newly involves international peer review of a list of top outputs submitted by the evaluated organisations, on the base of which the expert panel decides on distribution of a small amount of additional funding. Moreover, extra bonuses are awarded to research organisations, which obtained project funding from the ERC. Pillar III considers outputs of applied research, predominantly patents, and takes into account external funding acquired for applied research and contractual research. The formulae-based allocation of points for outputs recorded in the previous five years continues to be the dominant part of the evaluation. A major departure from the previous funding mechanism, however, is that results of the evaluation provide only background information for budget decisions; hence institutional funding is not supposed to be automatically allocated based on evaluation. Partial results of Metodika 2013 were announced in January 2015 and the full report should be released in the first half of 2015 in order to be used for drafting 2016 budget recommendations.

As the result of the implementation of the Reform of the RDI System, the number of R&D budget providers has been halved to 11 in the budget period 2013-2015. The responsibility for administrating national public support for applied research, experimental development and innovation was moved under the umbrella of the TA CR, which gradually takes over from ministries and other state institutions. On one hand, the budget of the TA CR grows, while the national R&D budget earmarked for competitive funding in the respective areas of ministries declines. On the other hand, the MEYS and MIT administer large Operational Programmes (OP) of the EU Structural Funds dealing with R&D and innovation; there is significant dynamics of expenditure within these programmes as national public co-financing is required.

Since 2012, TA CR has started to fund a portfolio of new programmes: i) ALFA supports applied research and experimental development and stimulates public-private R&D cooperation with a budget of about €290m over the period 2011-2016; ii) BETA is a programme of public procurement in research, experimental development and innovation for the needs of public administration bodies with a budget of €25m over the period 2012-2016; iii) OMEGA supports applied social science research and experimental development with a budget of €12 million over the period 2012-2017; and iv) Competence Centres supports projects of RDI centres in progressive fields with strong application potential and with conditions for the development of long-term collaboration between the public and private sectors, approximately 35 centres are supported with a budget of about €240m over 2012-2019, 28% of which has been already allocated to the recipients. Furthermore, TA CR started two additional programmes in 2014, namely i) GAMA

supporting the verification of R&D results in terms of their practical application and their subsequent commercial use with a budget of €69m over the period 2014 to 2019, and ii) DELTA funding grants for joint international projects with third countries with a budget of €30m over the period 2014-2019. TA CR also starts a new EPSILON programme in 2015, a follow-up on ALFA, which should last for 11 years until 2025 with a budget allocation of €373m, and which is aimed at supporting applied research and experimental development with a high potential for rapid application in innovations in the priority areas of i) Competitive knowledge-based economy; ii) Sustainability of energy and material resources; and iii) Environment for quality of life.

GA CR continues to administer project-based funding of basic research with an annual budget of about €130m in 2014, which is earmarked to growth steadily to €150m in 2017. The main funding instrument is a standard grant project, to which are allocated nearly three-quarters of the budget thus about €97m in 2014, the call for which is announced annually and which can have duration of 1-3 years. Other funding instruments with much smaller budget allocations include projects for excellence in basic research, postdoctoral grants, junior grants and international bilateral grants.

New research centres and infrastructure projects financed by the OP RDI, through the Priority Axes 1 and 2 that are going to have a profound impact of the whole R&D system are under construction and gradually opening (MEYS, 2013). Six large projects with a total amount of subsidy of €835m (85% funded by the ERDF) were approved for funding in regions outside of the capital city of Prague in 2010: i) ELI - Extreme Light Infrastructure (€271m); ii) BIOCEV - Biotechnology and Biomedicine Research Centre (€92m); iii) CEITEC - Central European Institute of Technology (€209m); iv) Centrum excellence IT4Innovations (€72m); v) ICRC - International Clinical Research Center (€94m); and vi) SUSEN - Udrzitelna energetika (€97m). In addition, CIIRC - Czech Institute of Informatics, Robotics and Cybernetics (€54m) located in Prague was approved for funding in 2013. National programs sustainability I and II have been established to fund launching of the new facilities until 2020.

Thematic funding programmes are underdeveloped and the thematic focus is not very strongly promoted by the existing funding sources. Hence, the share of public resources spent on thematically non-oriented research far exceeds expenditures on oriented research. According to the shares of socio-economic objectives (NABS), non-oriented research financed from general university funds had 28.3% and from other sources 29.9% share in GBAORD in 2012, respectively. Within thematically oriented research, representing the remaining 41.8% of GBAORD, industrial research prevails (15.9%), followed by medical research (6.2%) and transport, telecommunication and other infrastructure (4.2%). Other socio-economic objectives have a combined share of 15.5% on the total GBAORD (Eurostat, 2014).

Despite the Reform of the RDI system, the balance between thematic and generic funding has remained remarkably stable; oscillating in a narrow range between 58% and 61% share of generic funds in GBAORD over the period 2008-2012. So far the allocation of

thematic funding has only loosely reflected the national priorities and grand challenges. Yet this is planned to change with implementation of the updated priorities of oriented R&D for the period until 2030 (CRDI, 2012), which are designed to reflect major societal challenges in line with in the Horizon 2020, and which should be respected in the thematic focus of new support programmes and prospectively also in allocation of institutional funding. None of the existing policy documents, however, sets binding targets in this respect.

In July 2014, the government approved new operational programmes dealing with RDI that are going to be funded from the European Structural and Investment Funds (ESIF) during the programming period 2014-2020. The OP Enterprise and Innovation for Competitiveness (OP PIK) under the MIT with the EU contribution of €4.32b (a total budget allocation of €7.91b) is designed to support the development of a competitive and sustainable knowledge and innovation—based economy. The OP Research, Development and Education (OP VVV) administered by the MEYS with the EU contribution of €2.78b (a total budget allocation of €3.4b) is aimed to support the transition to economy based on education, motivated and creative labour force, high-quality research results and their implementation in practice. The Operational Programme Prague – Growth Pole of the Czech Republic (OP PGP) administered by the Prague City Hall with the EU contribution of €0.2b (a total budget allocation of €0.4b) includes one priority axis directly relevant to RDI on "Strengthening research, technological development and innovation" that is aimed at promoting public-private cooperation and the establishment and development of knowledge-intensive companies. It is expected that the OPs will be approved by the European Commission in the first half of 2015.

Overall, the policy measures follow the National RDI Policy 2009-2015 and its mid-term update from 2013; hence in a broad sense they jointly form a coherent and integrated framework for reforming the RDI system that is in line with the EU priorities and increasingly aimed at promoting excellence in research and fostering innovation. However, the degree of implementation of the reform agenda is highly uneven and often falls short of expectations. Stakeholders are fragmented into adversary interest groups, along the dividing lines of industry, university and government sectors, rather than working in concert. Opportunities for joint programming are seldom exploited, cross-border cooperation remains rare and the leverage effect of EU funding largely depends on how the challenge of integrating the new research centres and infrastructures is tackled. New long-term priorities of oriented RDI announced in 2012 that are largely in line with the grand challenges of Horizon 2020 are increasingly accommodated in the design of new programmes of targeted support. The National RIS Strategy was released at the end of 2014 and it remains to be seen to which extent it is going to be reflected in funding flows.

2.3 National Reform Programmes 2013 and 2014

The national 2020 target is to reach 1% of public R&D expenditure per GDP. In 2013, government sector R&D funding obtained from national sources reached 0.66% of GDP, whereas public R&D funding from abroad, primarily from the EU Structural Funds, amounted to 0.31% of GDP, which in total is 0.97% of GDP (Eurostat, 2014). Hence, the national 2020 goal has been almost met, if the foreign public sources are included. However, this is to a large extent due to a spike of EU funding for the construction of several major projects of research infrastructure. It remains to be seen whether the increased level of public R&D funding will be sustained after the investment phase of these large-scale investment projects fizzles out.

National Reform Programmes 2013 and 2014 stipulate that a new system of evaluation of research organisations and distribution of institutional funding is put in place (Office of the Government of the Czech Republic, 2013 and 2014a). IPN METODIKA project on "Efficient system of evaluation and financing of research, development and innovation" (as a part of the OP RDI under the auspice of MEYS), which is intended to conduct an in-depth revision of the methodology, is in progress, as a part of which in mid-2014 a consortium led by the Technopolis Group has been awarded a contract to produce the new methodology by mid-2015. After several years of a stalemate there seems to be an important policy shift, which is likely to lead into incorporating international best practices, including peer review, into the evaluation methodology. Nevertheless, no clear roadmap for implementation of the new methodology has been announced so far and it is expected that funding decisions could be based on results of the new methodology at the earliest in 2017.

Moreover, the National Reform Programme 2014 (Office of the Government of the Czech Republic, 2014a) recommends designing a new methodology of evaluation of targeted RDI support programmes, which includes ex-ante, interim and ex-post stages, and which involves the assessment of the intervention logic and evaluation of their effectiveness, results and impacts. In spring 2014, a working group consisting of the main providers of targeted funding started to work out the solution under the auspice of the CRDI. The working group is expected to outline systemic changes in the evaluation procedures of targeted support that are needed for achieving more efficient allocation of public funding. The memorandum produced by this working group is expected to be submitted to the government in spring 2015.

Finally, as required in the third specific recommendation of the National Reform Programme 2014 (Office of the Government of the Czech Republic, 2014a) with RDI relevance, the government shall prepare a methodology for evaluating large RDI infrastructures. In this regard, a comprehensive two-stage assessment of all existing and planned projects of large R&D infrastructures carried out by the MEYS in the second half of 2014. The evaluation was based on information submitted by research organisations, which registered their projects on a voluntary basis. In total, 119 projects have been

assessed and out of that 58 successfully passed the evaluation. The outcome of the evaluation will feed into the update of National Roadmap for Large Research, Experimental Development and Innovation Infrastructures that is going to be completed in 2015..

National Reform Programme 2013 (Office of the Government of the Czech Republic, 2013) further includes a range of recommendations that have been already addressed with various degrees of success. New priorities of oriented RDI are being reflected in the design of new programmes of targeted support (see Section 5.3). National Sustainability Programmes I and II aimed to fund operation of the new research centres and infrastructures are ready (see Section 5.3). New instruments stimulating business RDI as well as public-private cooperation have been launched most prominently under TA CR (see Sections 2.5, 4.4 and 5.3). New efforts have been started to upgrade technology transfer infrastructure (see Section 4.3). The National RIS Strategy has been published at the end of 2014 (see Section 2.6). Unfortunately, the launch of a public-private seed fund has been terminated due to an appeal to the Office for the Protection of Competition (see Section 4.6), however, there are plans to re-launch this effort in the new programming period. Foresight activities are developed under the MIT, TA CR and the Technology Centre of the ASCR.

2.4 Policy developments related to Council Country Specific Recommendations

The European Commission (2013b, 2014b) recommended introducing a new methodology for evaluating research and increasing the share of performance-based funding of research institutions. A revised methodology of evaluation of research organisations that is fully performance-based has been put in place for years 2013–2015 (for more details see Section 2.3), on the base of which institutional funding should be allocated until 2016. The revised methodology at least partly removes the highly criticized shortcomings of the previous evaluation system, though; the evaluation continues to heavily rely on the formulae-based approach. Contrary to the previous methodologies, however, it does not include explicit rules for allocating the institutional support, as the evaluation results only provide background information, which the CRDI is going to use for the preparation of its draft state budget for the RDI area. Hence, the evaluation system is based on performance indicators but institutional funding is distributed according to budget negotiations among actors. After 2015 a new system of RDI evaluation and distribution of institutional funding that is under preparation within the IPN METODIKA project by Technopolis Group (for more details also see Section 2.3) is scheduled to be gradually implemented; however, a roadmap has not been announced yet.

