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

Assessment of Public R&D Expenditures in the Czech Republic

Annex 1 to the Second Interim Report

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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 deals with 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 the planned budget investments. In addition to the national R&D financing, also a description of themes and priorities of the Operational Programmes of the EU Structural Funds are provided. Note that the analyses on the programme portfolio, in particular on the Operational Programmes, are currently still on-going. Hence, all presentations in this respect are preliminary.

1. R&D Financing in the Czech Republic

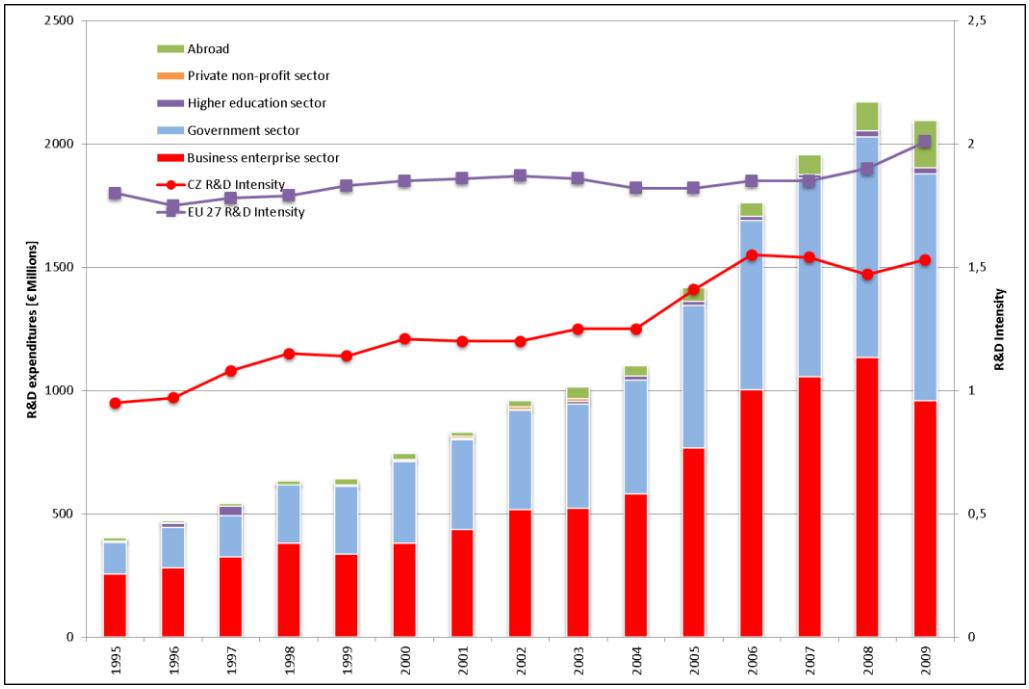
In this section we describe the current trends in R&D spending in the Czech Republic and assess whether these are comparable with EU investment levels. The main aim is to position the Czech Republic in terms of R&D investment levels and to find out whether bottlenecks and challenges in terms of overall research funding and performance of difference 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.

1.1 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 compound 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: Compound Annual Growth Rates in R&D (1995, 2009) by sources of funding

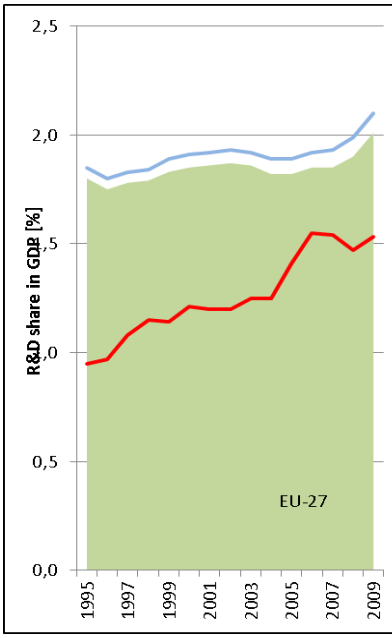
	Total	BERD	GOV	HERD	PNP	Abroad	R&D Ratio
Czech Republic	12.5%	9.9%	15.0%	13.3%	-7.0%	20.9%	3.5%
EU-27 (2008, R&D quota 2009)	4.9%	5.3%	3.7%	8.9%	7.8%	7.7%	0.8%

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. Hence, 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.

