International Audit of Research, Development & Innovation in the Czech Republic

Final Report - 1

Assessment of Public R&D Expenditures in the Czech Republic

JOANNEUM RESEARCH Forschungsgesellschaft mbH

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Michael Dinges

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List of Abbreviations

ASCR	Academy of Sciences of the Czech Republic
BERD	Business Enterprise Sector
BES	Business Enterprise Sector
ALFA	A R&D Programme of the Technology Agency
BETA	A R&D Programme of the Technology Agency
CLFS	Community Labour Force Survey
COST	Cooperation in the Field of Science and Technology Research (Europe)
CSF	Czech Science Foundation
CZK	Czech Republic Koruna
EARTO	European Association of Research and Technology Organisations
ERA	European Research Area
ERC	European Research Council
ESF	European Science Foundation
EU	European Union
EUREKA	European R&D funding initiative
EUROCORES	European Science Foundation - Collaborative Research Programmes Scheme
EUROSTAT	Statistical Office of the European Communities
FPs	European Union Framework Programmes for R&D
GACR	Grant Agency of the Czech Republic (Czech Science Foundation)
GBAORD	Government Budget Appropriations on Research and Development
GDP	Gross Domestic Product
GOV	Government Sector
GUF	General University Funds
HERD	Higher Education Research and Development Sector
HES	Higher Education Sector
ICT	Information and Communications Technologies
IP	Intellectual Property
MA	Master (academic degree)
MEYS	Ministry of Education, Youth and Sports
MIT	Ministry of Industry and Trade
MoA	Ministry of Agriculture
MoC	Ministry of Culture

MoD	Ministry of Defence
MoH	Ministry of Health
MSc	Master of Science (academic degree)
NACE	Nomenclature Générale des Activités Économiques dans les Communautés Européennes (EU classification system)
NRP I, NRP II	National Research Programmes I+II
OECD	Organisation for Economic Co-operation and Development
OMEGA	A R&D programme of the Technology Agency
OPEI	Operational Programme Enterprise and Innovation
OPRDI	Operating Programme Research and Development for Innovations
PNP	Private Non-Profit Sector
PRO	Public Research Organisation
R&D	Research and Development
R&D&I	Research and Development and Innovation
RCA	Revealed Comparative Advantage
SME	Small and Medium Enterprises
TA CR	Technology Agency of the Czech Republic
TIP	Programme of the Ministry of Industry and Trade
UK	United Kingdom
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States of America

Executive Summary

This document is the final report of Work Package A, which has explored the research financing and expenditure structure of the Higher Education Sector, the Government Sector, and the Business Enterprise Sector in the Czech Republic.

The analyses took into account the ratios of public funds allocated to individual research fields, the level of project funding within the Czech Republic, and the adequacy of national funding priorities (i.e. funding of specific research fields and sectors via R&D programmes). In this respect, also the diversification of financial support, in particular to the Business Enterprise Sector and the existence of critical masses therein, were considered in the international comparative analyses.

R&D investment levels

The Czech Republic is among the most R&D active new EU member states and has considerably increased its R&D investments in the past 15 years. Since 1995 total R&D expenditures of the Czech Republic have more than quadrupled. In 2009 R&D investments summed up to 2,094 million EUR, which corresponds to an R&D intensity of 1.53%. Although R&D investments of the enterprise sector have abruptly lost momentum with the onset of the crisis in 2008, **the narrowing gap in R&D intensity between the Czech Republic and the EU-27 would not have been possible without a considerable increase of business R&D investments**.

The international comparison of the R&D financing and performance structure shows, that the Business Enterprise Sector already accounts for a total of 60% of R&D expenditures in the Czech Republic, whereas the Government Sector accounts for 21.4% and the Higher Education Sector for 18.1% in 2009. In terms of financing the Business Enterprises Sector accounts for 45.8% only. This however, is mainly due funding from Abroad, which accounts for an additional 9.2% of R&D investments, of which the majority of sources (>70%) stem from foreign parent companies.

Despite the economic crisis, the enterprise sector itself has increased its own R&D financing by 40% in the period 2005-2009. Direct government support to enterprises increased by +44% in the same period. The public authorities have also increased the support for the Government Sector (+58%) and for the Higher Education Sector (+63%).

Overall, the composition of the financing structure has shown considerable fluctuations in the last decade, which was mainly due to varying trends in the Business Enterprise Sector. Given these fluctuations, the data of the last decade show, that the Czech Republic has the potential, that about 60% of total R&D financing may stem from private sources, if funding from abroad is taken into account.

We may therefore conclude that there is a solid base for the provision of both public and private R&D investments in the Czech Republic. The Czech Republic has set itself the goal, to increase public R&D investments to 1% of GDP by 2020. **The Czech Republic should continue to pursue this goal by increasing public R&D investments on an annual basis because at present (2008) only 2% of total government outlays were reserved for research expenditures.**

R&D Performance

The Czech Republic is characterised by three performance sectors: the Business Enterprise Sector, the Government Sector, and the Higher Education Sector.

The Higher Education Sector and the Government Sector

The Higher Education Sector just started to build R&D capacities in the mid of the 1990ies. As in many Central and Eastern European Countries the majority of Higher Education Institutions in the Czech Republic were mainly teaching universities. Whereas the Higher Education Sector gained importance in terms of R&D performance in the last decade, the Academy of Sciences (which is the main R&D performer of the Government Sectors) has been drastically reduced in size in the early 1990s, but its overall contribution to R&D performance has stabilized since then.

Both the Higher Education Sector and the Government Sector account for about one quarter of R&D activities today and can be considered to have considerable R&D capacities.

While in Western Europe and the United States of America the education of elites, and the provision of basic/fundamental research has been long the main objective of universities in the Western Europe, policy and the academic literature stresses to an increasing extent the so called 'third mission' of universities. This 'third mission' is to engage with industry and provide room for knowledge transfer activities and allow enterprises to make use of research results generated by academics (as the process of knowledge creation and its application does not only encompass codified knowledge, but also has a strong tacit component). The third mission of universities does not relate extensively to the provision of innovation services and experimental development, but rather refers to the transfer of 'tacit knowledge', i.e. making purely academic research applicable for research and innovation activities in enterprises.

The role of Public Research Organisations, that is mainly part of the Government R&D Sector in many countries, is to provide market oriented research and development activities, technology and innovation services to enterprises, governments and other clients.

In the Czech Republic, the Government R&D sector and the Higher Education Sector concentrate to a large extent on the performance of academic oriented research activities, aiming at high shares and high quality of scientific publications. Financing data and the findings on science industry linkages (Work Package E) show that interactions between the public R&D sector and the private sector are still very weak, and measures, which seek to integrate both sectors are absent from the funding system.

In the Higher Education Sector Engineering could be a field in which public policies could seek to considerably increase interactions with the Business Enterprise Sector, due to its relevance and maturity in both sectors.

In terms of research fields covered, the Government Sector and the Higher Education Sector complement each other. Apart from Engineering, the Higher Education Sector shows specialisations in Medicine, and Agricultural Sciences, while the Government Sector is strongly specialized in the Natural Sciences and the Humanities.

Specialisation analyses of R&D expenditures for the whole public sector R&D (HERD plus GOVERD) further revealed relative specialisations in the Natural Sciences and the Agricultural Sciences. Despite its strong relevance for the Czech industry, R&D expenditures for Engineering are just about at EU-average levels. The Social Sciences and the Humanities are underrepresented in international comparison.

As the Social Sciences and the Humanities are not covered by thematic oriented R&D programmes and restricted to response-mode funding of the Science Foundation, **we recommend establishing measures, which allow building up critical mass based upon excellence in the field.**

R&D Performance in the Business Enterprise Sector

R&D expenditures of the Business Enterprise Sector are strongly concentrated in the manufacturing sector. The motor vehicle, trailers and semi-trailers sector alone, accounts for about a quarter of total business R&D activities (23.2%). In addition, also the machinery and equipment branch and the precision instruments branch (medical, precision and optical instruments) are accounting for 8.1% and 4.7% of total business R&D activities in the Czech Republic.

On the other hand, some research intensive branches within manufacturing, namely the chemical and pharmaceutical industry (7.3%), the computer industry (0.1%) and the communication, TV and radio equipment industry (3.5%), only account for rather small shares of total business R&D activities in the Czech Republic.

Within the services sector, the Computer and related Services branch is comparatively strong, accounting for 8.3% of total business R&D activities. Furthermore, also the Research and Development Sector accounts for 16.6% of total business R&D activities. This branch contains companies, which provide research and experimental development on Natural Sciences and Engineering as well as in the Social Sciences and Humanities. In the Czech Republic, this branch is dominated by former and partly state owned companies (R&D institutes).

The specialisation analyses showed positive R&D specialisations in some manufacturing branches some service branches. **Within the services sector, positive specialisations are observed in the branches Public Administration, Financial Intermediation, Computer and Related Services, and Telecommunications. Within Manufacturing, positive specialisations in Textiles and Textile Products, other Non-Metallic Mineral Products, Basic Metals and Motor Vehicles can be observed.** In these branches Czech enterprises spend higher shares on R&D than the benchmarking countries. **The branches Fabricated Metal Products, Machinery and Equipment, and Electrical Machinery exhibit no negative specialisation.** Hence, the majority of sectors in which a positive or no negative specialisation exists are important not only in terms of absolute R&D investments in the Czech Republic, but the shares of national investment in these sectors already equal or exceed those of the benchmarking countries. In addition, these medium-high tech sectors are not only important in terms of R&D activities, but also in terms of employment.

Another important finding of the comparative analysis is that the Czech Republic shows a vivid distribution of R&D activities among firms of different size classes. It has to be considered as a myth, that small and medium sized companies show no or little R&D expenditures in the Czech Republic. In total, SMEs account for 36.2% of business R&D expenditures. 55.3% of total business R&D expenditures are financed by firms with more than 500 employees; companies between 250 and 499 spend 8.3% of total business R&D expenditures. The international comparison shows that large enterprises (>250 employees) account for more than 60% of total industry R&D expenditures in many of the old EU member states. Concentration of R&D expenditures is particularly high in countries with highest R&D ratios in the European Union and the largest EU member states: In Sweden and Finland more than 70% of R&D activities are performed by enterprises above 500 employees, in Germany even 84% of business R&D expenditures are performed by very large enterprises. Only countries with a weak industrial basis (Greece, Spain, Estonia, Poland, Romania, and Slovakia) show little concentration of R&D activities in the large enterprises. Hence, R&D intensity may only increase substantially in the long run in the Czech Republic, if large enterprises intensify their R&D activities.

The distribution of public R&D support among different beneficiaries

To varying degrees all three performance sectors are subsidized by public sources. In the Higher Education Sector 90% of R&D activities, in the Government Sector 87%,

and in the Business Enterprise Sector 14% of R&D activities are financed by the state. Due to this strong dependence on public funds in all three performance sectors, the study took a deeper look into the thematic orientation and the allocation mechanisms of public R&D funds.

The share of government R&D funding in the **Higher Education Sector** is very much comparable with most European Union member states. These have considerable higher shares of government funded research income than a number of non-European OECD countries. By large, this can be attributed to the low shares of income generated via student fees in the EU member states, resulting in low "own sources" for R&D. However, also the level of R&D funded by the business enterprise sector is particularly low (0.7%), and clearly below the EU-average level (2.6%). This, despite a specialisation in Engineering, in which Czech industry is highly specialised and synergies from mutual cooperation and co-funding opportunities could be expected.

We therefore recommend introducing measures aiming at an increasing the level of R&D financed by Business Enterprises for the Higher Education Sector. Types of measures may include incentives for Higher Education Organisations (i.e. formulae based funding systems which take into account private R&D financing), individuals (boni for acquisition of private R&D funds), and firms (i.e. tax deductions for R&D services purchased from Higher Education Sector). A wide array of programmatic measures, in particular geared towards the industry relevant engineering field, should be established in order to increase co-operation of business enterprises and higher education, in order to increase the long-term potential for additional co-financing (see Work Package Report on Science-Industry Linkages).

Also in the **Government Sector** public financing is the most relevant income source for R&D. However, in international comparison the share of private funded R&D is considerably higher than in the Higher Education Sector (approximately 10%). **The Academy of Sciences of the Czech Republic receives very considerable amounts of R&D income via licences, which account for 13% of total research income or 46 million EUR**. This has proved to be a very high amount in international comparison, but it is only one single unit within the Academy, which is responsible for more than 95 % of this amount. As this singularity also explains the share of R&D financed by the Business Enterprise Sector, **the incentive mechanisms and programmatic measures to be set up in the Higher Education Sector should also apply for the Government Sector**.

In the **Business Enterprise Sector**, the largest share of R&D is financed by own sources. Government R&D financing accounts for 13% of R&D financing in this sector, which is 6% points higher than the EU average. 20% of total public R&D investments are geared towards the Business Enterprise Sector.

The analysis has shown that large shares of public R&D support are concentrated in the R&D services sector, in which former publicly owned R&D institutes are placed. If we ignore this funding (which is functionally misclassified – it should be considered as part of the government sector), then the level of direct funding of BERD is at an EU average level.

Compared with the R&D expenditure structure and business R&D specialisation in the Czech Republic, we witness that within manufacturing only the machinery and equipment sector receives considerable amounts of public R&D support.

Furthermore, government R&D support for the Business Enterprise Sector is mainly distributed via response-mode R&D programmes, and concentrated on upgrading of existing technologies in order to sustain and further strengthen competitiveness in sectors of traditional strengths. In order to accelerate progress towards a knowledge based economy, **we recommend launching public efforts which seek to considerable increase innovation capacities in existing, medium-high and high-technology sectors,** such as the automotive industry, machinery and equipment, electric machinery and apparatus, chemicals and chemical products, medical, precision and optical instruments. **Co-operations between the Business**

Enterprise Sector and the Public R&D Sector should constitute a core element of these industrial R&D policies.

Project funding vs. institutional funding

The main direct R&D allocation mechanisms in the Czech Republic are institutional funding measures and project funding measures. As the allocation mechanism for institutional funding are portrayed in detail in the report on "The Quality of Research, Institutional Funding and Research Evaluation in the Czech Republic and abroad", this report focused on project funding and its relevance for the different performance sectors.

The main rationales for public authorities to put project funding mechanisms in place are to spur competition between researchers and research organisations in order to allow for building up critical masses and excellence in research. In addition, project funding mechanisms allow public authorities to steer the scientific community by setting distinct priorities in research in terms of topics and framework conditions (i.e. application requirements, co-funding requirements, public-private partnership requirements).

In the Czech Republic, the level of institutional R&D funding has constantly decreased in the last decade and in 2009, the latest year for which official R&D statistics are available, 49% of public R&D funds were distributed via project financing mechanisms, institutional funding accounted for 51%. Institutional funding is mainly geared towards the Higher Education Sector and the Government Sector.

Data presented in the study have shown **that the ratio of project funding versus institutional funding is already high in international comparison**. It provides the public authorities enough room for strategic steering, and **we see no need to further expand this share of funding** for the following reasons:

- Compared with institutional funding, **project funding is relatively costly**. Programmes have to be developed, fair and transparent selection procedures have to be established, the demand of the scientific community has to be validated, and respective awareness initiatives have to be launched. The programme implementation and its success have to be monitored and evaluated. All this is related with costs and needs to be taken into account when choosing project funding as main source of allocation.
- **Project selection mechanisms bear the risk to be biased**, which may have unintended consequences for the research community and hamper the effectiveness of the measures.
- Project funding mechanisms focus predominantly on shorter periods of times, which may be fulfilled within a period of 1-3 years. Empirical studies have shown that **the scientific impact of short-term research funds is considerable lower than for long-term centre-based funding mechanisms**. Longer-term funding and higher levels of funding concentrated on distinct research groups are a strong determinant for long-term scientific and commercial success.

As the relative share of project funding has become increasingly important, universities face the challenge to build up support capacities that monitor funding opportunities, make strategic choices regarding the use of project funding for building up additional research capacities in certain fields, and assisting academics in writing and submitting proposals in particular in complex international programmes.

Our survey has shown that at the research group level about 60% research activities are financed via project grants and service contracts. This means that project funding measures constitute the main base for R&D knowledge production in the Czech Republic.

Project funding from national sources is clearly of higher relevance than project funding from international sources, although EU Framework Programmes already

account for about 9% of total funds for research activities at the research group level. **For all actors in the public R&D sector, the structural funds measures (OPRDI, OPEI) do not play a major role for research until today.** For the Academy of Sciences, the Operational Programmes do not constitute a relevant funding source at all.

The survey further showed that the share of institutional funding has decreased for the majority of research groups in the Higher Education Sector and the Government Sector, whereas the level of funding from national research programmes, international programmes and contract services have remained unchanged in the last three years (2007-2010).

Public R&D expenditures: programmes and priorities

We further considered the portfolio of R&D project funding instruments in the Czech Republic, which was a complex issue, because the current portfolio is in big change. This change, however, was intentional. In the course of the present reform the budgetary chapters for R&D haven been reduced from 22 to 12, several programmes have been phasing out, responsibilities of ministries and funding agencies change, and a number of research programmes are just in a setting up phase and the study found that a large number of programmes, accounting for more than 60% of total targeted R&D financing, have discontinued to launch new calls in 2009/2010.

Apart from the impact in terms of the R&D programme portfolio, the National R&D Reform also put increasing pressure on R&D programmes to deliver "results", and consequently also seeks to set out how the results will be used. Hence, for the sphere of applied research activities the programmes and respectively projects need to deliver "results utilisable in innovation" (patents, realized technologies, software).

On the other hand, research excellence ranks high in the field of basic research. For projects in the field of basic research, in a strive for excellence, it is foreseen that "only world recognised results publications will be taken into account" (publications in prestigious publishing houses, publications in peer reviewed journals, publications originating at reputable conferences, etc.) with the exception of selected fields of Humanities and Social Sciences focused on a nationally oriented knowledge where the excellence will be measured within the National Reference Framework.

In order to ensure the use of R&D results, the national reform plan also foresees that a co-financing of programmes by public (state) and private resources, should take place in programmes of applied oriented R&D. The announced reason for this is that "the share of private resources is minimal and mostly they are not the resources of future users of programme results (enterprises), but the resources of investigators (research organisations).

A focus on scientific excellence, outputs and user orientation are common features of many national R&D policies. However, **the research and innovation policy approach of the reform documents follows a too narrow concept as regards the purpose of R&D programmes. The output orientation goes too far.** Applied and more industry oriented R&D programmes should be designed as measures to increase competencies of actors (increase the stock of useful knowledge), to define joint research agendas between industry and academia, and to allow for training of R&D personnel and knowledge transfer. Instead, science-industry collaborations in the Czech Republic should simply and directly lead to an application of results obtained from R&D programmes. This simplistic type of policy approach has led to an instrument portfolio, which at present does not incorporate measures for training of young researchers, measures to enhance knowledge flows between science and industry, and measures that seek to integrate Czech R&D actors in the European research arena in a coherent manner.

In addition, **the Czech R&D policy relies upon a funding system, in which thematic priorities are only defined in a very loose manner**. Although in many European countries thematic research priorities are only defined broadly, and

most adopt a generic approach to research funding with the inclusion of a variable number of thematic programmes, the (non) existence of thematic oriented R&D programmes in the Czech Republic raises concern: The cross-sectional R&D priorities security R&D and applied R&D of national and cultural identity, as well as the sector programmes on agricultural R&D and defence R&D, focus exclusively on themes which concern strategic national interests of the state and its citizens, but they do not encompass measures which seek to align research activities of industry and science around fields of strategic interest for enhancing the competitiveness of the economy. **This holds in particular true for the whole ICT research sector, which also is the largest thematic area addressed by the EU Framework Programmes** and it also concerns the Biotechnology and Life Sciences arena, and the programmes relating to New Materials and production processes.

Except from the ALFA programme and the programmes of the branch ministries, the R&D programme portfolio strongly leans towards a provision of generic, bottom-up oriented R&D support programmes:

- The portfolio of instruments of the Czech Science Foundation only consists of standard grant schemes, which can be found almost elsewhere throughout Europe and does (at present) not deliver mechanisms which allow for capacity building at the level of research organisations and at the level of research themes (i.e. networks of research actors at different institutions. Furthermore, an integrated approach geared towards the supply of new, highly skilled young scientists is missing within the range of activities of the Czech Science Foundation.
- The TIP programme of the Ministry of Industry and Trade does not provide sufficient incentives for science-industry collaborations, and its thematic steering is limited towards sectors of national strengths. The key characteristics of the programme are its output orientation, which concludes that every project has to result in at least one of the following outputs: patent, pilot, proven technology, functioning model, design, prototype, "utility model", applied certified methodology, software.
- The R&D branch programmes are in essence multi-annual thematic research programmes, which have a stronger systemic oriented approach, coping with a portfolio of activities that include i.e. the integration of international collaboration, inter-departmental co-operation, and co-operation with the Czech Science Foundation for increasing quality of R&D projects (only explicit in the strategy of the Ministry of Health), but the programmes are by nature limited towards their specific area of interest (security, health, defence, culture).

We therefore recommend setting up a limited number of thematic oriented R&D programmes, in which a potential for increased competitiveness for industry exists, which can only be nurtured through a strengthened engagement with the academic sector.

As the priorities outlined in the Reform Plan and the National R&D Strategy are not well incorporated in the R&D programmes (except from a strong “results” orientation) **we recommend to enhance the present portfolio of R&D instrument by accompanying measures that are embedded within the R&D programmes.** Bottlenecks of the Czech Innovation system, such as low interactions of the research community with the industrial community will not be eased just by a consideration in the selection process of projects. Awareness measures, training opportunities, and networking activities need to be incorporated into R&D programmes of the Czech Republic. This holds in particular true for the programme portfolio of the Czech Science Foundation and the industrial R&D support programme TIP. **TIP should be substituted by a more advanced programme that incorporates training measures, exchange schemes with the academic sphere, and offers tailored approaches for SMEs and larger companies.**

A coherent approach towards an incorporation of science industry linkages is so far missing, but in the near future the Competence Centre Programmes, could prepare the

field for intensified strategic partnerships of research and industry. The programme should also serve to create conditions for human resources development (focus on young researchers) and mobility of researchers between public research and industry and could serve as a point of reference and learning tool for designing R&D programmes.

The Operational Programmes

The national R&D programme portfolio is complemented by financing instruments of the Operational Programmes *Enterprise and Innovation* and *Research and Development for Innovation*. Whereas the national R&D programmes focus on the provision of project financing measures, which support labour costs, the Portfolio of support within the Operational Programmes put a stronger focus on setting up new infrastructures for research, development and innovation (Science and Technology Parks, Regional R&D Centres, European Centres of Excellence).

Within the *Operational Programme Research and Development for Innovation*, the *European Centres of Excellence* and the *Regional R&D Centres* aim at the development of new research workplaces and at increasing the capacity via setting up research infrastructure and equipping the research workplaces with modern technologies. The main risk associated with the programme was its slow implementation. However, as the conceptualisation of the European Centres of Excellence and the Regional R&D centres followed international good practice they are likely to have a huge impact on the Czech R&D system in the medium term future. Both programmes tackle critical issues of the Czech Research system which will be monitored through the use of performance contracts which include key parameters such as the acquisition of external funds, scientific output, international collaborative activities and interactions with industry.

Within the Operational Programme Enterprise and Innovation also forms of support are provided that can be considered as being in line with modern EU approaches of innovation policy, as support for spin-off firms, protection of IPR, business angels, clusters and technology platforms, cooperation between firms and R&D institutions. Measures which seek to strengthen inter-industry interactions and science-industry interactions science are to be found within the Cluster Programme and the Technology Platform Programme.

The Cluster Programme has achieved to develop cooperative groupings consisting of associating firms in a given field, regional authorities, universities, research and other institutions in the region, but at present no valid information as regards their R&D activity portfolio exists.

The Technology Platforms have raised some awareness among the participating groups of companies but according to the preliminary results of an evaluation of the Technology Platforms, the real impact of the platforms is rather overestimated. So-far activities are mainly restricted towards networking with relatively low results.

The Innovation part of the OPEI should allow firms to introduce product- and process innovations; these however, shall mainly be achieved by acquisition of machinery, modern-equipment and purchase of licences. No research activities are financed within this type of activity. Also the Potential Programme, for which about 40% of the priority axis funding are reserved, finances in large part the purchase of machinery and other facilities etc.

As the Operational Programmes Enterprise and Industry and Research Development for Innovation are likely to change the Czech Innovation System in medium term, **we recommend that the core elements of the programmes, in particular the Cluster Programme of OPEI, the European Centres of Excellence and the Regional R&D centres are subject to specific evaluations, in which the progress achieved in the implementation is assessed** as so far no evaluation of physical progress achieved in implementation of the OP has been undertaken so far

(Blazek 2010). Particular attention should be paid to the involvement of Clusters and Regional R&D centres in the national R&D programmes, and to the visibility of the European Centres of Excellence in the European Framework Programmes.

1. Introduction

The aim of this report is to analyse the research performance structure in the Czech Republic and to assess whether the public expenditure of Research, Technological Development and Innovation (R&D) in the Czech Republic are effective and comparable with the European level.

The specifications of the terms of reference have foreseen to analyse in particular the research financing and expenditure structure of the Higher Education Sector, the Government Sector (R&D Institute Sector), the total amount of public funds, and the level of private funding of R&D.

The analysis needs to take into account the ratios of public funds allocated to individual research fields, the level of project funding within the Czech Republic, and the adequacy of national funding priorities (i.e. funding of specific research fields and sectors). In this respect, also the diversification of financial support, in particular to the Business Enterprise Sector and the existence of critical masses therein, has to be considered in the international comparative analyses.

In order to provide an assessment of the level of R&D expenditures and the underlying financing structure in the Czech Republic, this report provides an analysis of the (R&D) performance and funding structure in an international comparative manner.

The first part depicts the overall national trends in R&D spending in the Czech Republic. We highlight the results of the global estimates on R&D spending in the last decade and provide an international comparison of the development of the R&D quota and the growth rates of R&D spending. Furthermore, an international comparison of the R&D financing structure is provided. In particular, the chapter details the structure of public R&D financing via an analysis of the Government Budget Appropriations on R&D (GBAORD) in international comparison. These analyses allow assessing critically the level of public and private R&D spending of the Czech Republic in the context of the European Research Area.

Another important aspect of the analyses is to provide information on the national public R&D funding and support structure. A more detailed consideration of the state budget for R&D and additional international sources allows describing the distribution of public support for R&D among the main performance sectors (Business Enterprise Sector, Higher Education Sector, and Government Sector) and type of financing.

In our analysis of the Czech Republics' public R&D funding system we distinguish between the main financing channels of the different types of institutions, in particular between institutional funding for R&D and project funding for R&D. Project funding is broadly defined as funding attributed on the basis of a project submission to a group or individuals for an R&D activity that is limited in scope, budget and time (Lepori et al. 2007). Institutional funding on the other hand is defined as the general funding of institutions with no direct selection of R&D projects or programmes. Sufficient amounts of project funding in research and innovation system are crucial, as in principle, project funding could allow for a more selective distribution of money, for example targeting the best research groups, promoting some subjects or supporting structural change such as the creation of cooperation networks and structures (Braun, 2003). However despite its importance, project funding as such has not yet found completely its way into research policy studies and official R&D statistics. Only a limited number of pilot studies have produced project funding indicators until today. Nevertheless the available studies allow demonstrating that level and orientation of national (project) funding patterns varies considerably between European Union member states, and hence provide relevant insights into such crucial issues for the Czech Republic as priority setting and management of allocation mechanisms in R&D.

The second chapter of this report provides an international comparison of the R&D performance structure of the Czech Republic. In particular, the chapter provides information on R&D performance in the three main performance sectors: The Higher Education Sector, the Government Sector, and the Business Enterprise Sector. By large, the analyses are based upon internationally available research statistics including a) the type of R&D activities conducted within the performance sector, and b) the relevance of specific research areas (field of science). Thereby, parameters of international specialisation provide information on critical masses and competitive advantages of the Czech Republic. For the Business Enterprise Sector, the analyses on the R&D performance structure do not only consider the different types of research activities and scientific research areas, but also a differentiation by industrial branches.

The third chapter of this report assesses the current state of R&D support in terms of programmes and financing measures. It concentrates on the level of targeted R&D funding measures aiming at particular themes and beneficiaries. We provide an overview about the current portfolio of instruments and financing measures, the corresponding priorities, and planned investments. In addition to the national R&D financing, the study also considers the Operational Programmes of the EU Structural Funds.

2. R&D Financing in the Czech Republic

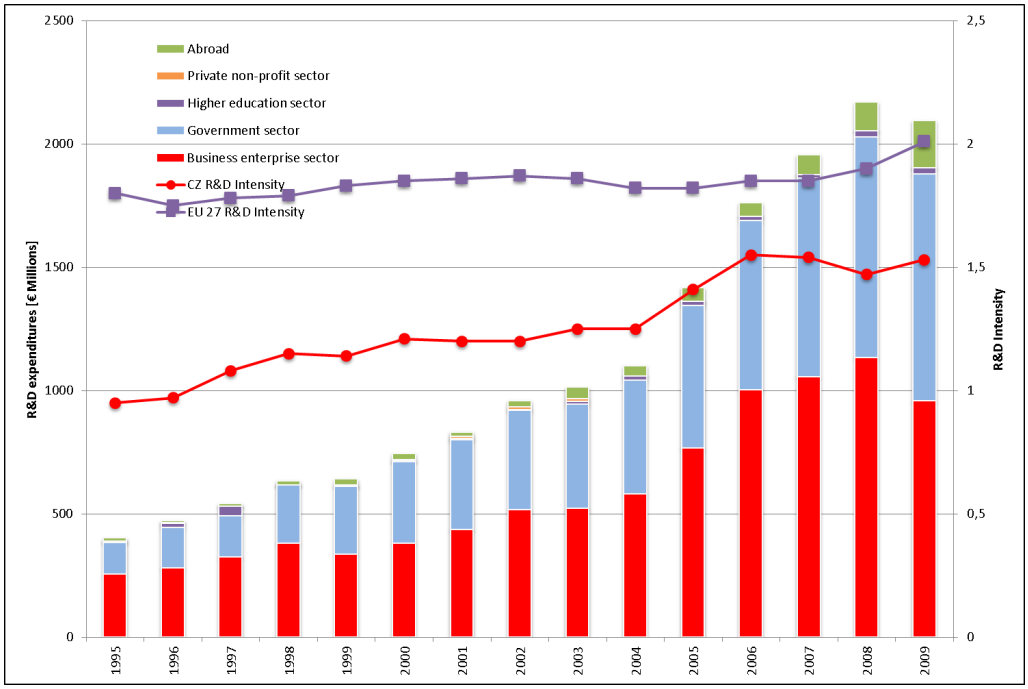
In this section we describe the current trends in R&D spending in the Czech Republic and assess whether these are comparable with EU investment levels. The main aim is to position the Czech Republic in terms of R&D investment levels and to find out whether bottlenecks and challenges in terms of overall research funding and performance of different sectors exist. The analysis has a clear macro perspective. Main sources are official OECD and EUROSTAT data, which stem from the Czech National Statistical Office. Where available, statistics have been complemented by data stemming directly from the Czech National Statistical Office. Overall, the data allow to a large extent for international comparisons.

2.1 International Comparison of R&D Investments

Since the mid-nineties, the R&D system of the Czech Republic was characterized by a continuous growth of investments in R&D, which only came to halt due to the overall financial and economic crisis, which in particular affected R&D investments of the Business Enterprise Sector.

In 2009 – the latest year for which EUROSTAT data are available – R&D investments summed up to 2,094 million EUR in R&D, which corresponds to an R&D intensity of 1.53%. A historic peak in R&D intensity was reached in 2007 with 1.54% of GDP.

Figure 1: Research and Development in the Czech Republic by Sources of Funding



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

Figure 1 shows that total R&D expenditures in the Czech Republic have more than quadrupled since 1995 and that the R&D intensity is approaching EU-27 average levels. The average annual growth rates displayed in Table 1 reflect that the Government Sector and the Business Enterprise Sector have considerably increased investments in the Czech Republic. In addition, also funding from abroad has considerably increased in the last years.

Table 1: Average Annual Growth Rates in R&D (1995- 2009) by sources of funding

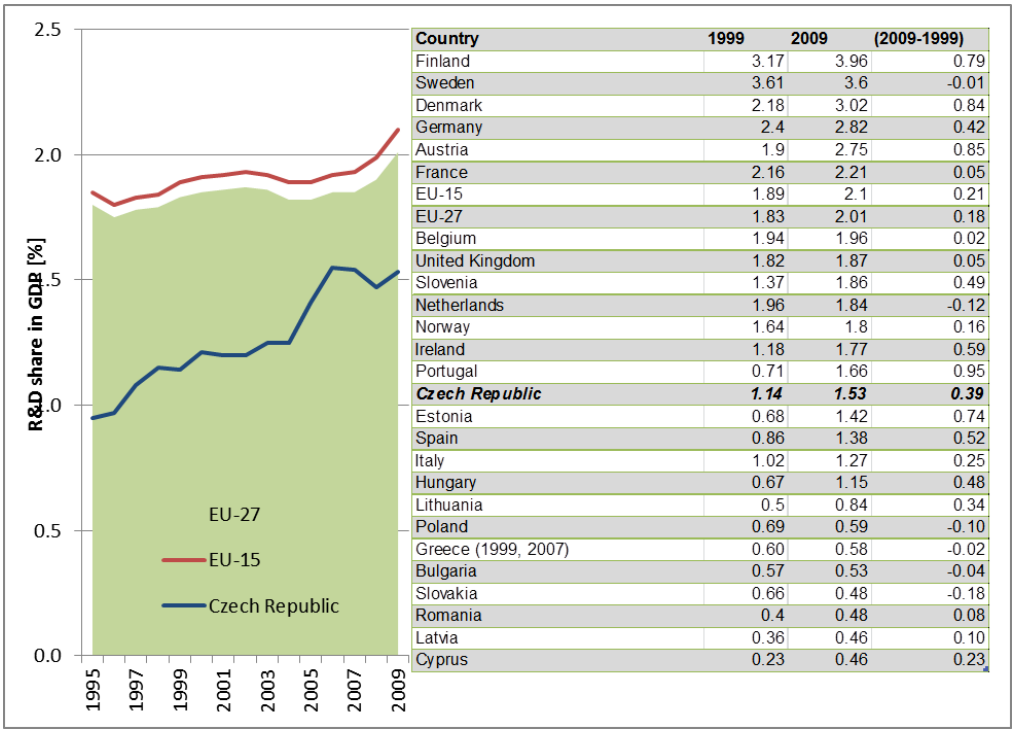
	Total	BERD	GOV	HERD	PNP	Abroad	R&D Intensity
Czech Republic	12.5%	9.9%	15.0%	13.3%	-7.0%	20.9%	3.5%
EU-27 (2008, R&D quota 2009)	4.9%	5.3%	3.7%	8.9%	7.8%	7.7%	0.8%

Source: Eurostat (2010), calculations JOANNEUM RESEARCH

However, business enterprises show a much more volatile investment structure in R&D than governments, as their financing patterns also depend on the economic business cycle in a pro-cyclical way. Hence, after being the driving force for an increased financing of R&D from 2003 until 2007, investments of the Business Enterprise Sector abruptly lost momentum in 2008 with the onset of the crisis and reduced the relative share of R&D funding of the business sector and compound annual growth rates. This however was not only a Czech phenomenon: As can be seen in the figure below, R&D expenditures of the Business Enterprise Sector have been considerably decreased in many countries in between 2008/2009.

Despite the recent downturn of R&D financing stemming from the Business Enterprise Sector, we are able to portray a positive picture regarding the Czechs' position of overall R&D investment levels and the underlying funding structure.