2.5 Funding trends

2.5.1 Funding flows

In 2013, gross domestic expenditure on R&D (GERD) amounted to €3.0b (CZK 78b) and increased by about 8% as compared to the previous year, driven mainly by the expansion of business and foreign funding, while national public funding stagnated. GERD jumped by 56% over the period 2008-2013, which marks a remarkable recovery. As a consequence, R&D intensity of the economy in terms of GERD as % of GDP increased to 1.91% in 2013, as compared to the lowest point of 1.24 % at the dawn of the crisis in 2008, hence noticeably approaching the EU28 average of 2.02%. The national 2020 target of 1% public R&D intensity of GDP has been almost reached already, if foreign public sources are factored in, however, national public sources tend to stagnate, which casts doubts about sustainability of the recent R&D investments growth (Eurostat, 2014).

Business enterprise expenditure on R&D (BERD) accounted for 54% (€1.62b) of the total, the higher education sector came second with 27% (€0.82b) closely followed by the public research institutions with 18% (€0.55b), while the private non-profit sector remained negligible accounting for less than 1% (€0.01b) in 2013. BERD as % of GDP reached 1.03% in 2013, which represents a significant increase compared to 0.86% in 2011, the crisis bottom of 0.73% in 2008, and about 0.70% ten years ago. BERD is characterised by a level of domination by foreign-owned companies that is one of the highest in the EU, as about 55% was performed by foreign affiliates in 2013 up from 51% in 2011 but down from 57% in 2008; this represents a particular challenge for the design of RDI policies (Eurostat, 2014 and CZSO, 2014a).

In 2013, the business sector financed 38% (€1.13b) of GERD, of which 97% was spend by the firms themselves, which testifies to the very weak link between the business sector and other parts of the system. About two-thirds of BERD continues to be financed from within the business enterprise sector, however, the share of BERD funded from abroad more than doubled from 10% in 2008 to 21% in 2013, driven predominantly by foreign business funding from members of the same group. The government sector funded 35% of GERD (€1.04b), most of which is split between higher education (47%) and public research institutions (35%). Foreign sources in total contributed by 27% (€0.81b) of GERD funding in 2013, tripling from only 9% in 2008. About 40% of the foreign funds came from private and 60% from public sources in 2012 and 2013; predominantly the EU funds, which is a major shift as the private segment dominated with more than 70% share before 2011; this casts doubts on the sustainability of this increase (Eurostat, 2014 and CZSO, 2014a).

The role of the EU Structural Funds in the funding of R&D has grown enormously in the programming period 2007-2013. Public R&D activities were financed particularly by two OPs administered by the MEYS: OP RDI (ERDF) and OP EC (ESF). The combined allocation of these two OPs equalled approximately €3.8b. Business R&D and innovation activities were

financed through the OP EI administered by the MIT with a total budget of approximately €3b for RDI relevant activities. Innovation activities with only a small fraction of possible R&D financing were also supported by the OP Prague -Competitiveness (OP PC) and OP Prague – Adaptability (OP PA). Czech participants active in projects funded under the 7th Framework Programme acquired from the EU support of €289m in 1,146 projects, which represents a sizeable increase as compared to the 6th Framework Programme with the EU support of €139m in 890 projects.

The government budgetary appropriations or outlays for R&D (GBAORD) amounted to €1.00b (CZK 26b) and the intensity of the economy in terms of GBAORD as % of GDP reached 0.67% in 2013, which represents a noticeable increase from €0.82b (CZK 20b) and 0.53% of GDP in 2008, respectively; however, the rise is largely due to the need to co-finance the EU Structural Funds. As the result, GBAORD as % of GDP nearly eliminated the gap as compared to the EU28 average of 0.69%, despite major cuts in other parts of the government budget during the prolonged recession (Eurostat, 2014). GBAORD stagnated roughly at the same level in 2013 and 2014 (CRDI, 2014) and are earmarked to slightly increase to €1.04b in the state budget approved by the parliament in 2015.

Table 1: Basic indicators for R&D investments

	2009	2010	2011	2012	2013	EU28 (2013)
GDP growth rate	-4.5	2.5	1.8	-1.0	-0.9	0.1
GERD (% of GDP)	1.30	1.34	1.56	1.79	1.91	2.02
GERD (euro per capita)	184.6	200.3	243.4	273.9	285.0	539.2
GBAORD - Total R&D appropriations (€ million)	870	894	1,048	1,040	1,005	90 506
R&D funded by Business Enterprise Sector (% of GDP)	0.52	0.55	0.59	0.65	0.72	1.10 (2012)
R&D funded by Private non-profit (% of GDP)	0.00	0.00	0.00	0.00	0.00	0.03 (2012)
R&D funded from abroad (% of GDP)	0.15	0.19	0.31	0.46	0.52	0.20 (2012)
R&D performed by HEIs (% of GERD)	19.7	20.0	24.4	27.5	27.2	23.6. (2012)
R&D performed by Government Sector (% of GERD)	23.3	21.7	19.8	18.4	18.3	12.2 (2012)
R&D performed by Business Enterprise Sector (% of GERD)	56.5	57.7	55.3	53.6	54.1	63.3 (2012)
Share of competitive vs. institutional public funding for R&D (in %)	44.2	46.5	48.1	49.1	51.5	..
Employment in high- and medium-high-technology manufacturing sectors (% of total employment)	9.5	9.5	10.3	10.5	10.8	5.6
Employment in knowledge-intensive service sectors (% of total employment)	30.8	31.8	31.5	32.0	32.8	39.2
Turnover from Innovation (% of total turnover)	..	15.3	..	..	..	13.4 (EU-27, 2010)

Data sources: EUROSTAT

2.5.2 Project vs. institutional allocation of public funding

The public R&D funding has been traditionally dominated by institutional support. However, this is changing in the context of the Reform of the RDI System that has been launched in 2008. As a result, according to the official classification used in GBAORD the share of project funds increased markedly in the last few years, namely from 44% in 2009 to 51% in 2014. The GBAORD multi-annual budget plan approved by the government in June 2014

outlines that the share of project funding will oscillate in the narrow range between 51% in 2015, 52% in 2016 and 50% in 2017 (CRDI, 2014). However, in fact the true share of project funding is higher, probably in the range between 55% and 60% over 2014-2017, because several items officially recorded under the heading of institutional funding, such as co-financing of the EU Structural Funds administered by the MEYS and MIT or support to projects of international cooperation under the MEYS, do not necessarily meet the definition.

Early in the reform a new methodology for evaluation of R&D results and distribution of institutional funding was introduced. The methodology was based exclusively on quantitative indicators. It has been decided that each provider receives institutional funds based on historical research results achieved over the past five years, as reported to the central database of research results. However, the new system has been heavily criticized by the academic community among other things for being too mechanistic, for not taking into account differences in publication behaviour between fields of science and for creating unstable funding conditions. In turn, the International Audit of Czech RDI concluded that the evaluation methodology is not fir for purpose and recommended a fundamental revision (Arnold, 2011).

A medium term modification of the evaluation methodology has been introduced for the period 2013-2015, so-called Metodika 2013 (CRDI, 2013b), on the base of which institutional funding is going to be allocated until 2016. The new formulae are based on the compromise between the need to use quantitative criteria and other considerations by the main stakeholders (for more details see Section 2.2). According to the initial reform plans, almost the full amount of institutional funding was supposed to be allocated using the performance-based formulae. However, in order to stabilize the funding flows, a consensus has been reached that only 20% of the money is allocated using the evaluation results, hence competitively, while 80% of the money is divided in the same proportion as in the previous year, hence representing block funding. After 2015 a new system of RDI evaluation and distribution of institutional funding that is under preparation within the IPN METODIKA project by the Technopolis Group is scheduled to be gradually implemented (for more details also see Section 2.3).

In 2014, the single largest recipient of institutional funds was the ASCR with €171m (CZK4.5b), which constituted 34% of the total institutional funding. Nevertheless, the ASCR increasingly acquires funding from other sources than its own public budget line. According to ASCR (2014), the total budget amounted to €486m (CZ12.6b) in 2013, of which thus public institutional funding only accounted for 35%, which represents a significant drop from 60% in 2009; the gap was filled mainly by the increase of resources received from budget lines of other public R&D providers and by the growth of funding from the EU, the combined share of which doubled from 17% in 2009 to 34% in 2013, while the rest was covered by increased funding from other external sources outside of the public budget. It is important to note that the institutional funds that are allocated to the ASCR in its own public R&D budget line become re-distributed between the member research institutes

using results of its own internal evaluation methodology that involves international peer review.

Overall, however, the largest share of the national institutional funding, about 44% and €217m (CZK5.6b) in 2014, is channelled to the sector of higher education by the MEYS, which distributes the funds among the individual higher education research organisations using results of the formulae-based evaluation. Much smaller amounts are channelled through other ministries which predominantly use the institutional funds to support field-specific research centres under their own umbrella (the Ministry of Agriculture, the Ministry of Health, the Ministry of Culture, and others). National public co-financing of the EU Structural Funds dealing with R&D and innovation that is administered by the MEYS and MIT and that amounted to €53m (CZK1.4b) in 2014 is also classified under the category of institutional funding in the public R&D budget.

The main providers of competitive project funding are the GA CR which allocates grants for basic research and the TA CR which supports applied research, experimental development and innovation. GA CR had an annual budget of €133m (CZK 3.5b) in 2014, which more than doubled from €59m (CZK 1.5b) in 2008. The legal statute of TA CR was adopted by the government in December 2009 and the first programme ALFA was launched in March 2010. The first projects were selected in November 2010 and started at the beginning of 2011. Another three programmes funded by TA CR called BETA, OMEGA and Competence Centres were launched in 2012, two additional programmes GAMA and DELTA started in 2014 and EPSILON replacing ALFA starts in 2015. As a result, the budget of TA CR has grown significantly in recent years from €34m (CZK 0.9b) in 2011, to €114m (CZK 3.0b) in 2014.

GA CR uses international peer review to guide the allocation of funds. The main funding instrument is a standard grant project, the call for which is announced annually and can have duration of 1-3 years. The applications are assessed by an expert panel (39 panels in 5 disciplinary areas) on the base of two-step review procedure; first, the applications are evaluated by two internal reviewers and then only those that satisfy minimal quality requirements (about two-thirds of the applications) are evaluated by at least two foreign reviewers (Slovaks are not perceived as foreigners). Other funding instruments of GA CR, i.e. postdoctoral grants, junior grants, projects for excellence in basic research and international bilateral grants, are evaluated using similar procedures. TA CR evaluates project proposals using peer-review but only with the help of domestic experts.

The major part of project funding for applied research used to be administered by the MIT, primarily through the TIP research programme the budget of which, however, has been significantly reduced with expenditures of €121m (CZK 3.0b) in 2012, €78m (CZK 2.0b) in 2013 and €41m (CZK 1.1b) in 2014, and is earmarked to continue shrinking in the medium-term budget outlook. From 2017 onwards the MIT is supposed to cease to administer competitive funding from the national public R&D budget and completely pass this role to the TA CR. The MEYS also has a significant budget devoted to project-based funding, which is directed primarily towards the higher education sector, including the

competitively allocated funding for research conducted by master and doctoral students – the so-called "specifický výzkum" – with a budget of €45m (CZK 1.2b) in 2014; there are no plans to transfer this funding under the GA CR or TA CR.

Much smaller amounts of project funding are channelled through five other ministries which provide funding through their individual research programmes (the Ministry of Agriculture, the Ministry of Culture, Ministry of Defence, Ministry of Health and Ministry of Interior). However, past experience has shown, that these programmes, while nominally project funds, are often used as a source of institutional funding for research institutes controlled by the given ministries and also as means of research funding for the needs of these ministries.

According to the International Audit of Czech RDI (Arnold, 2011, pg. 56), the share of project funding allocated competitively was too high, exceeding proportions that many countries deem as dangerous, and one of the key recommendation was that in order to assure stability and opportunities for long-term planning institutional funding should comprise at least 50% of the public R&D budget. Despite initial reform plans to reach 60% to 40% ratio between project (or targeted) and institutional funding by 2015, the policy has been updated in this respect and the ratio has stabilized around 50% over 2012-2014 and is projected to remain roughly at the same level in the medium-term budget outlook until 2017.