1.2 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, State 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].

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 are associated with them[3].

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[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 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.

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

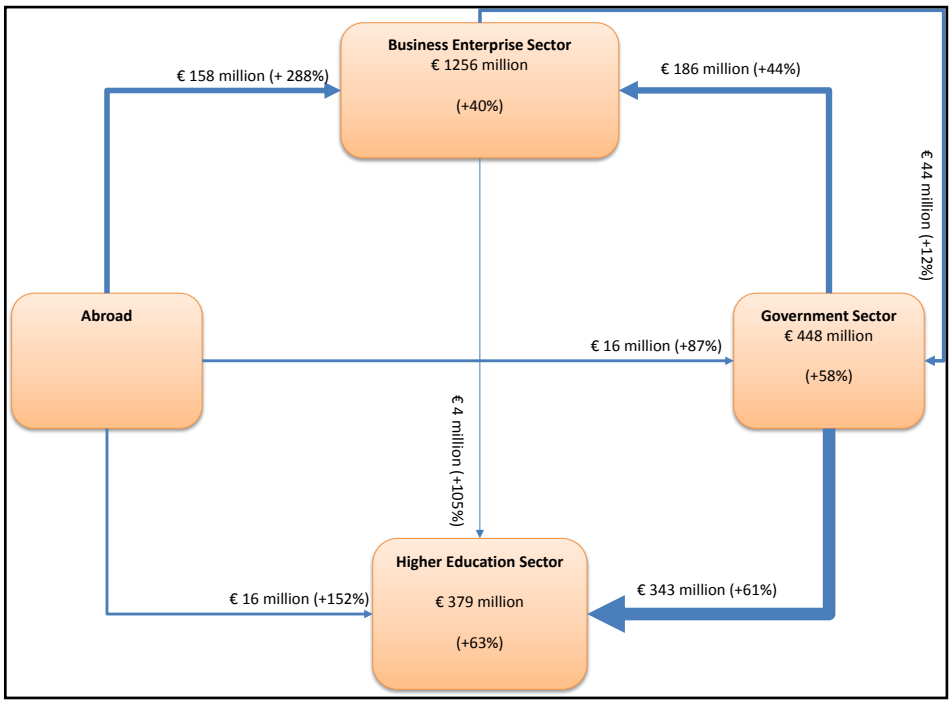
The table above provides information of the entire R&D expenditures for 2009 by sector of performance and source of funding.

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).

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. Unfortunately, official R&D statistics does not provide a repartition of the financing flows to different single institutes of the Government Sector, so we cannot comment whether this share of financing stems from the activities of one single institute. 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. 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.