Figure 2: Development of R&D Expenditures as a Percentage of Gross Domestic Products



Country	1999	2009	(2009-1999)
Finland	3.17	3.96	0.79
Sweden	3.61	3.6	-0.01
Denmark	2.18	3.02	0.84
Germany	2.4	2.82	0.42
Austria	1.9	2.75	0.85
France	2.16	2.21	0.05
EU-15	1.89	2.1	0.21
EU-27	1.83	2.01	0.18
Belgium	1.94	1.96	0.02
United Kingdom	1.82	1.87	0.05
Slovenia	1.37	1.86	0.49
Netherlands	1.96	1.84	-0.12
Norway	1.64	1.8	0.16
Ireland	1.18	1.77	0.59
Portugal	0.71	1.66	0.95
Czech Republic	***1.14***	***1.53***	***0.39***
Estonia	0.68	1.42	0.74
Spain	0.86	1.38	0.52
Italy	1.02	1.27	0.25
Hungary	0.67	1.15	0.48
Lithuania	0.5	0.84	0.34
Poland	0.69	0.59	-0.10
Greece (1999, 2007)	0.60	0.58	-0.02
Bulgaria	0.57	0.53	-0.04
Slovakia	0.66	0.48	-0.18
Romania	0.4	0.48	0.08
Latvia	0.36	0.46	0.10
Cyprus	0.23	0.46	0.23

Source: Eurostat, Czech Statistical Office, calculations JOANNEUM RESEARCH

A comparison with the EU member states shows, that the Czech Republic exhibits the second highest share of R&D investment among the new member states and has a higher R&D intensity at present than many of the South-European member states (Spain, Italy, Greece, Cyprus),and the growth of R&D intensity of the Czech Republic was among the largest within the EU27 member states.

The figure also shows that catching up in terms of research investments and innovation activities is a long lasting process for all countries. It involves not only public and predominantly private investments in R&D but matters of human

resources and education policy, governance, and the whole industrial structure and economic development – which depends on R&D capacities only in the long run.

Greece and Spain, despite joining the EU much earlier than the Czech Republic and receiving substantial structural support for decades, are still far away from advancing to R&D investment levels of the leading northern member states. The catching up-process in Austria started from a clearly below-average R&D intensity in the 1980s (1.1% of GDP in 1981, compared to a EU15 average of 1.64 %), and surpassed the EU15 average (now 1.83%) only in 1998 and the average of the OECD states in 2004 - despite the existence of a free market economy for decades. It is not clearly evident, that countries with lower R&D investments levels are even capable to start a catching-up process, which the Czech Republic has undergone so far: Hungary, Bulgaria, Romania, Poland and Slovakia are still far from approaching EU average levels of R&D intensity.

At the same time, the R&D intensity in some of the larger European countries has improved only marginally since 1999. While the EU15 countries are experiencing stable growth in R&D intensity, the historic trend of the EU27 countries has also been steady, although at a lower level. In this country group, the R&D intensity as well has only little increased and therefore the EU was barely able to approach its own quantitative goal set out at the Barcelona summit in 2002.

Bearing in mind that the EU-27 is far away from reaching its own goals as to achieve total R&D expenditures of 3% of GDP by 2010, and also that European convergence does not seem to become reality, the development of R&D investment ratios in the Czech Republic is at least promising.

For 2020 the government of the Czech Republic has set its own goal to increase public R&D investments to 1% of GDP. No goal for total R&D intensity has been set, but a target of 2.7% of GDP was discussed. Based upon the assumption of a nominal annual GDP growth of 4% until 2020 (it was higher than 7% in the last decade), this would mean that the government has to increase R&D financing by 8.3% p.a and the Business Enterprise Sector by 11.2% p.a.

2.2 The General Level of R&D Financing in the Czech Republic

In accordance with international conventions, the R&D sector consists of four performance sectors (Higher Education Sector, Government Sector, Private Non-Profit Sector, and the Business Enterprise Sector), and five main sectors of funding (Government Sector, Business Enterprise Sector, Private Non-Profit Sector, and Funding from Abroad). The sectors are defined as follows[1]:

The Business Enterprise Sector (BES): is formed of all companies, organisations and institutions whose principal activity is market production of goods or services for sale to the general public at an economically significant price.

The Government Sector (GOV): includes in the Czech Republic especially workplaces of the Academy of Sciences of the Czech Republic and other places of research under the competence of ministries (on 1 January 2007 the statute of most of these entities changed to public research institutions), institutions of central and local government, except for publicly managed higher education institutions; it also contains public libraries, archives, museums and other cultural establishments conducting R&D as their secondary activity[2].

[1] The definitions of sectors presented below stem from the methodological notes/fact sheet of the National Statistical Office and were provided by the Technology Centre.

[2] Note: All public research institutions irrespective of their institutional sector used in national accounts belong into the Government Sector in the R&D statistics. Before 2009 some public research institutions

The Higher Education Sector (HES): comprises both public and private universities and other institutions of post-secondary education. It also includes all research institutes, experimental facilities and clinics whose work is directly controlled or managed by higher education institutions or is associated with them[3].

The Private Non-Profit Sector (PNP): includes all institutions serving households sector (referred to as the Private Non-Profit Sector), which comprises private institutions, including private persons and households, whose primary aim is not profit formation but providing non-market services to households. They include e.g. associations of research organisations, societies, unions, movements, federations or foundations.

Table 2: R&D expenditures by sectors of performance and sources of financing (2009)

Sectors of Performance	in million EUR	Share in %	Sources of Funds	in million EUR	Share in %
All sectors	2093.799	100.0%	All sectors	2093.799	100.0%
Business Enterprise Sector	1256.58	60.0%	Business Enterprise Sector	959.594	45.8%
Government Sector	447.737	21.4%	Government Sector	919.268	43.9%
Higher Education Sector	379.122	18.1%	Higher Education Sector	22.715	1.1%
Private Non-Profit Sector	10.359	0.5%	Private non-profit sector	0.425	0.0%
			Abroad	191.796	9.2%

Source: Eurostat (2010), calculations JOANNEUM RESEARCH

The table above provides information of the entire R&D expenditures for 2009 by sector of performance and source of funding.

The interdependencies between these sectors of funding and performance are shown in Figure 3 and serve as a starting point for discussing the role of public R&D funding in the Czech Republic. The figure contains the following type of information:

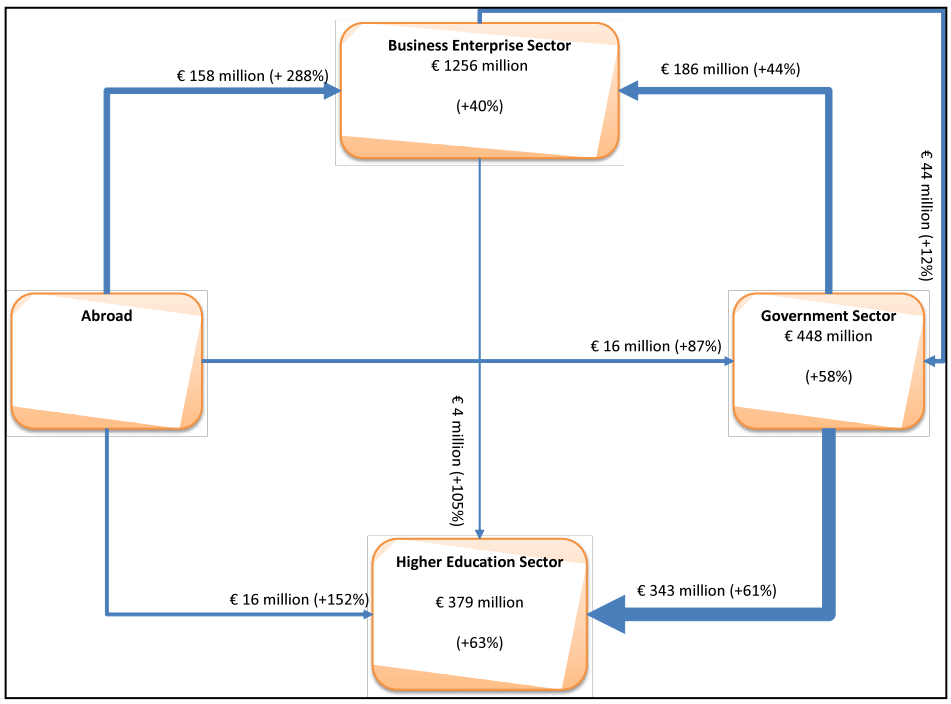
- The R&D expenditures of the individual sectors of performance are shown in the boxes
- The figures next to the arrows show the volume of financing
- The percentages illustrate the change compared to 2005.

The expenditures of the Business Enterprise Sector for R&D amounted to 1,256 million EUR in 2009, reflecting a +40% increase compared to 2005. The Higher Education Sector increased its R&D expenditures by 63% to 379 million EUR and the Government Sector increased its R&D expenditures by 58% by to 448 million EUR. Both account for 40% of total R&D expenditures. The Business Enterprise Sector accounts for 60% of total R&D expenditures (table 2).

were included in the Business Enterprise Sector due to the fact that since 2004 their institutional sector has been identified according to the international classification ESA as – nonfinancial enterprises. In order to maintain methodological correctness and comparability of data in time, all data were recalculated in 2009.

[3] Since 2005, in compliance with OECD methodology, the sector also includes teaching hospitals. This sector is not a separate institutional sector of national accounting, but has been separately identified for its important role in R&D.

Figure 3: Financing Structure of Research Expenditures in 2009, Investment Changes since 2005



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

As can be seen from Figure 3, there are three significant financing flows for R&D expenditures:

First, the Business Enterprise Sector finances about 46% of total R&D activities in the Czech Republic in 2009. By large, the Business Enterprise Sector finances its R&D activities itself (73%). Funding from abroad amounts to 158 million EUR (13% of total business R&D expenditures) and government funding amounts to 186 million EUR (15% of total business R&D expenditures). In terms of financing flows, the Business Enterprise Sector shows little interaction with the Higher Education Sector as only 4 million EUR of R&D funding flow into this performance sector. Interactions with the Government Sector are considerably higher. Funds financing 44 million EUR of R&D at the Government Sector stem from sources of the Enterprise Sector. This means that 10% of total R&D activities in the Government Sector are financed by business enterprises. However, the Annual Report of the Academy of Sciences 2009 (ASCR 2010) reveals, that sales of licences alone account for 1,131.9 million CZK (approximately 46.1 million EUR) of total own research, development and innovation resources of the Academy, which means that within the Government Sector the Academy has the largest . In terms of overall financing of the academy, a total of 2,228.5 million EUR stems from own sources (foreign grants, sales of goods and services etc). This contributes to 26% of total financing of the Academy.

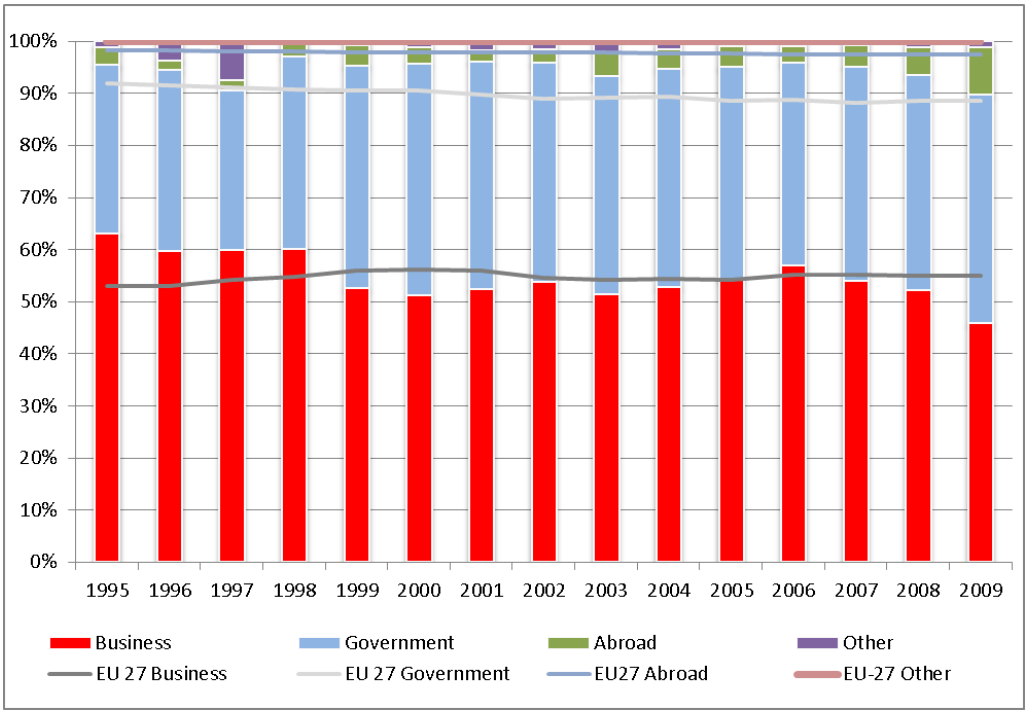
The second important financier of research and development is the Government Sector, accounting for 44% of total R&D funding in the Czech Republic. The main profiteers of government R&D financing are R&D institutions of the Government Sector (predominantly the Academy of Sciences) and the Higher Education Sector. In 2009 government sources financed 90% of total R&D expenditures in the Higher Education Sector and 85% of R&D performed in public research institutes. Compared with 2005 R&D financing for the Higher Education Sector has increased by 61%. In the same time period financing for R&D institutes of the Government Sector increased by 65%.

Apart from the government and the Business Enterprise Sector, also financing from abroad, plays a significant role for R&D investments in the Czech Republic nowadays.

Latest national data on R&D funding show that in 2009 foreign funding sources accounted for 9% of total R&D investments of the Czech Republic after 5% in 2008. Funding from abroad has increased considerably not only in relative terms, but also in absolute terms. Compared with 2005 the overall financing level from abroad has increased from 56 million EUR to 192 million EUR in 2009. As Figure 3 shows, funding geared towards the Business Enterprise Sector has increased by 288% since 2005, funding towards the Government Sector has increased by 87% and funding towards the Higher Education Sector has increased by 152%. This strong increase indicates an increased internationalisation of R&D financing in the Czech Republic. In fact, in 2009 R&D funding from abroad in the Czech Republic has reached the EU-27 average level.

Funding from abroad contains both the funds of foreign companies, international organisations and EU funds. The available data for 2008 show that 70% of the foreign investments worth 116 million EUR stem from (mainly multinational) companies investing in Czech subsidiaries, and 30% stem from the European Union[4].

Figure 4: R&D Expenditures in the Czech Republic by Sources of Financing (1995-2008)



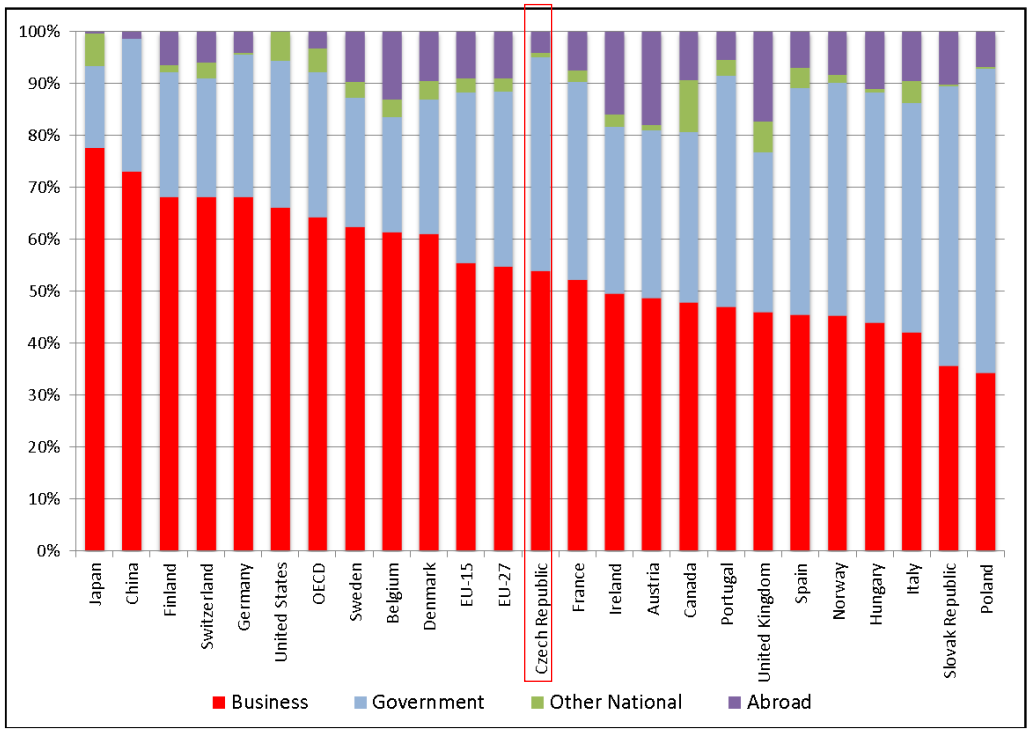
Source: Eurostat (2010) and Czech Statistical Office (2010), calculations JOANNEUM RESEARCH

As can be seen in the figure above, the overall composition of financing sources has been subject to various fluctuations, which may mainly be attributed to the Business Enterprise Sector. While in the mid-nineties the Business Enterprise Sector still accounted for 60% of R&D funding, a steep drop in the relative share occurred in 1998/1999, when business R&D funding declined to 53%, while government increased its share to 43%. However, facilitated by high growth rates of GDP, the share of business R&D investments increased to 57% in 2006. Since 2007, the share of funding from the Business Sector is decreasing again, a process which may be attributed to the global economic crisis so that the share decreased to 46% in 2009.

[4] The data for 2009 have not yet been made available by the Czech Statistical Office.

Figure 5 also contains information on the overall funding structure of the EU-27 member states. As can be seen therein, the level of business funded R&D has never exceeded 56% and is currently (2008) estimated at 55% for the EU-27. Interestingly, the level of government funding for the EU-27 decreased considerably throughout the last decade from 39% in 1995 to 34% in 2008. The remainder of 11% of total R&D funding is mostly financing from abroad (9%), which includes both funding from the European Union Framework Programmes and other international organisations as well as financial flows, stemming from foreign companies, funding from other sources account (e.g. the Private-Non-Profit Sector) accounts for 2% of total R&D financing.

Figure 5: Financing Structure of Research Expenditures by Country in % (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

Hence, for the EU-27, the EU-wide target, that 2/3 of R&D expenditures should stem from private sources, was only missed, if the target was taken literally. Focussing on the content of the objective, we see that the EU-27 has (almost) met the target, if funding from abroad is taken into account. Throughout the European Union financing from abroad amounts to approximately 9% of total R&D funds, and mainly consists of private sources (multinational companies which invest in affiliates and conduct R&D services in foreign countries). Although the Czech Republic does not fully live up to the 2/3 target, the relative share of funding from abroad has increased in recent years up to levels of EU-average.

Hence, despite the recent downturn in the relative share of financing stemming from the Business Enterprise Sector, the financing structure of the Czech Republic is comparable to those of well advanced European economies and resembles very much the level of the EU-27.

Internationally comparable data ahead of the onset of the crisis (2007) show that the Czech Republic has the potential, that about 60% of total R&D funding stem from private sources, if financing from abroad is taken into account. Thereby, the Czech Republic is positioned in between countries like the United Kingdom and France. Of course, one also has to account for the industrial structure of a country (see section on R&D expenditures in the Business Enterprise Sector), but the overall financing

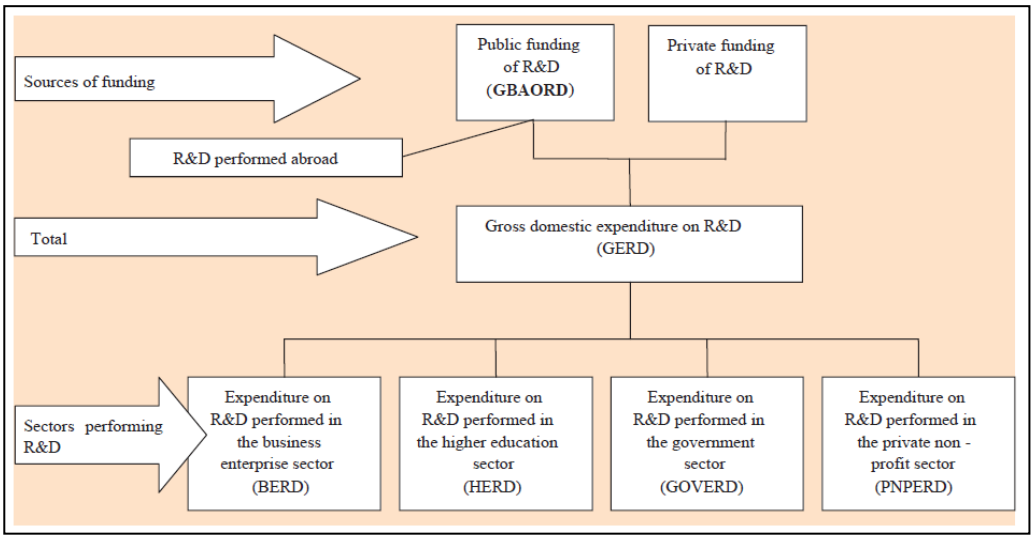
structure of the research expenditures in the Czech Republic show, there is a solid funding base for the provision of public and private R&D in the Czech Republic.

2.3 Public R&D Financing: an International Comparison

An additional international comparison of public R&D financing may be provided when looking at the government budget appropriations or outlays on research and development (GBAORD).

According to EUROSTAT (2010) GBAORD data include all funds allocated to R&D in the central government or federal budgets; provincial or state governments should also be included, when their contribution is significant. GBAORD data cover all government R&D outlays, hence include all R&D outlays and support measures for the Higher Education R&D Sector (HERD), the Government Sector (GOV), the Business Enterprise Sector (BERD), and the Private Non-Profit Sector (PNP).

Figure 6: Coverage of Government Budget Appropriations or Outlays on Research and Development



Source: Eurostat (2010)

The advantage of GBAORD data is their timeliness but EUROSTAT (2010) reports that drawbacks of GBAORD data are data sources (GBAORD data are compiled by national authorities from figures on public budgets) and harmonisation issues (different terminologies and methodology for budget items, which do not fully match the OECD/Eurostat methodology set as defined in the Frascati Manual), which need to be considered when using them[5].

GBAORD data are split by socio-economic objectives, depending on the R&D programme or project[6]. Thereby R&D programmes are allocated to specific socio-economic objectives based on the intentions at the time the funds are committed and not on the actual content of the projects concerned (EUROSTAT 2010).

2.3.1 GBAORD in an International Perspective

An international comparison of GBAORD as a share of GDP, adjusting for the size of the economy and making it easier to compare GBAORD levels between countries

[5] Information on methodological differences between GBAORD data and R&D expenditures data are to be found in the OECD Frascati Manual (Frascati Manual, OECD, 2002).

[6] Socioeconomic objectives are based upon the NABS – the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budget.

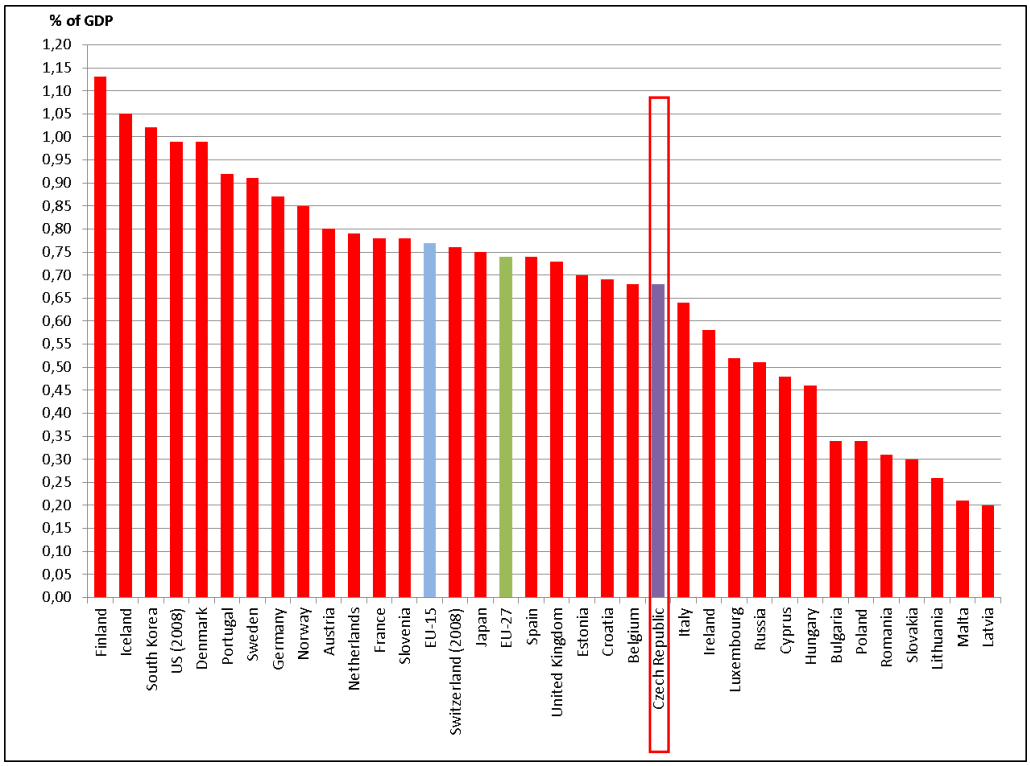
shows, that in 2009 GBAORD at 0.77% of GDP in the old EU-15 and 0.74% in the EU-27. However, this figure entails large discrepancies between the EU member states:

- In Finland GBAORD reached 1.13% of GDP in 2009, while in Latvia and Malta levels of 0.2% of GDP were recorded.
- Overall, 10 EU member states report GBAORD levels, which are higher than the EU-27 average and 15 member states report GBAORD levels below the EU-27 average.

Whereas the United States and South Korea are clearly above the EU-15 average, Switzerland and Japan exhibit right about the same levels as the EU-15. With a GBAORD of 0.68% of GDP, the Czech Republic comes close to the level of the EU-27.

Among the new member states only Slovenia, which has already surpassed the GBAORD level of the EU-15, exhibits higher rates of GBAORD investments measured in % of GDP. The Czech Republic has thereby surpassed relative investment levels of Italy, Ireland, Luxembourg and Russia.

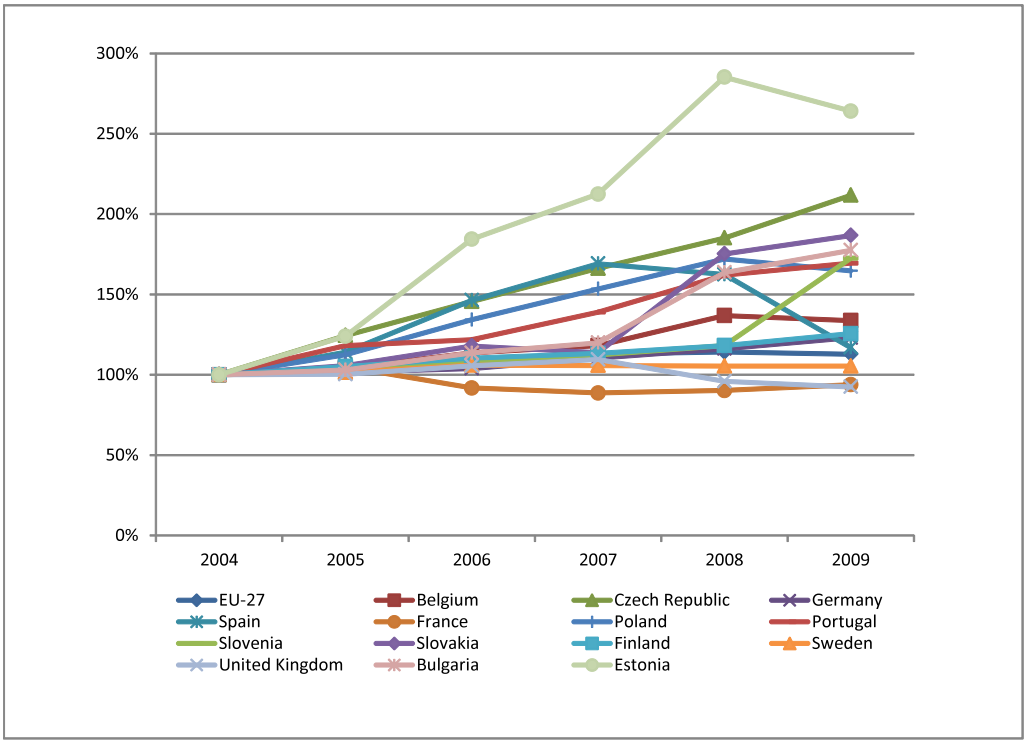
Figure 7: Total GBAORD as a Percentage of GDP, the Czech Republic and Selected Countries (2009)



Source: Eurostat

A comparison of GBAORD growth in some selected EU-economies shows, that GBAORD expenditures in the Czech Republic has risen by 212% since 2004, whereas for the EU-27 countries total growth of GBAORD expenditures was only 12%, which is mainly due to low or even negative growth of GBAORD in the larger European Union member states.

Figure 8: Comparison of GBAORD Growth in Selected Economies (2004-2009) (index 2004=100),



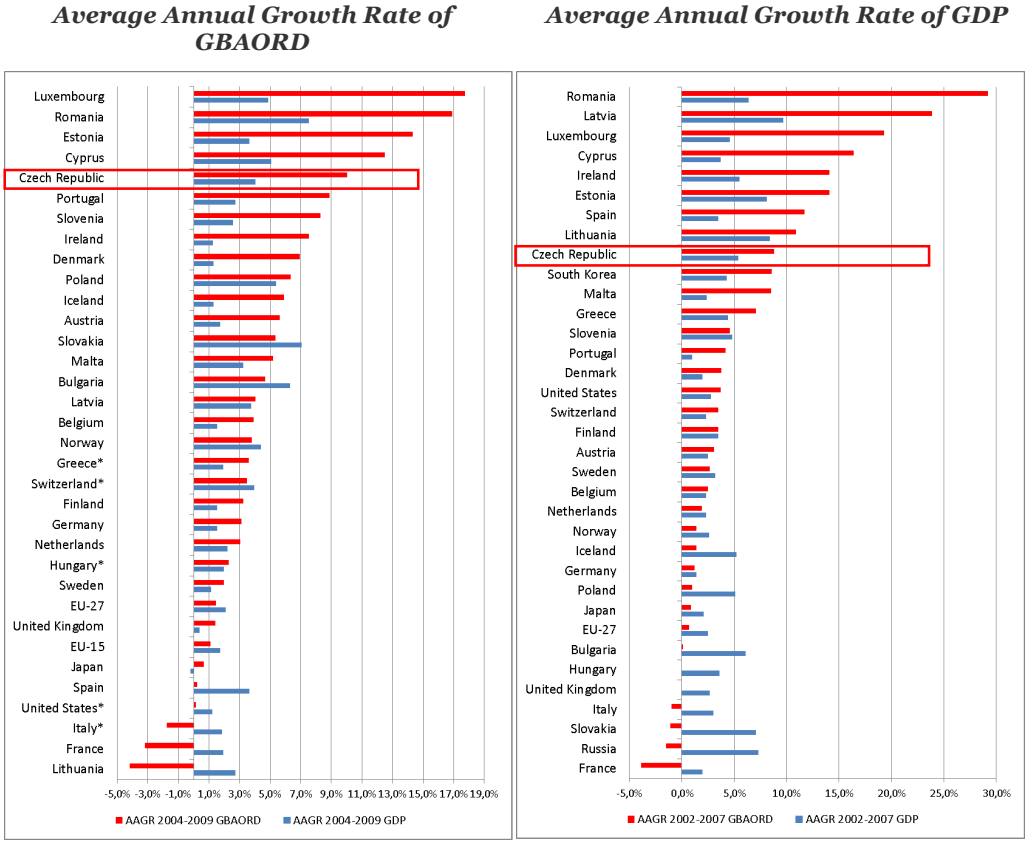
Source: Eurostat 2010

A comparative breakdown of the annual average growth rates of GBAORD and GDP, both expressed in purchasing power standard at 2000 prices for the period 2004-2009 confirms that the Czech Republic has been among the leading countries in the EU-27 as regards the growth of GBAORD.

Furthermore, the Czech Republic is one of the few countries which have sustained high levels of public growth in R&D investments from 2002 onward. In the reference period 2004-2009, only Luxembourg, Romania and Estonia and Cyprus exhibited higher growth rates of GBAORD than the Czech Republic. Out of these countries, only Estonia reached a slightly higher level of public R&D investments measured as a share of GDP in 2009, reflecting that the Czech Republic and Estonia had been the two main catching up countries regarding increased public R&D investments.

In total, average growth rates for the whole EU-27 were considerably lower than those of many smaller EU member states. This was mainly due to an actual decrease of public R&D investments in Italy and France, and very low growth rates in the United Kingdom and Spain, which together account for 57.5% of total EU-27 GBAORD. Hence, out of the largest EU-member states only Germany, which accounts for the largest share of public R&D expenditures in Europe (22.5%), exhibited comparatively high growth rates in public R&D investments.

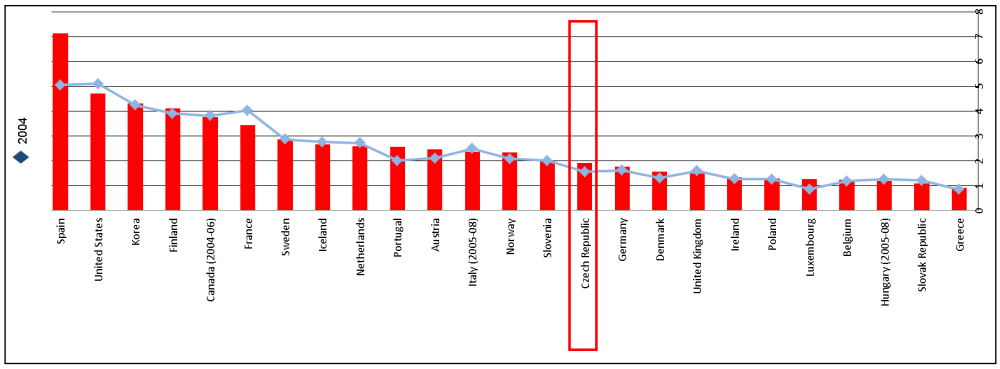
Figure 9: Average Annual Growth Rate of GBAORD and GDP (Expressed in Million Purchasing Power Standard at Constant 2000 Prices), Czech Republic and Selected Countries – 2004-2009 and 2002-2007



Source: Eurostat 2010

An additional indication of the relative importance of public R&D is its share in terms of total government expenditures. In 2008 2% of total government outlays were reserved for research expenditures. Compared with 2004, this share has increased only marginally. This means that no shift in terms of priorisation for research and development in public expenditures has occurred.

Figure 10: GBAORD as a % of Total Government Outlays in 2004 and 2008



Source: OECD (2010)

Although the share of R&D expenditures is comparable to well advanced economies like Germany, Denmark and the United Kingdom, several European Union member states spend considerable higher shares of overall public expenditures on R&D.

2.3.2 GBAORD by Socio-Economic Objective

A comparison of GBAORD by socioeconomic objectives is provided in the following table. The table shows that in the EU-27 the largest share of GBAORD (32%) accounts for General University Funds, followed by the category General Advancement of Knowledge: R&D financed from sources other than GUF (18%), Industrial Production and Technology (10%), Health (8%) and Defence (6%).

General University funds are one out of three types of financing sources of universities, which the Frascati Manual (OECD 2002) describes as follows:

- R&D contracts and earmarked grants received from government and other outside sources (such as businesses).
- The university's 'own funds' from sources such as endowments, shareholdings and property, plus surplus from the sale of non-R&D services such as fees from individual students, journal subscriptions, et cetera.
- General grants received from the Ministry of Education or from the corresponding provincial or local authorities in support of their overall research or teaching activities. For the purposes of international comparisons, the R&D content of these public general university funds is credited to the government as a source of funds.