Generally speaking, the key challenge that needs to be addressed for achieving more efficient and effective functioning of the funding allocation system is underdeveloped evaluation culture. As also pointed out by the International Audit of Czech RDI (Arnold, 2011, pg. 56), the system of R&D evaluation is grossly outdated, focused on counting outputs rather than aiming at assessing policy interventions, outcomes and their impacts, and hence provides limited feedback to the policy and programme development; there is a need for a fundamental upgrade of evaluation practices.

2.5.3 R&I funding

Until recently the government stimulated RDI in the business sector predominantly through direct subsidies. The programme TIP administered by the MIT provides subsidies to applied industrial research and R&D collaboration between the business and academic sectors. The OP EI is designed to address the needs of industry, from start-ups to mature firms, including Potential programme promoting R&D capacities in enterprises, the Cooperation programme for technology platforms and clusters, Prosperity supporting technology parks and business incubators and the Start, Development, Innovation, Progress and Guarantee programmes that help start-ups and SMEs to overcome the limited availability of external funding. Most importantly, TA CR, which was established in 2009 as prospectively the main provider of direct subsidies to applied research and innovation, launched a portfolio of new programmes, including ALFA and Competence Centres. Subsidies channelled through the MIT and TA CR, which amounted to about €150-200m (CZK 4-5b) annually over the period

2010-2014, are the dominant direct tools for stimulating innovation. Several regions have implemented innovation voucher programmes; however, their funding has been limited to a combined value of less than €1m (CZK 26m) annually, hence very small so far.

Yet there has been a shift from a system traditionally based on direct subsidies towards a wider portfolio of support measures. An R&D tax credit scheme has been launched in 2005 to stimulate private R&D expenditure. The new tax regulation enabled enterprises to deduct expenditures on R&D carried out for their own needs from the tax base, a major change as there was no measure of this kind before. In 2005, 27% of R&D performing businesses used the tax relief and the indirect support of R&D amounted to €27m (CZK 0.82b). In 2012, the number of companies drawing on indirect support to R&D was already around 45% of companies performing R&D activities and the indirect support of R&D reached almost €77m (CZK 1.99b). About 80% of firms that use the indirect R&D support have less than 250 employees and 70% of them are domestic-owned; hence this instrument proves to be particularly suitable for promoting R&D in domestic SMEs (CZSO, 2014b). Since 2014 the tax credits have been extended to the purchase of R&D services from research organisations. So far there has not been any evaluation of this support scheme.

Venture capital market is underdeveloped. Venture capital investment was limited to €12m in 2010, €8m in 2011 and dropped to less than €1m in 2012 and 2013. Only several companies receive venture capital funding each year (Eurostat, 2014). Public measures to support venture capital are missing. Since 2011 the MIT has attempted to establish a public-private seed fund to kick-start the market. A budget of €53m funded from the OP EI was earmarked for the fund, of which €32m to the SEED instrument for early-stage and €21m to the VENTURE instrument for expansion funding. However, in 2013 the launch of the seed fund became complicated by the ruling of the Office for the Protection of Competition due to dispute over the tender for the fund's custodian and in 2014 the project was eventually terminated by the government (CzechTrade, 2014).

2.6 Smart Specialisation (RIS3)

Regional authorities, consisting of 14 self-governing regions at the NUTS3 level, do not have any legally binding responsibilities in RDI policy. Yet the law does not prevent them from launching own RDI initiatives, which is, however, difficult given their restricted budgets. So far their main role has been in catalysing the EU Structural Funds projects, primarily those funded from the OP RDI. The South Moravian region is the main exception that proves the rule, representing the national role-model of regional innovation policy with dedicated authorities, a well-functioning innovation agency and a dialogue with the business community; for more information see (RISJMK, 2013). Several other regions are attempting to emulate this model with various degrees of success, most prominently Moravia-Silesia, Liberec, Zlín and Hradec Králové regions, while most of the other regions have either only paid a lip service or ignored the need to developing regional innovation policy altogether.

MEYS accepted the responsibility for designing the RIS3 strategy and appointed the so-called RIS3 Coordination Board in November 2012 (MEYS, 2014). Regional RIS managers were selected in April 2013 and the national RIS3 facilitator was assigned in September 2013; arguably facing a very tight schedule. The regional managers were appointed and funded by the MEYS. Only South Moravia and the Capital City of Prague have started to work on their RIS3 strategies in a bottom-up manner, independently of the national initiative. It remains to be seen to which extent the top-down approach to crafting of the regional RIS3 strategies will make a tangible difference on the ground, especially in the regions where indigenous initiative has been very limited so far. The National RIS3 Strategy has been approved by the government and submitted to the European Commission in December 2014. Management and implementation of the RIS3 strategy has been transferred under the auspice of the Deputy Prime Minister for the Science, Research and Innovation in Office of the Government of the Czech Republic.

The National RIS Strategy is organized around five pillars: i) Entrepreneurship and innovation; ii) R&D; iii) Human resources; iv) Digital agenda; and v) Social innovation. The key enabling technologies have been specified as: i) Advanced materials; ii) Nanotechnology; iii) Micro- and nano-electronics; iv) Advanced production technologies; v) Photonics; vi) Industrial biotechnology; vii) Knowledge for digital economy, cultural and creative industries; viii) Social science knowledge base for non-technical innovation. At this point, there are four national S3 platforms: i) Engineering; ii) Information and telecommunication services and software; iii) Transport equipment; and iv) Pharmaceuticals and life technologies; more are expected to be added as the entrepreneurial discovery process gets unfolded. The strategy provides detailed consideration of financial requirements from the ESIF; however, there are no details on the use of national funds beyond the ESIF co-financing; this is going to be specified by the government annually. Monitoring reports are expected to be published annually and evaluation is scheduled to be conducted every two years in order to feed into the update of the strategy.

So far RDI policy making has been fairly centralized. Co-ordination between the national and regional level innovation strategies has been very weak, if not missing altogether. National innovation strategy has addressed the regional aspects of innovation vaguely only. Drafting of the national RIS3 strategy involves, at least formally, a coordinated action of the national and regional authorities on the topic of innovation policy; hence representing a much needed opportunity for establishing a nation-wide debate on this topic. Needless to say, it is pertinent that this dialogue is sustained beyond this particular purpose and elements of multilevel governance of the RDI system are implemented in the future.

2.7 Evaluations, consultations, foresight exercises

Methodology of Evaluation of Research Organizations and Evaluation of Finished Programmes (valid for years 2013 - 2015), so-called Metodika 2013 (CRDI, 2013b), gives the official guidelines for evaluation of public R&D support. A major asset of the evaluation system is the regular, detailed and complete collection of data in the Research and Development and Innovation Information System of the Czech Republic, which provides open access to information about publicly funded support measures, projects and their outputs (for more details see Section 3.3.2). However, the data is underutilized for evaluation purposes. The evaluation methodology is limited to monitoring and descriptive tabulations of the data but does not provide strategic intelligence in terms of assessing the policy interventions, counterfactual analysis, impact evaluation and international benchmarking that can be taken on board in policy and programme development (for more details see Sections 2.3, 2.4 and 2.5.2).

The Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 has been approved by the government resolution No. 294 on 24th April 2013 (CRDI, 2013a). The update provides a comprehensive evaluation of the progress achieved so far in implementing the RDI reform. The main aim of the update is to improve conditions for innovation, knowledge transfer and diffusion of frontier technologies. The update revolves around four priority areas: i) Supply of high-quality human resources; ii) Enhancing the framework for transfer and utilization of knowledge; iii) Boosting the innovative capacity in the business sectors and iv) Improving strategic management of the system. As the keystone has been flagged the field of human resources, because this is deemed to be essential for successful operation of the newly constructed research centres and infrastructures. Another purpose of the update is to re-align the reform agenda with the government medium-term budgetary plans in public R&D spending, which have been significantly downsized by the economic crisis and prolonged recession. Nevertheless, the government maintains its commitment to meet the 2020 national target of 1% of government spending on R&D as % of GDP. So far a macroeconomic model has not been used to assess the RDI impact on economic growth and there are no plans to create one.

3. National progress towards realisation of ERA

3.1 ERA priority 2: Optimal transnational co-operation and competition

In the context of the National Policy of RDI 2009-2015 implementation, new long-term national priorities of oriented RDI (for the period until 2030) that are largely in line with the grand challenges of Horizon 2020 were prepared by panels of experts at the end of 2011 and approved by the government in mid- 2012 (CRDI, 2012). More specifically, the priority research fields were identified within six broader areas: i) Competitive knowledge-based economy; ii) Sustainable energy and material resources; iii) Environment for quality life; iv) Social and cultural challenges; v) Healthy population; and vi) Safe society. The governmental ministries, ASCR, GA CR and TA CR have responsibility for implementing the priorities within their authority; they are taken into account for the preparation of proposal of state budget expenditures for 2014 and later.

The Czech Republic has become a member of five Joint Programming Initiatives (JPIs), all four from the first wave of 2009 and only one from the second wave of 2010: 1) Neurodegenerative Disease Research, 2) Agriculture, Food Security and Climate Change, 3) Cultural Heritage and Global Change, 4) Healthy Diet for a Healthy Life and 5) The Microbial Challenge – An Emerging Threat to Human Health. However, the Czech Republic plays a rather passive role in the JPIs. The Czech Republic is also formally engaged in all five Joint Technology Initiatives (JTIs). But only in two of them, namely ARTEMIS and ENIAC, have been issued calls for proposals by the MEYS.

According to Acheson et al. (2012), the main constraints regarding to Czech participation in the JPIs are budgetary restrictions, limited human resources, lack of coordination at the national level and insufficient compatibility of the national and European rules and procedures. It is therefore no wonder that albeit there are several programmes at the national level which support research on topics relevant to the strategic research areas of the JPIs, the national funding providers have not come forward with direct involvement in terms of financial participation so far. Šebková, et al. (2011) conclude that national financial support to joint programs is very low; ERA-NETs funding is close to zero and bilateral agreements account for a very low part of research funding.

As far as national participation in European Innovation Partnerships (EIPs) is concerned, this is very early to evaluate. Four users from the Czech Republic registered and they are involved in 33 out of 293 initiatives in the pilot EIP on Active and Healthy Ageing since 2011; hence, there is a small number of highly active participants. The other four existing EIPs are too new to assess, indeed. Given evidence on the participation in other joint research efforts discussed above, however, it is reasonable to expect that the involvement of Czech entities is not likely to be particularly high, unless national policies stimulating indigenous initiative are put in place.

The Czech Republic is a member of the most of the intergovernmental organisations in ERA as well as the member of projects of large European infrastructures (ESFRI). The Roadmap

for Large Research, Development and Innovation Infrastructures in the Czech Republic was approved by the Government in March 2010 (updated in May 2011). Several large research infrastructural projects, including pan-European infrastructures, are under construction and gradually opening, which have a potential to open new avenues for internationally co-operation. The ELI project aims at creation of a large laser infrastructure; this is the only ESFRI Roadmap project which has a base in the Czech Republic.

The Czech Republic participates in the European Space Agency, European South Observation, European Molecular Biology Conference, CERN, OECD, EUROATOM, EFDA and other international programmes. ASCR and GA CR are the members of the European Science Foundation. Since 1993 research teams from the Czech Republic participate in the EU's framework programmes. Because of the existing and well-functioning environment for research co-operation within the EU, bilateral research agreements are oriented toward third countries; they are organized either on intergovernmental level or on inter-institutional level, involving, for instance, the GA CR and ASCR. However, judging from the funding flows, the activity under these agreements is limited and most of them are focused on establishing contacts, networking and promoting mobility, hence not joint research projects. In addition, there is a weak link between the Czech joint programmes on one hand and the European programs on the other hand.