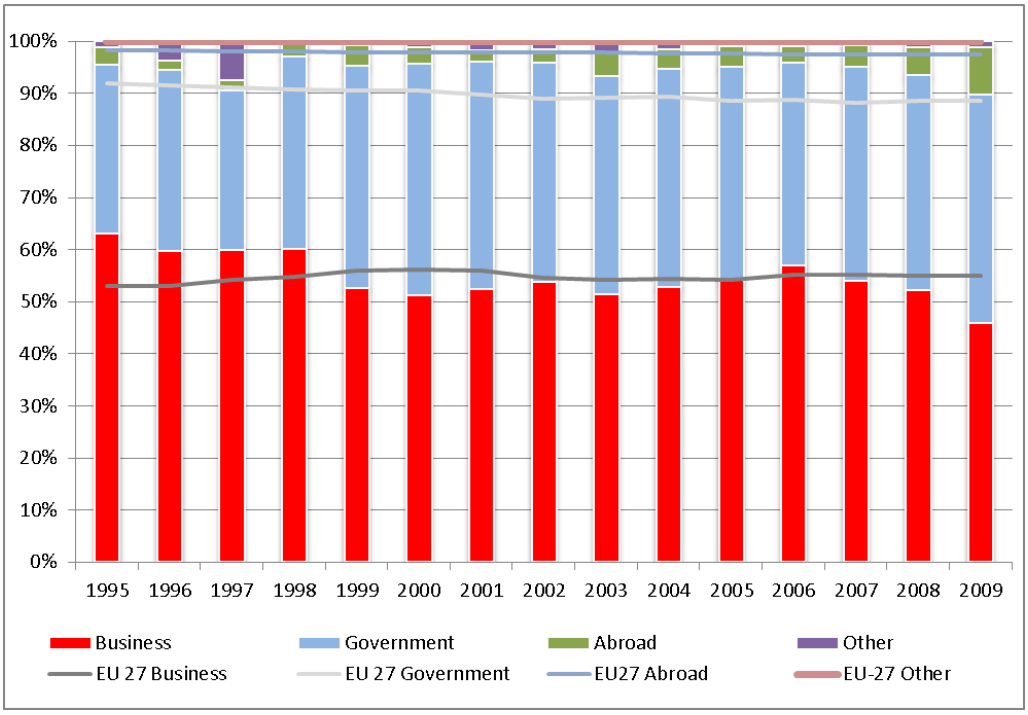
The second important financier of research and development is the Government Sector. Public Sector R&D financing is accounting for 44% of total R&D activities in the Czech Republic. The main profiteers of public R&D financing are public sector R&D institutions (predominantly the Academy of Sciences) 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 Public Sector R&D institutions increased

by 65%. The ratio of business R&D funding (186 million EUR) to public sector institutes and universities (726 million EUR) is hence 1:3.9.

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. But not only in relative terms, also in absolute terms funding from abroad has increased considerably. 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

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

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.

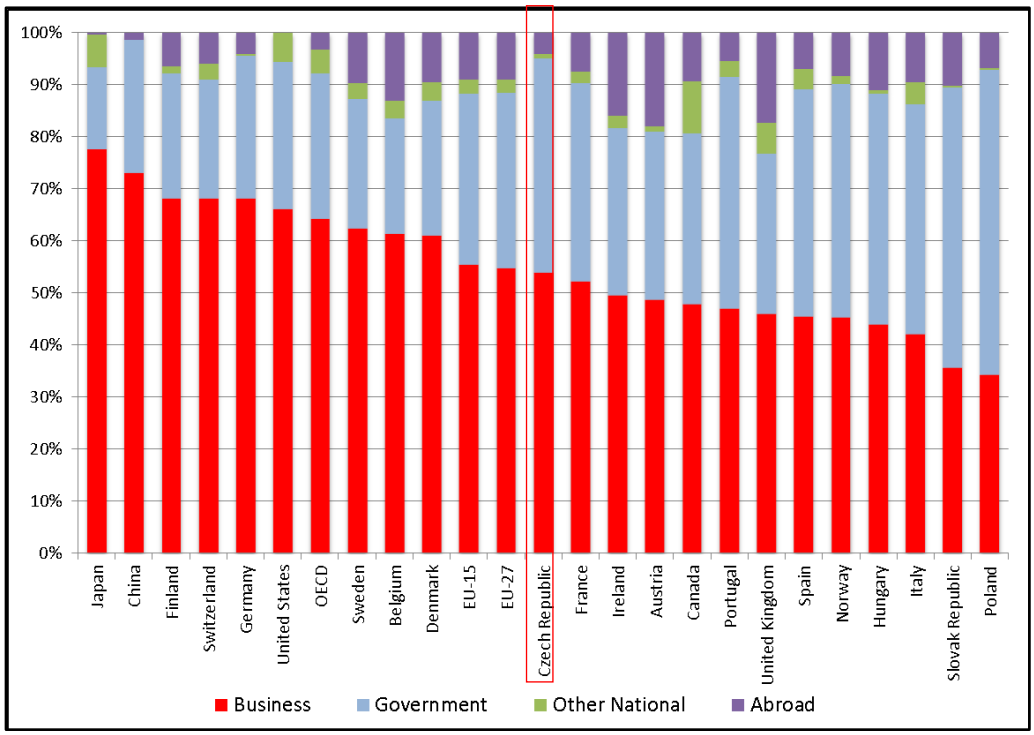
Figure 5 also contains information on the overall funding structure of the EU-27 member states. As can be seen therein, the level of business funded R&D has never exceeded 56% and is currently (2008) estimated at 55% for the EU-27. Interestingly, the level of government funding for the EU-27 decreased 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.