Table 3: Breakdown of GBAORD by Socio-Economic Objectives (% of total) and total GBAORD (in Mio EUR), EU-27 and Selected Countries (2009)

	Exploration and exploitation of the earth	Environment	Exploration and exploitation of space	Transport, telecommunication and other infrastructures	Energy	Industrial production and technology	Health	Agriculture	Education	Culture, recreation, religion and mass media	Political and social systems, structures and processes	GUF	General Advancement of Knowledge	Defence	Total civil R&D appropriations	Total R&D appropriations
European Union (27 countries)	*2*	*3*	*5*	*4*	*4*	*10*	*8*	*4*	*1*	*1*	*3*	*32*	*18*	*6*	*94*	*87605*
Belgium	1	3	7	2	2	35	2	1	0	2	3	17	25	0	100	2291
Bulgaria	1	1	0	3	2	3	2	20	5	0	1	10	51	1	99	118
Czech Republic	***2***	***2***	***2***	***4***	***3***	***14***	***6***	***5***	***0***	***1***	***1***	***27***	***30***	***2***	***98***	***939***
Denmark	0	3	2	1	3	9	8	3	3	2	3	44	19	0	100	2200
Germany	2	3	5	2	4	13	5	3	1	1	2	37	17	6	94	20851
Estonia	1	4	1	9	3	10	14	8	2	4	3	0	39	1	99	96
Ireland	0	2	0	1	4	15	5	12	4	0	2	25	32	0	100	929
Spain	2	5	2	6	3	11	12	8	1	1	2	26	18	3	97	7828
France	1	2	14	9	6	2	7	2			2	25	20	7	93	14928
Italy	3	3	7	2	4	13	10	3	3	2	9	32	7	1	99	9778
Latvia	2	7	1	8	8	10	7	16	2	3	0	-	34	0	100	38
Lithuania	0	4	0	0	0	0	1	0	93	0	1	0	0	0	100	70
Luxembourg	1	3	0	3	2	5	22	0	4	1	20	16	22	0	100	196
Hungary	0	3	0	6	2	11	11	9	0	1	1	28	26	1	99	429
Netherlands	1	0	3	4	3	11	4	5	0	0	4	44	18	2	98	4527
Austria	2	2	0	1	2	14	3	2	1	1	1	57	13	0	100	2203
Poland	1	4	2	4	4	19	8	4	1	1	10	16	22	3	97	1052
Romania	2	8	3	11	7	19	13	8	5	1	1	-	20	3	97	360
Slovenia	1	3	0	3	1	28	4	3	0	4	3	4	36	9	91	277
Slovakia	2	3	0	2	2	6	6	6	2	4	1	28	34	4	96	190
Finland	1	2	2	2	10	23	6	5	0	1	4	25	17	2	98	1928

Sweden	1	2	1	6	4	4	1	2	1	0	2	62	6	8	92	2662
United Kingdom	3	3	2	1	1	1	17	3	1	2	2	24	20	21	79	11341
Switzerland (2008)	0	0	4	0	1	0	0	2	0	0	1	62	27	1	99	2621
Norway	2	3	2	2	3	8	14	8	1	1	5	34	13	5	95	2313
Croatia	1	1	0	2	0	1	2	1	0	1	2	54	33	0	100	314
United States	1	1	8	1	2	0	22	2	0	0	1	0	6	57	43	96827
Japan	2	1	7	4	13	8	4	4	0	0	0	34	18	4	96	27343
South Korea	2	3	3	2	8	27	6	6	-	-	-	-	24	17	83	5994
Russia	-	0	22	1	2	8	3	2	3	0	0	0	-	-	-	4792

Source: Eurostat (2010)

The US National Science foundation states '*the treatment of GUF is one of the major areas of difficulty in making international R&D comparisons. In many countries, governments support academic research primarily through large block grants that are used at the discretion of each individual higher education institution to cover administrative, teaching and research costs. Only the R&D component of GUF is included in national R&D statistics, but problems arise in identifying the amount of the R&D component and the objective of the research. Government GUF support is in addition to support provided in the form of earmarked, directed or project specific grants and contracts (funds for which can be assigned to specific socio-economic categories). In the United States, the federal government (although not necessarily state governments) is much more directly involved in choosing which academic research projects are supported than are national governments in Europe and elsewhere. In each of the European G-7 countries, GUF accounts for 50% or more of total government R&D support to universities, and in Canada it accounts for roughly 45% of government academic R&D support. These data indicate not only relative international funding priorities, but also funding mechanisms and philosophies regarding the best methods for financing academic research*.'[7]

At a country level the table above shows that the two categories related to 'general advancement of knowledge' take the largest shares of GBAORD in many EU member states. In Denmark, the Netherlands, Sweden and Austria public general university funds account for more than 40% of GBAORD. Other funds accounting for general advancement of knowledge cover various science related programmes and specific funding mechanisms (i.e. performance based funding systems and long term research programmes), account in particular for large shares of GBAORD (above 30%) in many of the new EU member states (Bulgaria, the Czech Republic, Estonia, Latvia, Slovenia and Slovakia) and in Ireland.

Nowadays, the role of defence in public R&D expenditures only plays a major role in the United Kingdom, which spends 21% of GBAORD in this field. Since 2007, the role of defence oriented R&D has considerably diminished in Sweden, Spain, and France. In 2007, France spent 28.8% of GBAORD in this field, Sweden 16.4% and Spain 13.1%, whereas the latest figures in the table show that the share of defence R&D expenditures has fallen below the 10% level. On the other hand, data of the US GBAORD show that defence related R&D activities account for 57% of total GBAORD, representing a complete different public R&D funding structure than the European Union.

The GBAORD expenditures for the Czech Republic show that the two unspecific measures General University Funds (27%) and other measures for the general Advancement of Knowledge (30%) account for 57% of total GBAORD. Thereby, the Czech Republic is positioned slightly above EU average. As regards the repartition between General University Funds and other measures for the General Advancement of Knowledge, the Czech Republic is among the group of countries with relatively

[7] Source: http://www.nsf.gov/statistics/seind08/c4/c4s.htm#c4sb1

lower levels of GUF and relatively higher levels of other measures for General Advancement of Knowledge. Compared with the EU-27 the Czech Republic further shows large and above EU-average public R&D expenditures in the socio-economic objective Industrial Production and Technology.

In order to highlight the specialisation of public R&D financing in the Czech Republic, Figure 11 provides a specialisation profile of GBAORD in the Czech Republic.

As a parameter to determine scientific specialisation we use the Revealed Comparative Advantage (RCA) methodology as introduced by Balassa (1965). Following the formula of Grupp (1997) this RCA value has the following definition for GBAORD by socio-economic objective:

$$RCA_{ki} = 100 \tanh \ln\left(A_{ki} / \sum_{k} A_{ki}\right) / \left(\sum_{i} A_{ki} / \sum_{ik} A_{ki}\right)$$

with *A* indicating the amount of GBAORD expenditures, *k* indicating the country and *i* indicationg the socio-economic objective field.

Positive values point to the fact that the sector has a higher weight in the portfolio of the country than its weight in the comparative countries. Negative values indicate specialisations below the average. The indicator allows the assessment of the relative position of a sector in a country beyond any size effects. Neither the size of the sector nor the size of the country has an impact on the outcome of this indicator.

The transformations (logarithmic, tangent hyperbolic) of the division have been performed in order to make the indicator symmetric and truncated to *-100* and *+100* in order to allow better reading of graphs.

Of course, the use of the RCA also has negative impacts. The fact that the RCA indicator distils size effects from the specialisation profiles, results in specialisation changes, if (ceteris paribus):

1. more/ less money is spent on that field (in absolute terms) in the analysed country;
2. the structure of spending within the analysed country changes (i.e. the money spent on the given field changes in relative terms);
3. more/ less money is spend on the given field (in absolute terms) in the benchmark countries;

We also have to consider that specialisation is a relative term. Hence, a benchmark is needed that shows, in which areas a given country is specialised compared to this benchmark. The benchmark might be the world, a selection of countries (e.g. EU-15/EU-27), or a single outstanding country as regards R&D performance (best practice benchmark).The selection of the benchmark has, of course, a severe impact on the 'specialisation' result, but at the same time, the selection of the benchmark is heavily influenced by the availability of data.

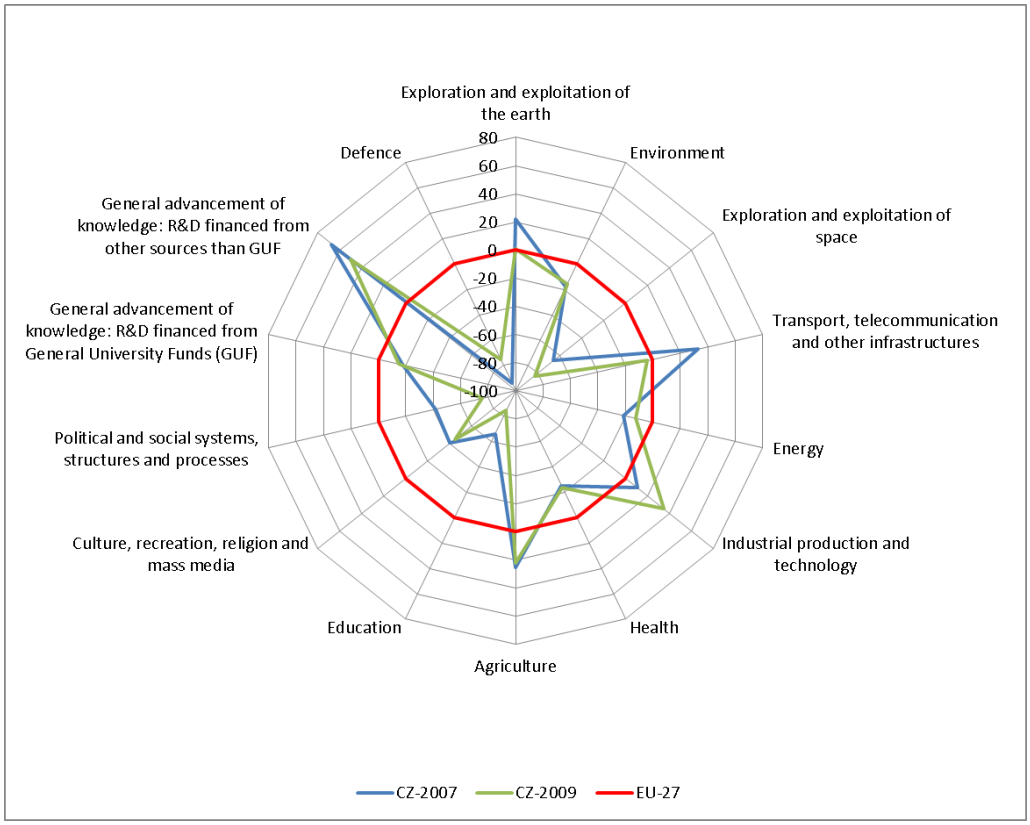
Figure 11 shows the Czech Republic's GBAORD specialisation in 2009 and 2007 compared with the EU-27 member countries. The figure displays a strong positive specialisation in the following socio-economic objectives:

- General Advancement of Knowledge: R&D financed from other sources than GUF
- Industrial Production and Technology
- Agriculture, and Exploration and Exploitation of Earth.

The strong specialisation in General Advancement of Knowledge, is basically due to the dual system of public research in the Czech Republic, with the relatively large Academy of Sciences (in the Government Sector), receiving institutional funding from this category, and the Higher Education Sector – which receives institutional funding from GUF.

A strong negative specialisation compared with the EU member states portrayed in Table 3 can be seen in the objective-fields Education, Culture, Political and Social Systems, Exploration and Exploitation of Space, and Defence. Compared with 2007[8] the Czech Republic lost its GBAORD specialisation in the field of Transport and Telecommunication and Exploration and Exploitation of the Earth.

Figure 11: Specialisation in GBAORD by Socio-Economic Objective compared with the EU-27 in 2009 and 2007 (based on RCA indices)



Source: Eurostat, calculations JOANNEUM RESEARCH

2.3.3 Type of Support: Institutional Funding vs. Project Funding

In addition to socioeconomic objectives, GBAORD may also be differentiated by type of support. The Czech Statistical Office distinguishes between institutional funding and project funding.

In 2008 about 54% of public R&D expenditures were distributed via institutional funding mechanisms and 46% via project funding mechanisms in the Czech Republic. In 2009 institutional funding accounted for 51% and project funding for 49% of total public R&D expenditures.

Highest levels of institutional funding are to be found in the objective fields General University Funds (76.6%) and Other Non-Oriented Research activities (60.3%), which reflect core-funding of universities and public research institutions. In addition, also the objective fields Other Civil Research, Exploration of Space and Exploration of Earth, as well as the Agricultural Technologies show high levels of institutional funding, as in these fields some public research institutes of the Academy of Sciences and other public research organisations are among the main beneficiaries. Research

[8] The latest historic year for which GBAORD data by socio-economic objectives for the EU-27 are provided by Eurostat.

activities which are by large devoted to industry (Industrial Production and Technology), Defence and Energy show much lower levels of institutional funding.

Although for GBAORD data by type of research funding no recent international comparison based upon the same data sources (GBAORD) exist as a repartition of GBAORD data in project funding measures and institutional funding measures is usually not provided by statistical offices, the overall level of project funding in the Czech Republic can be deemed to be high compared with other European countries.

Table 4: Total Project Funding in Selected Countries

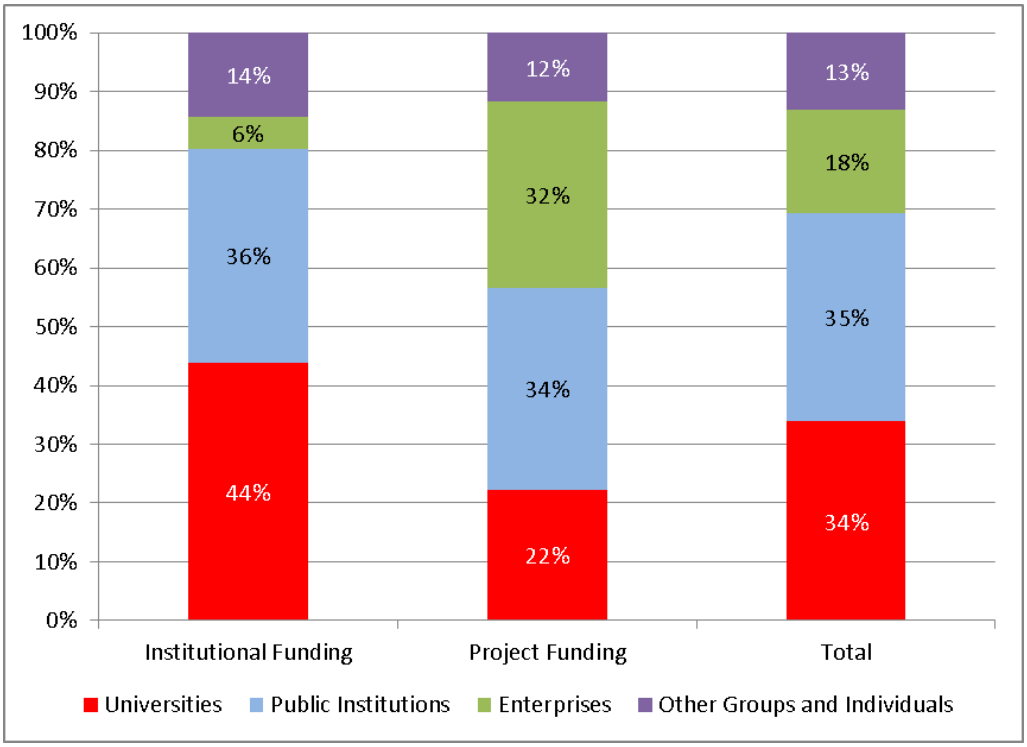
Country	Total Project Funding (Million current PPP USD)	Total Project Funding (% of GBAORD)	Total Project Funding (% of GDP)
Austria	495	31	0,2
France	3459	20	0,2
France (with CNRS)	5262	31	0,31
Italy	2467	24	0,16
Netherlands	1448	33	0,33
Norway	529	42	0,32
Switzerland	464	28	0,19

Source: Lepori et al. (2007)

Table 4 shows that the level of project funding (% of GBAORD) in a number of European Countries was far below the levels of the Czech Republic.

An estimate on the national distribution of institutional funding and project funding by type of beneficiary in the Czech Republic is provided in the figure below.

Figure 12: Distribution of Institutional Funding and Project Funding by Type of Beneficiary (2008)



Source: Estimate based upon Czech Statistical Office data (2009), calculations JOANNEUM RESEARCH

About 80% of total institutional funding goes to the Higher Education Sector and to Public Research Organisations. Other Groups receive 14% of Total Institutional Funding and Business Enterprises receive 6%, as in the Czech Republic some private research organisations are entitled to receive institutional funding, if some core criteria are met.

The overall distribution of project funding measures shows that public research organisations receive higher shares of project funding measures than the University Sector, which compensates to some extent the lower share of institutional funding. Enterprises receive 32% of total project funding measures and Other Organisations 12%.

Differences in terms of beneficiaries of project funding measures are rather large among the European countries (Lepori et al. 2007). In the sample countries of the study the share of project funds to private companies ranges between 19% in Switzerland (being mostly international funds) and 55% in Italy. The study suggests that national specificities appear to be the most important explaining factor:

- Switzerland has a research policy model that assumes that the state should not directly finance industrial R&D; this model has survived strong pressure from the OECD during the 1980s (Lepori, 2006). On the other hand, in the Italian case, project funding has been a choice instrument to support private research activities in a context, in which private investments are much lower than in other countries.
- Norway is also a very specific case, since there is a large sector composed of research institutes, mostly oriented towards applied research; about half the research performed is for industry-relevant purposes, financed by industry and is included in the Private Sector in the R&D statistics.
- The Netherlands displays a clear separation, with the universities receiving project funding essentially from the Research Council and a large number of mission oriented research institutes mostly funded by ministries through specific programmes. The relatively high level of 'undivided' refers to the growing support for schemes for university-industry-public research organisation (PRO) collaborations.
- France is a case for strong direct support to the private sector, both in absolute and relative terms; in fact, France has a tradition of direct support to public companies through large technological programmes, which have been progressively replaced in the last two decades by project funding instruments.

Lepori concludes that national specificities, both in the overall model concerning public intervention in the private economy (for example the 'colbertist' model in France or the liberal model in Switzerland) and specificities of the national research systems are stronger than international tendencies in determining the degree of support for private research.

2.3.4 Government R&D funding by sector of performance

2009 R&D survey data for the Czech Republic show that 20% of government R&D financing were performed by the Business Enterprise Sector, 42% by the Government Sector and 37% by the Higher Education Sector.

Table 5: Government funded R&D by sector of performance (latest available year)

	Higher Education	Business	Government	Other
Denmark(2009)	86%	5%	9%	0%
Switzerland(2008)	85%	5%	3%	6%
Ireland(2008)	79%	9%	12%	0%
Netherlands(2007)	75%	3%	22%	0%
Sweden(2009)	71%	15%	14%	0%
Estonia(2009)	70%	10%	19%	1%
Portugal(2008)	68%	4%	15%	13%
Lithuania(2009)	67%	2%	31%	0%
Italy(2008)	67%	7%	24%	2%
Greece(2005)	67%	4%	29%	0%
Latvia(2009)	65%	3%	32%	0%
Finland(2009)	63%	7%	28%	1%
Austria(2007)	63%	22%	14%	0%
Belgium(2007)	63%	18%	19%	0%
Norway(2007)	62%	10%	28%	0%
United Kingdom(2009)	59%	13%	25%	3%
EU-15(2008)	55%	14%	30%	1%
EU-27(2008)	54%	13%	31%	1%
Iceland(2008)	50%	8%	40%	2%
Cyprus(2008)	49%	6%	33%	12%
Germany(2008)	48%	11%	42%	0%
Turkey(2009)	47%	18%	36%	0%
France(2008)	46%	18%	36%	0%
Poland(2009)	44%	6%	50%	0%
Spain(2008)	43%	22%	35%	0%
Slovakia(2009)	43%	6%	52%	0%
Japan(2007)	42%	5%	49%	4%
Czech Republic(2009)	37%	20%	42%	1%
Hungary(2009)	37%	21%	38%	5%
Romania(2009)	35%	15%	49%	0%
Slovenia(2009)	32%	21%	47%	0%
United States(2008)	31%	24%	39%	6%
China(2008)	19%	14%	66%	0%
Russia(2009)	7%	54%	38%	0%
Bulgaria(2008)	7%	5%	87%	1%

Source: Eurostat (2011)

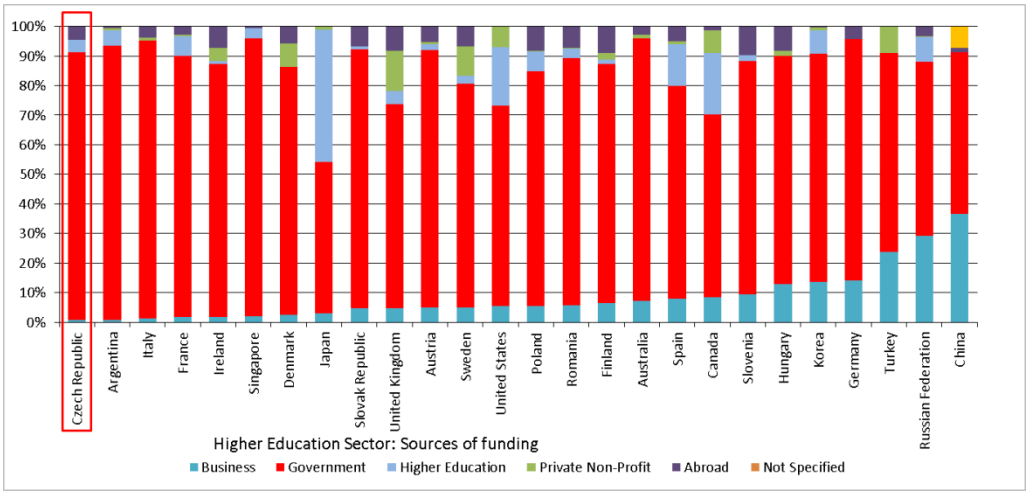
Among EU member states, the Czech Republic has the 4th highest share of public funded R&D performed in the Business Enterprise Sector. In Austria, Spain, Slovenia, Hungary, and France similar shares of public financed R&D performed by the Business Enterprise Sector. The shares of public R&D performed by the Higher Education Sector and Government Sector are not much different to that of many Central and Eastern European Countries and a number of other countries with relatively large public R&D institutions outside the Higher Education Sector.

The repartition of public R&D expenditures among the different types of performance sectors serves as a starting point for analysing the financing structure of the different performance sectors in the following sections of the study.

2.4 R&D Financing in the Higher Education Sector

An international comparison of R&D financing in the Higher Education Sector shows a large dependency upon government sources in most countries. In the Czech Republic about 90.5% of R&D income stem from the Government Sector, 4.5% from Abroad (which are mainly EU-funds), 4% from Own Sources and 0.7% from Industry.

Figure 13: Financing Structure of Research Expenditures by Country in the Higher Education Sector in % (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

The very little amounts of financing stemming from the Business Enterprise Sector, point towards the hypothesis of low science-industry interactions[9]. However, only in Germany, Korea, Hungary and Slovenia the shares of R&D financed by Business Enterprises are in between 10% and 20% of total R&D in the Higher Education Sector. China, the Russian Federation and Turkey are the only countries in which business financing exceeds 20%.

In a number of countries, notably non-EU member countries, research activities of the Higher Education Sector are also financed by own sources. In particular in the United States, Spain and Canada student fees account for relatively large amounts of R&D finances of the Higher Education Sector, whereas the majority of European countries (except from the United Kingdom, which decided to raise the ceiling up to GBP 9,000 per year) has no or relatively low student fees.

A more detailed consideration of the financing structure of the Higher Education Sector can be provided, when not only R&D financing sources but the overall public financing structure of the Higher Education Sector is considered. The box below defines the different funding sources for universities.

[9] The status-quo on Science-Industry interactions in the Czech Republic is being analysed in Work Package E of this study.

Public Funding: Block Grants/Institutional Financing

A block grant/institutional financing is defined as a financial grant which covers several categories of expenditure (such as teaching, on-going operational costs and research activities). In this framework, universities are mainly responsible for the internal allocation of funding according to their needs, although minor restrictions may apply (EUA 2011). Throughout Europe, the allocation of block grants adheres to different calculation mechanisms, in which input factors (number of students, staff, square metres…) or output factors (success rate, publications, research contracts) might be considered.

Public Funding: Targeted Funding

According to the EUA (2011) targeted funding is funding earmarked for the achievement of specific goals set by the public authorities.

Public Funding: Project Funding

Project funding is defined as money attributed to a group or an individual to perform a research activity limited in scope, budget and time, normally on the basis of the submission of a project proposal describing the research activities to be done. Whether the process of allocation is competitive or not is not decisive, since project funds can also be attributed through direct contracts (Lepori et al. 2007). Project funding may be allocated through competition, then labelled 'competitive funding' or directly attributed to the university. For project funding mechanisms co-funding requirements may apply. There exist national and international (mainly EU) project funding sources.

Private Funding: Student Fees

For the Higher Education Sector student fees can potentially be a major source of income, in particular to fund the teaching mission of the universities. Indeed, if public authorities wish to move away from funding higher education and towards subsidising it, i.e. share the cost of higher education with other funders, financial contributions from the students constitute the most directly available source (EUA 2011). It is however a choice that pertains to the public authorities and society which reflects the choice of a society to finance higher education either through taxes, contributions from future graduates, or through indirect tax incentives (ibidem).

Private Funding: Contracts with private partners

Contracts with private partners constitute a direct way of science-industry collaboration.

2.4.1 The Role of Different Funding Sources and their Modalities

At the system level data on the funding structure of the Higher Education Sector are represented to some extent in the official R&D statistics as presented above and in OECD and UNESCO data on the Higher Education Sector. At the institutional level no information in this regard exists across Europe. However, in a recent study of the European University Association (EUA 2011), an analysis on the diversification of the financing structure from over 100 European Universities spread over 27 countries was performed. This allows to a large extent comparing the findings of the survey conducted in this study with the findings of the EUA study.

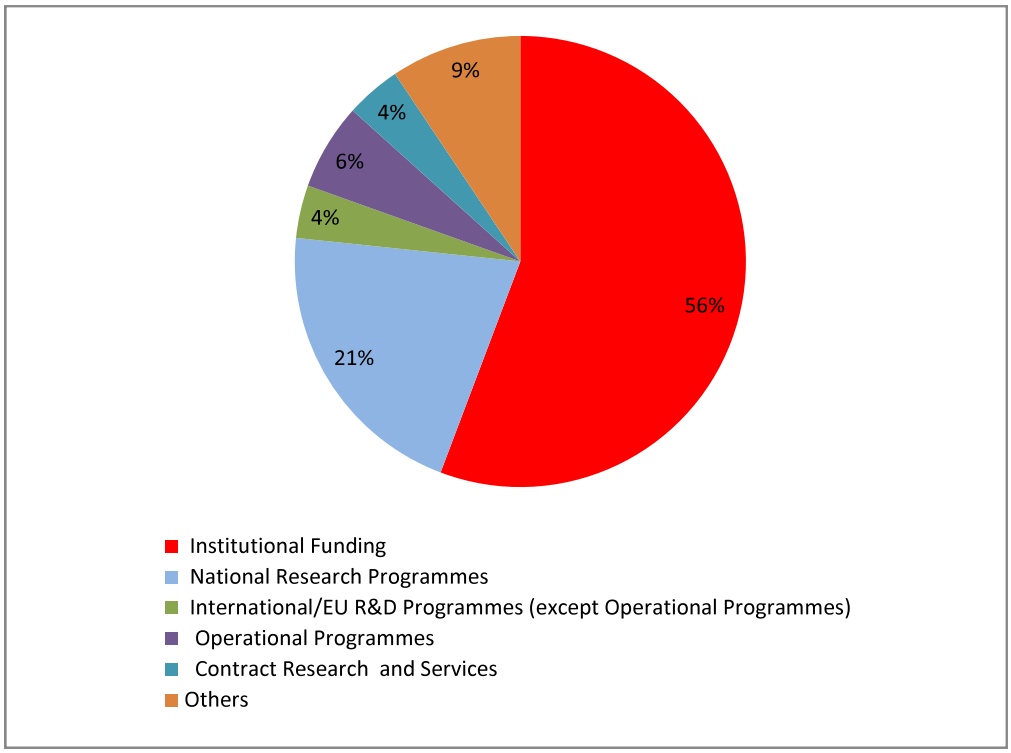
As the international comparison on R&D financing in the Higher Education Sector has shown, direct public funding continues to be the most relevant source of financing for the sector. This holds in particular true for the European Union member countries, in which the share of direct public funding on average accounts for 89.2% of total funding and 10.8% from private sources in 2007 (OECD 2010). For the total OECD countries, '*the share of public funding at the tertiary level represented on average, 69% in OECD countries. Among the 17 OECD countries for which trend data are*

available for all reference years, the share of public funding on tertiary institutions decreased slightly from 78% in 1995 to 76% in 2000 and to 71% in 2006 and 70% in 2007. This trend is apparent primarily in non-European countries where tuition fees are generally higher and enterprises participate more actively, largely through grants to tertiary institutions' (OECD 2010). According to OECD data, the reparation of public and private funding sources resembles that of the EU average: 88.7% of the higher education funds are provided by the public and 11.3% by private households. In between 2000 and 2007 the overall financing structure has remained the same.

Based upon an institutional survey, the average income distribution of the EUA study shows that for European universities 72.8% of financing stem from public sources. Student contributions account for 9.1% of financing on average and 6.5% stem from contracts with the Business Sector. International public funding accounts for 3% of average universities income and the remainder stem from philanthropic funding and service-related income.

Respective survey data among deans and directors of institutes conducted in the course of this audit show by large consistency with the international data. According to our survey, 77% of university income stem from public sources (institutional funding plus national research programmes), 10% from European Union funds, 4% from contract research and services and 9% from other sources.

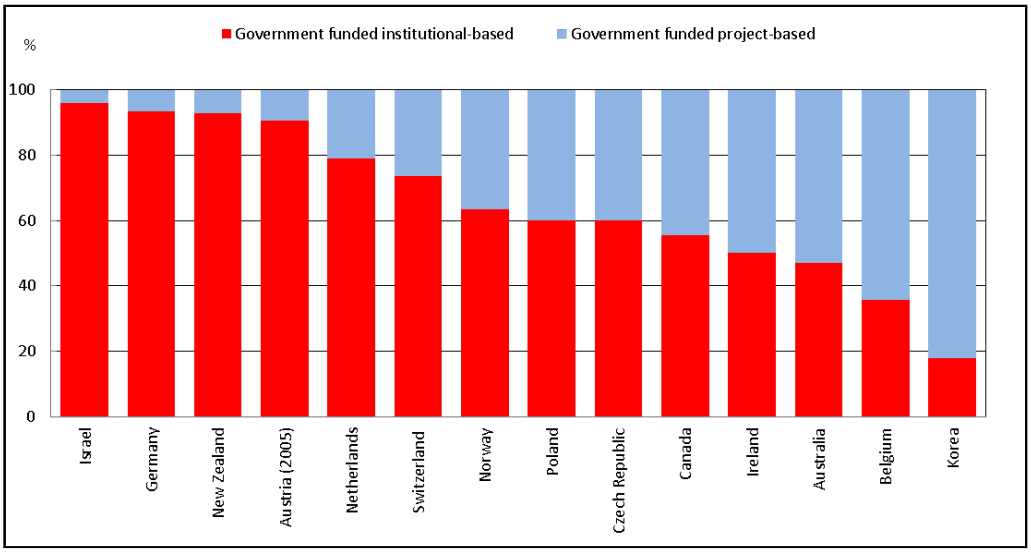
Figure 14: Research funding at the instate level (2009)



Source: Survey Directors/Deans of Faculties (2010)

As indicated above public funding may be allocated in terms of block grants and funding formulae, targeted funding, and project based funding. The OECD (2010) provides an overview about the repartition of institutional funding (block grants plus targeted funds), and project based funding. According to the OECD 60% of R&D expenditures of the Higher Education Sector in the Czech Republic stem from institutional-based funds and 40% from project funds. In international comparison, the Czech Republic is positioned well in the middle of the countries under comparison. In particular some leading countries in terms of scientific output (Switzerland and the Netherlands, Germany) have much higher shares of institutional funds.

Figure 15: Government Funding of HERD: Institutional Funding vs. Project Funding (2008)



Source: OECD (2010)

As the current system of institutional financing is considered in detail in the report on "The Quality of Research, Institutional Funding and Research Evaluation in the Czech Republic and Abroad", no focus is put on the concrete funding mechanisms in this chapter. Instead, we reflect upon the system level of institutional R&D financing for the Higher Education Sector and its field specialisation, as for the Czech R&D system the same rules apply for every institution.

Apart from institutional financing, national and international project funds constitute the second pillar of research income for the Higher Education Sector. The survey results presented in Figure 22 suggest that national project funding, the European Framework Programmes and the Operational Programmes account for 31% of total income of the Higher Education Sector.

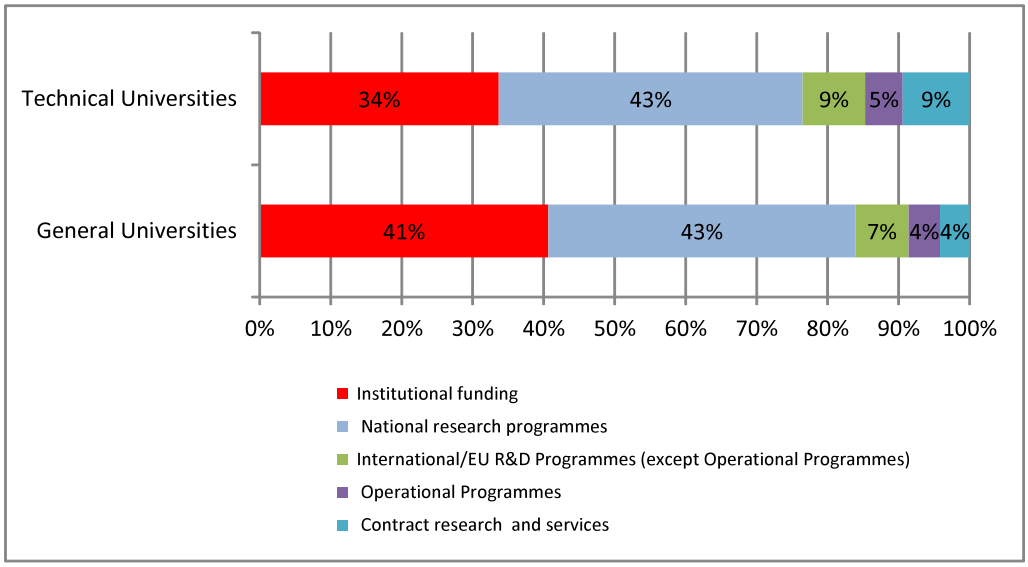
Exempt from some empirical case studies focussing on a limited number of countries, the amount of project funding is rarely covered in analyses. Furthermore no valid international benchmark, regarding an optimal ratio of project funding and institutional funding, both at system level and research group level exist. However in a number of countries the share of GUF in financing HERD has already decreased since the mid-1980s (see Geuna 2001). Apart from an increased trend towards project funding, the study identifies an increased internationalisation via the European Framework Programmes and increased funding of the Business Enterprises for some European countries. Van der Meulen (2004) suggests that for most small European countries that perform quite well in international scientific statistics the level of project funding at the system level used to be between 0.2. and 0.3 in the mid-nineties and has increased in most countries since then. In an empirical study investigating 5 European countries[10] it is also confirmed that the relevance of project R&D financing has increased in nominal and in real terms (Lepori et al. 2007).