MEYS which is the main intermediary body responsible for international cooperation in research manages a host of programs that support international cooperation in research, namely EUREKA, COST, EUPRO, INGO, KONTAKT (devoted to financing bilateral projects based on intergovernmental agreements primarily with third countries) and GESHER/MOST (with Israel). As a member of the European Science Foundation, GA CR coordinates and co-funds its programs in the European Collaborative Research (EUROCORES) framework (these programs comprise less than 1% of GA CR budget), Research Networking Programmes, Research Conferences, Forward Looks and Member Organisations Fora (however, there has been limited activity in the latter four initiatives so far). GA CR further provides funding for international bilateral research grants (the combined funding for the bilateral grants comprises about 2% of GA CR budget only). TA CR has launched a new DELTA programme with the aim to facilitate international cooperation of support to applied research and experimental development through joint programmes with technological (and innovation) agencies in non-European countries. The Visegrad fund and the Financial Mechanisms of the EEA/Norway also promote research cooperation with the respective countries.

National Information Centre for European Research (NICER) that operates under the Technology Centre of the ASCR provides comprehensive support for the participation of national teams in international research cooperation, especially in the EU Framework Programmes. Czech Liaison Office for Research, Development and Innovation (CZELO) in Brussels supports the successful integration of the Czech research into the European research cooperation, particularly through the EU Framework Programmes for Research and Development. The office provides free services to researchers from all fields and all

research bodies in the Czech Republic. CZELO is a project managed by the Technology Centre of the ASCR and financially supported by the MEYS

Bilateral agreements under GA CR recognize the assessment of proposals conducted by the partner funding agency, i.e. the National Science Foundation of Korea, National Science Council of Taiwan and Deutsche Forschungsgemeinschaft; however, it is not obligatory that the evaluation conforms to international peer-review standards (although this is typically the case). DELTA programme of TA CR that starts operation in 2014 recognizes evaluations of the partner technology (or innovation) agency as the basis for national funding decisions. Again, it is not explicitly required in the background documentation that the evaluation process of the partner agency conforms to international peer-review standards.

3.2 ERA priority 3: An open labour market for researchers. Facilitating mobility, supporting training and ensuring attractive careers

3.2.1 Introduction

In 2013, there were about 43 thousands researchers (full-time equivalent), of which nearly half were based in the business sector, a third in the higher education sector and slightly less than a fifth in the government sector. In terms of intensity, there were 3,300 researchers per million people, which means close to the EU28 average but roughly half of the level maintained in top performing countries. The number of researchers roughly doubled during the ten-year period between 2004 and 2013, whereas it remained roughly stable during the main crisis period of 2008-2010 and even increased by about 17% over the recent period of 2010-2013; hence the labour market for researchers is steadily expanding.

The approach to RDI human resource management is unsystematic. Human resources management practices in the public sector need to be revised in order to reduce the widespread in-breeding, make career progression paths more transparent and intensify competition for posts. Czech institutions or organisations have not received, not even a single one, the Commission acknowledgement for progress in the context of the HR Strategy so far, i.e. there is no organisation with the "HR Excellence in Research" badge. Two institutions, namely the ASCR and Central European Institute of Technology (CEITEC), have endorsed the Charter & Code. But there is no HRS4R acknowledged institution.

Arnold (2011) points to the fact that human resources management practices in the public sector need to be revised in order to reduce the widespread in-breeding, make career progression paths more transparent and intensify competition for posts. There is a considerable scope for making better use of research internationalization in the public sector, the limited extend of which is in a sharp contrast to the pivotal role of foreign affiliates in the business sector. Only less than 10% of researchers are foreign and half of

those are Slovaks, which is very small proportion by international standards. An explicit internationalization strategy of the public research system is lacking.

3.2.2 Open, transparent and merit-based recruitment of researchers

Generic labour laws set employment conditions. General conditions of employment and the role of the state administration (especially the Ministry of Labour and Social Affairs) are regulated by the Labour Code (Act no. 262/2006 Coll.) and the Act on Employment (Act. no. 435/2004 Coll.), if not stipulated by a special regulation. Most public research institutions conduct their activities in accord with the Act on Public Research Institutions (Act no. 341/2005 Coll.). For higher education institutions the main human resources issues are defined by the Tertiary Education Act (Act No. 111/1998 Coll.), which has been amended seventeen times and a novelization of which is in the pipeline, sets rules for the operation of higher education institutions, including the appointment of professors and docents.

Nevertheless, the system is based on a high level of institutional autonomy. Research institutions have extensive self-governing rights and decision-making powers which have been further decentralized to the faculty and departmental level. Generally speaking, research institutions employ individual academics in a market driven decentralized system; the recruitment process is an internal affair of every institute. Hence, it is hard to assess policy-measures that define the way researcher's recruitment is carried out.

Likewise, career development is a matter for internal institutional regulations in higher educational institutions. The Higher Education Act gives the task of appointing professors and obtaining venium docendi (habilitation) to the Scientific Board of the higher education institution. Professors are appointed by the President of the Czech Republic on the recommendation of the higher education institution's council, submitted through the MEYS. Academic careers are hierarchical and consecutive and the academic titles have lifelong and countrywide validity, even though the underlying conditions vary by institution. The academic labour market is quite internally oriented. There is a very low horizontal mobility of academic staff leading to a clear pattern of inbreeding and limited competition for posts. Opportunities for early career researchers are weak, post-doc funding remains limited and often not allocated on competitive basis.

The legislation rules provide an open access for foreign researchers to be employed at academic positions, especially in case of EU citizens. There are also several measures simplifying inward mobility of researchers from the non-EU countries, such as the Scientific Visa Package. Attracting talented doctoral students from abroad is high on the agenda on some research institutes, albeit the achievement of this goal is rather difficult because of low financial support available (through there is the Fellowship J. E. Purkyně awarded at the ASCR). A programme called NÁVRAT, i.e. "return" in English, administered by the MEYS is aimed to improve conditions for re-integration of top researchers coming back from abroad.

3.2.3 Access to and portability of grants

Overall, public research funders, such as GA CR and TA CR, support almost exclusively resident researchers, with the exception of special programmes and funding based on agreement for international research cooperation, which is however fairly limited. Funding for non-residents is generally not possible, unless they become residents for the purpose of conducting the research project. Language barriers for participation of foreign researchers are important; the main exception represents the grant programmes of GA CR that require applications exclusively in English, however, the background documentation remains to be accessible in Czech only.

National research funding programmes do not allow transferability of a grant to another country, thus research projects funded by national research programmes must be performed in the Czech Republic. An entity from other EU country may participate in a public R&D tender provided that such participant does not apply for support from the public funds of the Czech Republic. Hence, reciprocity is required in any international partnership. None of the existing laws or documents explicitly elaborates on access to research infrastructures by non-resident researchers and there are no specific measures to facilitate cross-border access to research infrastructures.

3.2.4 EURAXESS

The EURAXESS Centre is funded by the MEYS through the EUPRO programme: Project „EURAXESS Czech Republic 2012 - 2015". The national network created by the project includes two service centres in Prague and Brno and regional contact points in eight cities. Services Centres provide personalized assistance on the challenges faced by researchers and their families when relocating, including visas, work permits, accommodation, legal issues, social security, medical care, pension rights and taxes, family support, language courses, day care, schooling, research funding, etc.

There is no legislation dealing with the online publication of publicly-funded research jobs. It is therefore not formally required to advertise new positions nationally and internationally in media, thus in practical terms only a minority of vacancies is announced through EURAXESS and other international portals. In 2011, the MEYS admitted that the awareness of EURAXESS Jobs portal was very low (VERA 2011), however, the situation has improved markedly in recent years: the number of accesses to the EURAXESS Jobs portal increased from 13,053 in 2011 to 30,263 in 2014, the number of queries to the EURAXESS network nearly quadrupled from 3,310 in 2011 to 12,427 in 2014 and the number of personal assistances provided by the EURAXESS service centre in Prague tripled from 580 in 2011 to 1742 in 2014, including assistance to 400 foreign researchers. According to the European Commission (2014d), the number of researcher posts advertised through the EURAXESS Jobs portal per thousand researchers in the public sector was 22.8 in the Czech Republic compared to 39.9 among the Innovation Union reference group and an EU average of 43.7 in 2013, hence still remaining below its full potential.
Since 2007, in line with the Council Directive 2005/71/EC on a specific procedure for

admitting third-country nationals for the purposes of scientific research, researchers from non-EU countries and their families can apply for a Scientific Visa for the purpose of carrying out a research project at a public as well as private Czech research organization (based on the Hosting Agreement). Hence, there is special regime with lower administrative burden and shorter processing period for a long-term residence permit of researchers of foreign origin. Nevertheless, there is a considerable scope for making better use of research internationalization in the public sector.

3.2.5 Doctoral training

Universities are fairly autonomous in the way they develop doctoral training, which makes it extremely difficult to derive general conclusion on the degree to which the Principles for Innovative Doctoral Training are taken into account. Generally speaking, there are very large differences in this respect. Standardisation of PhD programmes is being currently tackled within the reform of tertiary education based on the debate corresponding to challenges identified in the White Paper on Tertiary Education (adopted by the Government in 2009;[1]). However, the policy does not refer nor takes into account the Principles for Innovative Doctoral Training so far, i.e. there is no support that specifically promotes the setting up and running of innovative doctoral training programmes.

3.2.6 HR strategy for researchers incorporating the Charter and Code

None of the Czech institutions or organisations has received the Commission acknowledgement for progress in the context of the HR Strategy so far, i.e. there is no HRS4R acknowledged organisation with the so-called "HR Excellence in Research" badge. Nevertheless, three institutions, namely the ASCR, Charles University in Prague and CEITEC - Central European Institute of Technology, have endorsed the Charter & Code, so the underlying principles have been transposed at national level by individual institutions, most notably in the sector of public research institutes. In contrast, with the major exception of Charles University, there is generally little awareness and support of the principles in the higher education sector. So far national authorities have not encouraged public funded institutions to adhere to the Charter & Code.

3.2.7 Education and training systems

Labour market for researchers continues to suffer from a lack of experts. According to the data from the Czech Statistical Office (2014a), the number of PhD graduates has stagnated in recent years and there is a long-term tendency for the proportion of science and technology tertiary students to decrease in comparison to those of social science and

[1] http://www.msmt.cz/reforma-terciarniho-vzdelavani/bila-kniha

humanities, however, policies to boost the supply of (post)graduates in science and technology are lacking. The assessment of MIT (2011b) concluded that because the reform of tertiary education remains uncompleted, there has been an unchecked expansion of university graduates, the quality of which is however hard to judge. As shown by National Training Fund (2012), opportunities for early career researchers are weak, post-doc funding remains limited and especially in the university sector often not allocated on competitive basis, which leads to in-breeding. Arnold (2011) reported that management of research groups is underdeveloped, the groups tend to be very small, locked into existing research trajectories and lacking interdisciplinarity, there is little use of career development plans and mobility among researchers is poor. Overall, the approach to research human resource management is unsystematic.

Apart from several smaller initiatives, the most prominent measure to increase the attractiveness of research careers is the Česká hlava (Czech Head) project which awards an annual prize to distinguished Czech scientists. Recently this award has been extended for talented secondary students. Several projects supported by the EU Structural Funds entitled Otevřená věda (Open Science) and Otevřená věda regionům (Open Science for Regions) were organized by the ASCR in 2005 and 2007, respectively, the former was prolonged as Otevřena věda II, III and IV over the period 2009-2015; the projects were targeted at secondary school teachers and assisted them in directing students to research careers. In addition, activities aimed at increasing the attractiveness of research careers and popularising research include science and technology popularisation courses under the OP EC and development of science learning centres under the OP RDI.

NÁVRAT (RETURN) brain gain programme with the aim to improve conditions for re-integration of top researchers coming back from abroad is operated by the MEYS since 2011. The ASCR awards the Fellowship J. E. Purkyně to attract outstanding scientists from abroad since 2004; both Czech scientists working abroad and top foreign scientists are eligible. The MOBILITY programme is focused on outwards mobility of researchers supporting short-term internships at foreign partner institutions. Bilateral mobility of students and researchers is funded by the MEYS from the EU Structural Funds. MEYS also runs the Scholarship Awards within the Foreign Development Assistance Programme intended for talented Master and PhD students coming from third countries and studying in public universities. Scientific Visa Package that simplifies procedures required by researchers from non-EU countries to apply for a long-term residence permit was established in 2007; this regime only applies to foreign nationals employed at universities and public research organisations.