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.

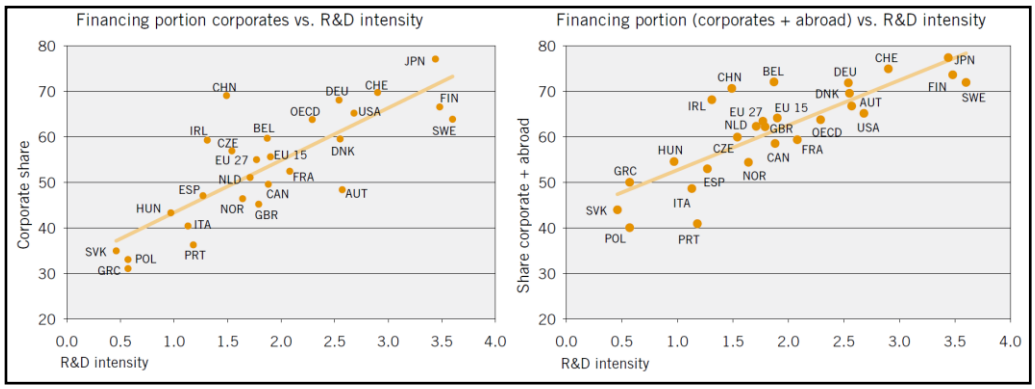
Figure 5: Financing Structure of Research Expenditures by Country in % (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

The figure below illustrates that countries, which tend to have high shares of Business R&D, also tend to have high shares of R&D intensity. Thereby, the Czech Republic is almost exactly positioned at the trend line, which is an indication that the investments of the business sector fit to the research capacity of the country, and that the country does not suffer from structural underinvestment in research from businesses.

Figure 6: Business Share of the R&D Rate by Country (2007)



Source: OECD, calculations JOANNEUM RESEARCH

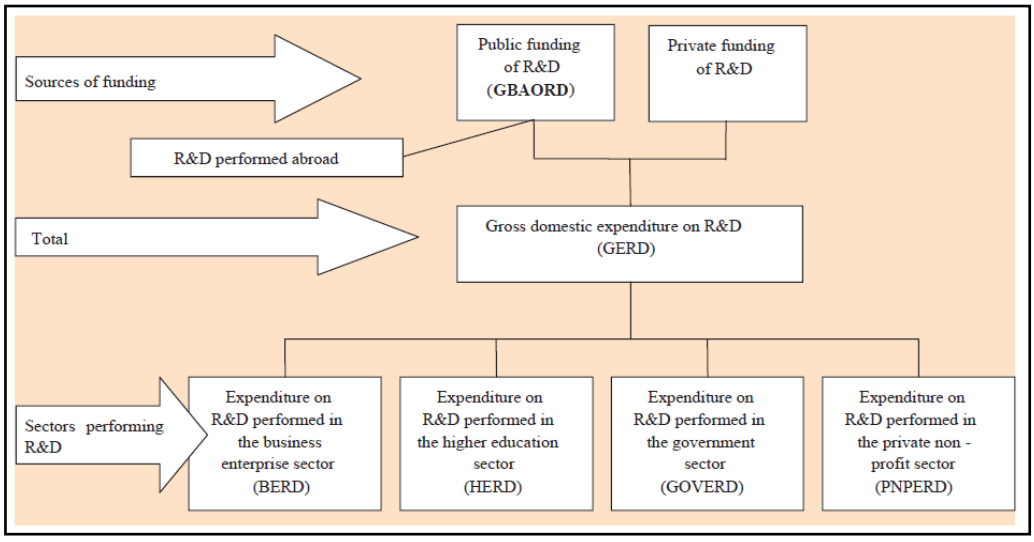
1.3 Public R&D Financing: an International Comparison