According to our survey results geared at deans and directors of universities, institutional funding for the Higher Education Sector accounts for 56% of income. For all other income streams of Czech Universities' competition special rules for application and potentially co-funding requirements apply.

[10] France, Switzerland, Austria, Netherlands, Italy

At the research group level, the survey results suggest that project funding has even a much stronger relevance compared with the institutional level. This means, that project funding measures constitute the main base for R&D knowledge production in the Czech Republic.

Figure 16: Research Funding at the Research Group Level of Public Universities (2009)



Source: Survey Researchers (2010)

Another interesting feature is the evolution of the research funding structure. The data provided in the table below show that the share of institutional funding has decreased for the majority of research groups in all three types of organisations considered in the survey, whereas the level of funding from national research programmes, international programmes and contract services is perceived to have remained unchanged in the last three years.

Table 6: Evolution of the Research Funding Structure in the Different R&D Entities (2006-2009)

Trends: University	Decreased	Unchanged	Increased	N.A	Nr. responses
Share of institutional funding	25%	34%	6%	36%	308
Share of funding from national research programmes	13%	33%	15%	39%	308
Share of funding from int'l/EU programmes (except OP)	7%	38%	10%	44%	308
Share of funding from Operational Programmes	3%	37%	12%	48%	308
Share of funding from contract research and services	8%	37%	7%	48%	308

Source: Survey Researchers (2010)

As the relative share of project funding in the income structure of the Czech Universities is increasingly important, this means that universities face the challenge to build up support capacities that monitor funding opportunities, make strategic choices as regards the use of project funding for building up additional research capacities in certain fields, and assisting academics in writing and submitting proposals in particular in complex international programmes.

For the public authorities the high level of project funding may be beneficial because of increased levels of competition, which potentially helps to direct funds toward high-potential and high-class researchers. However, most important in this respect, is that

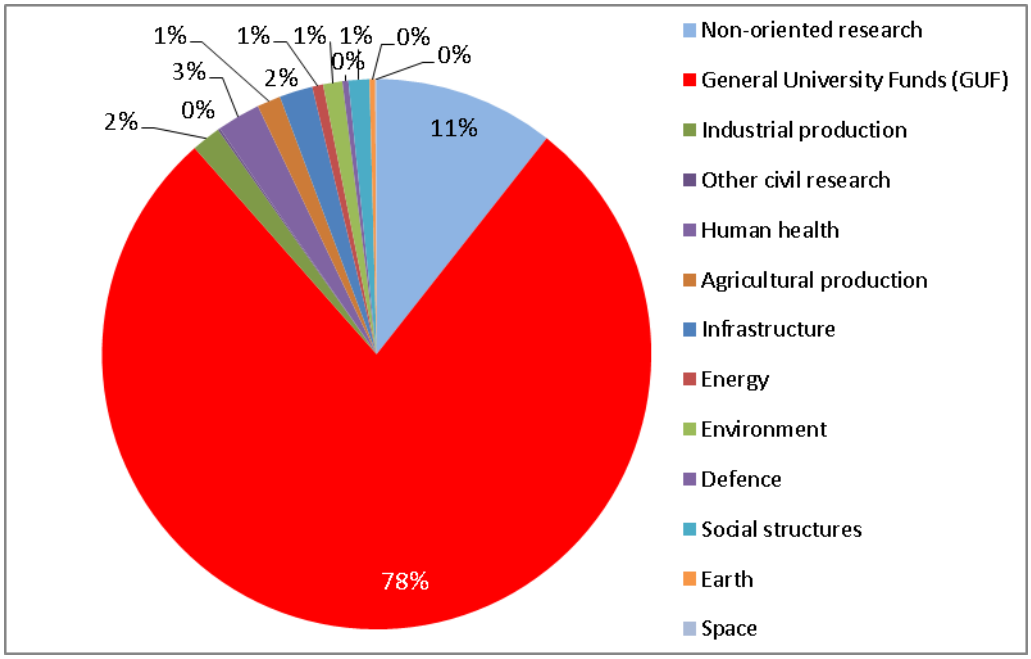
the level of national project financing provides an opportunity to influence strategic choices of universities by setting the rules of the game in terms of the strategic orientation of the research programmes, rules for application, and project selection mechanisms, which aim at fostering research excellence. Whether this will lead to a rise of scientific output or an improvement of scientific quality in the long term cannot be judged by now and will only fully live up expectations, if certain conditions regarding the governance and operational structure of the research funding are met. In this respect van der Meulen (2004) outlines the following criteria:

- Competitive funding for the researchers needs to be sufficiently attractive in relation to the institutional funding. This is related to the size of the grants, the conditions attached to the grants, as well as the time investments (proposal writing) to acquire competitive funding. Van der Meulen states that most research councils work with accepted rates below 30%, towards even 10% for very competitive schemes, and some have implemented changes to the allocation decision process to re-balance the investment costs, attractiveness of funding and success rates. These changes include earmarking of the competitive funding, increase of the grant size, and additional steps in the peer review process. For an effective national project funding system, the different funding bodies should also 'compete' with other non-institutional sources of funding, like private foundations, national research programs and contract research in order to facilitate mutual learning and increase efficiency and effectiveness of the administrative procedures.
- Another precondition is that the competition for research grants needs to be open for new 'players', in a way that those not-funded feel that it is worthwhile to try. Any peer review allocation system faces the risk that the specific criteria and procedures create an elite, which chances on success in the allocation procedure depend not only on the quality of their proposals, but also on earlier success, status and membership of the 'old boys network'. Studies of peer review processes in research councils have shown that certain ways of organising the peer review process and the allocation decisions may favour established researchers over new comers, in terms of disciplines, university, status and gender – even in such a way that for some groups research council funding becomes a stable source of income.

2.4.2 Socio-Economic Objectives of Public Research Funds for the Higher Education Sector

The strategic orientation of national public R&D financing can be portrayed to some extent by looking at national GBAORD expenditures for the Higher Education Sector by socio-economic objectives. The official statistics report that the largest part of public R&D financing of HERD (78%) stems from General University Funds. Non-oriented research accounts for an additional 11% of public R&D funds. All other socio-economic objectives account for less than 5% of total public R&D financing.

Figure 17: Public R&D Expenditures for the Higher Education Sector: Repartition by Socio-Economic Objective (2008)



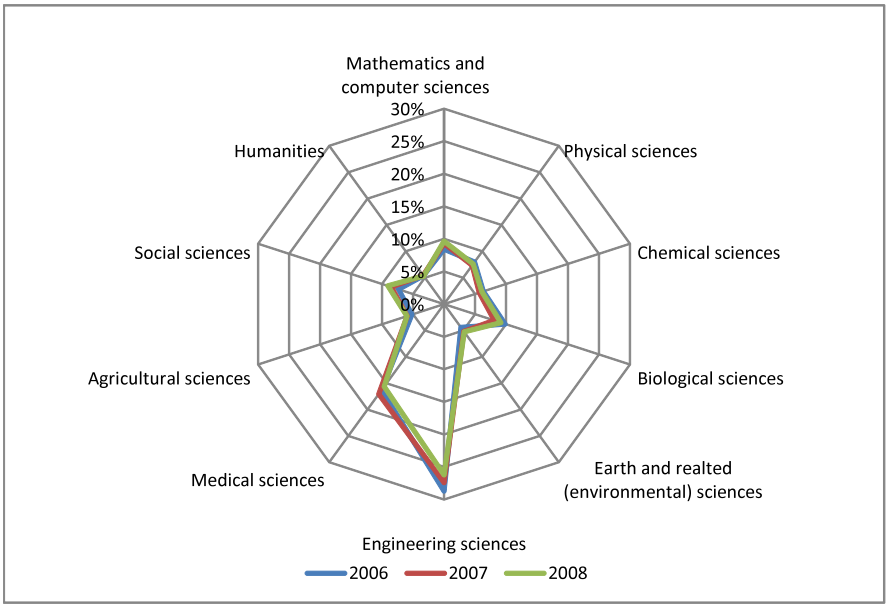
Source: Czech Statistical Office (2010)

Additional information on the orientation of General University Funds is also to be found in GBAORD data via a repartition by field of science.

The repartition of the socio-economic objective General University Funds-GUF by field of science shows that 26% of GUF accounted for Engineering. The share decreased by 3% since 2006. The Medical Sciences exhibited constantly 16%-17% and the Biological Sciences 9%-10% of GUF. Also Mathematics and Computer Sciences and the Social Sciences receive about 9% of total General University Funds. Hence, despite some minor shifts, GUF levels for scientific disciplines were held at relative constant levels and only minor changes among the largest disciplines occurred.

In absolute terms GUF increased by 11.6% since 2006. Within GUF Social Sciences (+37.2%), Earth and related sciences (+31.9%) and Mathematics and Computer Sciences (+27.4%) exhibited highest growth rates whereas expenditures for Engineering and Technical Sciences increased by a mere 1.9%. Hence, the data show that additional GUF funding has been concentrated in fields receiving less funding in the past.

Figure 18: GBAORD – Research Financed from General University Funds and General Advancement for Knowledge



Source: Czech Statistical Office (2010)

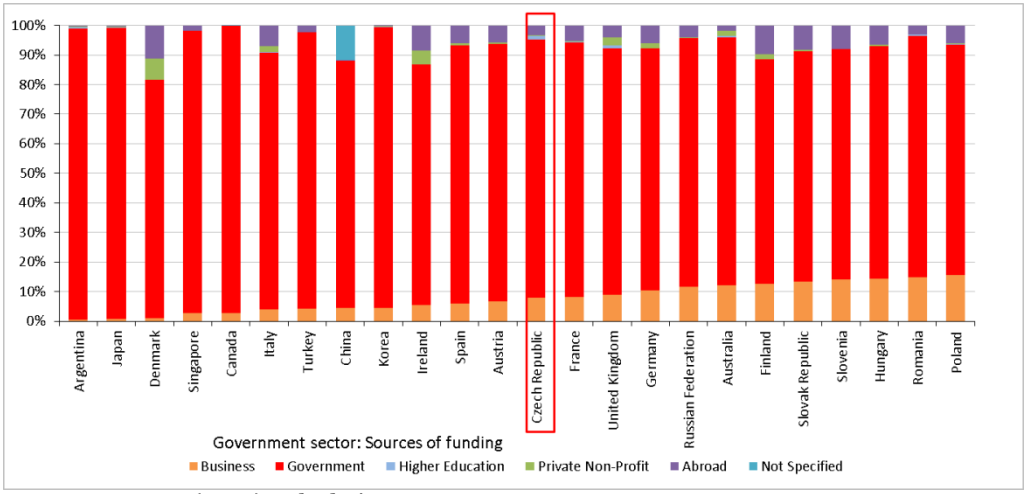
The strategic orientation of public R&D expenditures may be further analysed in a qualitative manner by focussing on public R&D financing in terms of R&D programmes. Thereby, themes and priorities as to be found in the programming documents can be considered. The strategic orientation of national and international R&D programmes is covered in chapter 3 of this report.

2.5 R&D Financing in the Government Sector

Also the financing structure of the Government Sector shows that only a limited number of countries have shares of business R&D financing beyond 10%. This is an indication that collaborative science-industry R&D endeavours are frequently not self-funded by industry, but rather subsidized knowledge transfer activities. However, the Government Sector is quite heterogeneous in terms of both size and scope. Functions, organisational and financing structure of this sector cannot be easily compared.

Regarding the position of the Czech Republic, we see that despite an almost exclusive orientation of the Government Sector on basic research activities (see chapter 3 on R&D performance structures), financing from business enterprises is comparatively high in the Czech Republic.

Figure 19: Financing Structure of Research Expenditures by Country in the Government Sector in % (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

National GBAORD data suggest that 55% of the research expenditures of the Government Sector stem from institutional funds. For the Czech Academy of Sciences a more detailed picture of the financing structure can be provided by data of the 2009 Annual Report of the Academy (ASCR 2010). The report details that the total non-investment funds of the Academy amounted to 8,590.6 million CZK and are distributed as follows:

- Institutional income: Total resources from the budget chapter accounted for 4.749.7 million CZK or 55% of the Academies' total resources.
- National project funds: Funds from the Czech Science Foundation account for 610.5 million CZK and other ministries' projects for 1,001.9 million CZK, which jointly corresponds to a share of 19% of national project financing.
- Own resources: A total of 2,228.5 million CZK stems from own sources (foreign grants, sales of goods and services etc). This contributes to 26% of total financing of the Academy. The most important sources in this respect are:
  - Sales of licences: Which alone account for 1,131.9 million CZK or 13% of total income.
  - Sales of goods and services and main activity orders: Account for 4% of total income.
  - Foreign grants and donations: Account for about 3% of total income.

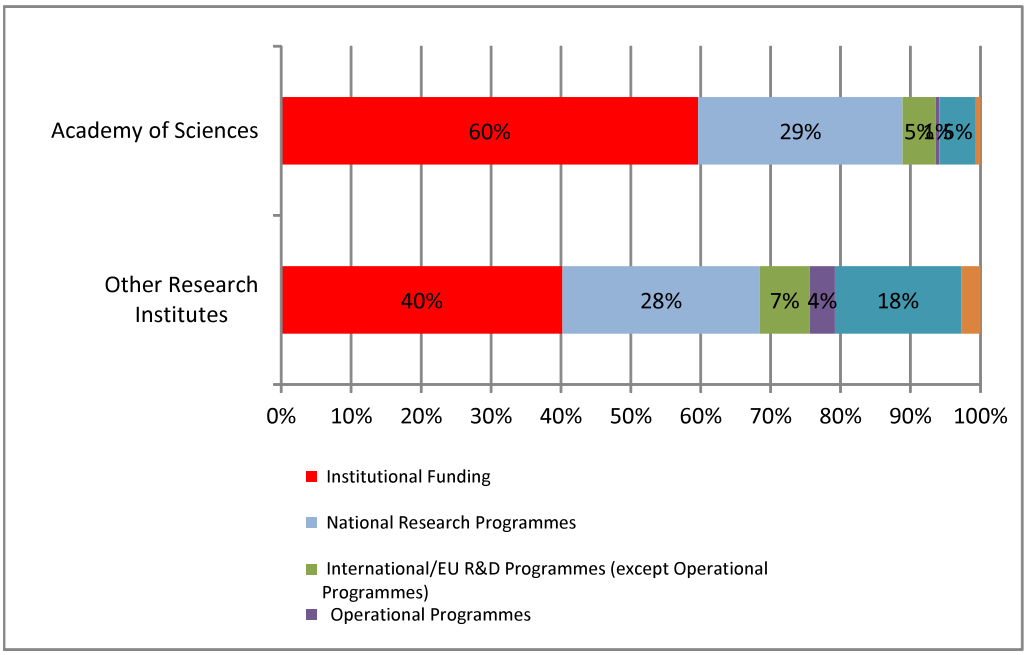
In particular the share of sales and licences, which totalled to 46 million EUR, is extraordinary high, even in international comparison. Licensing income of Public research organisations are not monitored in a systemic way, but some facts regards distribution and relevance for some European and US research organisations are known. The OECD (2003) reports that there is an enormous variation across countries and across PROs within a country and there is a wide range in the average number of licences that earn income. The OECD reports that the median number of licences earning income is consistently quite low: often only one or no licences earn income in a given year and only German, Japanese and Spanish PROs, Italian non-university PROs and Korean universities report more than one income-earning license per institution. The study also suggests with respect to US universities that to date only a half dozen US universities manage to earn a significant percentage of their total research income in licensing revenues, the vast majority of universities earns less than 10% of their research expenditures from IP commercialisation. Arundel and Bordoy

(2006) report that the share of license revenue as a percentage of reported research expenditures is 1.0% for the UK, 1.2% for Australia, 1.01% for Canada, and 3.0% for Europe, and 3.5% for the United States in a joint consideration of several license specific surveys. Sales of licences are hence for most research institutions a meagre source of research funding, which makes the position of the Academy of Sciences even more respectable.

Data stemming from the survey of directors confirm by large the presentation of the financing structure as portrayed in GBAORD and the Annual Report of the Academy. According to the survey results the level of institutional funding accounts for approximately 60% of research expenditures of the Academy of Sciences, and 40% of the research expenditures of other public research institutions.

In addition to institutional funds, national research programmes constitute the second pillar of research funding for all three sectors, accounting for 29% of research funding in the Academy, an estimate which is considerably higher than the overall financing volume suggests. As can be seen in the figure, international research programmes (excluding Operational Programmes) already play a considerable role for all public research actors, accounting for 5% of total research funding in the Academy and 7% in other public research organisations. However, the Operational Programmes do not play a relevant source of income for the Academy. According to the survey respondents, the share of funding from contract research and services plays a particular role in public research organisations (18%). In the Academy of Sciences service contracts from private sources are estimated to account for 5% of total income, which corresponds to the overall financing structure as shown in the Annual report.

Figure 20: Research Funding in the Government Sector, (Directors, 2009)



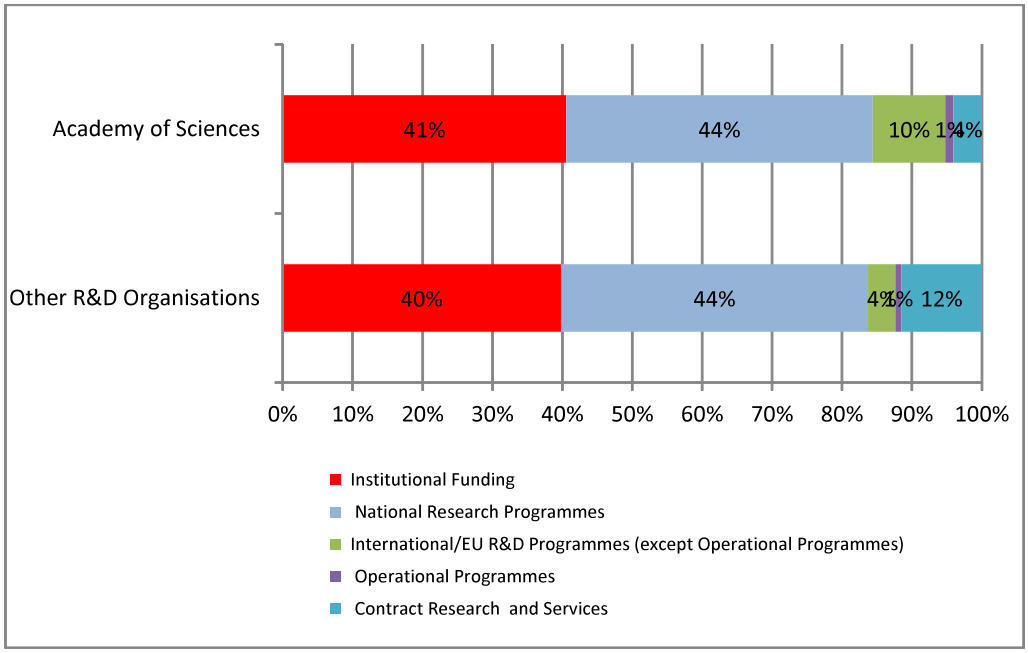
Source: Survey of Directors (2010)

At the research group level, which constitutes the entity carrying out real research activities, the survey results suggest that project funding has even a much stronger relevance compared with the overall estimate of the directors/dean level.

Project funding from national sources is clearly of higher relevance than project funding from international sources, although EU Framework Programmes already account for about 10% of total funds for research activities at the group level. The Operational Programmes do not play a major role as regards the financing of research

activities. In particular for the Academy of Sciences, the Operational Programmes do not constitute a relevant funding source at all.

Figure 21: Research Funding in the Government Sector (Research Group Level, 2009)



Source: Survey Researchers (2010)

Table 7 takes into account the evolution of the research funding structures. The data show that the share of institutional funding has decreased for the Academy and other public research organisations. On the other hand, only 24% of researchers in the Academy and 20% of researchers in other sectors state that financing from national R&D programmes has increased.

Table 7: Evolution of the Research Funding Structure: The Academy of Sciences and Other Research Organisations (2006-2009)

Trends: Academy	**Decreased**	**Unchanged**	**Increased**	**N.A**	**Nr. responses**
Share of institutional funding	41%	26%	4%	29%	285
Share of funding from national research programmes	13%	34%	24%	29%	285
Share of funding from int'l/EU programmes (except OP)	8%	39%	13%	40%	285
Share of funding from Operational Programmes	3%	42%	4%	51%	285
Share of funding from contract research and services	4%	42%	7%	47%	285
Trends: Other Research organisations	**Decreased**	**Unchanged**	**Increased**	**N.A**	**Nr. responses**
Share of institutional funding	40%	26%	2%	31%	87
Share of funding from national research programmes	15%	36%	20%	30%	87
Share of funding from int'l/EU programmes (except OP)	7%	40%	9%	44%	87
Share of funding from Operational Programmes	1%	43%	7%	49%	87
Share of funding from contract research and services	13%	33%	17%	37%	87

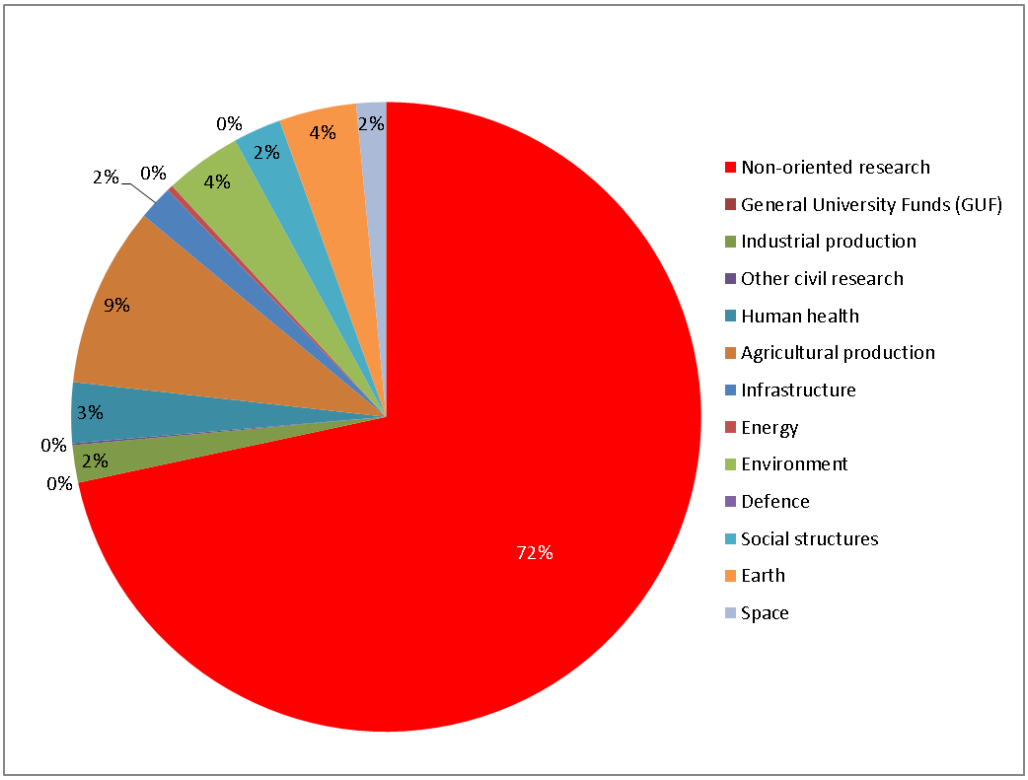
Source: Survey Researchers (2010)

2.5.1 Socio-Economic Objectives of Public Research Funds for the Government Sector

As for the Higher Education Sector, the strategic orientation of public R&D financing can be portrayed to some extent by looking at national GBAORD expenditures by socio-economic objectives.

The official statistics report that the largest part of public R&D financing of HERD (72%) stems from the category Non-oriented Research/General Advancement of Knowledge. In addition, 9% of funds account for Agricultural Production, 4% on Environment, and 3% on Human Health.

Figure 22: Public R&D Expenditures for the Government Sector: Repartition by Socio-Economic Objective (2008)



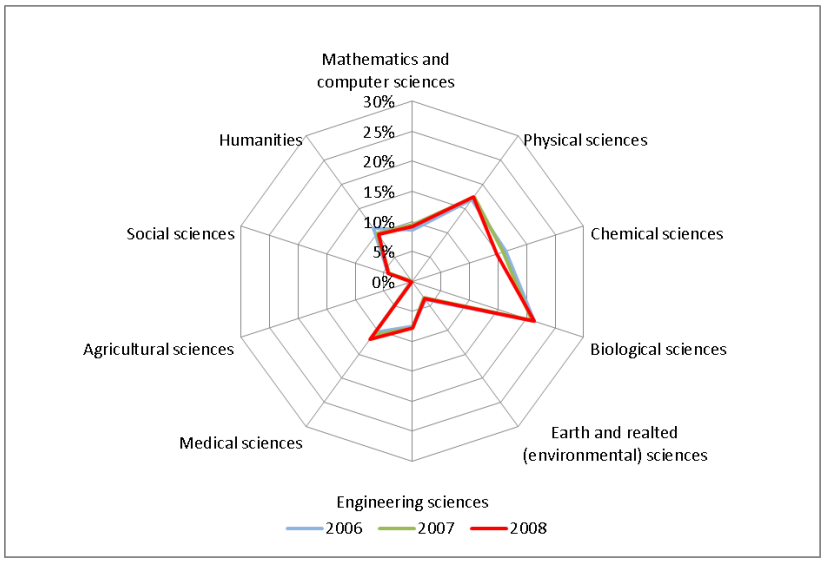
Source: Czech Statistical Office (2010)

The socio-economic objective non-oriented research reflects by large the research expenditure structure of the Government Sector in terms of addressed research fields.

The Biological Sciences receive 21% of GBAORD, followed by Physics (17%) and Chemistry (15%). For all three research fields funding shares were held constant in the last three years under consideration.

GBAORD in the socio-economic objective field General Advancement of Knowledge increased by 24.7% since 2006. On a field level growth rates were highest for Agricultural Sciences (+99%), Medical Sciences (+43.2%) Mathematics and Computer Sciences (+33.5%), and Physical Sciences (+28.1%). The Humanities, the Chemical Sciences and Earth Sciences showed growth rates below the average.

Figure 23: GBAORD – Research Financed from General Advancement for Knowledge



Source: Czech Statistical Office (2009)

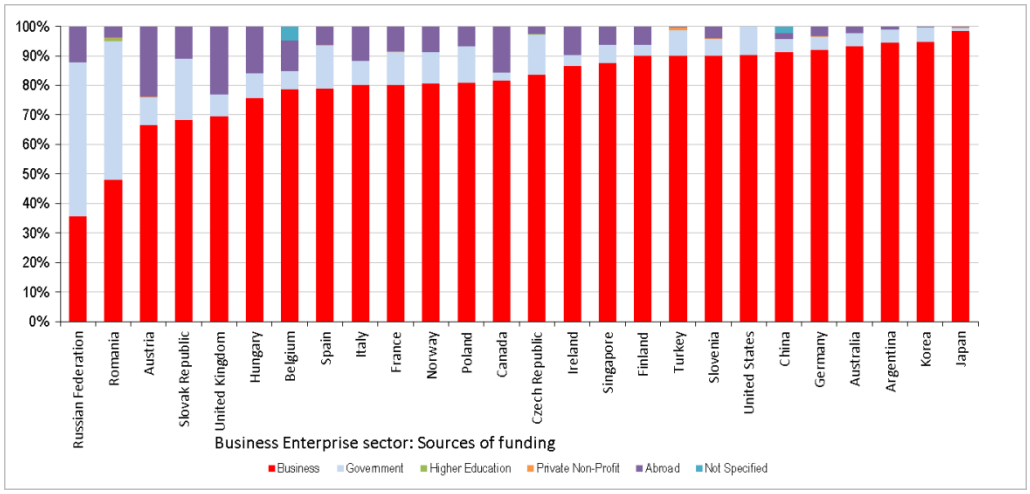
The strategic orientation of public R&D expenditures may be further analysed in a qualitative manner by focussing on public R&D financing in terms of R&D programmes. Thereby, themes and priorities as to be found in the programming documents can be considered. The strategic orientation of national and international R&D programmes is covered in chapter 3 of this report.

2.6 R&D Financing in the Business Enterprise Sector

Data before the onset of the crisis show that more than 80% of R&D performed in the Business Enterprise Sector stem from own enterprise sources. Funding from abroad in the last years amounted to some 5% to 6% of total business R&D financing on average, which was comparatively low. However, latest national data for 2009 indicate that the share has risen to 13%, which actually close the gap towards the EU 27 average.

In 2007, compared internationally, the share of Business Enterprise R&D funded by public sources was high (13%), 6% points above EU-27 and EU-15 average. In the European Union similar levels of support are only provided by Austria (10%), France (12%), Slovakia (13%), Poland (12%) and Spain (16%).

Figure 24: Financing Structure of Research Expenditures by Country in the Business Enterprise Sector in % (2007)

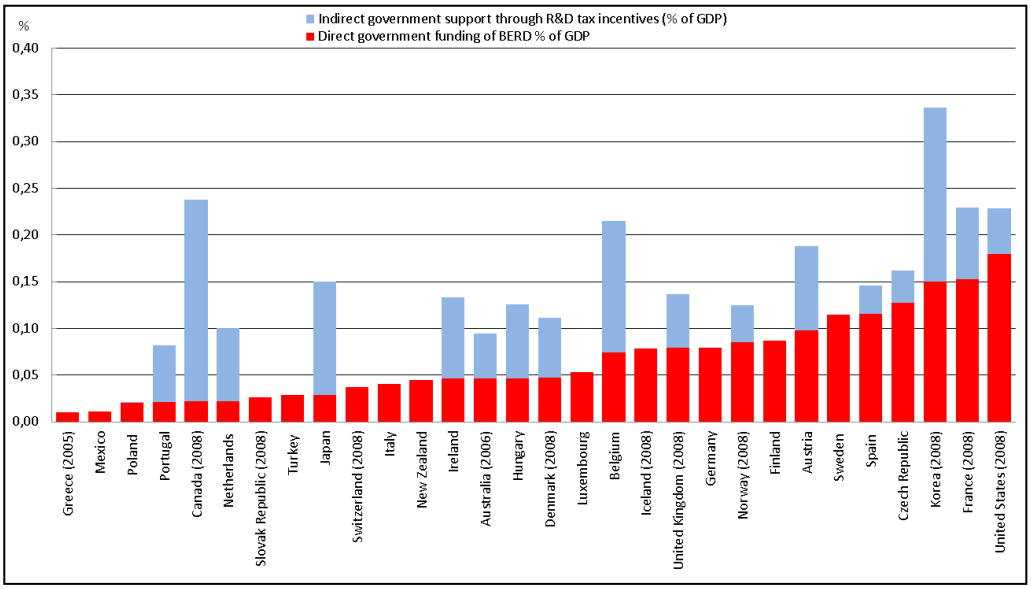


Source: Eurostat (2010), calculations JOANNEUM RESEARCH

This observation also holds true when looking at the level of direct public R&D support measured as % of GDP (Figure 25) and the share of government funded R&D in the Business Enterprise Sector. The Czech Republic provides the 4th highest share of direct R&D support to industry among all countries under consideration, just behind the United States, France and Korea.

The Czech Republic is one of a limited number of countries, which also provide tax incentives for R&D activities in firms. Although the actual volume of the tax break is considerably smaller than in some other OECD member states, the tax incentives further increases public financed R&D activities to 0.17% of GDP in the Czech Republic. As regards the tax break the OECD (2008) has also articulated a warning: The existing tax break[11] for R&D has proved popular with private-sector spending on R&D, apparently increasing by about 20% between 2005 and 2006, whereas the average growth rate in the previous years (2000-2005) was considerably smaller in the range of about 11% per year. Hence, the OECD warns that such an increase contains a degree of deadweight loss and creative accounting, which should be taken into account in any further measures.

Figure 25: R&D Support to Industry in 2009 (% of GDP)



Source: OECD (2010)

Support for industrial R&D may further be differentiated by industrial branch. Table 8 provides information on R&D expenditures by industrial branch, sources of financing, and average annual growth of R&D financing in the branch since 2004.

The table shows that public R&D support for enterprises is concentrated in the services sector (59%), the manufacturing sector receives 38% of public support.

Within the services sector public R&D support is concentrated in the research and development branch, in which the former state owned R&D branch institutes are

[11] In a comparative study of Price Waterhouse Cooper on the impact of R&D tax incentives on investments of private companies into R&D in the Czech Republic, the Czech Income Taxes Act is defined as follows: It enables companies to deduct up to 100% of R&D costs from their annual tax base in the form of a so-called R&D tax allowance. As there is a 21% corporate income tax rate in the Czech Republic for 2008, each 1,000 CZK of R&D costs will gain 210 CZK of tax benefit in 2008.

located (27%). In addition, the branches computer and related activities (10%) and the public administration and communities (9%) receive considerable support.

In the manufacturing sector, largest shares of public R&D support are to be found in the branches machinery and equipment (13%), medical and precision instruments (5%), other transport equipment (4%).

In terms of funding mechanisms, most industrial sectors receive exclusively financing via project funding measures. However, national GBAORD data show that for the following branches institutional financing plays a considerable role (Czech Statistical Office 2010):

- In the computer and related activities sector institutional funding is exceptionally high. 61% of industrial GBAORD are institutional funds.
- In the public administration and community services branch institutional funding accounts for 35% of industrial GBAORD.
- In the Research Sector institutional funding accounts for 32% of industrial GBAORD.
- In the agricultural sector institutional funding accounts for 21% of industrial GBAORD support.

Although these branches receive institutional financing, total R&D activities of the branches mentioned above are by large financed by own sources, except from the public administration and services sector (70% government support) and the agricultural sector (53% government support). In the R&D service sector state subsidies account for 27% of total R&D funds, in the computer and related activities sector for 13%.

If we take into account institutional and project financing measures for the former branch R&D institutes, which cannot be singled out from the statistics, the data indicate that the real level of business R&D support is not above EU average levels. Except from the branch machinery and equipment, business R&D support is strongly concentrated in branches where former public R&D institutes are located.