3.3 ERA priority 5: Optimal circulation and access to scientific knowledge

3.3.1 e-Infrastructures and researchers electronic identity

The keystone of the Czech e-infrastructure for research is CESNET (Czech Education and Scientific NETwork); national partner of GÉANT and EGI.eu and the coordinator of NGI (National Grid Infrastructure). CESNET, association of legal entities, was established in 1996 as a joint venture of universities and the ASCR. Its main goals are: i) Operation and development of the Czech NREN; ii) Research and development of advanced network technologies and applications; and iii) Broadening of the public knowledge about the advanced networking topics. CESNET participates in a number of international projects (DANTE shareholder, TERENA member, Internet2 partner, European GN2 project and GLIF participant).

CESNET is an integral part of the Roadmap for Large Research, Experimental Development and Innovation Infrastructures in the Czech Republic (integrated in the ESFRI Roadmap), approved by the government in March 2010 (updated in May 2011). The CESNET is developing this infrastructure with support from public budgets under two major RIs projects, namely CESNET Large Infrastructure and Extension of the National R&D Information Infrastructure in Regions (eIGeR). The reconstruction of the CESNET2 backbone network started in 2011; it forms the necessary foundation for the other components of the national information e-infrastructure.

IT4Innovations is a unique project (integrated in the ESFRI Roadmap) of a national Centre of Excellence in the field of information technologies. The centre enables the concentration of a wide range of scientific disciplines relating to information technologies and thus achieves development in respective spheres. Part of the project is acquisition of a high-performance supercomputer which has been put into operation in 2014 and which ranks among the top 100 most powerful supercomputers in the world. IT4Innovations is the national partner of PRACE (Partnership for Advanced Computing in Europe).

EDUROAM infrastructure has been implemented by CESNET. The purpose of the eduroam.cz project is to support and spread IP mobility and roaming within the Czech NREN. CESNET task is to in coordinate and propagate eduroam ideas at national level, supporting academic organisations interested in cooperation with eduroam.cz project. Moreover, CESNET operates the Czech academic identity federation eduID.cz project. The eduID.cz federation is based on the Shibboleth project developed by Internet2 and is a member of eduGAIN and participates in REFEDS. CERIT Scientific Cloud offers storage and computing resources and related services, including support for their experimental use.

3.3.2 Open Access to publications and data

Generally, there is growing consensus in the scientific community to allow open access to publications whenever possible, but the concern is about the funding for such arrangements. Hence, open access to both scientific publications and data for research purposes hinges on poorly developed infrastructure and institutional framework. The awareness of open access movement ideas is concentrated among library staff, but there are efforts to raise the awareness, such as the portals www.openaccess.cz and www.dspace.cz, which promote the open access ideas among researchers. Policies with regards to access to scientific publications are fragmented; the deals are negotiated separately by the individual research organizations. National open access repository does not exist.

Archambault, E., et al. (2014) reported that during the period 2008-2013 the percentage of peer-reviewed articles published in open access journals was 6.8% compared to the EU28 average of 9.4% in the green category, i.e. self-archiving of final peer-reviewed manuscripts in institutional or subject repositories and 9.6% compared to the EU28 average of 8.6% in the gold category, i.e. pay to publish in open access, respectively. Hence, there is a noticeable room for improvement in using the green open access, but there is already a sizeable potential for leveraging the possibility of gold open access, which however makes a difference only if the author actually pays for it. Unfortunately, no data is available on the latter.

According to OpenAIRE, there is no official government mandate to deposit research output arising from grants, no research funding agency requires that, nor exists any university which mandates to deposit published journal articles in its open repository. OpenAIRE gives a list of 11 open access repositories and 4 research data repositories scattered in libraries of various research organisations and universities. Although the Berlin Declaration has been signed by eight organisations, including the GA CR, ASCR and Masaryk University, and there is a growing number of open access journals published by the Czech research organisations, the adoption of open access to scientific publications remains in the early phase.

The Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 admits that policies with regards to access to scientific publications, i.e. journal subscriptions, are fragmented; the deals are negotiated separately by the ASCR and universities, which leads to inefficiencies, and that there is a need for forming consortium at the national level for this purpose (CRDI, 2013a). It is concluded that "access to information infrastructure for the system of research, development and innovation is not provided in a satisfactory manner". Admittedly, there is a looming deficit in this respect that represents a major challenge for policy. The CRDI at its 291st meeting in February 2014 approved a resolution on open access to publicly funded scientific publications that recommends to develop a national strategy of open access, intensify support to efforts of research organizations to facilitate open access and encourages research funding agencies

to require open access. Nevertheless, there are currently no measures or funding at the national level for promoting open access publishing.

The Czech Statistical Office (CZSO) provides confidential statistical data for scientific research purposes. Microdata can be provided only on the basis of a special contract, which stipulates conditions for the data confidentiality protection and the exact way of data use in accordance with the legislation. Data is provided in the form not allowing the direct identification of reporting units only to domestic and foreign legal entities the primary mission of which is scientific research. However, microdata is provided only from a handful of surveys, especially access to firm-level data is severely limited. In addition, there is no safe-room in the CZSO and on-line remote access to micro data for scientific purposes is not provided; each data release needs to be negotiated separately, which hinges merging of datasets, creating longitudinal panel data and hence undermines efforts to conduct research on the data systematically over long-term.

The CRDI administers the Research and Development and Innovation Information System of the Czech Republic (ISVaV), a well-developed information system for a collection, processing, publication and utilisation of data about publicly funded research activities, projects and their outputs. Access to this information system is required to be open and available on-line by the law. The system consists of the following databases: 1) Central register of R&D projects (CEP); 2) Central register of Institutional Research Plans (CEZ); 3) Information register on R&D results (RIV); 4) Central register of R&D Activities (CEA); and 5) Register of public R&D tenders (RES). Most of the datasets are updated quarterly and direct searching in the databases is possible through the user application.

4. Innovation Union

4.1 Framework conditions

In 2008, a comprehensible reform of the research, development and innovation system was launched. The reform is outlined in the National RDI Policy of the Czech Republic 2009–2015 (CRDI, 2009) and the Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 (CRDI, 2013a). The main act regulating the field of research, development and innovation is the Act No. 130/2002 Coll. on the Support of Research and Development from Public Funds and on the Amendment to Some Related Acts, which has been substantially updated by the reform amendment announced as Act. No 211/2009 Coll. The reform profoundly changed the governance of system and the responsibilities of the main players, namely mandated the CRDI to become the central player with the main strategic and coordinating role in policy making, established the TA CR as the dominant supporter of applied research and increased the share of public funding allocated on a competitive basis. The reform also brought to the attention of policy-makers the role of innovation and private-public research linkages for national competitiveness.

Business investment in research and innovation is not only supported by direct subsidies anymore, which used to be the dominant policy measure, but by much broader portfolio of instruments, including R&D tax credits both for internal activities as well as purchase of external inputs from research organizations, support programmers for joints research projects between the public and private sectors, regional innovation voucher programmes and measures planned to boost the venture capital market. Nevertheless, RDI policies continue to be focused predominantly on the supply side; neglecting the potential of using demand side instruments, and deeply rooted in the linear model of innovation. Coordination between the various policy instruments, including within the supply side, is underdeveloped and their synergies remain unexploited. Public procurement is not seen as an instrument to promote innovation.

4.2 Science-based entrepreneurship

The ublic research system is relatively strong consisting of an elaborate network of public universities and research institutes. However, a major weakness of the public research sector has traditionally been limited knowledge transfer from science to practical applications, poor commercialization of scientific outputs and underdeveloped entrepreneurship culture among scientists. Professors rarely get involved in spin-offs. No official data is available on the number of start-ups involving scientists, which is at least partly attributable to the fact that anecdotal evidence suggests that they are extremely rare. The evaluation system, including the allocation of institutional funding at the organization level and career progression paths at the individual level, heavily relies on indicators of scientific output and does not motivate scientists to get involved in commercialization activities. Public support specifically to science-based entrepreneurship

is lacking, except only for funding for the establishment of technology transfer offices (for more details see Section 4.4).

Nevertheless, there have been bottom-up efforts to promote university spin-offs at the level of individual institutions that deserve to be mentioned. Several business incubators for start-up companies of university students have been opened in the higher education sector, for example, InovaJET at the Czech Technical University in Prague has already supported about 80 projects since 2010 and xPort at the University of Economics in Prague and Point One at the Czech University of Life Sciences Prague have been just launched. In addition, the ASCR has published, as a part of its new Strategy AV21 released in December 2014, the overview of its so-called "application laboratories" in order to promote linkages to the industry. Yet the results of this measure remain to be seen.

4.3 Knowledge markets

Formal methods of intellectual property rights (IPRs) protection, in particular patents and their licensing, remain underutilized, as clearly shown by European Commission (2014), in spite of the continuous effort to improve the use of public R&D outputs in innovation processes and despite the fact that state of the art IPRs legislation is in place. Too few experts and little experience can be found in this domain, especially in the public sector, except only perhaps of a few exceptions under the umbrella of ASCR, such as the Institute of Organic Chemistry and Biochemistry (IOCB), that prove the rule. Poor commercialisation of R&D outcomes in general requires systematic attention as well as support to research excellence to produce high valuable research outcomes being worth of patenting costs.

While statistics on applications to national patent office are not always comparable across countries, they can provide some indication of technological development activities that are not captured by EPO/PCT data. In the Czech Republic, according to the data by INCENTIM KU Leuven and Bocconi University (2014), 1.3 thousand patent applications were made at the EPO, 1.5 thousand patent applicants took the PCT route and the Industrial Property Office of the Czech Republic received about 8 thousand applications in the period 2000-2010; these figures are based on fractional counting (). In terms of patenting per capita, however, the Czech Republic remains far below advanced countries.

According to the survey of licenses by CZSO (2014a), between 2007 and 2013 the number of organizations with licensed patents nearly doubled from 40 to 73 and the number of licensing agreements on patents more than tripled from 155 to 472, respectively, hence there is a positie trend, despite the low levels. In 2013, public research organizations and universities had a share of 36.8% in national patent applications and 30% in the number of licensed patents but accounted for 85% of €88m income from licence fees from patents(, but a lion share of the latter can be traced back to income of a single organization, namely the IOCB, from licencing of patents for antiretroviral drugs developed by professor Antonín Holý to U.S. pharmaceutical companies. Hence, this is not a systemic feature.

As far as the policy in the area of IPRs is concerned, the owner of invention developed in the public sector, i.e. supported by institutional or project funding, is nominally the university or the government research institute and its utilization needs to be specified by their internal regulations. However, the oversight and enforcement of this rule is weak and there is a large scope for opportunistic behaviour of researchers when deciding on who owns IPRs on knowledge generated within public support. In practice, commercialization of inventions originating from the public sector follows both formal and informal rules established at the level of individual organizations, much depends on governance of the particular workplace, and hence there are wide differences in this respect throughout the system. National strategy of IPRs utilization is lacking.

4.4 Knowledge transfer and open innovation

Among the top objectives of the ongoing reform of the RDI system is to improve the commercialization of R&D outputs on the market for technology and innovation processes at large. Many support measures are in place to foster technology transfer and public-private R&D cooperation with the aim to steer research towards practical outcomes. However, the linkages between public and private R&D sectors remain weak. In particular, there is a lack of supporting institutions (both formal and informal), a lack of qualified human resources for the technology transfer, unfavourable conditions for setting up academic spin-offs and insufficient supply of mediation services provided to innovative companies.