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 7: 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).

1.3.1 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 shows, that in 2009 GBAORD at 0.77% of GDP in the 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.

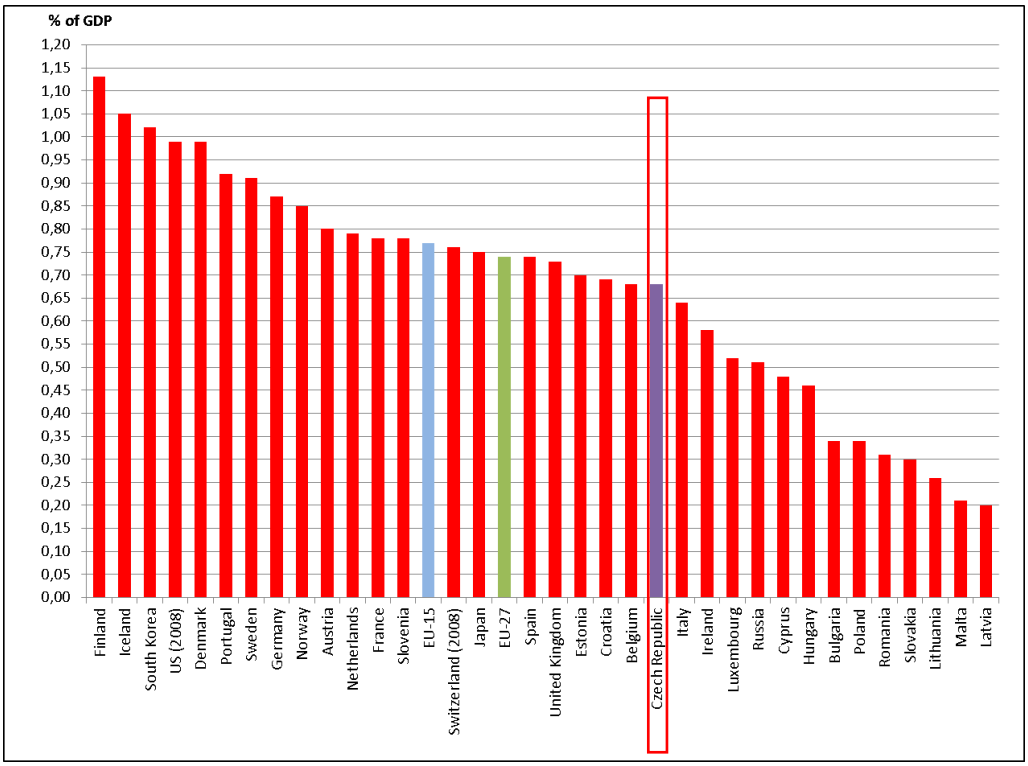
[5] Information on methodological differences between GBAORD data and R&D expenditures data are to be found in the OECD Frascati Manual (Frascati Manual, OECD, 2002).

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

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.