Table 8: R&D in the Business Enterprise Sector by industrial branch and source of financing in Mio EUR (2008)

	All sectors			Business				Government				Abroad			
	2008	% Total	AAGR since 2004	2008	% Total	AAGR since 2004	% source 08	2008	% Total	AAGR since 2004	% source 08	2008	% Total	AAGR since 2004	% source 08
Total	1,342.30	100	18	1,077.80	100	18	80	176.8	100	15	13	85.9	100	34	6
Services	*481.7*	*36*	*18*	*301.8*	*28*	*19*	*63*	*104.7*	*59*	*10*	*22*	*73.4*	*85*	*34*	*15*
Manufacturing	*836.8*	*62*	*18*	*756.7*	*70*	*18*	*90*	*67.6*	*38*	*24*	*8*	*12.5*	*15*	*35*	*1*
Research and development	181.2	13	11	110.5	10	9	61	48.6	27	7	27	20.4	24	50	11
Machinery and equipment n.e.c.	101.2	8	20	73.2	7	19	72	23.6	13	22	23	4.4	5	22	4
Computer and related activities	135.4	10	22	84.5	8	18	62	17.4	10	15	13	33.4	39	47	25
Other business activities	52.4	4	23	31.4	3	28	60	16.7	9	21	32	4.2	5	6	8
Public administration and community services	23.1	2	10	6.6	1	35	29	16.1	9	4	70	0.4	1	22	2
Medical, precision and optical instruments	71.5	5	58	60.4	6	57	84	9.4	5	58	13	1.7	2	131	2
Other transport equipment	59.4	4	25	52.1	5	25	88	7.1	4	28	12	0.2	0	39	0
Wholesale and retail trade	34.2	3	22	20.9	2	40	61	5.1	3	29	15	8.2	10	0	24
Motor vehicles, trailers and semi-trailers	327.4	24	16	321.6	30	15	98	4.1	2	91	1	1.6	2		0
Electrical machinery and apparatus n.e.c.	46.9	3	18	41	4	17	87	3.9	2	29	8	1.9	2	8	4
Chemicals and chemical products (except pharm./ medicne)	29.4	2	12	25.5	2	10	87	3.3	2	24	11	0.6	1	54	2
Fabricated metal products	21	2	15	16.7	2	14	80	3.1	2	11	15	1.2	1	103	6
Radio, television and comm. equ.	47.8	4	19	44.7	4	20	94	3	2	11	6	0.1	0		0
Basic metals	13.4	1	13	9.8	1	10	73	2.8	2	14	21	0.7	1		5

	All sectors			Business				Government				Abroad			
	2008	% Total	AAGR since 2004	2008	% Total	AAGR since 2004	% source 08	2008	% Total	AAGR since 2004	% source 08	2008	% Total	AAGR since 2004	% source 08
Agriculture; fishing	4	0	10	1.9	0	19	48	2.1	1	4	53	0	0	-100	0
Pharmaceuticals, med. chem.	43.5	3	9	41.4	4	9	95	2	1	22	5	0	0		0
Construction	13.8	1	13	11.8	1	12	86	1.9	1	16	14	0	0		0
Rubber and plastic products	26.3	2	26	24.9	2	26	95	1.4	1	22	5	0.1	0		0
Other non-metallic mineral products	19.5	1	6	18.3	2	7	94	1.2	1	4	6	0	0	63	0
Food products, beverages and tobacco	12.7	1	28	11.7	1	29	92	0.9	1	19	7	0	0		0
Textiles and textile products; leather and leather products	8.4	1	7	7.9	1	8	94	0.5	0	-7	6	0	0		0
Telecommunications	17.5	1	150	10.3	1	128	59	0.4	0	65	2	6.7	8		38
Furniture; manufacturing n.e.c.	4	0	5	3.7	0	7	93	0.4	0	-9	10	0	0		0
Office machinery and computers	2.9	0	23	2.5	0	24	86	0.4	0		14	0	0	-100	0
Electricity, gas and water supply	2.7	0	69	2.4	0	80	89	0.3	0	38	11	0	0	-5	0
Wood and wood products	0.8	0	1	0.5	0	1	63	0.3	0	1	38	0	0		0
Mining and quarrying	3.3	0	30	3.1	0	29	94	0.2	0	66	6	0	0		0
Recycling	0.3	0	-29	0.1	0	-46	33	0.2	0	3	67	0	0		0
Financial intermediation	36.8	3	49	36.8	3	49	100	0	0	-8	0	0	0		0
Coke, refined petroleum products and nuclear fuel	0.5	0	7	0.5	0	7	100	0	0		0	0	0		0
Hotels and restaurants	0	0	-47	0	0	-47		0	0			0	0		

Source: Eurostat (2011)

3. International Comparison of R&D Performance Structure of the Czech Republic

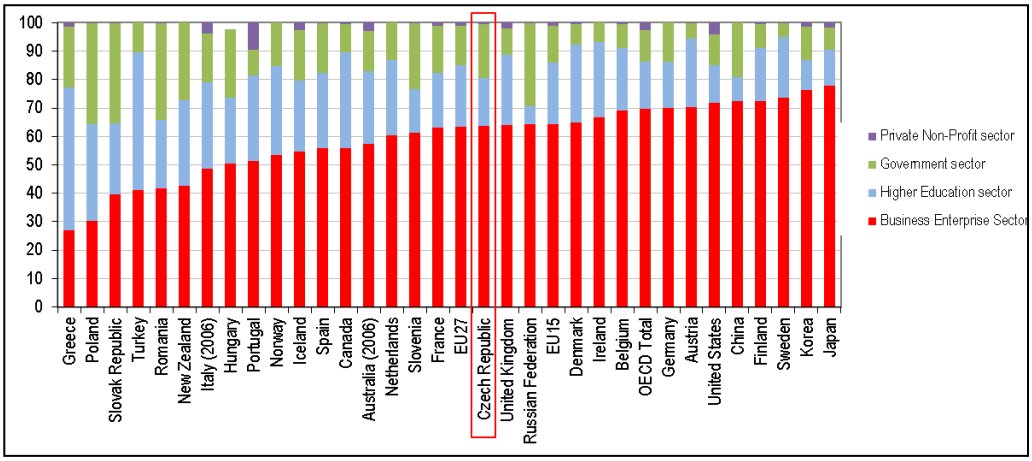
Regarding the performance structure of R&D, the international comparison shows that the Czech Republic nowadays can be characterised as a country which has considerably closed the gap towards the EU-27 average and the OECD member states.

In 2007, before the onset of the crisis (and the latest year for which international data are available at present), we see that the Czech Republic is positioned in between France and the UK in terms of the share of R&D performed in the Business Enterprise Sector - just ahead of the EU-27 member states. 64% of total R&D expenditures were performed by business enterprises, 17% by the Higher Education Sector, 19% by the Government Sector and 4% by the Private Non-Profit sector.

In addition to R&D performance in the business sector, the figure also shows that the relevance of the Higher Education Sector and the Government Sector is quite diverse among the countries under comparison, which is mainly due to different roles and scope of research in these sectors among countries.

In the Czech Republic, the majority of institutions within the Higher Education Sector only started to build R&D capacities since the mid 1990ies, as before higher education institutions were supposed to be (pure) teaching universities. On the other hand, the Academy of Sciences has been considerably reduced in size in the early 1990s, but its contribution to overall R&D performance in the Czech Republic has stabilised since 2000.

Figure 26: Performance Structure of Research Expenditures by Country in % (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

As the Higher Education Sector has built up considerable R&D capacities in the last decade today the Government Sector and the Higher Education Sector account for about the same share of R&D investment levels in the Czech Republic. This is neither good nor bad as a number of leading economies (i.e. Germany and France) and also the OECD average have Government Sectors which are about the same size as the Higher Education Sector. The usefulness of both R&D sectors depends by large not on its size but on the complementarity of tasks fulfilled in the different types of organisations and the cooperation agreements between the different organisations.

An example in this respect is the function of tertiary teaching. As nowadays, the Higher Education Sector in the Czech Republic accounts for considerable amounts for R&D expenditures, this may contribute that an increasing number of students takes up

knowledge created in research activities and make it circulate. On the other hand, the Academy of Sciences has a huge repertoire of research activities, which might be used as well for educational purposes. By means of cooperation, the Academy of Sciences and the Higher Education sector takes up its role in tertiary education in a complementary manner: In 2009, practically all of the workplaces of the ASCR were involved in tertiary education and the employees of the workplaces of the ASCR provided a total of 3,487 individual cycles of lectures, training sessions or seminars at various higher education institutions comprising a total of 76,744 hours (ASCR 2010). In addition, the employees of the Academy guided a considerable number of students (in particular at the doctoral level) through their qualification. In 2009 2,157 doctoral students (319 from abroad) received training at workplaces of the Academy (ASCR 2010).

In the following, we compare the research performance structure of the three main performance sectors by means of an international comparison, and reflect upon the functions the different entities seek to fulfil.

3.1 R&D Performance in the Higher Education Sector

Focussing first on the University Sector, which accounts for about one quarter of total R&D activities in Europe, we need to consider that universities fulfil quite different functions regarding research, education and innovation activities. In some countries, in addition to the education of elites, the provision of basic/fundamental research was increasingly seen as one of the main tasks of universities from an innovation perspective since World War II, because knowledge generated by fundamental research was found to be a critical input for the development of new technologies. Nuclear energy and space exploration were typical technologies at the agenda at that time (that was characterised by 'traditional', mission-led research and innovation policy, see Gassler et al. 2006). Due to approbiability constraints of results from fundamental research, (public) universities and public research organisations received the majority of public funds for fundamental research in particular in the USA and Western Europe.

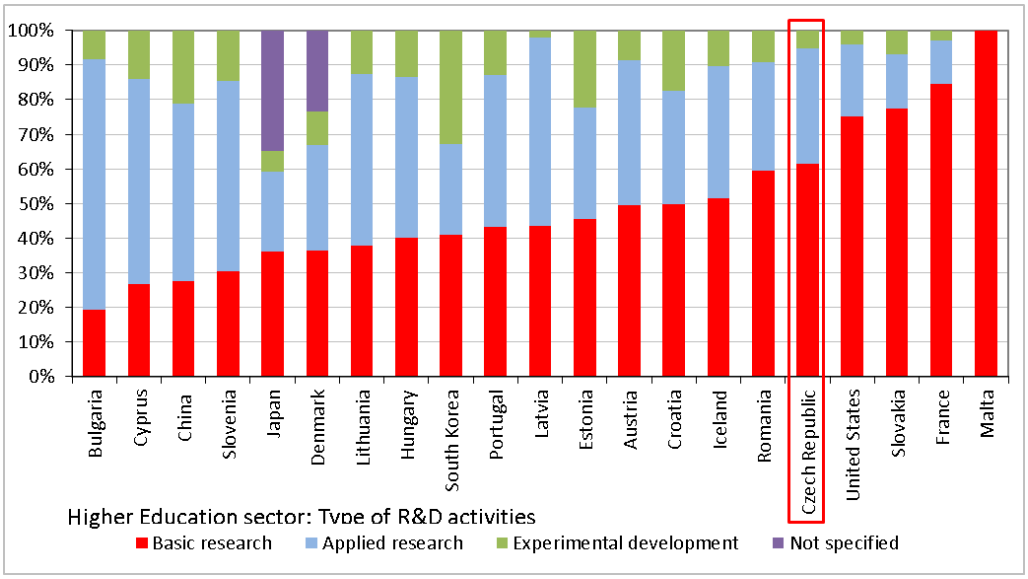
The fact that knowledge does not only encompass information that can be codified but also has a strong tacit component, subsequently leads to the need for (research departments of) enterprises to co-operate closely with academic research units in order to have the absorptive capacity required to make use of research results generated by academics (Cohen and Levinthal 1990). From a university perspective this led to the requirement to engage with industry, the so-called 'third mission that was subsequently enhanced by other forms of direct engagement with society. Higher education institutions throughout Europe differ greatly in addressing these functions, and hence their profiles and research activities differ.

International available datasets do not allow comparing the research profiles of different university systems in detail. A rough picture on national differences in research profiles can be provided by looking at the R&D expenditures by type of research and country and by fields of research covered. We first portray R&D expenditures by type of research and then by field of science.

3.1.1 R&D Expenditures by Type of Research

In the Czech Republic slightly more than 60% of R&D expenditures in the Higher Education Sector account for 'Basic Research' expenditures. According to the OECD Frascati Manual basic research is thereby defined as experimental or theoretical work, undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view (OECD, 2002).

Figure 27: R&D Expenditures by Research Type and Country in the Higher Education Sector (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

Another 33% of R&D expenditures in the Higher Education Sector account for 'Applied Research', defined as original investigations, undertaken in order to acquire new knowledge. Applied research is, however, directed primarily towards a specific practical aim or objective.

The remaining 6% of R&D expenditures in the Higher Education sector are costs for 'Experimental Development', which is defined as systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.

Regarding an international comparison using this type of differentiation two issues have to be considered:

1. The number of countries which provide data on R&D expenditures by type of research is limited.
2. The differentiation between 'Basic Research' and 'Applied Research' very much depends upon the extent to which the researchers involved label it. The boundaries between basic, non-oriented research and applied research activities are blurred and hence a differentiation between these two types of research should not be used for making policy decisions, as it barely reflects the full spectrum of research activities.

Hence we see a great variation among countries, as regards the extent of basic and applied research covered within the Higher Education Sector. However, only in a limited number of countries the share of basic research expenditures is either below 40% or above 70% of total higher education R&D expenditures. In addition, the role of experimental development provides an indication to which extent universities are able to fulfil research services for the Business Enterprise Sector.

Interestingly, the Czech Higher Education R&D Sector, which in the past focused primarily on education while the Academy of Sciences focused mainly on academic research activities, has built up competencies in conducting basic research activities as well. Nowadays both types of institution have a comparable amount of scientific output measured by publications (see ERAWATCH 2010).While the differentiation between basic and applied research may be artificial to some extent, we should consider that also the level of experimental development, which might serve as a hub

for the provision of scientific support to industry in a very direct manner, is very low in the Czech Republic. Due to the specific differentiation of the 25 public higher education institutions and 45 private entities providing tertiary education in the Czech Republic, which can be divided into three main types – traditional universities (usually the older ones with traditional faculties such as Arts, Medicine, Science, etc. and granting MA degrees), technical universities (covering technical disciplines and granting MSc degrees) and specialised universities in selected fields, specifically Agriculture, Veterinary Science, Fine Arts and Economics, one rather would have expected that universities (in particular the technical universities) rather concentrate on applied R&D activities and experimental development.

However, the fact that the Higher Education Sector has built up competencies in conducting basic research activities, does not necessarily mean that this hampers science-industry relations. Scientific knowledge is a combination of 'tacit' knowledge (incorporated in the human resources working in labs on certain phenomena) and codified knowledge (scientific articles, publications). In particular knowledge derived from frontier research may only be transferred to industry via means of direct collaboration between science and industry: the nearer to the frontier, the most difficult it is to take-up knowledge and make it circulate, or, as Latour said, 'to circulate knowledge you need to transport the lab'. The implication was that in high technology sectors, it was important for firms to develop strong connections with academic labs, if they wished to be in a position to master new knowledge (Laredo 2007). Laredo also stresses that this (the increased complexity of the knowledge creation and application process) explains why progressively more and more doctoral students have been attracted by private sector R&D and that also in terms of policy instruments, this dual flow has given rise to two completely new streams of policy instruments: 'Technological Programmes' on the one hand and 'Triangular Doctoral Allocations' between a candidate, a university PhD programme and a firm R&D department (see the French CIFRE or the British CASE fellowships).

The role of science-industry collaboration is discussed in the Final Report - 5 on Science-Industry Linkages. Chapter 3 provides an overview on public support mechanisms that allow for knowledge intensive science industry collaborations.

3.1.2 R&D Expenditures by Field of Science

In addition to the type of research, also the repartition of research expenditures by field of science may be displayed for the Czech Republic, 20 European Union member states, and a selection of candidate countries and Russia (Table 9).

In the Czech Republic, Engineering and Technology (37%) account for the highest share of research activities, followed by Natural Sciences (21%) and Medical Sciences (20%). The Social Sciences account for 10% of total R&D activities and the Humanities for 8%. The remaining 7% account for Agricultural Sciences. Thereby, the higher education R&D system of the Czech Republic spends considerably less on Social Sciences and Humanities than the EU average.

The specific relevance of Engineering and Technology research in the Higher Education Sector points again towards the fact, that the sector could play a distinct role in collaborative R&D endeavours with enterprises. However, at least data on research financing flows show (see Figure 3) that interactions between these two sectors are limited.

Table 9: R&D Expenditures by Research Field and Country in the Higher Education Sector (% of total and Mio Euro), (2007)

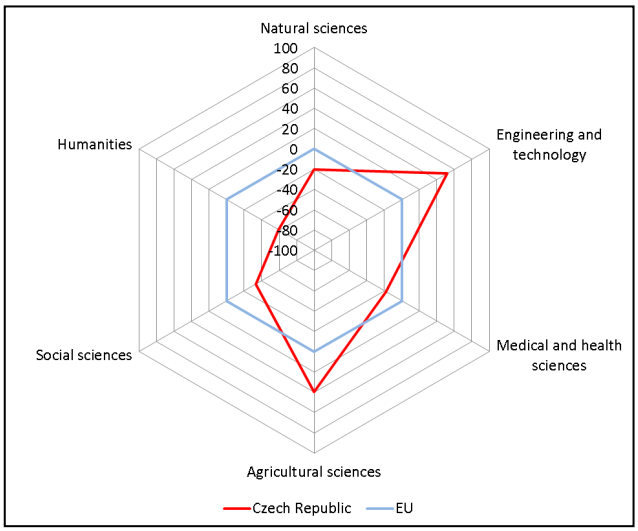
	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Humanities	Total (Mio Euro)
EU-Total (20 available countries)	26	21	24	4	14	11	22662.8
Bulgaria	10	58	7	2	15	8	13.5
Czech Republic	*21*	*37*	*20*	*7*	*10*	*5*	*329.8*
Denmark	21	12	31	12	15	9	1550.6
Germany	28	19	28	3	10	12	9907.8
Estonia	41	24	10	6	11	8	72.6
Spain	21	24	14	3	23	15	3518.6
Cyprus	38	23	1	0	29	9	31.9
Latvia	33	22	12	8	14	12	54.2
Lithuania	22	28	14	5	19	12	117.8
Hungary	25	21	18	9	18	9	228.2
Malta	12	17	22	1	32	17	10.1
Austria	31	15	26	4	15	10	1637.3
Poland	30	47	2	5	12	4	598.0
Portugal	28	25	10	6	20	12	587.0
Romania	33	42	8	11	4	1	157.3
Slovenia	10	42	14	16	13	4	77.9
Slovakia	37	26	11	7	18	2	63.0
Finland	25	20	23	3	22	8	1164.6
Sweden	19	22	32	5	14	7	2542.7
Iceland	13	66	-	8	8	6	100.79
Norway	21	10	35	3	20	10	1462.346
Croatia	10	29	12	18	11	20	117.409
Turkey	9	15	42	6	18	10	1642.793
Russia	29	47	3	2	14	5	670.275

Source: Eurostat (2010), calculations JOANNEUM RESEARCH

In order to provide a picture on research specialisation of the Czech Republic, Figure 28 displays the scientific specialisation of higher education research expenditures in the Czech Republic compared with the 20 European Union member states, for which R&D expenditures differentiated by field of science are available.

Compared with the EU-20, the Czech Republic shows distinct specialisations in the Agricultural Sciences and Engineering and Technology. This means that the share of R&D expenditures in these fields is considerably higher than in the twenty reference countries. A strong negative specialisation is displayed in the Social Sciences and the Humanities. The Natural Sciences and the Medical Sciences also show negative specialisations for the Czech Republic, but the distance towards the EU-20 is closer.

Figure 28: Scientific Specialisation in the Higher Education Sector (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

3.2 R&D Performance in the Government Sector

Also for the Government Sector, the international comparison shows that a considerable diversity among countries exists. In particular in the new European Union member states, the Government Sector consists mainly of the institutes of relatively large Academy of Sciences, which still have a clear focus on frontier research activities, whereas in many of the 'old' Western European countries and the US, China, and Japan the Government Sector is characterised by R&D activity profiles, which exhibit in particular higher shares of experimental development, which distinctly mirrors their role for industrial development support, science industry collaboration and knowledge transfer activities aiming at the provision of market oriented R&D services.

Nevertheless, the Public Research Organisations Sector in the European Union has to be considered as heterogeneous in many aspects. According to Hyytinen et al. (2009), Public Research Organisations (PROs) differ in their functions, organisational and financing structure and ownership. In the US and Western Europe PROs have mainly been established since World War II to satisfy the research needs in a contemporary economic and societal context.

The EARTO (European Association of Research and Technology Organisations), states that there is a clear and basic rationale for PROs: Many PROs have been established in response to perceived actual or potential market or systemic failures. Considering market failures, the PROs' main function relates to supporting SMEs' technological competence building and risk-taking capability, whereas systemic failures relate to norms and standards.

3.2.1 R&D Expenditures by Type of Research

The EARTO has defined the PRO's main activity as 'to provide research and development, technology and innovation services to enterprises, governments and other clients'. Thereby, the EARTO seeks to differentiate the different types of research organisations in an innovation system by a division of labour – based on corresponding functions and targets. The aim is to provide a basis for a complementary and symbiotic role of these such as universities and enterprises in an innovation system based on functions and targets. Anyway, the purpose of the differentiation is to clarify the division of labour between the different types of organisations in the innovation system and thus evolve the complementary and symbiotic role of these organisations. A PRO's role and orientation in an innovation

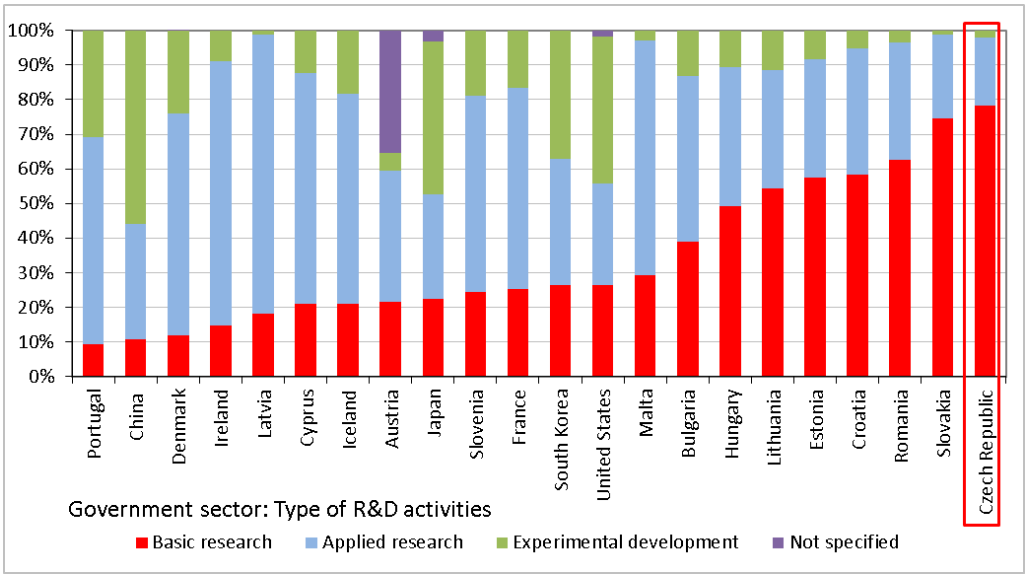
system can also be defined on a functional, sectoral or competence basis. In the study published by PREST (2002), the main role of PROs is in their mission-oriented applied research. In addition, their function is in development work and basic research, while part of their function relates to knowledge transfer (diffusion), certification and standards and provision of facilities.

Contrary to that, the Government Sector of the Czech Republic is dominated by the Academy of Sciences, whose own defined primary mission of its institutes is to conduct basic research in a broad spectrum of the Natural, Technical and Social Sciences and the Humanities. This research, whether highly specialised or interdisciplinary in nature, aims to advance developments in scientific knowledge at the international level, while also taking into account the specific needs of both Czech society and national culture. Scientists of the Academy institutes also participate in education, particularly through doctoral study programmes for young researchers and by teaching at universities as well.

The Academy also incorporates in its mission to foster collaborations between applied research and industry and contribute to the integration of Czech science into the international context. Despite a clear focus on general advancement of knowledge a total of 67 national sponsored projects with partners from the users sphere were conducted, and an additional 40 projects with various forms of support from both public and private sources (8 of which being international) were being resolved (ASCR 2010).

A level of 10% of industry funded R&D in the Government Sector suggests that the sector is already capable to attract considerable amounts of private R&D financing, despite its non-service orientation. As indicated in the section on R&D financing, this high amount was most likely to be fulfilled via the high revenues stemming from the sale of licenses. The complete absence of experimental development activities in the Government Sector is nevertheless striking, as this reflects that neither the Higher Education R&D sector nor the Government Sector at present takes up the role of applied R&D service provision for industry.

Figure 29: R&D Expenditures by Research Type and Country in the Government Sector (2007)



Source: Eurostat (2010)

3.2.2 R&D Expenditures by Field of Science

In addition to the type of research, the R&D expenditures of the Government Sector may also be differentiated by field of science. The table below shows the repartition of

R&D expenditures of the European Union member states and a selection of other countries for the year 2007.

Table 10: R&D Expenditures by Research Field and Country in the Government Sector (% of total and Mio Euro), (2007)

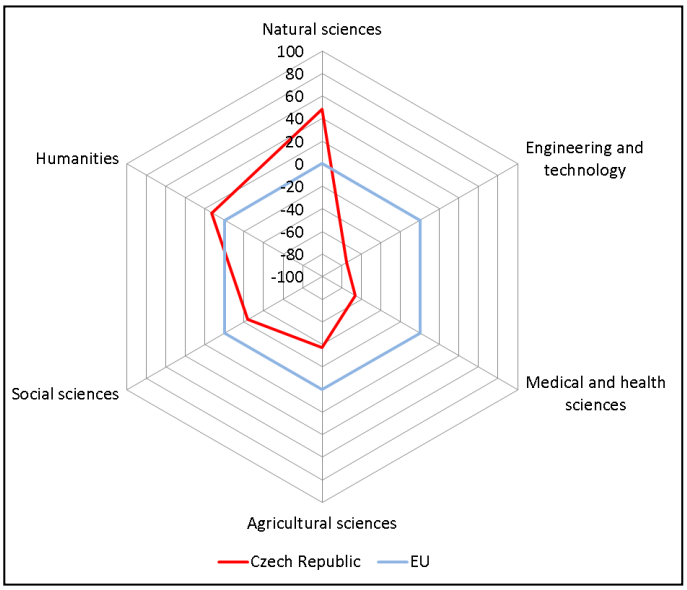
	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Humanities	Total (Mio Euro)
EU (available member states)	38	26	13	10	6	7	15484.0
Bulgaria	40	18	3	27	3	9	81.6
Czech Republic	65	10	6	7	5	8	407.2
Denmark	25	3	41	1	22	8	190.1
Germany	47	28	7	5	4	8	8540.2
Estonia	35	7	9	14	4	30	15.0
Ireland	19	1	18	54	8	1	171.0
Spain	16	25	35	15	6	3	2348.8
Cyprus	15	2	2	60	7	14	17.0
Latvia	45	15	6	31	4	0	30.5
Lithuania	43	20	1	15	9	12	48.5
Hungary	48	8	7	16	10	11	236.1
Malta	5	6	0	35	48	0	0.8
Netherlands	31	25	7	21	14	3	1259.0
Austria	12	7	38	11	11	21	367.3
Poland	35	31	15	12	4	3	624.9
Portugal	18	28	15	23	10	5	184.5
Romania	44	36	2	7	6	5	221.6
Slovenia	52	14	4	4	14	12	122.5
Slovakia	41	13	11	19	9	6	89.1
Finland	17	41	16	19	13	2	528.3
Iceland	12	16	20	33	11	7	71.5
Norway	20	17	13	23	23	3	714.5
Croatia	44	10	7	8	17	13	88.7
Russia	38	44	7	5	3	3	3083.7
Japan	27	47	6	17	na	na	8554.2
South Korea	12	62	3	12	11	0	2866.0

Source: Eurostat (2010), calculations JOANNEUM RESEARCH

Among all countries displayed in the table, the Czech Republic exhibits the highest share of Natural Sciences in its Government Sector, which is mainly due to the specific orientation of the Academy of Sciences.

Compared with the 20 EU member states for which respective data are available, the Government Sector of the Czech Republic has particular little emphasis on the research fields Engineering and Technology, which accounts for large shares of government R&D expenditures in many Western European EU member states and reflects the specific role of the Government Sector regarding science-industry collaborations. Also the Medical Sciences and Health Sciences show clear below EU-average R&D expenditures in the Government Sector, whereas the research fields Agricultural Sciences, Social Sciences and Humanities are close to the shares of the EU average.

Figure 30: Scientific Specialisation of the Czech Government Sector (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

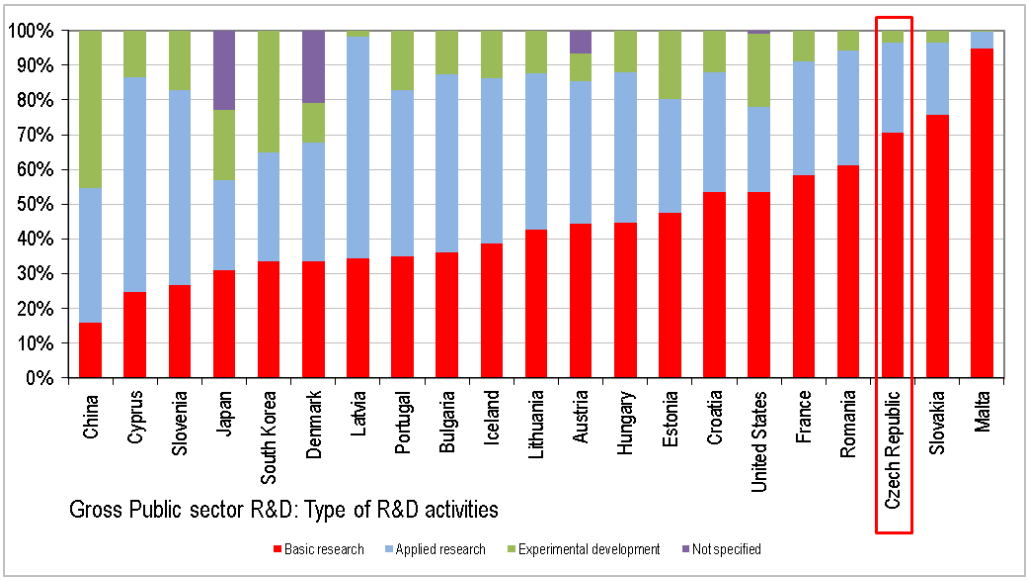
The specialisation analysis of research expenditures by field of sciences confirms that the Czech Government Sector is strongly specialised in the Natural Sciences, whereas a strong negative specialisation in the fields of Engineering and Technology, Medical and Health Sciences is observed. Furthermore, a weak positive specialisation in the Humanities and a weak negative specialisation in the Social Sciences and the Humanities can be observed.

This profile of Czech Government R&D sector still reflects its past specialization of Academy on basic sciences, especially in areas of physics and chemistry. On the other hand, engineering was in domain of ex-industrial institutes which have been largely privatised, and is therefore underrepresented in the government R&D sector.

A joint consideration of the gross public R&D sector, which includes the Government Sector and the Higher Education Sector, reveals that the performance structure of the Czech Republic is rather imbalanced. Both the Higher Education Sector and the Government Sector concentrate on the conduct of research activities, whereas a concrete support function for industry, in terms of providing (costly) experimental development activities (partly paid by industry itself) is almost absent from the system.

This situation is largely caused due to the legacy of transition, which led to privatisation of ex-industrial institutes which now operate as commercial R&D sector while public sector has withdrawn from direct technology support of industry.

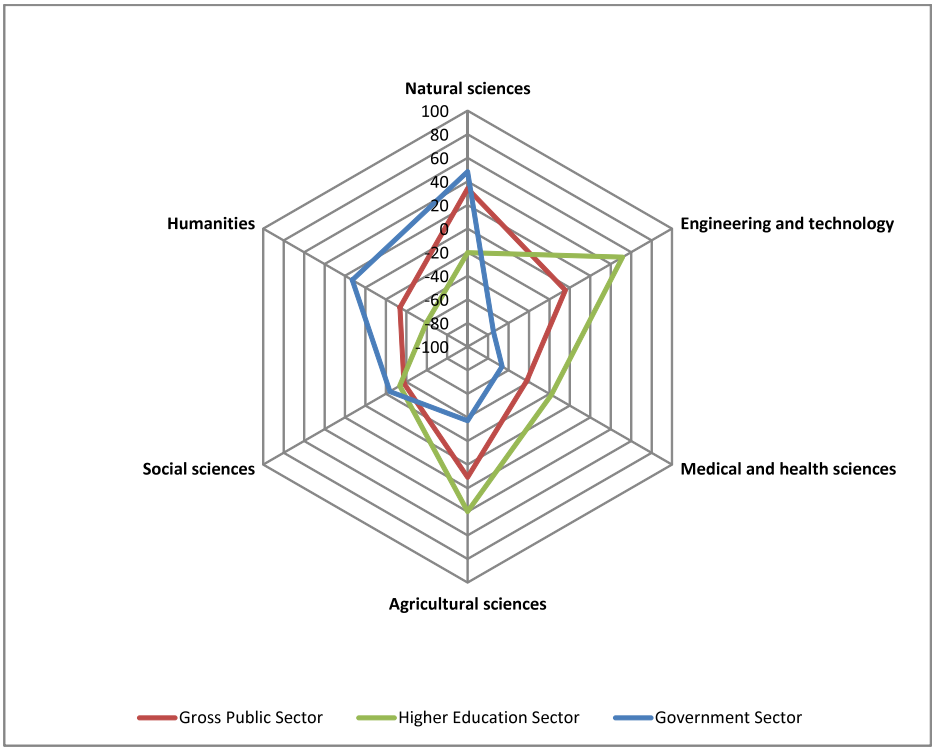
Figure 31: R&D Expenditures by Research Type and Country in the Gross Public R&D Sector (2007)



Source: Eurostat (2010)

Turning our focus towards the scientific specialisation of the Gross Public R&D Sector, we see that the Higher Education Sector and the Government Sector have to some extent different scientific specialisations. Whereas the Higher Education Sector shows specialisations in Engineering and Technology, Medicine, and Agricultural Sciences the Government Sector is in international comparison strongly specialised in the Natural Sciences and the Humanities.

Figure 32: Scientific Specialisation of the Gross Public Sector (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

However, a merged analysis for the Gross Public Sector reveals that only positive specialisations in Natural Sciences and Agricultural Sciences remain. R&D expenditures in the Social Sciences and the Humanities are clearly below the shares of the benchmarking countries, and also the Medical Sciences show a negative specialisation. In Engineering and Technological Research R&D expenditures of the Gross Public Sector reflect the structure of the benchmarking countries.

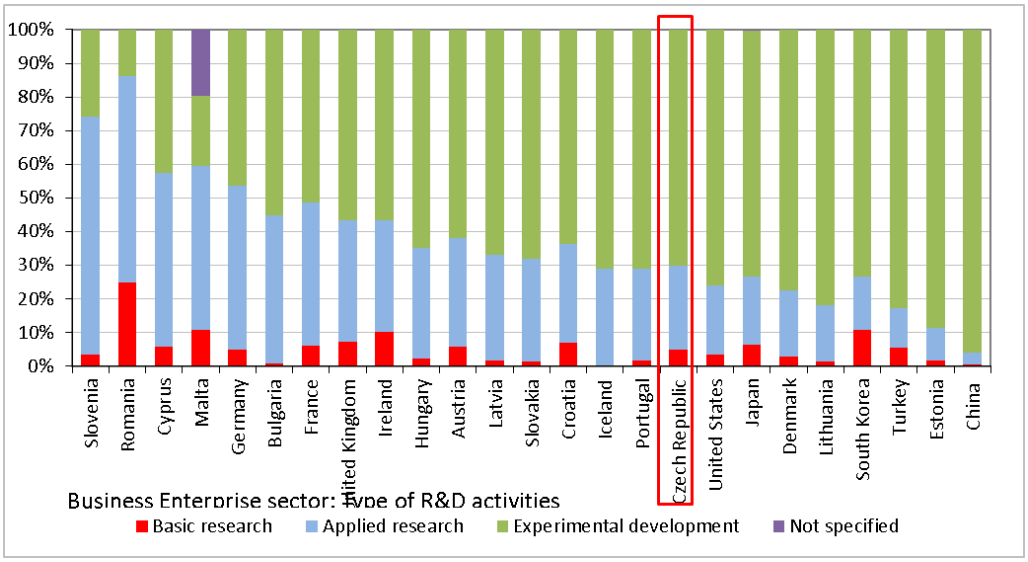
3.3 R&D Performance in the Business Enterprise Sector

Finally, an international comparison of the type of R&D expenditures in the Business Enterprise sector shows that the Czech Republic has a distinct focus on experimental development (71%), whereas the level of applied research and basic research is comparatively low, although the structure in this respect resembles that of the US and Japan, which of course have much higher rates of R&D investments in the Business Enterprise Sector.