ALFA, Competence Centres, DELTA and EPSILON support programmes recently launched (or under preparation) by the TA CR emphasize as one of their main goal promoting collaboration of enterprises with public research organisations. GAMA programme of TA CR with a budget of €69m over the period 2014 to 2019, the first call of which was launched and ten projects with a budget of €4.0m were selected for funding in 2014, is specifically designed to support the verification of R&D results in terms of their practical application and their subsequent commercial use. Many regional governments have implemented innovation voucher programmes in recent years, including the so far largest Inovační vouchery programme in the capital city of Prague with a budget of €0.5m in 2014; hence the resources devoted to this instrument have been very small so far. Since 2014 tax credits that enable enterprises to deduct R&D expenditures from their tax base have been extended to the purchase of external R&D services from research organisations.

Nevertheless, there is strong evidence that technology transfer is limited. In 2013, privately-funded public R&D only amounted to €36m and 1.2% of GERD and only 3.3% of GERD financed by the business sector was performed by other organizations than the firms themselves (CZSO, 2014a), which testifies to the weak link between the business sector and other parts of the innovation system. In fact, these proportions display a declining trend since 2000 and remained consistently low over 2008-2013. The share of public-private co-publications was about 1% compared to the EU28 average of 2.2% and remained below the EU28 levels in the vast majority of scientific fields over 2003-2013.

Private-public mobility of researchers appears to be weak. In 2012, about 7% of R&D employees in the business sector were doctorate holders (CZSO, 2014a), hence received research training in the university sector. Unfortunately, no direct data is available on the circulation between the private and public sectors, such as the share of researchers in public organisations with experience in the private sector and vice-versa. Other relevant information, including the share of professors whose primary occupation is in industry and the number of researchers benefiting from academia-industry exchange contracts, is probably not collected, because it is very close to zero. Also there is no official data on the number of invention disclosures, public-private research partnerships and start-ups stemming from public-private cooperation, because these events are fairly rare.

Technology Transfer Offices (TTOs) are in infancy in the public sector. Currently, there are at least 15 TTOs, most of which have been established quite recently, though the number is growing with the increasing public support for their establishment. The majority of them operate within major universities (especially those oriented at technical and material sciences) or specialised intermediary organisations. Establishing technology transfer points and offices in research institutions as a way to use research results is one of the activities eligible within the Priority Axis 3 "Commercialisation and popularisation of R&D " of the OP RDI administered by the MEYS. The first technology transfer offices were supported from this programme at the beginning of 2012. In addition, the MEYS supported the EF-TRANS project on "Efficient Transfer of Research and Development Outputs in Production and their Subsequent Utilization" with the goal to set up and bring into effect knowledge transfer between R&D institutions and industry.

According to the Technological profile of the Czech Republic database developed by the AIE, there are 42 science and technology parks and 17 technological platforms. The Science and Technology Parks Association registers 10 accredited parks, 34 parks in the process of accreditation and 7 parks under preparation. CzechInvest provides a list of 13 business incubators. Developing innovative clusters is supported by the programme COOPERATION-Technological platforms in the Priority Axis 5 "Environment for Enterprise and Innovation" of the OP EI administered by the MIT.

"Cooperation and knowledge transfer between academia and industry" is one of four priority areas of the National Innovation Strategy of the Czech Republic (NIS) that has been produced jointly by the MIT and MEYS in line with recommendations of the Innovation Union strategy of the EU in 2011. The NIS gives a rather dreadful account: "A very important mechanism of knowledge transfer is informal networks based on personal contacts. The problem is that collaboration happens between individuals and not between enterprises and research organisations, as the results of which research organisations suffer a loss of income. Moreover, these issues generate personal conflicts in research teams. For many researchers in the public sector, these informal linkages represent the main source of their personal income, which in turn limits the time they devote to science itself." MIT (2011, pg. 7, translated by the author).

Generally speaking, the lack of rules, the inadequate enforcement of the existing ones, ineffective administrative processes, hence poor management of public-private linkages, creates fertile ground for opportunistic behaviour. Knowledge transfer incentives are usually set through internal payroll regulations and other internal regulations defining remuneration of researchers including extraordinary bonuses related to successful transfers, patents, licences etc. However, these practices differ by organisation, thus there are no generally accepted standards of behaviour. Systematic solution of the technology transfer issues at the national level, hence national knowledge transfer policy, is lacking.

4.5 Innovation framework for SMEs

TA CR has been established in 2009 as the dominant supporter of applied research and innovation and launched a portfolio of new programmes (most prominently ALFA, Competence Centres and the forthcoming EPSILON) but none of its programmes is specifically devoted to supporting innovation in SMEs. Several programmes of the OP EI under the MIT, namely Start, Development, Innovation, Progress and Guarantee, help start-ups and SMEs enterprises to overcome the limited availability of external funding, while the Cooperation programme supports the establishment of technology platforms and clusters. INOSTART programme, a joint effort of the main commercial bank Česká spořitelna and the MIT that is backed by the Partnership Fund of Czech-Swiss Cooperation and the state-owned Czech-Moravian Guarantee and Development Bank, supports innovative business start-ups in terms of loan guarantees for innovative projects and consultancy services. Regional governments are increasingly implementing innovation voucher programmes, including in South Moravia, Moravia-Silesia and Prague. Hence, there is a small number of support programmes tailored particularly to the needs of innovative SMEs in place.

4.6 Venture capital markets

The European Commission (2014a) data indicates that the utilisation of venture capital to support innovative businesses and spin-off firms is one of the lowest among European countries and that the limited access to external sources of finance for innovation is perhaps the single most important obstacle to the improvement of the innovative performances. Unfortunately, a lack of experience among potential clients and rather traditional entrepreneurial culture do not form an environment favourable to venture capital expansion. Statistics on crowdfunding and business angels is not available, at least not reliable data from official sources, and there are no policy measures in place in this regard. Venture capital market is very small, only several projects are funded each year (for more details see Sections 2.5.1 and 2.5.3), which is probably why more nuanced information is not accessible.

The MIT plan to launch a pilot project of a public-private seed fund supported from the OP EI has collapsed. The aim of the fund was to boost the grossly underdeveloped national

market for venture capital and support the creation of new knowledge-based companies, including university and research spin-offs. The pilot project was already presented at 15 universities during the autumn of 2012 and four workshops for entrepreneurs in the spring of 2013. A budget of €53m was earmarked for this purpose. The seed fund was ready to start operation; however, the launch of the project has been derailed by the appeal of an unsuccessful candidate for the Fund's custodian to the Office for the Protection of Competition (CzechTrade, 2014). In early 2014 the government decided to cancel the project. Nevertheless, there are plans to re-start this effort in the new programming period 2014-2020.

4.7 Innovative public procurement

Generally speaking, public tenders, except of those for R&D, are very rarely recognised as the opportunity to promote innovation. Public procurement in R&D (assigned competitively) for the needs of public administration bodies is newly centralised under the BETA programme of the TA CR. A national target on public procurement of innovative goods and services has not been announced. The national procurement policy does not consider the objective of supporting innovation.

5. Performance of the National Research and Innovation System

5.1 Performance of the National Research and Innovation system

The Innovation Union Scoreboard 2014 (European Commission, 2014a) classified the Czech Republic among the "moderate innovators", which maintain the overall innovative performance slightly below the EU28 average. Nevertheless, the Czech Republic moved up to the 2nd place in the moderate innovators category just short of Italy but already ahead of Spain, Portugal and Greece. Despite scoring below the EU28 average in most of the individual indicators under consideration, the Czech Republic is catching up with the category "innovation followers" in many important areas. In a nutshell, the Czech RDI system can be characterised by a combination of both moderate level and growth performance.

The main strengths are in Human resources (youth with upper secondary education), Firm investment (non-R&D innovation expenditure) and Economic effects (sales share of innovations and contribution of medium and high-tech product exports to trade balance). The weak areas in which the Czech RDI system is far behind the EU28 average are concentrated in Open, excellent and attractive research systems (top scientific publications and non-EU doctorate students), Finance and support (venture capital) and Intellectual assets (patents, trademarks and designs). High growth has been detected in population with tertiary education, R&D expenditures, trademarks and designs, whereas the prime setback (from already a very low base) has been in venture capital.

On average in 2012, the Czech Republic produced 15.97 publications per 10,000 inhabitants, slightly the EU28 average (13.80), of which only 37.46% were internationally co-published, which is the sixth lowest share in the EU28. In 2012, the Czech Republic had about 598 international scientific co-publications per million population, which roughly corresponds to the level observed in other moderate innovators. In the period 2002-2012, a bit more than 7% of the Czech scientific publications were in the top 10% most cited publications worldwide in comparison with 11% of top scientific publications produced in the EU28 (ScienceMetrix, 2014).[2] The share of public-private co-publications in the Czech Republic is 1.0% in the period 2008-2013 against 2.8% in the EU28.[3]

According to the more detailed country profile (European Commission, 2014c), in particular the quality of scientific production and technological development, in other words the level

[2] These publication data are based on Elsevier's Scopus database. ScienceMetrix, Analysis and Regular Update of Bibliometric Indicators, study conducted for DG RTD. They represent an update of the data displayed in the table below. See also http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=other-studies

[3] Scival 2014, Scopus based publication indicators derived from Elsevier's SciVal platform, www.scival.com last accessed December 2014.

of excellence in S&T, is markedly behind than the EU28 average and is catching up only very slowly. Structure of the economy is generally favourable but business R&D investment is relatively low, despite a positive trend, thus the innovation performance is deemed to remain below its potential. Another evergreen weakness that is highlighted refers to the limited cooperation between the science and business sectors. The key science and technological strengths are identified in the fields of automobiles, other transport, construction, materials, energy and environment.

Table 2: Assessment of the Performance of the National Research and Innovation System.

1. ENABLERS	**Year**	**CZ**	**EU**
Human resources			
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	2011	1.50	1.70
Percentage population aged 30-34 having completed tertiary education	2012	25.60	35.80
Open, excellent and attractive research systems			
International scientific co-publications per million population	2012	567.52	343.15
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	2009	5.61	10.95
Finance and support			
R&D expenditure in the public sector as % of GDP	2012	0.87	0.75
Venture capital (early stage, expansion and replacement) as % of GDP	2012	0.00	0.08
2. FIRM ACTIVITIES			
R&D expenditure in the business sector as % of GDP	2012	1.01	1.31
Linkages and entrepreneurship			
Public-private co-publications per million population	2011	33.75	52.84
Intellectual assets			
PCT patent applications per billion GDP (in PPS€)	2010	0.70	3.92
PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	2010	0.15	0.85
3. OUTPUTS			
Economic effects			
Contribution of medium and high-tech product exports to trade balance	2012	3.79	1.27
Knowledge-intensive services exports as % total service exports	2011	29.17	45.26
License and patent revenues from abroad as % of GDP	2012	0.10	0.59

Source: European Commission, IUS Database (2014).

5.2 Structural challenges of the national R&I system

Many national assessments of the RDI system have been recently carried out in the context of the ongoing reform, notably the International Audit of Czech RDI summarized by Arnold (2011), the Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 by CRDI (2013a) and the National RIS Strategy by MEYS (2014). Moreover, there are the twin documents the Competitiveness Report by the National Economic Council (2011) and the Strategy of International Competitiveness by MIT (2011a), including the follow-up National Innovation Strategy produced jointly by MEYS and MIT (2011b), which scrutinize the role of RDI in the broader policy context. Drawing on their findings, which are by and large in parlance with results of the Innovation Union Scoreboard assessments by the European Commission (2014ac) and with each other, the main structural challenges can be detected, not necessarily in the order of importance, in the following five areas.

Governance, evaluation and research excellence

Since 2008 the governance system is undergoing a profound reform outlined in the National RDI Policy of the Czech Republic 2009–2015 (CRDI, 2009) and the mid-term Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 (CRDI, 2013a). RDI funding system has been streamlined. TA CR has been established as the dominant provider of national support to applied research. The role of ministries has been gradually reduced, especially in favour of the CRDI, GA CR and TA CR. The CRDI has centralised principal activities, become effectively responsible for setting the entire national research budget and de facto assumed the role of a science ministry. However, the CRDI formally continues to be an advisory body of the government only; without adequate executive administration, analytical capabilities and budget line, which inhibits its capacity to make informed decisions on long-term strategy development. The CRDI has become overburdened with responsibilities, which it struggles to cope with given the limited resources.