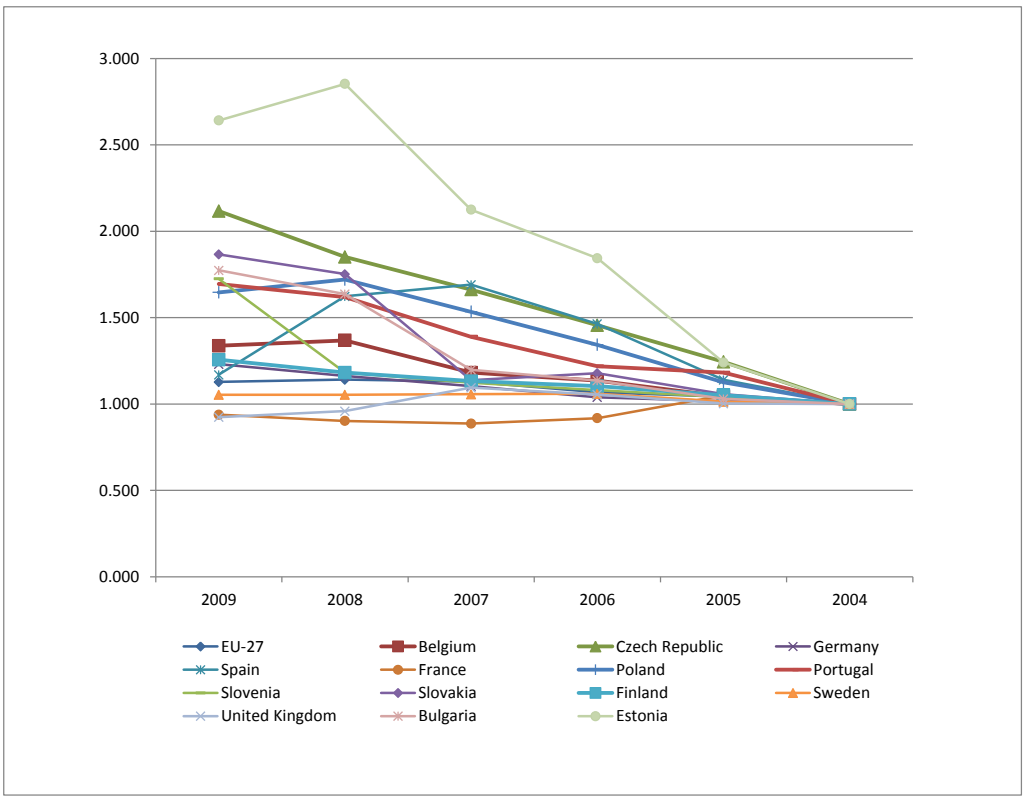
Figure 8: Total GBAORD as a Percentage of GDP, the Czech Republic and Selected Countries (2009)



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 9: Comparison of GBAORD Growth in Selected Economies (2004-2009),