The high level of experimental development supports the thesis stated in ERAWATCH (2010), that the innovation process of Czech companies is still mainly characterized by purchasing foreign machines and equipment, which they adapt to their own production process or completely replace this process with the new technologies. Innovation is thus based in particular on adapting knowledge developed abroad. Innovation based on utilisation of in-house developed R&D results or R&D results developed by domestic research institutes in the Czech Republic is realized only to a limited degree (ERAWATCH 2010). In addition, the R&D performance structure is also very much influenced by the industry structure of a country. For example, Slovenia has the highest shares of applied research due to much higher share of Pharmaceutical in its business R&D sector, while the Czech Republic has much more engineering based industries (automotives, machinery) for which experimental development is a stronger requirement.

Finally, for some countries data quality is very poor.

Figure 33: Business R&D Expenditures by Research Type and Country



Source: Eurostat (2010)

A comparison of R&D expenditures by research field and country in the Business Enterprise Sector shows that a) almost exclusively new member states and Southern European member states provide this type of information and b) that the majority of countries concentrate its R&D expenditures in the research field Engineering and Technology. Agricultural Sciences only play a considerable role in early stage catching-up countries (Bulgaria, Romania, Poland), whereas some Southern European member

states (Portugal, Cyprus) and also Latvia have considerable shares of enterprise R&D in the field of Social Sciences.

Table 11: R&D Expenditures by Research Field and Country in the Business Enterprise Sector (2007)

	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Humanities	Total
Bulgaria	6	78	6	10	0	0	43.5
Czech Republic	13	79	5	2	0	0	1210.8
Cyprus	36	48	9	1	6	0	16.1
Latvia	15	55	8	1	21	0	40.9
Hungary	11	79	6	3	2	0	492.0
Malta	31	51	15	1	na	0	20.9
Poland	6	75	12	5	2	0	535.4
Portugal	22	56	7	1	14	0	1010.8
Romania	18	59	6	15	2	na	271.8
Slovenia	5	57	37	0	0	0	299.5
Slovakia	14	75	8	1	2	0	99.7
Croatia	30	62	4	2	2	na	141.4
Turkey	5	86	3	1	5	0	1406.9
Russia	10	89	0	1	1	0	6807.5
South Korea	11	79	9	1	0	0	18747.1

Source: Eurostat (2010)

In the Czech Republic, the high shares of Engineering and Technology point to the relevance of sectors Producing Fabricated Metal Products, Machinery and Equipment, Instruments, Transport and Motor Vehicles, which in total accounts for more than 43% of all business R&D activities. On the other hand, the comparatively low levels of private R&D expenditures in the Natural Sciences and the Medical and Health Sciences reflect the limited role of the pharmaceutical industry and chemistry.

A more precise picture on the specific relevance of industrial R&D activities may be provided when business R&D expenditures are differentiated by industrial branches. 59.2% of total business R&D activities are conducted in the Manufacturing Sector and 39.1% within the Services Sector. The Agricultural Sector and Mining account for 0.5% of total business R&D activities only.

Within the manufacturing sector Czech business R&D activities show a very distinct distribution. The Motor Vehicle, Trailers and Semi-Trailers Sector is the most relevant branch in terms of R&D activities, as it accounts for about a quarter of total business R&D activities (23.2%). In addition, also the Machinery and Equipment Branch and the Precision Instruments Branch (Medical, Precision and Optical Instruments) are very relevant– accounting for 8.1% and 4.7% of total business R&D activities in the Czech Republic. On the other hand, some very research intensive branches, namely the Pharmaceutical Industry (3.3%), the Computer Industry (0.1%) and the Communication, TV and Radio Equipment Industry (3.5%) only account for rather small shares of total business R&D activities in the Czech Republic.

Within the Services Sector, Computer and Related Services Branch is comparatively strong in the Czech Republic, accounting for (8.3%) of total business R&D activities. Furthermore, also the Research and Development Sector accounts for 16.6% of total business R&D activities.

The branch contains companies which provide research and experimental development on Natural Sciences and Engineering as well as in the Social Sciences and Humanities. In some countries, like in Austria, this branch is dominated by state owned companies which provide R&D services for business enterprises whereas in other countries the sector is dominated by affiliated companies of manufacturing and service industries, which specialise on R&D activities.

The international comparison of R&D performed in distinct branches proves that the Motor Vehicles Industry plays an exceptional role in business R&D activities in the Czech Republic, whereas the Chemical/Pharmaceutical Industry, the Production of Computers, Office and Accounting Machines, and also Communication, TV and Radio Equipment only play a very limited role. The table also shows that the Czech Republic has a relatively strong Services Sector within industry R&D (36.6%). Computer and Related Services account for 8.3% of total R&D expenditures, a ratio well above many EU and OECD member states, whereas in the computer hardware production sector R&D intensity is very low.

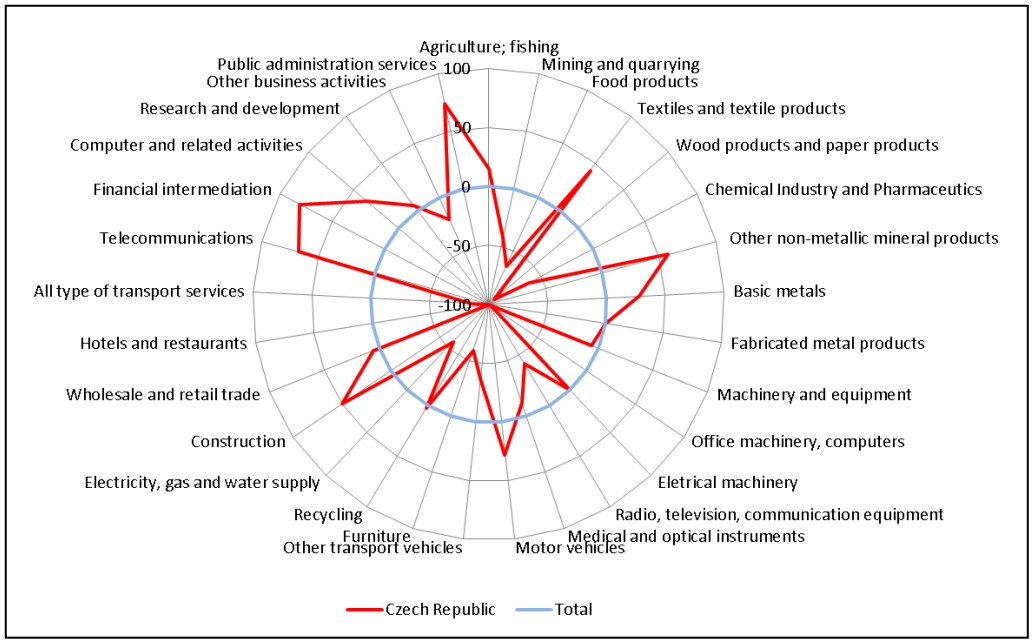
Table 12: R&D Performed in the Business Enterprise Sector by Industrial Branches and Selected Country (2007)

	CZ	DE	ES	AT	BE	DK	HU	PL	PT	RO	SI	UK
Total	1210.8	43034	7453.9	4845.9	4420.4	4030.3	492	535.4	1010.8	271.8	299.5	23542.8
Agriculture; fishing	0.3	0.2	1.0	0.0	0.6	0.0	2.0	0.5	0.1	11.1	0.0	0.1
Mining and quarrying	0.2	0.1	1.7	0.2	0.0	0.0	0.0	0.4	0.1	3.6	0.7	0.4
Food products	0.6	0.8	2.4	0.0	2.1	3.7	1.5	4.5	0.0	0.9	0.4	1.8
Textiles and textile products	0.8	0.5	1.6	0.7	1.2	0.1	0.1	1.2	1.6	0.6	2.4	0.1
Wood products and paper products	0.1	0.5	1.0	0.9	0.5	0.2	0.5	0.9	1.6	0.0	0.2	0.3
Chemical Industry and Pharmaceutics	7.3	17.3	14.0	0.0	34.7	32.3	38.9	12.5	0.0	14.4	43.3	6.3
Other non-metallic mineral products	1.3	0.6	1.5	1.5	1.1	0.2	0.3	0.9	2.7	0.2	0.8	0.2
Basic metals	1.2	0.9	1.0	2.4	2.2	0.0	0.4	0.8	0.8	0.0	0.9	0.3
Fabricated metal products	1.2	1.3	1.9	2.1	1.5	0.4	0.4	1.5	1.5	0.5	4.5	0.3
Machinery and equipment	8.3	11.1	4.5	11.4	5.8	4.7	6.4	7.8	2.8	5.2	9.0	6.4
Office machinery, computers	0.1	1.6	0.7	0.4	0.6	0.2	0.1	0.2	0.2	2.0	0.4	0.9
Eletrical machinery	3.2	3.1	2.3	13.4	4.1	1.7	3.3	5.4	1.2	5.7	7.9	1.2
Radio, television, communication equipment	3.6	7.1	3.3	9.6	7.7	2.9	8.5	1.3	3.1	0.0	10.1	2.4
Medical and optical instruments	4.9	7.2	1.7	3.3	2.5	6.8	2.4	2.3	0.5	1.8	4.6	4.3
Motor vehicles	23.9	31.4	3.4	8.3	1.9	0.0	10.1	5.0	4.5	12.9	2.4	4.8
Other transport vehicles	4.1	4.9	5.1	2.5	2.0	0.0	0.1	3.4	0.4	3.3	0.8	10.9
Furniture	0.3	0.5	0.7	1.6	0.3	0.5	0.1	3.3	0.8	0.1	0.7	0.4
Recycling	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity, gas and water supply	0.2	0.3	1.4	0.2	0.2	0.2	0.3	0.1	3.9	7.3	0.0	0.1
Construction	1.0	0.1	4.1	0.4	1.3	0.0	0.2	0.0	1.9	1.1	0.0	0.1
Wholesale and retail trade	2.3	0.4	2.0	4.6	1.7	9.6	12.4	1.3	2.0	0.1	0.3	3.3
Hotels and restaurants	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
All type of transport services	0.0	0.0	0.9	0.2	0.3	0.0	0.2	0.1	3.9	0.0	0.0	0.0
Telecommunications	1.3	0.0	2.6	0.9	3.6	0.0	0.3	2.5	9.8	0.0	0.0	9.0
Financial intermediation	5.2	0.5	1.5	0.2	1.9	10.2	0.2	0.0	16.6	0.0	0.0	1.8
Computer and related activities	8.5	3.8	8.7	5.3	4.9	17.7	3.6	6.7	10.7	9.2	2.1	6.2
Research and development	14.1	2.7	19.1	9.4	9.7	15.4	1.2	34.5	1.9	13.9	4.4	31.1
Other business activities	4.0	2.6	8.2	8.6	6.8	6.1	4.4	0.4	13.5	1.0	3.9	5.8
Public administration services	1.8	0.0	2.8	0.2	0.8	0.1	1.9	0.8	0.0	1.4	0.0	1.3

Source: Eurostat (2010)

The specialisation profile for business R&D activities in the Czech Republic displayed in Figure 34 is based upon disaggregated sectoral R&D performance data for the 12 EU member states displayed in Table 12. The countries have been selected as benchmarking countries because for the remaining EU member states no, or just incomplete recent disaggregated data by industrial branch exist. Although not all EU-member states are represented in the analyses, the benchmarking countries contain a solid mix of large and small countries as well as old and new EU member states.

Figure 34: Specialisation Profile of Business R&D Expenditures in the Czech Republic (2007)



Source: Eurostat, calculations JOANNEUM RESEARCH

The specialisation figure shows that the Czech Business Enterprise Sector has positive specialisation values in some manufacturing branches and in some service branches.

Within manufacturing, positive specialisations in the branches Textiles and Textile Products, Other Non-Metallic Mineral Products, Basic Metals and Motor Vehicles can be observed. In these branches Czech enterprises spend more on R&D than the benchmarking countries. In addition to these specialisations, several branches exhibit specialisation values around zero, which means that the relevance of these sectors resembles those of the benchmarking countries. These branches are Fabricated Metal Products, Machinery and Equipment, and Electrical Machinery.

Within the services sector, positive specialisations are observed in the branches Public Administration and Related Services, Financial Intermediation, Computer and Related Services, and Telecommunications.

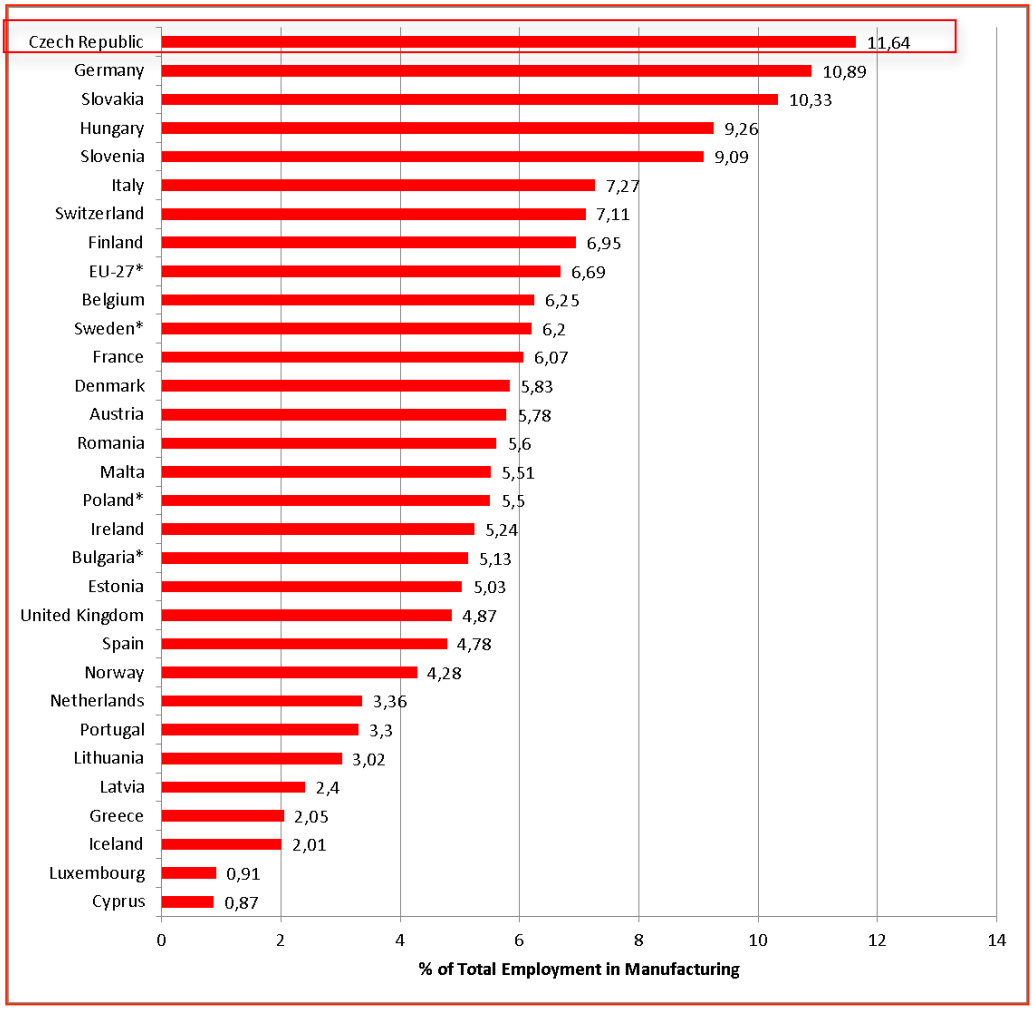
When comparing the national distribution of Business R&D expenditures by industrial branch with the specialisation profile of the Czech Business R&D expenditures, we see that the Czech Republic is by large specialised in branches which play a considerable role in the Czech R&D system (i.e. account for high shares of total R&D expenditures); the Motor Vehicles Sector (23.2% of total business R&D activities), and Machinery and Equipment (8.3%). In particular, the Motor Vehicles Sector and the Production of Materials also plays a very prominent role as regards exports. According to the UN Comtrade database (UN 2010), the Machinery and Transport Equipment accounted for more than half (52.9%) of total exports in 2008. Other major commodity groups included Manufactured Goods classified chiefly by material and miscellaneous manufactured articles respectively for 19.2 and 10.4%. From 2006 to 2008, top exported products were motor cars and other motor vehicles principally designed for the transport, parts and accessories of the motor vehicles of headings 87.01 to 87.05 and automatic data processing machines and units thereof.

The importance of the manufacturing sector for R&D may also be demonstrated, when considering its role in terms of employment. Latest Eurostat data show that the Czech Republic has the highest share of employment in High-Technology and Medium-High-Technology Manufacturing Sector of all EU-27 member countries. The figure below shows the employment in the gross high- and medium-high technology manufacturing

sectors per country as a share of total employment; data source is the Community Labour Force Survey (CLFS). The definition of High- and Medium-High Technology Manufacturing Sectors is based on the OECD definition (itself based on the ratio of R&D expenditure to GDP).

Although to a large extent this employment is due to low-skill assembling type of activities, it is nevertheless a positive sign that the Motor Vehicles Sector and related engineering activities constitute the main sources of private R&D investments in the Czech Republic.

Figure 35: Employment in High- and Medium-High Technology Manufacturing Sectors (2008)



Source: Eurostat (2010)

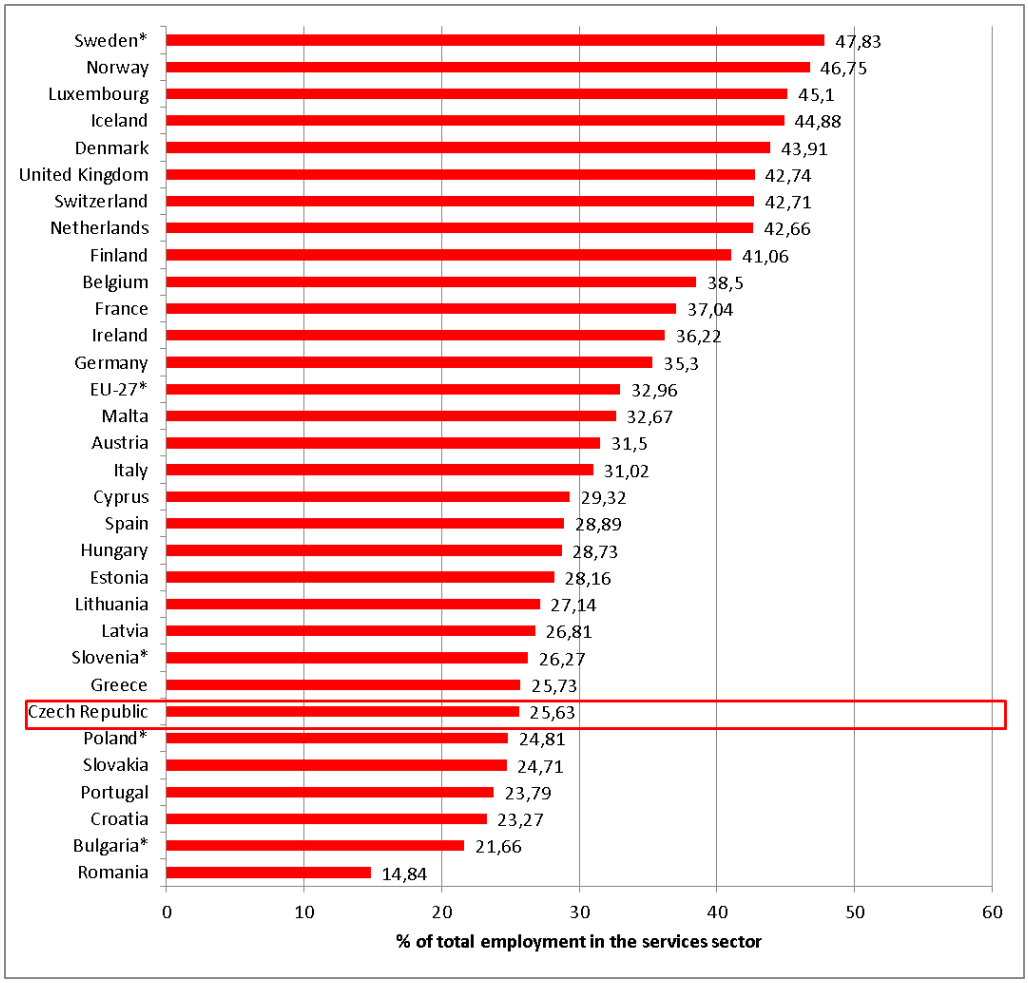
Also in terms of high- and medium technology exports the Czech Republic is in a catching-up phase. In the last fifteen years the share of high-technology exports has more than doubled and is currently at 12.735%, just slightly below the EU27 average and countries like Germany and Sweden, and already ahead of Austria.

However, whereas the situation regarding employment and exports in manufacturing is quite favourable, employment data in the knowledge intensive Service Sector show that there is still room for a catching up.

The figure below shows the employment in Knowledge-Intensive Service Sectors per country as a share of total employment. Data source is the Community Labour Force Survey (CLFS). The definition of Knowledge-Intensive Services including High-Technology Services used by Eurostat is based on a selection of relevant items of

NACE Rev. 1 on 2-digit level and is oriented on the ratio of highly qualified working in these areas.

Figure 36: Employment in Knowledge-Intensive Sectors (2008)



Source: Eurostat (2010)

Another aspect of business R&D activities is its distribution among different size classes. It has to be considered as a myth, that small and medium sized companies show no or little R&D expenditures in the Czech Republic. In total, SMEs account for 36.2% of business R&D expenditures. 55.3% of total business R&D expenditures are financed by firms with more than 500 employees; companies between 250 and 499 spend 8.3% of total business R&D expenditures.

The international comparison shows that in particular large enterprises (>250 employees) account for more than 60% of total industry R&D expenditures in many of the old EU member states. Concentration of R&D expenditures is particularly high in countries with highest R&D ratios in the European Union and the largest EU member states: In Sweden and Finland more than 70% of R&D activities are performed by enterprises above 500 employees, in Germany even 84% of business R&D expenditures are performed by very large enterprises. Only countries with a weak industrial basis (Greece, Spain, Estonia, Poland, Romania, and Slovakia) show little concentration of R&D activities in the large enterprises.

Figure 37: Distribution of Business R&D expenditures by size class (in % of total)

	Year	Total	Between 1 and 9	Between 10 and 49	Between 50 and 249	Between 250 and 499	Between 500 and 999	500 or more	1 000 or more
Belgium	2006	4106	2.3	13.7	22.8	8.2	7.8	48.7	40.9
Bulgaria	2007	43	4.8	11.6	30.9	3.3	1.8	48.7	46.8
Czech Republic	***2008***	***1342***	***1.2***	***9.3***	***25.7***	***8.3***	***10.0***	***55.3***	***45.3***
Denmark	2005	3477	2.8	12.3	14.0	8.7	13.2	62.2	49.0
Germany	2007	43034	0.5	2.6	7.6	5.3	0.0	84.1	
Estonia	2007	82	6.5	26.2	13.7	35.3	8.5	18.3	9.8
Greece	2005	357	4.3	29.4	26.0	5.9	17.4	34.4	17.0
Spain	2007	7454	4.9	20.6	28.9	10.9	8.8	34.8	26.0
France	2007	24470	1.8	5.5	11.0	7.9		73.8	
Latvia	2007	41	7.9	14.4	29.4	1.7		46.6	
Lithuania	2007	66	1.7	13.7	28.8	5.5		50.2	
Hungary	2007	492	5.7	10.7	10.8	7.8	20.7	63.1	42.4
Netherlands	2007	5495		6.8	15.4	9.0	22.7	68.6	45.9
Austria	2007	4846	2.6	7.4	17.8	10.3	15.3	62.0	46.7
Poland	2007	535	0.6	4.8	27.9	20.2	22.3	46.6	24.2
Portugal	2007	1011	2.2	10.1	26.2	12.6	7.0	48.9	41.9
Romania	2007	272	2.3	9.9	26.6	16.4	22.0	43.5	21.6
Slovenia	2007	299	3.5	7.2	15.4	8.3	18.1	65.6	47.4
Slovakia	2007	100	2.2	9.0	45.5	6.3	17.6	36.9	19.3
Finland	2007	4513	2.4	7.3	10.3	9.2		70.8	
Sweden	2007	8805	-	6.5	11.8	8.3	7.5	73.4	66.0
United Kingdom	2007	23543	0.5	3.7	11.9	9.1	11.0	72.8	61.8

Source: Eurostat 2010

4. Public Support for R&D Activities: Programmes and Priorities

Whereas the previous chapters of this report focused on the level of (public) R&D funding and the R&D performance structure in the different sectors, this part of the report deals with the current state of R&D support in terms of programmes and measures. Hence, it concentrates on the level of targeted R&D funding measures in terms of direct R&D support programmes aiming at particular themes and beneficiaries.

In order to be able to critically analyse the Czech R&D funding priorities and the system of public R&D support, the chapter starts with a short framing on priority setting and the use of national R&D programmes to pursue certain objectives.

We then provide an overview on the national science and technology policy priorities, the emerging portfolio of national science and technology programs and the measures provided by the structural funds. Thereby, we assess whether the portfolio of instruments is aligned to national needs, and whether the opportunities to use EU structural funds for building up capacities are being utilised.

These assessments on the funding portfolio of national and structural funds measures will lead to recommendations on the R&D program mix, the priorisation processes, and the use of structural funds.

4.1 Priority setting and the use of R&D programmes

According to Freeman's (1987) concept of technology policy, technology policy involves all public measures that influence and encourage actors (i.e. enterprises, public institutions and households) to develop new knowledge and technologies (invention) and to take these new technologies and commercialise (innovation) or use (diffusion) them. Hence, the concept of technology policy includes the very promotion of fundamental new knowledge as well as more recent policy approaches that are subsumed under the heading innovation policy.

From its very beginning, priority setting in technology policy has been a key issue for public policy, because technology policy has always had a strong focus on promoting the development of specific new technologies that are expected to contribute to societal and economic policy objectives (Gassler et al. 2008).

The academic literature on priority setting in technology policy shows, that the scope of priority setting has been subject to considerable paradigm changes during the last decades, adding to a classic mission oriented top-down approach with an emphasis on large-scale technologies (i.e. defence, energy, transport), aspects of priority settings which put particular emphasis on:

- Functional/generic priorities, which seek to overcome systemic failures within the concept of a (national) innovation system framework;
- Socio-economic and societal challenges (sustainable development, climate change, ageing, safety and security, health), and hence a stronger inclusion of beneficiaries and technology users, and horizontal coordination of hitherto separated policy areas;
- Key strategic sectors for a knowledge based economy, including i.e. ICT and Biotechnology, which seek to further contribute to technological change and increased technological and industrial competitiveness.

Today elements of all types of priority paradigms are to be found simultaneously (Gassler et al. 2008), but one can observe an overall convergence of guiding concepts underlying research and technology policy in EU and OECD countries, concentrating on the approach of Innovation Systems. In the course of this process, functional priorities (which tackle specific, systemic failures of the innovation process) have

become increasingly important in technology policy, whereas the extent of classic mission oriented priorities has decreased.

The concentration on functional priorities also had an impetus on R&D programmes. First of all, targeted R&D programmes have become increasingly important, and constitute a major mechanism for public policy support (see chapter 1.3 on the use of different funding modalities), as direct R&D support measures allow public authorities to specifically target R&D funding towards specific scientific areas and industrial branches, and may also influence the beneficiaries' behaviour through the modalities of financing and the conditions set up in a measure. Thereby, the concept of the Innovation System framework has more and more influenced the scope and rationales behind R&D programmes: Contrary to old-style thematic programmes with a very narrow industry/discipline focus, functional dimensions of the innovation system are increasingly being included in R&D programmes. These dimensions include (Rammer et al, 2004):

- Support for Industry science-cooperation,
- Integration of different technologies and research areas,
- (Regional) Cluster programmes,
- Special emphasis on and support for SMEs, NTBFs and start-ups,
- Formulation of R&D programmes with an eye on innovation and diffusion.

Despite the increased use of targeted R&D programmes, general support for R&D activities of firms (i.e. tax incentives, generic bottom-up R&D projects) and bottom-up oriented funding for projects aiming at scientific excellence are even used by countries with a most pronounced top-down planned priorities in terms of specific technologies. One explanation therefore is that free market principles are regarded as superior in selecting new technological developments and in potential successful innovations (see Gassler et al. (2008).

Another important aspect in terms of national R&D priority setting and national R&D programmes is the increased internationalisation of research and innovation, and the aligning impetus of European Union policies. In order to advance towards the European Research Area, a series of strategies and measures including the European Union Framework Programmes for R&D (FPs) have been set up by the European Union technology policy, which had an impact on national policies, in particular with regard the inclusion of the very idea of "new missions" including societal challenges, which was adopted by various member states, and secondly, EU technology policy had a direct impact on the behaviour of major research actors and has increased the intra-European cooperation in particular.

Gassler et al (2008) witness a convergence towards the FPs priorities in terms of thematic areas addressed by European Union member states. The FPs in itself, despite its thematic priorities, are thereby a concrete example of a (huge) R&D programme incorporating a series of functional/systemic priorities, as an array of systemic issues such as the inclusion of users, coherence of the European Union, a pooling of resources and establishment of joint research agendas of relevant actors, training and mobility issues are included within the objective agenda of its specific programmes.

4.2 Priorities of the Czech Technology Policy

The priorities of the Czech Technology Policy are embedded within three main strategic documents, the "Reform of the System of Research, Development and Innovation in the Czech Republic, the "National Policy of Research, Development and Innovation for years 2009-2015" and the "Priorities of applied R&D&I for 2009-2011".

The National Reform focuses on the delivery system of research and innovation support system, and lays out basic principles of R&D programmes and tasks to be fulfilled by the different stakeholders of policy delivery. The National Reform document has had a considerable impact on the composition of intermediaries

delivering R&D policy support (ministries and funding agencies), and the basic orientation of the funding activities.

The National Policy for R&D&I sets out the main objectives of publicly funded R&D activities for the Czech Republic, and hence should have an impact on the design of R&D programmes, as it is highly intertwined with the "Priorities of applied R&D&I for 2009-2011.

Whereas details on the role of the intermediaries are provided in the Report on R&D Governance (Final report - 2), the analysis in this report focuses on the implications of these two strategic documents for the content characteristics of the programme portfolio in an international perspective.

4.2.1 The Reform of R&D&I system and its implications for the programme portfolio

The National Reform document represents a set of strategic decisions concerning the Czech innovation system. The document concerns especially institutional arrangements, but also legal matters, as well as important changes in the system of funding of the Czech research (the system of institutional based funding). Main reasons for the reform have been:

- A very low benefit of the Czech research for its economy and society;
- A low effectiveness of the existing forms of R&D support;
- A fragmentation of the Czech research and a lack of clear priorities, leading to a further lagging behind in the international context.

The motto of the reform is in its own words is: To create an innovative environment through reforming the system of research, development and innovation in the Czech Republic in order to be held true that "Science makes knowledge from money, innovation makes money from knowledge."

Therefore, the reform sets out 7 objectives regarding: 1) The efficiency of the R&D support system 2) The simplification of the R&D support 3) The support of excellence in R&D, and facilitation the application of R&D results in innovation 4) A strengthening of the cooperation between R&D sector and the users of R&D results 5) An establishment of a more flexible organisational structure of public research organisations 6) A provision of qualified human resources for R&D&I 7) and an intensification of the CR's involvement in international R&D&I cooperation.

In terms of a reorganisation of public R&D support via measures of targeted and bottom-up oriented project funding, the reform put particular focus to a) the reduction of the number of funding entities (budgetary chapters), b) to support excellence in research, with a preferential treatment of activities in which results may be used for innovation, and c) condition the programme support of R&D upon the co-operation of public research with users of R&D results based on co-financing from public and private resources.

In the implementation phase of the reform, the following relevant changes for R&D programmes have so far been achieved:

- The budgetary chapters were being reduced from 22 to 11 entities, which provide targeted R&D funding measures.
- The role of the Academy of Sciences and its Grant Agency changed12. The Academy gradually ceased to be the provider of special-purpose public support in research and development, which will lead to its gradual ending of the activity of

[12] Act No. 110/2009 Coll., which amended Act No. 130/2002 Coll., On Research and Development Support from Public Funds.

the Grant Agency of the ASCR and not announcing and administering research, development and innovation programmes in the future (ASCR 2010).

- The Technology Agency of the Czech Republic was established in July 2009; it aims to serve as main funding agency for applied R&D endeavours in the Czech Republic. It is foreseen that the new agency is going to be fully operational by 2011/2012.

As a consequence of the reform, the Czech Science Foundation (Grant Agency of the Czech Republic) and the Technology Agency were supposed to be the major providers for targeted R&D results, in which the former should be the sole provider for the field of basic research and the latter should be the sole provider for the field of applied research, technological development and innovation.

The Reform Plan also sets out the main task for the Technology Agency, which are to:

- Support the projects in applied research, development and innovation that are to be used in practice;
- Support, for the whole Czech Republic, the projects in applied social economic research intended to meet the state administration's needs that will be realized under public contracts after the applicable programme is approved by the Government;
- Provide full range of services to users throughout the whole process (legal, financial, protection of results, etc.);
- Encourage the communication between the research organisations and private sector, and the co-financing of projects;
- Cooperate with foreign technology agencies (especially of the EU countries) and take advantage of their experiences.

The Czech Science Foundation - GACR (Grantová agentura České republiky), which was established in 1993, represents the main body on the Czech R&D scene that provides project-based funding of a bottom-up type (i.e. classic basic research types of grants driven by the intentions of applicants).

In addition to the tasks of the Technology Agency and the Science Foundation, the reform plan identifies four "cross-sectional R&D spheres", which are to be funded both institutionally and through targeted measures, and three sectoral R&D areas that have a sectoral character, but at the same time they are so specific that they cannot be effectively supported through TA CR like other sectoral research and development.

The cross sectional R&D spheres are:

- International collaboration in R&D – which will remain under the competence of the Ministry of Education, Youth and Sports
- Security R&D – which will be coordinated and supported from the budgetary chapter of the Ministry of Defence (MoD)
- Applied R&D of national and cultural identity – which will be coordinated and supported from the budgetary chapter of the Ministry of Culture (MoC)
- Support of large R&D infrastructures – which will, with regard to close links to international cooperation and the structural funds Operational Programme for Research, Development and Innovation, be within the MEYS competencies.

The three sectoral R&D areas, which are deemed to be so specific that they cannot be effectively supported through TA CR like other sectoral research and development, are:

- Applied agricultural R&D – under the responsibility of the Ministry of Agriculture (MoA)
- Applied defence R&D – under the responsibility of the Ministry of Defence (MoD)

- Applied healthcare R&D – under the Ministry of Health (MoH)

All ministries mentioned above, plus the Ministry of Interior, were obliged to develop long-term concepts for the research activities to be performed, with a certain aim at increasing at the same time the involvement of research organisations (PRIs, PHEIs, and others) and enabling the use of results for the application sphere.

Hence, currently, intermediaries for the implementation of the national R&D&I policies are 7 Ministries and the 2 Agencies (the Czech Science Foundation and the Technology Agency). The Ministry of Industry (MIT) will continue to play a role for R&D support to industry, as it continues to operate a programme which is supposed to continue until 2017. Furthermore, the Ministry of Industry and Trade is responsible for the implementation of the Operational Programme on Enterprise and Innovation. The Ministry of Education is responsible for the Implementation of the Operational Programme Research and Development for Innovation.

4.2.2 The National Policy for R&D&I for 2009-2015 and the Priorities of applied R&D&I for 2009-2011: The issue of thematic priority setting

In addition to the reform of the R&D&I system, the National Policy for R&D&I for 2009-2015 and the Priorities of applied R&D&I constitute the main documents, which outline the strategy for R&D&I for the Czech Republic.