A particularly thorny liability of the CRDI, which haunts the policy debate for several years, is the dysfunctional evaluation methodology of research institutions, which determines the allocation of public institutional funding. The formulae-based approach that has been implemented early in the reform automatically reallocated the entire flow of institutional funding annually based exclusively on outputs generated in the preceding five years. The idea was to make the allocation performance-based, which in turn was expected to reward quality, boost productivity and de-politicise the funding process. But the methodology has been resisted by the stakeholders and criticized as simply “not fit for the purpose” by Arnold (2011) for falling into the trap of reductionism, creating inherent instability of the funding flows, failing to address differences between fields of science, stimulating opportunistic behaviour and ignoring national thematic priorities.

As the result, the strategic policy-making has been complicated by arguments over the evaluation methodology. More recently, the institutional funding flow has been refined with the aim to address at least some of its flaws. In 2012, there was a short-term patch into the formulae that redirected the flows in a way agreed in political negotiations among the key stakeholders and that made the flows more stable. In 2013, a medium-term patch of the evaluation methodology, the so-called Metodika 2013 (CRDI, 2013b), has been introduced that awards bonuses for the best performing institutions and involves elements of international peer review, however, the evaluation methodology continues to heavily rely the formulae. In 2014, the MEYS signed under the IPN METODIKA project a contract with Technopolis Group to design a new system of evaluation of research organisations and allocation of institutional funding, which should be ready in May 2015. Nevertheless, a roadmap of its implementation has not been announced yet. This dispute locks the stakeholders in short-term focus and represents a major impediment for tackling many other problems that are intimately related to incentives laid down in the evaluation methodology.

Political instability had a major negative impact on the RDI system in recent years, as there have been frequent changes of ministers, in particular in the MEYS, that made it difficult to implement consistent policy. All too often, the reform debates have been politicised and the decision making process dominated by interest groups, not based on strategic intelligence and dealing with the problems in a systematic manner. Many of the unresolved issues are symptoms of a lack of trust among the key actors, especially between the academia and industry on one hand and the stakeholders and the government on the other hand, which thwarts attempts to make deeper changes in the system. In 2014, the political framework seem to stabilize, but it remains to be seen whether the new majority government that took the office in early 2014 makes a tangible difference in governance of the RDI system.

Stagnating public funding and new large infrastructures

New large research centres and infrastructural projects with a total amount of subsidy of nearly €900m that are under construction and gradually opening with the support from the EU Structural Funds represent a great promise for boosting the national research output. However, the new projects represent a major funding puzzle, because the EU support is for the initial investment only. Later on, wage, maintenance and other operating expenses must be covered from other sources. So there is a danger that these projects turn from blessing to a curse for the public R&D system, as sizeable opportunity costs needs to be resolved. Many of these projects pledged when approved to obtain funding from private sources. But this seems to cover only a fraction of their needs and their operating costs start draining public R&D funding from the existing facilities. It is a major challenge for the RDI policy to integrate these new projects into the national system.

In the meantime, national public R&D funding stagnates. Unless there is a breakthrough in the near future, unless the government noticeably expands outlays for R&D, public

research organisations, including the newly build projects, may end up being underfunded. According to preliminary estimates the full operating costs of the new research centres and infrastructures might amount from CZK 5b to 10b (€190m to 385m) per year (Rádio Impuls, 2013), which roughly represents as much as one fifth to one third of the current public R&D budget. Either the new projects or the existing infrastructure might need to shrink; possibly quite significantly. And in the final analysis this can have major disruptive impact for functioning of the national RDI system.

Another critical bottleneck for success of the new large research centre and infrastructure projects is availability of qualified human resources, not to mention star scientists, on the labour market. Arguably, this can turn out to be a major problem, as the expected demand by far exceeds domestic supply in the relevant scientific fields. Some of the new staff will have to be poached from the existing infrastructure. Some of them, perhaps even their majority, will have to come from abroad. But attracting large numbers of top foreign researchers in a relatively short span of time required for launching the full operation of the projects is not going to be easy, if one considers the above mentioned funding uncertainties, the unresolved rigidities of national labour market for researchers, the lingering difficulties with attracting foreign talent and last but not least given the fact that the remuneration of scientist in the national system is far below the international competitive wage level.

Skills shortages, rigid labour market for researchers and internationalization

According to the assessment of MIT (2011b), because the reform of tertiary education remains uncompleted, there has been an unchecked expansion of university graduates, the quality of which is however hard to judge. Not much has changed in this respect in the meantime. The lack of highly skilled personnel is often cited as not only hampering the quality of research in public institutions but even more so as the major obstacle of innovation in the private sector. Yet modernization of the higher education system is long overdue, the higher education act has been amended seventeen times and it is broadly acknowledged that a comprehensive reform of the education system is necessary.

Human resources management practices in the public sector need to be revised in order to reduce the widespread in-breeding, make career progression paths more transparent and intensify competition for posts. Horizontal mobility of academic staff is very limited. Arnold (2011) noted that management of research groups is underdeveloped, the groups tend to be very small, locked into existing research trajectories, lacking interdisciplinarity, there is little use of career development plansand only less than 10% of researchers are foreign, which is very small proportion by international standards. . An explicit internationalization strategy of the public research system is lacking. Since the higher education reform ended up in doldrums, these caveats remain as relevant as ever.

Gender situation in research is unsatisfactory (NKC – ženy a věda, 2014). The share of female researchers (full-time equivalent) is very low, only 25% in FTE in 2013 and

decreasing in recent years (CZSO, 2014a), which is far below the EU28 average. Gender equality issues are almost entirely ignored in research policy, the testimony to which is the fact that there is very little, if anything, on this topic in the key strategic documents and there are no regulations or instruments in this regard in place. Overall, the approach to research human resource management in the public sector is unsystematic.

Innovation capabilities, disembedded multinationals and venture capital

Structurally, the business sector appears sound; the share of industries considered to be high- and medium-high-technology sector is relatively large, which represents a potential for upgrading. However, the business sector tends to specialize in low value added segments of value chains and competes predominantly on prices. Path-breaking innovation is rare; the economy is based on absorption of foreign technologies that are new to the firm or new to the country but not new to the world, as domestic sources of knowledge generation have not been yet established as the main driver of economic development. A major shift in policies during the reform has been from a system traditionally focused on science towards more attention devoted to boosting innovation. But the success has been at best partial so far.

According to European Commission (2013a), only two Czech firms, both state-owned, feature amongst the world or EU top R&D investing firms, namely ČEZ (electricity) is 1667th in top 2000 world and 453th in top 1000 EU R&D performers and České dráhy (transport) is 860th in top 1000 EU R&D performers. About 55% of business R&D was performed by foreign affiliates in 2013, which is a very high proportion in international standards. As noted by MIT (2011b), foreign affiliates are largely doing low-added value work, even within high-tech industries, as the parent companies tend to keep the core research activities close to their headquarters abroad. A major policy challenge is how to make the multinationals more embedded in the national innovation system and how to motive them to upgrade the activities perform locally.

Limited access to external private sources of finance for innovation is perhaps the single most important obstacle for improving the innovative performance, particularly in the sector of SMEs. Availability of venture capital to support innovative businesses and spin-off firms trying to commercialize research outcomes is well-known to be extremely low; one of the lowest among European countries. A lack of experience among potential clients and rather traditional entrepreneurial culture do not constitute a favourable environment to venture capital expansion. No tax measures supporting venture capital or business angels are in place.

Underdeveloped public-private collaboration, technology transfer and market for technology

Given the historical separation of science and business and the prevailing differences in culture or attitudes in these spheres, the lack of collaboration between them is one of the

main policy issues. Despite steady effort to strengthen public-private linkages, deficiencies are present on both sides, namely limited industry-valuable results and poor technology transfer practices in the public sector on one hand and low absorptive capacity of public research outputs in companies on the other hand. Since the business sector tends to lag behind the technology frontier, except perhaps of the dis-embedded multinationals, most of the firms focus on absorbing existing technologies rather than collaborating with science. Poor horizontal mobility of professionals between the sectors and sometime too rigid setting of support measures reinforce the weaknesses. National governance strategy of public-private collaboration and technology transfer is lacking.

Table 3: Policy measures addressing structural challenges in the Czech Republic.

Challenges	**Policy measures/actions addressing the challenge**	**Assessment in terms of appropriateness, efficiency and effectiveness**
1. Governance, evaluation and research excellence	CRDI became the central RDI policy actor Public R&D funding is streamlined Share of competitive funding increased TA CR takes over support for applied R&D and innovation Evaluation of research institutions patched More complex evaluation in the making	CRDI does not have sufficient administrative and analytical capacity to deliver Evaluation method of research organisations is ineffective is stimulating research excellence Most institutional funding continues to flow through the old mechanistic formulae Progress in putting forward more complex evaluation methodology has been very slow
2. Stagnating public funding and new large infrastructures	Public R&D funding stagnates Large research infrastructures constructed National program sustainability I is launched	Public R&D needs to increase to meet the challenges Long-term funding of large research infrastructures not secured Staffing of the large research infrastructures is problematic
3. Skills shortages, rigid labour market and internationalization	Higher education reform in doldrums Česká hlava awards Otevřená věda I. and II. popularization programmes NÁVRAT brain gain programme Scientific Visa Package	Higher education reform is overdue for a long time In-breeding is widespread in higher education Competition for posts is not transparent and generally limited Early career opportunities remain scarce Gender inequality problems are ignored Internalization is very low
4. Innovation capabilities, disembedded multinationals and venture capital	TA CR launched a portfolio of new support programmes R&D tax refunds Investment incentives for establishing R&D centres	Commitment to support upgrading of innovation capabilities Shifting emphasis from direct subsidies to indirect support of business R&D Evaluation of innovation policy remains poor Attempts to kick-start the venture capital market have not been successful so far

Challenges	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
5. Underdeveloped public-private collaboration, technology transfer and market for technology	TA CR programmes stimulate joint public-private projects and commercialization Support for technology transfer services, management of IPRs, etc. R&D tax refunds extended to contract research	Much greater emphasis on public-private collaboration in new programmes Governance of technology transfer in research organisation remains poor National governance framework is lacking

5.3 Meeting structural challenges

National RDI Policy of the Czech Republic 2009–2015 (CRDI, 2009) is the central policy document, which has been developed to facilitate the implementation of the Reform of the RDI system in the Czech Republic (CRDI, 2008a). More recently, the Update of the National Research, Development and Innovation Policy 2009-2015 with an outlook to 2020 (CRDI, 2013a) has brought the reform agenda into line with the medium-term plans of public R&D spending, the growth of which has been significantly downsized due to the economic crisis, but otherwise confirmed the reform track.

The main objectives of the updated national RDI policy are fourfold:

- To stimulate research excellence, use of new knowledge and aligning the allocation of public funding to these ends;
- To utilize R&D outputs in innovations, improve public-private cooperation in RDI and conditions for efficient diffusion and use of knowledge;
- To develop human resources, promote mobility of researchers and prevent brain drain abroad;
- To facilitate development/sustainability of new research centres and infrastructures, their cooperation with each other and with the application sphere;

New R&D programmes are supposed to follow the updated National Priorities of Oriented Research, Experimental Development and Innovation (CRDI, 2012) that have been summarized under six long-term thematic focus areas:

- Competitive knowledge-based economy
- Sustainable energy and material resources
- Environment for quality life
- Social and cultural challenges

- Healthy population
- Safe society

The priorities are designed to reflect major societal challenges and needs of the society as concrete goals solvable through RDI in available capacities and are set for the time horizon until 2030. The new priorities should be taken into account in the multi-annual R&D budget plans and respected in designing public RDI support, including prospectively in allocation of institutional funding.

The National RIS Strategy identified eight key enabling technologies: i) Advanced materials; ii) Nanotechnology; iii) Micro- and nano-electronics; iv) Advanced production technologies; v) Photonics; vi) Industrial biotechnology; vii) Knowledge for digital economy, cultural and creative industries; viii) Social science knowledge base for non-technical innovation, which are broadly in line with the long-term thematic priorities, and there are four national S3 platforms: i) Engineering; ii) Information and telecommunication services and software; iii) Transport equipment; and iv) Pharmaceuticals and life technologies (MEYS, 2014).