The national R&D&I policy was prepared by the Council for Research and Development and Innovation which is in charge of it according the act on public support of R&D. The national R&D&I policy is supposed to be a substitute for various partial strategies concerning R&D&I, together with its reform, which would overcome its weaknesses and inefficiencies. Hence, the National Policy of Research, Development and Innovation in the Czech Republic is the first strategic document that deals with the Czech innovation system as a whole (incl. R&D, innovation and education). It consists of nine main objectives:

- Establish a strategic management of R&D&I at all levels based on systematic impact assessment of the National Policy as well as analyses of R&D&I.
- Increase the efficiency of the public support to R&D;
- Utilize the R&D results in innovation processes and enhance the co-operation of the public and private sector in R&D&I;
- Intensify the Czech Republic's involvement in the international R&D&I co-operation;
- Provide qualified human resources for R&D&I;
- Create an environment stimulating R&D&I in the Czech Republic;
- Ensure the compatibility and linkages of the National Policy with other sectoral policies;
- Ensure consistent evaluation of the R&D&I system;

The objectives of the National Policy document are very much in line with the National Reform Plan. The focus of the national R&D policy is on generic themes of the national innovation system. However, in terms of thematic priority setting, the policy document is accompanied by the Priorities of applied research, development and innovation for 2009-2011, which identified a set of thematic priorities via a series of expert round tables. The following eight research directions were identified: 1) Biological and ecological aspects of a sustainable development 2) Molecular biology and biotechnology 3) Sources of energy 4) Material research 5) Competitive engineering 6) Information society 7) Security and defence 8) Priorities of development of Czech society.

These broadly defined priorities are at present only partly reflected in the actual public funding of R&D, because most of the funds allocated towards programmes and

intermediary actions cannot be assigned to any of the thematic priorities since it is mainly funded through research programmes that are not sector- or theme-specific (ERAWATCH 2010).

The main sector specific actions include the cross-sectional and sectoral R&D programmes mentioned in the National Reform Plan (Security R&D, Applied R&D of national and cultural identity, Applied agricultural R&D, Applied defence R&D, Applied healthcare R&D). These sectoral R&D programmes are in essence multi-annual thematic research programmes too, with competitive calls for proposals for funding of research activities in the given field, but at the same time, are used as a source of institutional funding for some selected research institutes controlled by the given ministries and also as a means of funding policy research for the needs of the ministry. The budgets of these ministries therefore represent a mix of instruments (ranging from project funding, through policy research for the use of the ministry / procurement to institutional funding of given research institutes).

In addition to the sectoral programmes, the programme ALFA of the Technology Agency, and TIP of the Ministry of Industry and Trade provide certain priorities within their programmes. TIP focuses on New Materials and Products, New Advanced Technologies, and New Information and Controlling systems. ALFA focuses on Progressive technologies, materials and systems (support of enabling technologies applicable in multiple industries), Energy resources and creation and protection of environment (renewable resources of energy, protection of ecosystems, environmentally friendly technologies), and sustainable development of transportation[13].

Budget data indicate that thematic funding (targeting a specific research field, such as ICT, health, nanotechnology, energy, environment, defence, agriculture, etc.) in 2009/2010 represented about only 20% of the total, whereas nearly 40% of this share was directed to health and quality of life (mainly through the Ministry of Education, Youth and Sports and through the Ministry of Health) [14]. Still in 2009, ICT received an earmarked amount in the form of specific thematic budget in the overall budget of Ministry of Education, Youth and Sports with an allocation of CZK 52m (€2m), plus CZK 180m (€6.9m) within the budget of the Academy of Sciences, which also operated a small sector oriented programme. As ICT research is not re-presented by a specific ministry, it is today not represented via a dedicated thematic budget.

4.2.3 Key findings in the light of international experiences

The implementation of the reform had some implications on the portfolio of R&D programmes. In the course of the present reform the budgetary chapters for R&D haven been reduced from 22 to 11. As the responsibilities of ministries and funding agencies have changed, a number of research programmes are right now just in a setting up phase.

Through an analysis of the R&D budget we found that a large number of R&D programmes, accounting for more than 60% of total targeted R&D financing, have discontinued launching new calls in 2009/2010. The most important programmes which discontinued its financing activities recently were:

- The National Research Programmes I+II

[13] A more detailed description of the thematic R&D programme portfolio is provided in the next section of the report, as this part focuses on the policy priorities.

[14] Source: ERAWATCH http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=13&parentID=12&countryCode=CZ

- The Academic Research Programmes of the Grant Agency of the Academy of Sciences
- The Programmes TANDEM and IMPULS, which were operated by the Ministry of Industry and Trade, and
- Several branch programmes, operated by other ministries.

Whereas the research programmes of the Academy of Sciences, except from two thematic oriented programmes, resembled to a large extent the type of financing provided by the Science Foundation (bottom-up financing for basic research activities at different stages of the scientific career), the National Research Programmes I+II, and the Programmes Tandem and Impulse targeted specific objectives in terms of priorities and financing modalities.

The National Research Programmes I+II (NRP I, NRP II) were an attempt to launch thematic and problem oriented research programmes, as they included specific sub-programmes called *Sustainable Prosperity*, *Health and Quality of Life*, *IT for a Knowledge Based Society*, and *Socio-Economic Development*. Both NRP I and NRP II were open for higher education institutions, research institutes and business enterprises, and provided opportunities for science-industry collaborations, although it is not known, whether the building of distinct consortia was obligatory.

The NRP II also provided financing for so called “National Research Centres”, which aimed to concentrate research capacities of several actors in a limited number of centres. The centres should provide research oriented to the long-term requirements of the application sphere (industry) and regional development, early-stage researcher support and cooperation between different types of institutions. Many of these tasks are now foreseen to be implemented via the Operational Programmes of the structural funds and the Science Foundation is about to start a centres of basic research programme in 2012.

The programmes TANDEM and IMPULS were operated by the Ministry of Industry and Trade, and had a clear focus on R&D endeavours between research institutes and business entities. Whereas TANDEM provided technology support to SMEs and tried to increase applied R&D efforts to foster the competitiveness of products and technologies, the intention of the IMPULS programme was to transfer R&D results into the development of models, prototypes, and semi-operational equipment in order to increase possibilities of deployment and market success.

TANDEM and IMPULS were main funding schemes for science-industry collaboration on a project basis. A condition for financing was to secure that results of the projects will be further developed so that they are finally transferred in new products, technologies and materials. Both programmes were considered to be successful policy measures, at least in terms of demand.

The programmes were replaced by TIP, which is supposed to fund applied R&D in industry. As opposed to TANDEM and IMPULS, TIP has a stronger sector oriented focus on research for New Materials and Products, New Advanced Technologies, and New Information & Controlling Systems. Contrary to TANDEM and IMPULS, TIP does not require collaborations between industry and research organisations. Furthermore, the programme is strongly output oriented. Each project has to result in at least one of the following outputs: patent, pilot, proven technology, functioning model, design, prototype, "utility model", applied certified methodology, software.

Apart from the impact in terms of the R&D programme portfolio, the National Reform also puts increasing pressure on R&D programmes to deliver “results”, and consequently also seeks to set out how the results will be used. Hence, for the sphere of applied research activities the programmes and respectively projects need to deliver “results utilisable in innovation (patents, realized technologies, software, results projected into legal regulations, standards, directives, and non- legislative regulations binding within the competence of each respective provider, and certified methodology, etc.).

In order to ensure the use of R&D results, the national reform plan foresees that a co-financing of programmes by public (state) and private resources, should take place in programmes of applied oriented R&D. The announced reason for this is that "the share of private resources is minimal and mostly they are not the resources of future users of programme results (enterprises), but the resources of investigators (research organisations). Thus the main reason for co-financing disappears – to engage the future user of results in the solution, allow the transfer of knowledge, etc."

On the other hand, also research excellence ranks high in the field of basic research. For the projects in the field of basic research, in a strive for excellence, it is foreseen that "only world recognised results publications will be taken into account" (publications with prestigious publishing houses, publications in reviewed journals, publications originating at reputable conferences, etc.) with the exception of selected branches of humanities and social sciences focused on a nationally oriented knowledge where the excellence will be measured within the National Reference Framework.

In order to achieve excellence in research, also a major change in the institutional R&D landscape is already outlined in the reform plan. In the framework of the Operational Programmes, the "European Centres of Excellence" and the "Regional Research Centres", it is foreseen that the European centres of excellence will be more focused on creation of knowledge to be used in the long term and significant involvement in the international collaboration (and corresponding structure of financing from the state, European and private sources), while the regional research centres will be more focused on immediate collaboration with the application sphere and quicker use of knowledge.

An international comparison of these results show that the innovation policy approach outlined in the reform document in this respect is following a relatively narrow concept as regards the purpose of R&D programmes, while it incorporates in general many aspects (i.e. human resources, leveraging of private R&D resources, fostering scientific excellence) that are part of research priorities in other countries.

In the Czech Republic, applied and more industry oriented R&D programmes (not the Centres of Excellence) are not seen as measures to increase competencies of actors (increase the stock of useful knowledge), to define joint research agendas of industry and academia, and to allow for training of R&D personnel, but Science-industry collaborations should simply and directly lead to application of results obtained from R&D programmes.

Examples on different policy agendas, highlighting a more systemic approach towards the needs of an innovation system, are to be found in policy strategies in many other European Union member states, which also focus on an increased excellence in R&D, and a stronger results orientation[15]:

- In Austria, thematic programmes which support application-oriented research and technology development, call for collaborative projects (making science-industry cooperation a non-thematic priority in many thematic programmes). Public funding is provided for both academic and industrial partners, according to EU state aid rules. Generally, project budgets are split between the different types of partners, according to their defined role in the project. The thematic R&D programmes are frequently complemented by a set of specific additional measures. These seek to bring together the stakeholder community in order to identify the key actors within a certain theme and define common research agendas, provide support for feasibility studies, and to establish accompanying training measures.
- In Flanders (Belgium) the economic valorisation and a more output driven research policy are also on the agenda of the 2009 reform programme. However,

[15] Main source of this information: ERAWATCH

the reform plan puts strong focus on the human resources potential in research, and is operating with a considerable wider concept of R&D results and innovation than the Czech Republic. The scope of innovation has been increasingly broadened from technological innovation, to a type of innovation that includes all different sorts of organisational improvements because of adding knowledge and ideas to products, services, organisations or processes. This implies that the innovation policy targets a much broader field of innovators and innovations.

- In France, the pact for research, takes the internationalisation of research activities as a starting point, emphasising that a greater competition between research units amongst countries is visible and therefore, in order to gain international visibility, research should reach excellence. Secondly the relation between science and society ought to be reinforced. The Pact for Research underlines the need to encourage public researchers and PROs to augment partnerships with socio-economic actors. Collaborative research between public research organisations and companies is seen as a tool to promote the transfer of technologies from public research to the economy as well as a leverage mechanism on private research activities.
- In Germany, the federal government follows the "High-Tech Strategy" which defines the central goals of Germany's research policy. The aim is to increase competitiveness within the economy and to use public money more efficiently in order to create a stronger leverage in terms of employment and economic growth via knowledge production and distribution. The High-Tech Strategy is an important instrument to improve the coordination and cooperation across all affected agencies. Particularly relevant for science and research policy is the focus on 17 cutting-edge fields that receive particular attention and the support of clusters and networks. In the Top Cluster Competition up to five clusters receive substantial financial support (€200m in total) for a duration of five years. Especially relevant for innovation and competitiveness is thereby the intense cooperation between public research organisations and private firms in these clusters. In addition, excellence in academica is supported through the Initiative for Excellence (Exzellenzinitiative). This competition allocates €1.9b to selected graduate schools, clusters of excellence and universities.
- In the Netherlands, the strategic agenda for higher education, research and science policy calls for the universities to introduce new governance mechanisms that are able to select priorities in research in order to align research with societal and economic needs, also in an international context. As regards, science-industry collaboration, the strategy calls for an intensified relationship between knowledge institutes and professional practice in order to facilitate a greater exchange of knowledge and specific cooperation in the development of new insights and products. In particular for SMEs, science industry collaborations are seen as a measure to initiate R&D activities.

In addition to these features regarding a more systemic approach towards the needs of an innovation system, an international comparison of R&D priorities shows that thematic R&D priorities and functional R&D priorities co-exist in many European countries. The ERAWATCH policy inventory shows that the majority of European countries do specify thematic research priorities although in terms of funding allocation, most adopt a generic approach to research funding, with the inclusion of a variable number of thematic programmes. The most commonly selected thematic areas are:

- Nanotechnologies (inc. new materials, microtechnologies)
- Biotechnology & Life Sciences (inc. genomics)
- Agro-technologies and Food
- Bio-medical and Health
- Information and Communication Technologies

- Transport, mobility, logistics (inc. aerospace)
- Energy
- Sustainable Development (inc. Water resources and technologies)
- Environment and Earth science
- Security and Defence Research:
- Social, Cultural Sciences & Humanities: (inc. Knowledge Society, National identity and cultural heritage)

As in the Czech Republic, thematic priorities are very often defined only on a broad level, and the concrete tuning of research agendas, and the implementation is implemented within responsible intermediaries or agencies. These rely upon interactions with key stakeholders in the field. For the analysis on the processes for defining strategic concepts see Final report - 2 of this audit.

Although the thematic priorities of the Czech Republic fit well into the mainstream of EU member states funding priorities, they raise some concern. The cross-sectional R&D priorities security R&D and applied R&D of national and cultural identity, as well as the sectoral programmes on agricultural R&D and defence R&D, focus exclusively on themes which concern strategic national interests of the state and its citizens, but they do not encompass measures which seek to align research activities of industry and science around fields of strategic interest for enhancing the competitiveness of the economy. This holds in particular true for the whole ICT research sector, which also is the largest thematic area addressed by the EU Framework Programmes, but also concerns the Biotechnology and Life Sciences arena, and the programmes relating to New Materials and production processes.

4.3 The national portfolio of competitive R&D funding

The medium-term outlook of the National Public R&D outlays for 2013 is currently estimated at a total of 25,392 million CZK[16] (approx. 1.024 million Euro), of which 50% are foreseen to be spent via R&D programmes and projects, indicating that the distribution of R&D funding is further shifting from institutional funding towards targeted funding (in 2008 the ratio was 54%:46%). In absolute terms, the level of targeted funding has more than doubled since 2003 and is further expected to rise, although at a much slower pace. Co-funding of international programmes (operational programmes) accounts for about 11% in 2009 and levels are expected to stay roughly at these levels.

Due to the results of the R&D&I policy reform, main changes are foreseen as regards the allocation of targeted funding over the different funding bodies. After setting up the Technology Agency and widening the scope of R&D funding of the Czech Science Foundation (Grant Agency), the two agencies are expected to account for 36% of total targeted funding in 2013. As a consequence, also the portfolio of R&D programmes in the Czech Republic is in a phase of considerable change.

Although a number of programmes are just in a starting phase, it is possible to capture and assess the current state of the targeted R&D financing portfolio, and sketch ways forward for its future development. Funding measures for Czech R&D national R&D programmes stem from 6 Ministries and 2 Agencies (the Czech Science Foundation and the Technology Agency), with certain responsibilities. In addition, international funds provided by the Operational Programmes constitute main pillars of innovation policy in the Czech Republic.

[16] Source: P□íloha k □j.: 13877/10-RVV

The table below provides an overview about the current state of funding bodies, the main programmes of the intermediary agencies, the main target groups of the programmes, and a short description of the key focus of the measures.

In the following, we then outline the scope of the programmes in more detail.

Table 13: Overview on the R&D instrument portfolio

Funding Body /Programmes	Duration	Main Beneficiaries	Main purpose	S/I focus	Thematic focus	Accompanying Measures	International focus	Share of total in 2012
Technology Agency								
ALFA	2011-2017	Businesses, Universities, Research Organizations	Applied, results oriented R&D in co-operative projects, focusing on distinct themes per call	Partly	Progressive technologies, materials and systems Energy resources Sustainable transportat systems	No	No	12%
BETA	2011-2016	Universities, Research Organizations	Public tenders in research, development and innovation required by organisations included in the national governance system	No	No	No	No	1%
OMEGA	2011-2016	Universities, Research Organizations	Applied, results oriented socio-economic research	No	Socio-economic research	Yes	Yes	0.5%
Competence Centres (in development)	2012-2018	Businesses, Universities, Research Organizations	To build up joint medium term research agendas between science and industry for the application of R&D results	Yes	No	Not known	No	3%
Czech Science Foundation GA CR								
Standard Projects	Indefinite	Individuals Researchers	Response mode funding for excellent academic research	No	No	No	No	20%
Post-Doctoral Projects	Indefinite	Individual Researchers	Response mode funding for excellent academic research	No	No	No	No	
International Projects	Indefinite	Individual Researchers	International co-operation	No	No	No	Yes	1%
ERC-CZ		Individual Researchers	Fostering excellence at European Scale	No	No	No	Yes	NA
Centres of Excellence	2012-2018	Research Teams	Promotion of research teams in a certain theme	No	No	Not known	No	1%
Ministry of Industry and Trade								
TIP	2009-2017	Businesses	Promotion of applied industrial R&D and innovation	No	New Materials and Products New Advanced Technologies New Information & Controlling Systems	No	No	24%
Ministry of Education Youth and Sports								
International Co-operation	Til 2017	Universities, Research	Participation in	No	No	No	Yes	6%

		Organizations, Enterprises (EUREKA)	international cooperation (FP7, COST, EUREKA) and international R&D organisations (ESF etc.)					
Support for large R&D infrastructures	2017	Large R&D infrastructures financed by OPs	provision of funds for large R&D infrastructures	Yes	No	Yes	Yes	14%
Ministry of Defence								
Development of attained operational capabilities of the Czech Armed Force	2011-2015	Businesses, Universities, Research Organizations	Increasing National Security	Partly	Several themes related to weapons, capacities, etc.	Inter-departmental co-operation	Yes	1%
Ministry of Agriculture								
Research in the Agricultural Complex	2011-2015	Businesses, Universities, Research Organizations	Ensuring sustainable rural development	Partly	Sustainable development in agricultural sector Rural area natural resources management	Research-Education collaboration, public communication of R&D results	Yes	3%
Ministry of Culture								
Applied research and development of national and cultural identity Programme	2011-2015	Businesses, Universities, Research Organizations	Protection and use of cultural identity and heritage	Partly	Cultural heritage and national identity History and multicultural society Technologies, procedures and materials	Dissemination	No	2%
Ministry of Health								
Departmental Research and Development Programme III	2011-2015	Businesses, Universities, University Hospitals, Research Organizations	To improve healthcare practices and services delivery: prevention, diagnosis, treatment of diseases	Partly	12 thematic priorities related to virtually all medical fields	Communication with stakeholders	No	6%
Ministry of Interior								
Security Research for the Needs of the State	2010-2015	Businesses, Universities, Research Organizations	Increasing security of citizens and infrastructure	Partly	in total 26 priorities	Inter-departmental co-operation	Yes	4%

4.3.1 The Technology Agency

The Technology Agency is supposed to be the main provider of the competitive support of R&D from 2011/2012 respectively. According to its own definition, the primary objective of TA CR is to support applied research, experimental development and innovation in the Czech Republic in compliance with the Czech legal system as well as with legal norms of the European Union.

The creation of TA CR is one of the cornerstones of the research and development (R&D) reform in the Czech Republic, which pursued the main aim to simplify the national R&D support system.

4.3.1.1 ALFA

The first R&D support programmes of TA CR are focused on advanced prospective technologies and specifically on R&D and innovation needs in the sectors of transport, energy, and environment. The respective ministries were the first lose their own R&D funding competencies in terms of programme implementation. The programme is called ALFA.

ALFA has launched its first call in 2010. The programme has been approved for the period from 2011 till 2016 in which three calls are expected – in 2010, 2011, and 2012. The estimated overall budget of the programme is approx. 7.5 billion CZK with an estimated public support of 65% (approx. 290 million EUR). The ALFA programme contains three sub-programmes with a specific technological orientation:

- Progressive technologies, new materials and systems (support of enabling technologies applicable in multiple industries)
- Energy resources and creation and protection of environment (renewable resources of energy, protection of ecosystems, environmentally friendly technologies)
- Sustainable development of transportation (development of infrastructure, telematics, and energy efficient, environmentally friendly and safe transportation)

For the first call of the programme, 657 project proposals were received by Technology Agency of the Czech Republic out of which 50% applied for the first sub-programme, 29% to sub-programme focusing on energy resources, and creation and protection of environment, and 22% of applications run into the third sub-programme. Based on the results of the evaluation process 253 of the received project proposals (38.5%) were recommended for financing. According to information from the Technology Agency, the vast majority of applicants stemmed from R&D organisations, which previously had conducted their R&D activities within the framework of the former branch programmes – new incumbants were limited.

The average subsidy is in between 8 and 40 million CZK and depends heavily upon the sub-programme, which all have specific annual budgets, and for which projects are selected in separate selection procedures.

The main aim of the programme is to produce R&D results that can be used by industry. Therefore, the programme adheres to the specifications of applied R&D results as outlined in the Evaluation Strategy. Publications are not desired outputs of the programme, although the majority of projects within ALFA are led by research institutes.

Although a strengthening of an effective cooperation in research and development between companies and research organizations is one of the main objectives of this programme, science-industry collaborations are not a pre-requisite, but are taken into account within the project evaluation system. In order to ensure that the co-operation is actually “effective” participating research organizations have to account for at least 10% of the project costs. In total 20% of the project costs have to stem from own sources of the consortium.

According to our interviews, the programme is indeed co-operative. 90% of the projects within ALFA are built of R&D consortia, containing various partners. About 80% of the projects had at least one industrial partner. As regards the project lead about 1/3 of the projects were led by industry and 2/3 by academic institutes. The share of financing to industrial partners and academic partners, no information could be provided by the Technology Agency.

The ALFA Programme is to be seen as a thematic oriented R&D programme, which puts particular emphasis on the production of R&D results in terms of patents, prototypes, methodologies, and software developed.

Despite being the largest thematic oriented R&D programme, the programme has not a dedicated significant budget for awareness measures, training of participants, networking and co-ordination of actors in a national and international perspective around a specific research theme.

In this respect, the ALFA programme differs considerably from many other thematic oriented R&D programmes within the European Union. An example for such a type of programme, although not as results-oriented as the ALFA programme, is the Austrian NANO-Initiative programme.

The Austrian NANO Initiative

The Austrian NANO Initiative is a multi-annual funding programme for nanosciences and nanotechnologies in Austria. It funds collaborative R&D in large-scale project and it also coordinates NANO-related policy measures on the national and regional levels. It is supported by several federal Ministries, provinces and funding institutions, under the overall control of and mainly financed by the Federal Ministry of Transport, Innovation and Technology (BMVIT). The programme is managed by the Austrian Research Promotion Agency (FFG) on behalf of the BMVIT. The strategy and objectives of the Austrian NANO Initiative have been developed jointly with scientists, entrepreneurs and intermediaries.

The Austrian NANO Initiative has the following objectives (as stated on its official website):

1) Broadening the cooperation basis between science and industry

2) Strengthening research competence in fields of application relevant to Austrian enterprises

3) Accelerating technology transfer and increasing the economic utilisation of nanotechnology

4) Improving access to know-how and to cooperation partners abroad

5) Decreasing insecurities and information deficits with regard to health risks and environmental risks

Establishing nanotechnology in the context of public perception of Austria as a research location, of science communication and of promoting young researchers

The Austrian NANO Initiative mainly funds collaborative research. The collaborative setting is similar to what can be seen in European Framework Programmes with consortia of research institutes, universities and firms working on problem driven basic research questions with a medium term perspective (5-7 years). It was perceived that the Austrian funding systems lacked an adequate funding instrument this kind of research which is considered crucial for the development of NANO in Austria.

On the level of thematic orientation the rational for establishing the programme has to be seen in a more international context: Nanotechnology as label for a new research field associated with high economic prospectives has been on the agenda of the Austrian policy debate since the early 2000. The motivation to establish a national research programme was driven by the fact that most peer countries (Germany,

Switzerland, UK, Finland) as well as the European Framework Programmes used the label Nanotechnology for framing focused research programmes. Thus the establishment of a national programme was expected to help establishing and strengthening a national research community in specific fields in order to better link to international communities.

The main idea of the programme is to bring together scientists from universities and research institutes with companies as the potential users of the new technologies to be developed. Activities of the Austrian NANO-Initiative range from problem oriented (basic) research to pre-competitive research and include human resources development and Networking measures. The initiative consists of 4 programme action lines:

1. Research and Technology Development Project Clusters: large-scale research project clusters, selected by international peers in competitive calls for proposals.

2. Networks and Confidence Building: open calls for exploratory projects, information/awareness events or network activities.

3. Training and Education Measures: training and education measures, is implemented in collaboration with the specific programme "Forschung macht Schule", which aims at attracting girls and boy to careers in research

4. Transnational Projects (within ERA-Networks): transnational projects, is implemented in the context of ERA-Networks together with other funding programmes from different European countries and funds international R&D projects in competitive calls for proposals

An interim evaluation has been performed in 2006. All in all, the evaluators confirmed that the NANO Initiative has managed to make substantial progress towards its objectives. The programme was perceived well by the community as it provides attractive funding conditions for longer term collaborative activities. The application procedures however seem highly complex and tricky to work with. Decision times are too long. Industry involvement has not been sufficient: most project clusters were clearly science driven. Management structures were considered too complex. All in all, the intended mobilisation of the NANO community has been successful.

The evaluators recommended to continue supporting NANO-research through a specific programme in order to ultimately reach the economic goals, i.e. industrial applications. They also recommended simplifying funding guidelines and the programme management.

4.3.1.2 BETA

BETA is a programme focused on public contracts for R&D, which are carried out to serve the needs of the public administration (especially of the ministries and other civil services that have no own budget chapter on R&D). The programme shell meet the needs of the Czech Mining Office, the Czech Office for Surveying, Mapping and Cadastre, the Ministry of Transport, the Ministry of Labour and Social Affairs, the Ministry for Regional Development, the Ministry of Internal Affairs, the Ministry of Foreign Affairs, the Ministry of Environment and the state Office for Nuclear Safety.

The programme aims to improve current practices, methodologies, regulatory mechanisms, supervisory activities of the above mentioned civil services. The programme supports the creation of various models, in particular, amendments of laws and strategies for the current state policy.

The expected results should propose methods for evaluating the effectiveness of particular state policies and strategies to obtain feedback and forming the basis for future policy direction in order to improve state administration and the efficient allocation of public funds.

Each of the above mentioned civil services has identified its needs and objectives during the preparation phase of the programme. These objectives are specific to individual civil service and form the specific objectives of the programme. R&D needs of the civil services will be further specified in the calls, which will be announced every year until 2015.

In terms of beneficiaries it is expected that 90% stem from research institutions. A considerable share of research institutions is expected to be private research institutes (35%)

4.3.1.3 OMEGA

OMEGA is a programme of public competition supporting applied socio-economic research in a broad sense. The programme is approved for the period 2012 – 2016. Its budget is much smaller, only a little over 2 million EUR for the first year. Focus is placed on:

- Increase the efficiency of public policy in the CR at all levels.
- Formulate priorities of policy for regional development
- Strengthen the position of CR in the European Union in the ongoing European integration process.
- Identify the causes and consequences of the ongoing socio-economic and environmental phenomena, the formulation of priorities, measures and instruments to improve the quality of life in the CR.
- Optimize state interventions and reduce their negative impact on economic and social development in the CR and the quality of the environment.
- Increase the competitiveness of Czech economy in the European and international context.
- Increase the efficiency of the education system in the CR.
- Set priorities and social policy measures to address social inequalities, poverty and social exclusion of certain groups.
- Reduce negative impacts of demographic development

The programme is complementary to the programme National and Cultural Identity – NAKI operated by the Ministry of Culture, and targets mainly universities and public and private research organisations (80%)

4.3.1.4 Technology Agency - Competence Centres Programme

The Competence Centre programme is a new programme of the Technology Agency, which aims at the establishment and operation of centres of research, development and innovation in advanced industries with high application potential and prospects for a substantial contribution to increasing the competitiveness of the Czech Republic.

The programme is approved for the period from 2012 to 2019. The total budget amounts to 6 billion CZK for the whole period. Two-stage calls of this programme will be launched in 2011 (spring), 2013 and 2015.

The main objectives of the programme show that the programme focuses on several bottlenecks of the Czech R&D innovation system. Its main aims are to:

- Strengthen the long term cooperation between public research organisations and private sector
- Create strategic partnership of public research and industry in order to successfully transform R&D results into innovation
- Strengthen the interdisciplinary R&D activities

- Create conditions for human resources development (focus on young researchers) and mobility of researchers between public research and industry

Although the programme has the word "centre" in it, the "centres" are actually virtual, and no single location or common infrastructure will be funded by the programme. Overall, it is estimated that around 30 centres containing at least 3 enterprises and one public research organization will be funded.

As regards the financing of the Competence Centre programme, the consortium has to ensure 30 % co-financing from private resources. Aid intensities will be calculated for single participant in the consortium based on State aid rules (Community Framework).

As expressed by the Technology Agency, the competence centre programme is seen to be the real strategic programme of the Technology Agency. It is about to replace the research centres 1M, which have been funded by the Ministry of Education, Youth and Sports throughout 2005-2011. The Technology Agency expects that consortia out of the 1M programme, as well in the future from the Regional R&D centres are going to apply for this programme. Main differences between the two programmes are provided in the following table.

Table 14: The research centres 1M and the Centres of competence

	Research centres 1M	**Centres of competence**
Applicants	Consortia (no limits)	Consortia (at least 1 public research organisation and 3 independent enterprises) or Companies established by at least 1 public research organisation and 3 independent enterprises)
Funding rate	up to 90 %	up to 70 %
Expected results	applied results, however also publications are accepted	at least one applied result
Selection criteria	past research results of applicants were stressed (weight 25 %)	emphasis on strategic research agenda (research plan), organization structure of the proposed centre and potential for successful implementation (commercialization) of research results
Evaluation	no explicit framework for mid-term and ex-post evaluation in the programme	emphasis put on mid-term evaluation (after 4 years), ex post evaluation and evaluation of impact of particular projects (centers) 3 years after the projects finish
Collaboration	**no explicit privilege**	**effective collaboration according to the Framework is privileged by a higher funding rate (up to 70 %)**

4.3.2 The Czech Science Foundation

The Czech Science Foundation (CSF) represents the main body on the Czech R&D scene that provides project-based funding of a bottom-up type (i.e. classic basic research types of grants driven by the intentions of applicants). It was established in 1993 as an independent institution.

The Czech Science Foundation administers the third largest share of the public R&D budget (behind the Ministry of Education, Youth and Sports and the Ministry of Industry and Trade) which is then distributed through open competitions in the form of grants to researchers for basic research.

The main focus of the Czech Science Foundations' work according to its own definition is to promote progress over the whole range of basic research in the Czech Republic. The main function of the Czech Science Foundation is to provide, on the basis of

public tender, financial support for research projects submitted by individuals or organisations. The main source of the funds available is the state budget, but contributions from other sources are also possible.

The Czech Science Foundation has an annual budget of 2 billion CZK (around 8.1% of total annual public R&D budget in 2010) and 98% of its budget goes to project funding. Tenders for proposals are organised on a thematic basis within five thematic areas (technical, natural, medical, social and agricultural sciences). Although the budget foreseen for the Science Foundation is expected to double in the next years, one cannot conclude that R&D financing for excellent basic research activities is going to rise. Taking into account financing from the closed Grant Agency of the Academy, which had about the same instrument portfolio but operated also two thematic programmes, the level of financing is only to increase by a mere 12%.

At present, the Czech Science Foundation provides support via the following funding mechanisms presented in the table below.

Table 15: Funding Schemes of the Czech Science Foundation

	Standard Grant Projects	**Post Doc Grant Projects**	**EUROCORES**	**Bilateral Grants**
Purpose	Disciplinary and interdisciplinary research in all fields of study basic research	Basic research grants for young scientists	To create conditions for financing basic research at a pan-European level	support joint projects allowing participating scientific teams from both countries in international cooperation
Eligibility Criteria	No specific criteria	Early stage researchers with small research teams	Only for funding organizations that are participating in a EUROCORES Programme	scientists of any discipline working at Czech research institution; topic of research is chosen by an applicant
Allocation Criteria	Scientific relevance Quality of staff Peer review Feasibility Availability of R&D infrastructure	Scientific relevance Quality of staff Peer review Feasibility Availability of R&D infrastructure	High scientific quality, novelty, added value, interdisciplinary cutting edge themes	Complementary approach, high scientific quality, novelty, added value
Funding	Max 34 tsd Euros per year for max 5 years	Max 12.560 Euros for max 4 years	Up to 3 years	By sending organisation

In order to replace the Centres of Basic Research Programme, which was operated by the Ministry of Education, Youth and Sports, the Czech Science Foundation will additionally set up a programme called “Projects Facilitating Excellence in Fundamental Research”. As the “Research Centres 1M”, and the Competence Centre Programme, also the Centres for Basic Research have not been real centres, but indeed co-operative research endeavours, which tried to strengthen the Czech research system, and to contribute to education of young researchers. The new programme continues to promote excellence in basic research, based upon scientific co-operation,

but it has, at least in its planning document, a lower focus on training of human resources.

Hence, basically, the portfolio of instruments of the Czech Science Foundation consists at present of three standard instruments, which can be found almost elsewhere throughout Europe: Grants for individual researchers, grants for young researchers (mainly post-docs), and grants for international co-operation. Completely missing within the portfolio of the Science Foundation are:

- Measures focussing on human resources development, offering opportunities for scientific careers in a co-ordinated manner; (in particular specific programmes for women in research are totally absent from the overall funding portfolio)
- Measures incorporating thematic priorities: programmes in the field of biotechnology, genomics and applied human medicine would allow for strong co-ordination and joint programming with the branch programmes of the ministry of health
- Measures focussing on co-operation between different research institutions in order to achieve critical masses in certain scientific disciplines; here, the centres of basic research, which are planned to be transferred to the Science Foundation in 2012, could be a starting point.
- Measures dealing with targeted and oriented research, which consider research results from the point of view of concrete industrial applications or other societal benefits and require joint thoughts with industry and/or society.

International examples for the tasks to be fulfilled by organisations like the Czech Science Foundation may be provided by the German "Deutsche Forschungsgemeinschaft – DFG", which provides a series of measures focussing on scientific excellence in an international perspective, and training facilities as well as by the Dutch NWO, which incorporates measures dealing with the utilisation of knowledge.

- DFG Research Centres - An instrument to support university's strategic planning: The primary objective of this programme is to establish a limited number of internationally visible and competitive research centres at German universities. The centres should be an important element of a university's strategic planning, serving to enhance the research profile and further research priorities. The DFG's commitment to initially finance and support professorships will facilitate the desired concentration of excellent scientists, resources and expertise at the university. The universities are expected to continue funding the professorships following a defined time period.
- DFG Research Training Groups - A measure to promote young researchers: Research Training Groups are established by universities to promote young researchers. They are funded by the DFG for a period of up to nine years. Their key emphasis is on the qualification of doctoral researchers within the framework of a focused research programme and a structured training strategy.
- NOW: Advancing knowledge utilisation: The policy for encouraging knowledge utilisation has various elements. NWO facilitates the awareness of researchers so that third parties can possibly use their research results and can pay due attention to knowledge utilisation. On top of this NWO is introducing grants that must facilitate the interaction between researchers and potential users of knowledge.