The Government adopted a comprehensive long-term Strategy of International Competitiveness in 2011 (MIT, 2011a), which addressed framework conditions affecting innovation performance in a broad sense. The core of the competitiveness strategy called "3i" deals with institutions, infrastructure and innovation; the three pillars that are indicated as the main weaknesses of the current system. In parallel, the National Innovation Strategy (MIT, 2011b) that was produced jointly by the MEYS and the MIT develops in more comprehensive way the innovation pillar. The strategy outlines a long list of concrete goals for innovation policy summarized under four main priority axes:

- Improving conditions for excellent research
  - Efficient public R&D spending
  - Access to state-of-the-art infrastructure
  - Leveraging ERA participation
- Developing cooperation for transfer of knowledge between business and academia
  - Governance of PROs geared for technology transfer
  - Extending support for public-private cooperation
  - Deepening innovation infrastructure at the regional level
- Promoting innovative entrepreneurship
  - Providing access to high-quality consultancy services
  - Developing venture capital market
  - Targeting investment incentives for research activities
  - New instruments for export promotion
  - Technological foresight as the source of strategic intelligence
  - Public procurement and regulation with innovation in mind
- Skilled human resources for innovation

- Higher education reform necessary for boosting quality
- More support for lifelong learning
- Core competencies and skills for innovation in curriculum
- Attracting talent from abroad

Evolution and analysis of the policy mix

One aim that has been repeatedly stressed is promoting excellence in research. Yet this has been grossly mismanaged by introducing the formulae-based system of evaluation of research institutions, regardless of other concerns. Arnold (2011) recommended that the evaluation practice should be the subject of root and branch reform, refocusing on outcomes and impacts in addition to outputs. The latest modification of the evaluation methodology, the so-called Metodika 2013 (CRDI, 2013b), established two new pillars that involve international peer review and bonuses for research excellence; however, the formulae-based pillar remains dominant. IPN METODIKA project launched under the auspice of MEYS is preparing a new more complex evaluation methodology, which should be ready during 2015.

Another closely related challenge is to secure funding for operation of the newly constructed research centre and infrastructure projects, which is likely to send ripples throughout the public research sector. To secure immediate funding the MEYS has launched the National program sustainability I. and the prospective National program sustainability II. that is going to support at least the start of their operation. Nevertheless, the induced pressures in allocation of institutional funding and the broader picture of their integration into the national system remains a challenge. Overall, national public R&D funding has stagnated in recent years in the context of the economic crisis but needs to start increasing again in order to tackle the funding problems and to safeguard meeting the national target of 1% of GDP flagged in Europe 2020 initiative.

Unfortunately, reform of the labour market for researchers that was in preparation for three years ended up in doldrums. The higher education reform initially involved bold plans for modernization of conditions for human resources development. The reform was supposed to be implemented already but the drafting process has been derailed due to instability of the government and disagreements among the stakeholders The push for enacting a new law has been first relegated to an amendment that has been delayed by the collapse of the centre-right government in mid-2013 and then watered down significantly. The amendment is a compromise with the existing establishment that falls short of expectations if compared to the ambitious aims of the reform agenda. For instance, the new regulation is not expected to alter the current system of recruitment, hence not tackling the problem of inbreeding.

In recent years, the government has started to be much more active in promoting cooperation of private and public bodies in R&D. A number of new measures were introduced that are shifting the focus of innovation policy from supporting internal RDI in

firms to leverage public subsidies for the purpose of stimulating public-private collaboration and commercialization of research results. At the forefront of this transformation is the wave of new programmes designed and implemented by the TA CR, which support applied research, collaboration between research and application spheres and transfer of knowledge:

- ALFA supports projects of applied research and experimental development and stimulates intensity and effectiveness of R&D cooperation between businesses and research organisations;
- BETA is a programme of public procurement in RDI for the needs of public administration bodies;
- OMEGA supports research in applied social sciences;
- Competence Centres funds creation and operation of RDI centres for progressive fields with strong application potential and a perspective for significant contributions to competitiveness;
- GAMA supports the verification of R&D results in terms of their practical application and their subsequent commercial use;
- DELTA provides applied research grants for joint international projects with third countries.
- EPSILON is aimed at supporting applied research and experimental development with a high potential for rapid application in innovations in a selected the priority areas.

Attention to support of RDI in industrial enterprises from start-ups to mature enterprises and fostering public-private linkages is paid in the programmes administered by the MIT and financed either from the OP EI (the sub-programmes called Innovation, Potential, Cooperation and ICT and Strategic Services) or from the national sources (TIP). The OP RDI administered by the MEYS also includes several research and academia-industry links funding measures, which include support of commercialisation of R&D outputs in research institutions, financing research up to the stage of the subsequent commercial use (proof of concept stage) and support of intellectual ownership protection. Several regional governments have started innovation voucher programmes since 2012, which represents a much needed early step to regionalization of innovation policy, but the amount of funding channelled through this route is very limited.

Since 2005 the Ministry of Finance (MF) operates a system of tax incentives that allows firms to deduct expenditures on R&D carried out in-house from their tax base. It has been recognized, however, that this form of tax deduction is going against the need to intensify collaboration between the business sector and academia. Hence, starting from 2014 the indirect fiscal support through R&D tax credits was extended to the purchase of external

R&D services from research organizations with the aim to stimulate public-private linkages. Access to venture capital continues to be problematic.

Assessment of the policy mix

Generally speaking, the national policy mix attempts to tackle the major structural challenges, however, is some areas the outcome falls short of expectations. A lot of attention has been devoted in the RDI reform agenda to making the national research system more effective; leaving the dysfunctional mechanism for allocating institutional funding aside, a noticeable progress has been made in streamlining the funding system, increasing the share of public funding allocated on a competitive basis and pinpointing sensible thematic research priorities.

The CRDI that has assumed a central role in the new governance system needs to be provided with resources that allow it to live up to this task. The GA CR and TA CR that have become responsible for competitive funding need to be further supported to mitigate the fragmentation of support programs. Several large research infrastructural projects, including pan-European infrastructures, are opening or under construction, which, if their funding is secured, have a potential to both open new avenues for international co-operation and make the system more competitive. Much remains to be done in improving labour market for researchers and in fostering gender equality in research, particularly as far as limited mobility, internationalization, early career opportunities, rigid recruitment practices and widespread in-breeding are concerned.

The inadequate evaluation methodology of research institutions results inter alia in the insufficient quality of R&D results and the detachment of public research from industrial and societal needs. More generally, standards of evaluation remain fairly low and this in turn appears to be a rather understated problem. Present evaluations of research programmes tend to be highly descriptive, including only quantitative formulation of the results achieved, which rarely provide strategic intelligence insights for policy makers. Assessment with regards to development of relevant science fields, industry sectors or grasping societal needs, not mentioning counterfactual analysis, is not conducted. Systematic evaluation of research organisations is missing.

Major challenges remain to be tackled in the domain of circulation, access and transfer of scientific knowledge, which has been historically a weak aspect of the system. More intensive inclusion of the private sector in joint public-private research projects seems to be promising, such as, for instance in the new programmes that have been introduced by the TA CR, though evidence on their effectiveness is not available yet. Despite these measures for the public-private interface, the commercialization of publicly funded research into innovative solutions in the business sector remains a constant challenge. IPRs continue to be grossly underused.

A major policy shift that needs to be applauded has been from a system traditionally based on direct public subsidies to RDI in the business sector towards introducing much

wider portfolio of measures aimed at alleviating the problem of insufficient availability of funding for private R&D efforts, such as the R&D tax credits, loans, guarantees and venture capital; which target the type of applicants, including small and new firms, that typically do not use the direct support. More measures that go beyond the direct subsidies are clearly desirable in the future.

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Annex 2 – Abbreviations

Abbreviation	English	Czech
ASCR	Academy of Sciences of the Czech Republic	Akademie věd ČR
AIE	Association of Innovative Entrepreneurship	Asociace inovačního podnikání ČR
AVO	Association of Research Organizations	Asociace výzkumných organizací
BERD	Business Expenditure on Research and Development	Výdaje na výzkum a vývoj v podnikatelském sektoru
CERN	European Organisation for Nuclear Research	Evropská organizace pro jaderný výzkum
COST	European Cooperation in Scientific and Technical Research	Evropská spolupráce ve vědeckém a technickém výzkumu
CRDI	Council for Research, Development and Innovation	Rada pro výzkum, vývoj a inovace
CZK	Czech koruna	Česká koruna
CZSO	Czech Statistical Office	Český statistický úřad
ELI	Extreme Light Infrastructure	Extreme Light Infrastructure
ERA	European Research Area	Evropský výzkumný prostor
ERDF	European Regional Development Fund	Evropský fond pro regionální rozvoj
ESF	European Social Fund	Evropský sociální fond
ESFRI	European Strategy Forum on Research Infrastructures	European Strategy Forum on Research Infrastructures
ESIF	European Structural and Investment Funds	Evropské strukturální a investiční fondy
ESO	European Southern Observatory	Evropská jižní observatoř
EU	European Union	Evropská unie
EU28	European Union including 28 Member States	Evropská unie s 28 členy
FP	European Framework Programme for Research and Technology Development	Evropský rámcový program pro výzkum a vývoj
FP7	7th Framework Programme	7. rámcový program pro výzkum a technologický rozvoj
GA CR	Czech Science Foundation	Grantová agentury ČR
GBAORD	Government Budget Appropriations or Outlays on R&D	Státní rozpočtové výdaje a dotace na výzkum a vývoj
GDP	Gross Domestic Product	Hrubý domácí product
GERD	Gross Domestic Expenditure on R&D	Celkové výdaje na výzkum a vývoj
HEI	Higher education institutions	Vysokoškolský sektor
ICT	Information and Communication Technologies	Informační a telekomunikační

		technologie
IOCB	Institute of Organic Chemistry and Biochemistry of ASCR	Ústav organické chemie a biochemie AV ČR, v.v.i.
IPO	Industrial Property Office of the Czech Republic	Úřad průmyslového vlastnictví
IPR	Intellectual Property Rights	Práva duševního vlastnictví
MEYS	Ministry of Education, Youth and Sports of the Czech Republic	Ministerstvo školství, mládeže a tělovýchovy ČR
MIT	Ministry of Industry and Trade of the Czech Republic	Ministerstvo průmyslu a obchodu ČR
MRD	Ministry of Regional Development of the Czech Republic	Ministerstvo pro místní rozvoj ČR
MoLSA	Ministry of Labour and Social Affairs of the Czech Republic	Ministerstvo práce a sociálních věcí ČR
NABS	Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets	Nomenklatura pro analýzu a srovnání vědeckých programů a rozpočtů
NIS	National Innovation Strategy	Národní inovační strategie
OP	Operational Programme	Operační program
OP EI	Operational Programme Enterprise and Innovation	Operační program Podnikání a inovace
OP PIK	Operational Programme Enterprise and Innovation for Competitiveness	Operační program Podnikání a inovace pro konkurenceschopnost
OP PGP	Operational Programme Prague – Growth Pole of the Czech Republic	Operační program Praha – pól růstu ČR
OP RDI	Operational Programme Research and Development for Innovation	Operační program Výzkum a vývoj pro inovace
OP VVV	Operational Programme Research, Development and Education	Operační program Výzkum, vývoj a vzdělávání
PROs	Public Research Organisations	Veřejné výzkumné organizace
R&D	Research and development	Výzkum a vývoj
RDI	Research, Development and Innovation	Výzkum, vývoj a inovace
RIs	Research Infrastructures	Výzkumné infrastruktury
RIS3	Research and Innovation Strategy on Smart Specialisation	Strategie inteligentní specializace
S&T	Science and Technology	Věda a technologie
TA CR	Technology Agency of the Czech Republic	Technologická agentura ČR

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