4.3.3 The Ministry of Industry and Trade

The Ministry of Industry and Trade (MIT) is a central body of state administration for national industrial policy, trade policy, foreign economic policy, power engineering, gas engineering, treatment of oil, natural gas, solid fuels, exploitation of mineral resources, for a range of industries, foreign trade, SME-related issues, and also for technical standardisation, industrial research and technology development (INNO

Policy Trendchart 2008). Hence, the ministry is responsible for all industrial R&D support and is the main body providing public support to private R&D (competitive grants for private sector and collaborative grants between public and private sectors).

The Ministry of Industry and Trade is the second biggest funder of competitive R&D and this funding is almost exclusively based on research programmes. Additionally, the ministry is the management authority of the Operational Programme Enterprise and Innovation (2007–2013), for which the operational management of calls has been transferred to the funding Agency CzechInvest.

The Ministry of Industry and Trade has launched its new programme TIP in 2009. The programme has replaced the programmes TANDEM and IMPULS. The main aim of TIP is to support R&D projects which lead to a more efficient, environmentally friendlier, safer and more flexible production. The programme is organised in 3 sub-programmes:[17]

- *New Materials and Products:* Applied R&D&I focused on the development of new competitive materials, as well as on new or improved industrial products and equipment (testing, prototypes, demonstrators). The projects are expected to focus on future market needs, prove the sustainability of their resources, and respect environmental, energy and social factors.
- *New Advanced Technologies:* The aim is to improve the competitiveness of the Czech industry by an enhancement of their efficiency in relation to the internationally accepted values of precision, quality and safety, speed of delivery, cost efficiency, and environmental friendliness. Projects should focus on technologies with multiple application fields, multidisciplinary technologies, biotechnologies, nanotechnologies, etc.
- *New Information & Controlling Systems:* Applied research and experimental development that allows for more cost efficient, environmental-friendly, flexible, safer and faster production processes. Funding is depending on the possibilities for implementation of the results (plan), the transfer of knowledge (i.e. the results of the applied research & experimental development project) into practice and the usability of the results by enterprises active in different market sectors and SMEs.

Key characteristics of the programme are its output orientation, which concludes that every project has to result in at least one of the following outputs: patent, pilot, proven technology, functioning model, design, prototype, "utility model", applied certified methodology, software.

Overall, the TIP programme, operated by the Ministry of Industry and Trade may be considered as a clear step back from the programmes TANDEM and IMPULS, which have ceased its funding activities.

TANDEM and IMPULS were main funding schemes for science-industry collaboration on a project basis. A condition for financing was to secure that results of the projects will be further developed so that they are finally transferred in new products, technologies and materials. Both programmes were considered to be successful policy measures, at least in terms of demand.

The TIP programme, has somewhat incorporated a stronger sector oriented focus on research for New Materials and Products, New Advanced Technologies, and New Information & Controlling Systems, and thereby resembles to some extent the orientation of ALFA, but it completely ignores that systemic challenges may be integrated in a programme design.

[17] Based on the description for the call in 2011

4.3.4 The Ministry of Education Youth and Sports

The Ministry of Education, Youth and Sports (MEYS), has been a major provider of R&D policy in the past, as it administered i.e. two programmes of so called 'R&D Centres', 1 for more applied oriented research and one for more basic oriented research activities. Both programmes are being replaced by new programmes of the Czech Science Foundation (Starting in 2012) and the Technology Agency (Competence Centre programmes). In addition the ministry managed the largest thematic oriented R&D programmes "The National Research Programmes I +II", for which a third series of this programme was foreseen but had never been launched.

The responsibility of MEYS is nowadays limited to the responsibility for participation of the Czech Republic in multilateral and bilateral international cooperation (7th Framework Programme, COST, EUREKA, etc.) and for the participation of the Czech Republic in international R&D organisations (European Science Foundation, etc.). In addition, the Ministry is responsible for the implementation of the Operational Programme Research and Development for Innovation (OPRDI) and, as a consequence, the co-ordination of the large R&D infrastructures emerging from this programme.

For these infrastructures, the ministry is responsible for the inter-sectoral co-ordination and financing, and an "Inter-sectoral concept of support to large R&D infrastructures" was being set up. The main aim of this concept is to create conditions for the implementation of the Reform of the system of research, development and innovation of the Czech Republic in the field of large infrastructures for R&D, through the use of public funds (national financial resources, operational programmes and other EU sources) and private funds.

The aim of the concept is to create conditions for financially sustainable development (construction or reconstruction and function) of required number of large infrastructures, which will be heavily involved in cooperation with major European infrastructures. Research results generated in these infrastructures shall be used for innovations.

Large infrastructures for research, development and innovation mean unique research facilities (including its acquisition, investments and ensuring their activities), which are necessary for comprehensive R&D activities with high technological and financial intensity. These facilities are approved by government and administered by a particular research institution. Infrastructure may be used by multiple research institutions.

The large infrastructures are being created in the course of the OP-RDI are:

- The European Centres of Excellence
- The Regional R&D Centres

An analysis of the large infrastructures is provided in the section on the European Structural Funds measures.

4.3.5 Sector specific R&D Programmes

Sector specific R&D programmes are provided by the Ministry of Culture, the Ministry of Interior Affair, the Ministry of Defence, the Ministry of Agriculture, and the Ministry of Health:

- The Ministry of Culture funds research related to the national and cultural identity and has an inter-departmental concept which seeks to integrate research falling under other support providers.
- The Ministry for Interior Affairs is responsible for the security research agenda. Thereby, the ministry bundles competencies of R&D activities of the Ministry of Justice, the State Office for Nuclear Safety, and the Czech Mining Office.
- The Ministry of Defence is in charge of the development of applied defence R&D.

- The Ministry of Health is responsible for the development of the health research programme.
- The Ministry of Agriculture is responsible for the agricultural research agenda.

The sectoral R&D programmes are in essence multi-annual thematic research programmes, with competitive calls for proposals for funding of research activities in the given field, but at the same time, are used as a source of institutional funding for some selected research institutes controlled by the given ministries and also as a means of funding policy research for the needs of the ministry. The budgets of these ministries therefore represent a mix of instruments (ranging from project funding, through policy research for the use of the ministry / procurement to institutional funding of given research institutes).

As can be seen in the overview table on the national R&D programme portfolio, the targeted R&D financing for all these thematic oriented R&D programmes will account for about 18% of total targeted R&D financing in 2012, of which the largest shares are for the departmental programme of the Ministry of Health (6%) and Security Research for the needs of the state.

The sectoral branch programmes all tackle areas of strategic national importance for the functioning of the state, and the direct well-being of the citizens. Within the operational objectives of the sectoral R&D programmes, the programmes do not only focus on achievement of applied R&D results, but emphasis is also put on programme related issues such as:

- The integration of international collaboration in R&D (Ministry of Agriculture, Ministry of Defence, Ministry of Interior)
- Inter-departmental co-operation
- Co-operation with the Czech Science Foundation for increasing quality of R&D projects (only explicit in the strategy of the Ministry of Health)
- Research-education collaboration (explicit in the strategy of the Ministry of Agriculture)
- Communication with stakeholders and Users

The specific Final report - 2 on R&D governance already acknowledges that the strategies are geared towards an improved coordination of the research funding as well as an improved response of research funded to the needs of user communities beyond the traditional sphere – and that the level of co-operation between the organisations is unusually high.

In the light of international experience, the portfolio of the sectoral branch programmes, however fails – by nature of its specific departmental orientation - to address thematic priorities of strategic importance related to industrial restructuring of the economy, and progressing towards ERA.

An illustrative example of such an R&D programme may be provided by the concept of “Strategic research in strategic growth technologies - Strategisk forskning inden for strategiske vækstteknologier” of the Danish Agency for Science, Technology and Innovation, which focuses on the areas of Nano-Technology, biotechnology and ICT.

Denmark: Strategic research in strategic growth technologies

A starting point of the programme was that Denmark is dependent on the use of new knowledge and competence for securing the further development of the society. Future oriented research is here a key issue. As many other countries have strengthened the research input in nanotechnology, biotechnology and ICT, and Denmark feared lagging behind in the application of the scientific results if no national actions were taken. The development in all three technology areas is seen as important for several industrial branches in Denmark, where Danish industry traditionally has a strong position. The programme is focussing on synergetic effects by supporting research at the interfaces between these technologies.

Therefore, the programme aims to strengthen and contribute to new research at the interface between nanotechnology, biotechnology and information and communication technology, in order to making possible international breakthrough and/or important social utility value, including economic relevance. Key priorities are that projects are based on near collaboration between firms and public research groups and across established knowledge areas. In terms of instruments, the programme provides:

Strategic research projects: The focus of strategic research projects is to find solutions to a relatively restricted set of research issues. The projects must promote the research institutions' and the public and private-sector parties' development of interdisciplinary expertise with purpose of promoting innovation among recipients in the public and private sectors. The projects are expected to engage in user involvement and collaboration with international research environments and individual researchers. The projects are required to create a basis for subsequent international positions of strength.

Strategic research centres: Strategic research centres are employed as an instrument where there is a need for environments of a high scientific standard with a keen focus on developing solutions to complex problems in order to serve a comprehensive aim, where the solutions will have great strategic significance and great societal and commercial potential.

Strategic research alliances: A strategic research alliance is a research initiative devoted to finding solutions to a key challenge, where a major future need for research exists. The premise for this instrument is that research in the area is scattered across small-scale environments and because of this is a need to create alliances between existing Danish research environments or between Danish and international research environments with the view to establish stronger research alliances at a high scientific level.

A grant for a strategic research project is minimum DKK 10 million and has duration of three to five years.

4.3.6 Key findings on the national programme portfolio in the light of international experiences

The analyses have shown that in 2012 the national R&D programme portfolio will mainly consist of the standard programmes of the Czech Science Foundation, the industry oriented TIP programme, the ALFA programme of the Technology Agency, various branch programmes, and a number of small international co-operation programmes, which are managed by the Ministry of Education, Youth and Sports. In addition a Competence Centre programme and a Centres of Excellence programme are currently being in an implementation phase and will fully operate until 2012/2013.

Except from the ALFA programme and the programmes of the branch ministries, the R&D programme portfolio strongly leans towards a provision of generic, bottom-up

oriented R&D support programmes. By large, these programmes do not incorporate systemic oriented R&D financing approaches that deal with specific challenges of the National Innovation System, such as the strengthening of Science-Industry-Linkages, or the provision of qualified human resources.

The portfolio of instruments of the Czech Science Foundation only consists of standard grant schemes, which can be found almost elsewhere throughout Europe and does (at present) not deliver mechanisms which allow for capacity building at the level of research organisations and at the level of research themes (i.e. networks of research actors at different institutions. Furthermore, an integrated approach geared towards the supply of new, highly skilled young scientists is missing within the range of activities of the Czech Science Foundation.

The TIP programme of the Ministry of Industry and Trade does not provide sufficient incentives for science-industry collaborations, and its thematic steering is limited towards sectors of national strengths. The key characteristics of the programme are its output orientation, which concludes that every project has to result in at least one of the following outputs: patent, pilot, proven technology, functioning model, design, prototype, "utility model", applied certified methodology, software.

The sectoral R&D branch programmes are in essence multi-annual thematic research programmes, which have a stronger systemic oriented approach, coping with a portfolio of activities that include i.e. the integration of international collaboration, inter-departmental co-operation, and co-operation with the Czech Science Foundation for increasing quality of R&D projects (only explicit in the strategy of the Ministry of Health), but the programmes are by nature limited towards their specific area of interest (security, health, defence, culture).

The international examples presented in the chapter have highlighted that the Czech R&D programme portfolio does not incorporate a systemic approach in its policy measures. The priorities outlined in the reform plan and the national R&D strategy are not well incorporated in its financing mechanisms, except from the fact that all programmes have a strong results orientation. In particular missing are programmes which focus on critical themes and issues in order to build up competencies in specific knowledge domains with high levels of growth in terms of scientific output and potential for commercialisation.

Also a coherent approach towards an incorporation of science industry linkages is so far missing, but the Competence Centre Programmes, which aim to strengthen the long term cooperation between public research organisations and the private sector could prepare the field for intensified strategic partnerships of research and industry. The programme should also serve to create conditions for human resources development (focus on young researchers) and mobility of researchers between public research and industry. It could therefore serve as a good practice example also for setting up thematic oriented R&D programmes.

4.4 International targeted R&D Funding: The European Structural Funds

In addition to national R&D financing, also the operational programmes of the EU-Structural Funds play an important role regarding targeted R&D funding in the research and innovation system of the Czech Republic. Through the European cohesion policy, the EU strives for balanced economic and social development of all its member states and their regions.

For the programme period of 2007-2013, the Czech Republic has set up two thematic Operational Programmes, which are of particular relevance for the national research and innovation system:

- The Operational Programme Enterprise and Innovation, managed by the Ministry of Industry and Trade
- The Operational Programme Research and Development for Innovation, managed by the Ministry of Education, Youth and Sports.

In addition to these programmes, the thematic Operational Programme Education for Competitiveness, which is managed by the Ministry of Education, Youth and Sports, contains the priority axis tertiary education, research and development, and pays attention to the development of human resources in R&D. The priority axis in particular seeks to address:

- Innovation of study programmes in accordance with requirements for a knowledge-based economy and labour market needs, bringing in specialists from both business and abroad during the creation and implementation of innovated educational programmes,
- Further education of teachers, management and administrative staff at tertiary professional schools, further specific professional education of research and development employees, further education of research and development employees in the area of R&D management,
- Support of inter-sectorial mobility, especially mobility between research institutions and the private sector.

A key issue of the above mentioned programmes is that the City of Prague is excluded from these Operational Programmes due to EU structural funds rules. Nevertheless, a considerably smaller operational programmes for the city of Prague have been set up.

The research and innovation relevant parts of the operational programmes for the city of Prague, in which in the priority axis innovation and enterprise of the programme 'Competitiveness' the amount of EUR 96.7 million has been reserved for the development of the innovative infrastructure (science parks, incubators, innovation centres, centres of excellence), establishment of partnership relations between research institutions etc. In addition, support of favourable business environment (EUR 11.9 million) is provided by support of activities aimed at development of innovation capacities of the existing enterprises, stimulation of new forms of cooperation between firms, public entities and the academic sector.

In the Prague Adaptability Programme, the amount of EUR 41.4 million has been reserved for training and education measures, which seek to provide support among others for the education and qualification systems in firms, support of building capacities of human resources in research and development, education and consulting upon establishment of new firms.

The Operational Programme Enterprise and Innovation and the Operational Programme Research and Development for Innovation each consist of different priority axis, which are translated into specific programmes.

In the following, we analyse the key measures for the promotion of research, development and innovation in the OP Enterprise and Innovation and the OP Research and Development for Innovation, based upon the relevant information from the information site of the EU-Structural Funds in the Czech Republic, information provided by the Ministry of Education, Youth and Sports and the Ministry of Industry and Trade, and interviews.

4.4.1 The Operational Programme Enterprise and Innovation (OPEI)

The operational programme Enterprise and Innovation is focused on support for development of the entrepreneurial environment and support for implementation of research and development results into entrepreneurial practice. The programme aims to support in particular:

- The establishment of new and the development of existing companies
- The development of the innovation potential of the participating companies
- The adaption of the newest technologies and renewable sources of energy
- The improvement of quality of R&D infrastructure and services for business activities

- The establishment of cooperation between enterprises and the scientific-research institutions.

The main beneficiaries of the OPEI are business enterprises, but also research institutions, universities and other R&D active organisations (non-profit organisations, natural persons) may apply for support. The activities of OPEI are distributed among **7 priority axes**, which are further specified and broken down into specific action lines or areas of support.

Table 16 provides a short description of the priority axes, the foreseen actions and programmes, and the level of financing provided in the period 2007-2013. The programme supports an array of support measures including the development of research infrastructures (technology parks and technology transfer centres), co-operation among industry members (technology platforms and clusters).

Of key interest, for the development of the National Innovation System, are in particular the programmes *Innovation*, *Potential*, *Cooperation*, and *Prosperity*:

- The programme *Prosperity*, with a total financing volume of 429 Mio EUR seeks to support the creation and further development of infrastructure required for technological development and innovation via the **creation of science parks, technology transfer centres and business incubators**.
- The programme *Co-operation*, with a total financing volume of 190 Mio Euro, provides support for the **creation of cooperative sectoral associations, clusters, and technology platforms.** Furthermore, the programme *Cooperation* seeks to provide incentives for clustering of firms to branches, and the development of joint technology platforms.
- The programme *Innovation*, supports innovation activities of enterprises in terms of product-innovations and process-innovations. Organisational innovations and marketing-innovations are only supported for SMEs. The programme does not support any form of research and development activities. The PRO-INNO Europe description of the programme states, that the programme enables Czech companies **to acquire the modern machinery, equipment, know-how and licences necessary for the implementation of innovations'**. In addition to innovation support, the programme also finances activities in relation to technology transfer and intellectual property rights.
- The programme *Potential*, for which about 40% of the priority axis total funding are reserved, finances by large the purchase of machinery and other facilities, buildings, land and long-term intangible assets such as the acquisition of licences. Furthermore consultancy services are rewarded.

Within Prosperity, financing of facilities is strongly oriented towards the acquisition of machinery and other facilities, building, land, and the acquisition of licenses and know-how, whereas the development of own technologies and concrete innovative activities are missing. Furthermore, technology transfer offices (TTO) are implemented from this program. They should be the main department for R&D commercialization within the research organization. However, researchers often implement transfer of technologies or knowledge alone and they do not use the TTO services. Research organizations have therefore no information on successful transfers of technologies and meanwhile they lose finances because they cannot intervene in the license agreements and distribution of revenues from R&D results commercialization.

The parts of the Operational Programme Enterprise and Industry which are more focused on concrete activities are hence restricted to the Cooperation programme, which seeks to structure and align the needs of industry in terms of creating joint innovation activities and (partly) research agendas via the use of Technology Platforms and Clusters.

Table 16: OPEI – Priority Axis and Programmes

Priority Axis	Foreseen Actions	Total Funding (Mio EUR)
Establishment of Firms: Support of new entrepreneurs, start-ups and spin-offs	*Programme: START* Financing of entrepreneurial start-up and spin-off projects with innovation potential	79.1
Development of Firms: Instruments to support SMEs and instruments which support upgrading of ICT technologies in manufacturing and services sector	*Programme: Guarantee* Facilitation of innovative projects of SMEs through the use of bank guarantees *Programme: Progress* Support for dynamically developing SMEs in the form of subsidiary loans *Programme: ICT Business and Support Services* Support for acquisition of new technological equipment with higher technical usability in SMEs. *Programme: ICT in Manufacturing Companies* Grants for introduction and expansion of ICT technologies in enterprises and use of related services.	243
Effective Energy Energy saving and renewable sources of energy	*Programme: Eco-Energy* Implementation of technologies which save energy and expanded use of renewable energy sources	121.6
Innovation Increase of innovation performance in firms Increase of capacities to perform R&D in firms	*Programme: Innovation* Support for innovation projects in enterprises; support for activities aimed at IPR protection. *Programme: Potential* Support for new methods of organizing corporate processes and cooperation with firms and public institutions, establishment and extension of research infrastructure at business enterprises.	680.2
Environment for Enterprise and Innovation Co-operation platforms Infrastructure for human resources development Infrastructure for enterprises	*Programme: Cooperation* Support for cluster development, technology platforms, cooperative branch groupings (intra business) *Programme: Prosperity* Support for creation of science and technology parks, and technology transfer centres *Programme: Training Centres* Support for infrastructure creation aimed at education and development of human resources in businesses *Programme: Real Estate* Support for creation of business property and infrastructure, enterprise zones and brownfield regeneration	1,076.6
Business Development Services	*Programme: Consultancy* Consultancy services for SMEs, development of a national registry of consultants, information services *Programme: Marketing* Support for marketing services regarding entrance of foreign markets, support for participation in	209.5
Technical Assistance	Financing of activities connected with the programme management (wages of employees engaged in the OPEI management, selection of projects, monitoring of projects and of the programme etc.)	89.6

4.4.1.1 The Cluster Programme

In the Czech Republic, the Cluster programme was already launched in the 2004-2006 period of the first Operational Programme. It was aimed at supporting the

establishment and development of communication and cooperation between the business and science-and-research spheres. The programme offered support to cluster initiatives in two phases:

- In the first phase, support was provided for seeking out firms for participation in clusters.
- The second phase consisted in the actual establishment and further development of clusters. In total 25 new legal entities have been established – clusters, and a range of other projects are passing through the mapping phase.

Today, the Clusters are seen to contribute to the development of cooperative groupings consisting of associating firms in a given field, regional authorities, universities, research and other institutions in the region. Typically a cluster builds a formalized legal entity from a minimum of 15 members (including a research institute – either from university or other) to cooperate in joint projects. These clusters are managed by teams of up to 5 persons.

According to the view of the responsible Ministry of Industry and Trade, the Cluster Programme so far managed to establish that industrial partners were brought together and were able find out about common needs and joint actions. **No information could be provided which clusters were actually active in national R&D programmes, and respective overviews about the developments of the clusters are missing within the Ministry or not communicated to the project team.**

Nevertheless, an Evaluation of the Cluster Programme of the first operational programme, provided by the Technology Agency, provides a rather positive picture on the development of the Cluster Programme in the Czech Republic (Technology Centre 2008). The study highlights that the main reasons for the establishment of clusters included the objective to increase the competitiveness of participants and the possibility to join and create joint R&D projects, the ability to share information, and an effective development of human resources. The findings have to be interpreted with caution, because they are based upon 12 responses from cluster managers and not participating firms/entities.

4.4.1.2 The Technology Platform Programme

The Technology Platforms seek to support the establishment and development of cooperating branch groupings at the national level as a tool for developing the competitiveness of the economy and economic growth.

Support for the establishment and development of national technology platforms (TP) in the form of subsidisation of personnel and operating costs. Supported TP activities are those that lead to cooperation between the public and private sectors in the area of research and development in technical fields that are important for the business sphere, creation of strategic documents and implementation thereof, involvement of Czech research institutes and companies in European technology platforms and initiation of research and development projects in the commercial and public spheres.

Until today, 19 projects have been selected for support, and the Czech TPs are currently in the mid of their three-year project duration.

First results of an on-going study on the TPs, show that according to survey results, TPs put much emphasis on science-industry networking, while cooperation with state administration bodies is rather a minor issue. The potential usefulness of the in view of the respondents depends highly upon raising awareness among political leaders about the activities of technology platforms and on mutual dialog of TPs' representatives and the state administration.

The representatives of the TPs see the highest value of technology platforms in development of science-industry links, they are perceived this area of activities should be further dealt with by platforms. However, according to the preliminary results of

the evaluation, the real impact of the platforms is rather overestimated, and so-far activities are mainly restricted towards networking with relatively low results.

4.4.2 The Operational Programme Research and Development for Innovations

With a total financing volume of over 2 billion EUR, the Operating Programme Research and Development for Innovations (OPRDI) is the fourth largest Czech operational programme. As the OPEI, is split into different priority axes and further specified by 'areas of support', which define the scope of supported projects within the different priority axes.

The programme is operated by the Ministry of Education, Youth and Sports and its main beneficiaries are public research institutes and universities carrying out R&D activities.

Table 17 provides an overview about the priority axes and their support measures.

As for the OPEI, the OPRDI contains an array of measures ranging from education and training measures towards the implementation of new R&D infrastructures, in which the European Centres of Excellence and the Regional R&D centres account for the highest shares of funding.

However, despite the high number of activities foreseen within this Operational Programme, the Programme is the one with the most challenging situation as regards its implementation. As announced by Blazek (2010) by the end of 2009 only 4 projects had been approved in OPRDI, and consequently not a single project had been completed and the values of all output and result indicators are equal to zero. It was thereby, the only OP in danger of decommitments at the end of 2010.

Given this indication for caution at the very beginning, progress has been made in the course of the establishment of the two largest priority axes, namely the *European Centres of Excellence* and the *Regional R&D Centres,* which account each for one third of the OPRDI.

Both programmes have a strong focus on the creation of research infrastructures which should ultimately provide research and technological development projects relevant for the market and social-economic development of the Czech Republic, and the needs of the regional industry. Hence both measures are also deemed to foster science industry linkages and to further contribute to the integration of the Czech Republic in the European Research Area.

The "Regional R&D Centres" put emphasis on the practical side of R&D results and on improving institutions that should make research results relevant to users through close cooperative work. The reason for creating this priority axis is the uneven coverage of Czech by R&D institutions that are able to provide results applicable in the business sector. Therefore, this priority axis should provide funds for capacity building of application-oriented research entities with the potential for collaboration with industry. Selection of centres usually corresponds with the regional economic and research specialization, and it is assumed that this specialization of each region will be strongly supported.

Two public tenders in the second priority axis for project proposals have been announced till the end of 2010. The approval has been gained to 19 projects of the regional R&D centres. Many of the project proposals in the second priority axis have not been approved by the EU yet. The approved projects are eligible to source allocated funds until 2015 but many of them will finish in 2013.

The objective of the European Centres of Excellence is the creation of a limited number of centres of excellence, i.e. research centres equipped with high-tech infrastructure with national and international significance. Excellent research results will be aimed at ensuring strategic partnerships with prestigious research institutes, both in the Czech Republic and abroad.

Table 17: OP Research and Development for Innovations

Priority Axis	Foreseen Actions	Total Funding (Mio EUR)
European Centres of Excellence	Reconstruction and extension of R&D capacities or possibly an economically justified construction of new capacities, including the necessary project documentation, acquisition of instrumental, laboratory and information equipment and infrastructure for research, technological development, projects of top R&D relevant for the market and social-economic development of the Czech Republic in the form of a start-up grant that will allow a smooth start and functioning of the new infrastructure, etc.	*685.4*
Regional R&D Centres	Creation and development of quality-equipped R&D workplaces; Reinforcement of their cooperation with the application sector (enterprises, hospitals, etc.) according to the needs of the region.	*685.4*
Commercialisation and Popularisation of R&D	Support of commercialisation of R&D outputs in research institutions, in particular by financing the stage from R&D information up to the stage of the subsequent commercial use (proof of concept stage) and support of the commercialisation system and intellectual ownership protection, including the establishment and development of centres for transfer of technologies by research organisations, etc.	*213*
Infrastructure for University Teaching Connected with Research and Direct Effect on Increase of Human Resources for Research and Development Activities	Investments into the research infrastructure connected with R&D at universities, in particular infrastructure connected with scientific education of students, schoolrooms of teaching laboratories, reconstructions and adjustments of the existing capacities (buildings and equipment), modernisation and extension of the university information infrastructure for research, development and education, etc.	*414*
Technical Assistance	Project and programme monitoring, processing of studies and analyses, programme publicity, support of the ability of potential beneficiaries to draw finances from the program, support of administration of the tools of the OPRDI Communication Plan, development of the absorption capacity, cross-sectional expert information and consultation services, expert specific training, etc.	*72*

Source: National Co-ordination Authority – Structural Funds

Linking Czech R&D teams with leading international research organizations and the European research infrastructure will contribute to the development of human resources in research and attract qualified national and international researchers.

For both Regional R&D centres and the European Centres of Excellence, the evaluation procedure was based on a two-step international peer review procedure and for the operational phase of the programme, performance target contracts have been set up. This was a novelty for the Czech Research system, as for the first time, operational targets for research institutions have been settled. The performance contracts for the centres include key tasks such as the acquisition of external funds, scientific output, international collaborative activities, interactions with industry.

Although the Regional R&D centres and the European Centres of Excellence are currently just in a starting phase, they are likely to have a huge impact on the advancement of the national innovation system. However, scepticism was raised as

regards the medium-term financing of the centres. While co-funding obligations of the Ministry of Education will remain in place after the termination of the Operational Programmes, both types of Centres are likely to play a considerable role as applicants for national R&D programmes, including the Competence Centre Programme.

4.4.3 Key Findings on the Operational Programmes

The portfolio of financing instruments of the Operational Programmes *Enterprise and Innovation* and *Research and Development for Innovation* complement the national R&D programme portfolio by large.

The Portfolio of support within the Operational Programmes Enterprise and Innovation put a strong focus on setting up new infrastructures for research, development and innovation (Science and Technology Parks), whereas the national R&D programmes focus more on the provision of project financing measures, which support labour costs. In addition the OPEI also provides forms of support that can be considered as being in line with modern EU approaches of innovation policy, as support for spin-off firms, protection of IPR, business angels, clusters and technology platforms, cooperation between firms and R&D institutions.

Measures which seek to strengthen inter-industry interactions and science-industry interactions science are to be found within the Cluster Programme and the Technology Platform Programme. The Cluster Programme has achieved to develop cooperative groupings consisting of associating firms in a given field, regional authorities, universities, research and other institutions in the region, but at present no valid information as regards their R&D activity portfolio exists. The Technology Platforms have raised some awareness among the participating groups of companies but according to the preliminary results of the evaluation, the real impact of the platforms is rather overestimated, and so-far activities are mainly restricted towards networking with relatively low results.

The Innovation part of the OPEI should allow firms to introduce product- and process innovations; these however, shall mainly be achieved by acquisition of machinery, modern-equipment and purchase of licences. No research activities are financed within this type of activity. Also the Potential Programme, for which about 40% of the priority axis total funding are reserved, finances in large part the purchase of machinery and other facilities, buildings, land and long-term intangible assets such as the acquisition of licences.

Hence, a recent evaluation of the Operational Programme raised criticism as regards the OPEI: “greater attention (and resources) should have been devoted to the development of own technologies instead of simply the purchase of new technology. Secondly, other ‘state of the art’ forms of support might have been explicitly supported, like “proof of concept funds” or “innovation vouchers” (Blazek 2010).

Within the *Operational Programme Research and Development for Innovation*, a strong focus is put on the financing of research infrastructures too. The *European Centres of Excellence* and the *Regional R&D Centres* aim at the development of new research workplaces and at increasing the capacity via setting up research infrastructure and equipping the research workplaces with modern technologies.

As indicated in the chapter, the main risk associated with the OPRDI is that the implementation of the OPRDI proceeds at a very slow pace. However, as the conceptualisation of the European Centres of Excellence and the Regional R&D centres followed international good practice they are likely to have a huge impact on the Czech R&D system in the medium term future. Both programmes tackle critical issues of the Czech Research system which will be monitored through the use of performance contracts which include key parameters such as the acquisition of external funds, scientific output, international collaborative activities and interactions with industry.

5. Conclusions and Recommendations

The Czech Republic is among the most R&D active new EU member states and has considerably increased its R&D investments in the past 15 years. Although an R&D intensity of 1.53% is still far from reaching EU average levels, the Czech Republic has a R&D funding and performance structure which allows to progress towards a new phase of research and innovation policy in order to accelerate progress towards a knowledge intensive economy. Based upon the analyses in this report, we provide recommendations to contribute to this objective.

A precondition to facilitate knowledge driven growth in the long term, is to continue to invest in research. The Czech Republic has set itself the goal, to increase public R&D investments to 1% of GDP by 2020. **The Czech Republic should continue to pursue this goal by increasing public R&D investments on an annual basis because at present (2008) only 2% of total government outlays were reserved for research expenditures.** Since 2004, this share has increased only marginally.

The government also sets priorities, incentives and funding conditions in order to assure that progress towards a knowledge based economy can be assured. For the purpose of contributing to this aim, the study has taken a deeper look into the R&D expenditure structure and the R&D financing structure, including programmes and priorities. Based upon these analyses, the conclusions and recommendations are as follows:

- As regards the level of project funding, we conclude that that **the ratio of project funding versus institutional funding is already high in international comparison**. It provides the public authorities enough room for strategic steering. **We therefore see no need to further expand this share of funding.**
- We witnessed that the research and innovation policy approach in terms of programmes and measures follows a too narrow concept as regards the purpose of R&D programmes. **The output orientation of the programmes in place goes too far.** Applied and more industry oriented R&D programmes should be designed as measures to increase competencies of actors (increase the stock of useful knowledge), to define joint research agendas between industry and academia, and to allow for training of R&D personnel and knowledge transfer.
- In order to address bottlenecks of the Czech Innovation system, such as low interactions of the research community with the industrial community **we recommend enhancing the present portfolio of R&D instruments by accompanying measures that are embedded within the R&D programmes.** Awareness measures, training opportunities, and networking activities need to be incorporated into R&D programmes of the Czech Republic. This holds in particular true for the programme portfolio of the Czech Science Foundation and industrial oriented R&D programmes. The programme **TIP should be substituted by a more advanced programme that incorporates training measures, exchange schemes with the academic sphere, and offers tailored approaches for SMEs and larger companies.**
- **The Czech R&D policy relies upon a funding system, in which thematic priorities are only defined in a very loose manner**. All existing thematic programmes focus exclusively on themes which concern national interests of the state and its citizens, **but they do not encompass measures which seek to align research activities of industry and science around fields of**

strategic interest. This holds in particular true for the whole ICT research sector, which also is the largest thematic area addressed by the EU Framework Programmes and it also concerns the Biotechnology and Life Sciences arena, and the programmes relating to New Materials and production processes. **We therefore recommend setting up a limited number of thematic oriented R&D programmes**, in which a potential for increased competitiveness for industry exists, which can only be nurtured through a strengthened engagement with the academic sector.

- **For the public sector (higher education and government sector) and the private sector we recommend introducing measures which aim at an increased cooperation between them.** Types of measures may include incentives for Higher Education Organisations (i.e. formulae based funding systems which take into account private R&D financing), individuals (boni for acquisition of private R&D funds), and firms (i.e. tax deductions for R&D services purchased from Higher Education Sector). A wide array of programmatic measures, in particular geared towards the industry relevant engineering field, should be established in order to increase co-operation of business enterprises and higher education, in order to increase the long-term potential for additional co-financing (see Work Package Report on Science-Industry Linkages).
- **In the Higher Education Sector, Engineering should be a field in which public policies seek to considerably increase interactions with the Business Enterprise Sector** due to its relevance, maturity in both sectors, and the potential for increased levels of co-financing.
- For the Business Enterprise Sector, **we recommend launching public efforts which seek to considerable increase innovation capacities in existing, medium-high and high-technology sectors, such as the automotive industry, machinery and equipment, electric machinery and apparatus, chemicals and chemical products, medical, precision and optical instruments.** Co-operations between the Business Enterprise Sector and the Public R&D Sector should constitute a core element of these industrial R&D policies.
- **As the Social Sciences and the Humanities are not covered by thematic oriented R&D programmes and restricted to response-mode funding of the Science Foundation, we recommend establishing measures, which allow building up critical mass based upon excellence in the field**.

The study also had a closer look at the EU structural funds. The Operational Programmes will only have an impact in the medium term, and it is too early to make a final assessment. Nevertheless, the following findings can be summarised:

- We witnessed that the Cluster Programme has achieved to develop cooperative groupings consisting of associating firms in a given field, regional authorities, universities, research and other institutions in the region, but at present no valid information as regards their R&D activity portfolio exists.
- The Technology Platforms have raised some awareness among the participating groups of companies but the real impact of the platforms is rather overestimated. So-far activities are mainly restricted towards networking with relatively low results.
- The European Centres of Excellence and the Regional R&D Centres aim at the development of new research workplaces and at increasing the capacity via setting up research infrastructure and equipping the research workplaces with modern technologies. The main risk associated with the programme was its slow implementation. However, as the conceptualisation of the European Centres of Excellence and the Regional R&D centres followed international good practice

they are likely to have a huge impact on the Czech R&D system in the medium term future. Both programmes tackle critical issues of the Czech Research system which will be monitored through the use of performance contracts which include key parameters such as the acquisition of external funds, scientific output, international collaborative activities and interactions with industry.

- We **recommend that the core elements of the Operational Programmes, in particular the Cluster Programme of OPEI, the European Centres of Excellence and the Regional R&D centres are subject to specific evaluations, in which the progress achieved in the implementation is assessed.** Particular attention should be paid to the involvement of Clusters and Regional R&D centres in the national R&D programmes, and to the visibility of the European Centres of Excellence in the European Framework Programmes.

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Erik Arnold
Technopolis Limited
Managing Director