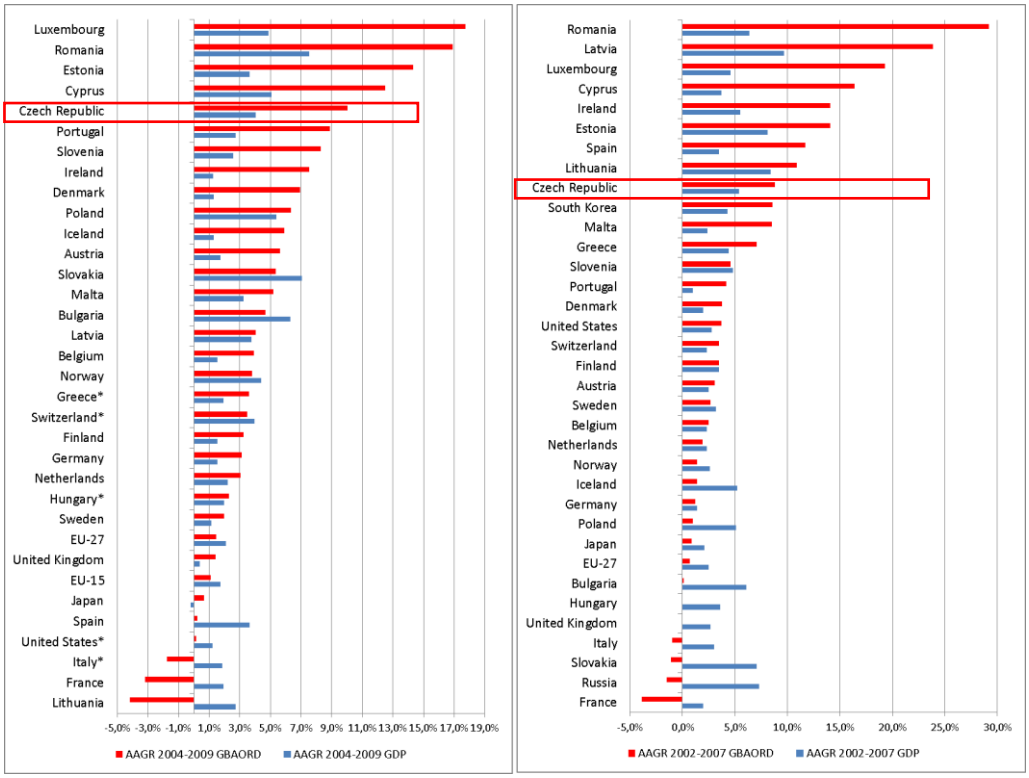
Source: Eurostat 2010

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.

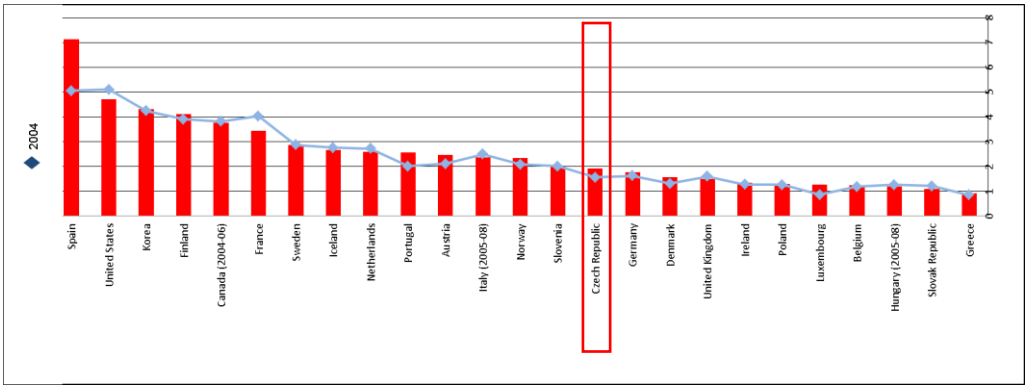
Figure 10: Average Annual Growth Rate (AAGR) of GBAORD and of GDP (Expressed in Million Purchasing Power Standard at Constant 2000 Prices), Czech Republic and Selected Countries – 2004-2009 and 2002-2007



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 11: 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.

1.3.2 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 (as a % of total) and total GBAORD (in Million 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*	*8760 5*
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 considerable 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

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

between General University Funds and other measures for the General Advancement of Knowledge, the Czech Republic is among the group of countries with relatively 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 12 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:

$$RCA_{ki}(X) = 100 \times \tanh \ln \left(\frac{X_{ki} / \sum_i X_k}{\sum_k X_{ki} / \sum_{ki} X_{ki}} \right)$$

with X_{ki} indicating the amount of GBAORD expenditures of country *k* in the research field *i*.

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 logarithmic transformation has the effect that the indicator is symmetrically centred around *1* as the relation of the shares before this transformation is not symmetrical (range zero to infinity) and in particular, it is not linear.

The tangent hyperbolic transformation has the effect that extreme values (of the logarithmic distribution) are truncated to *-1* and *+1* (or *-100* and *+100* when multiplied by 100 as in our case). We apply this transformation because the logarithmic function at the tails of the distribution cannot further be interpreted as quasi-linear. Any possible correlation analysis of logarithmic specialisation indices will be highly affected by these (non-linear) outliers. This distribution has less extreme tails and more 'linear' behaviour.

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;

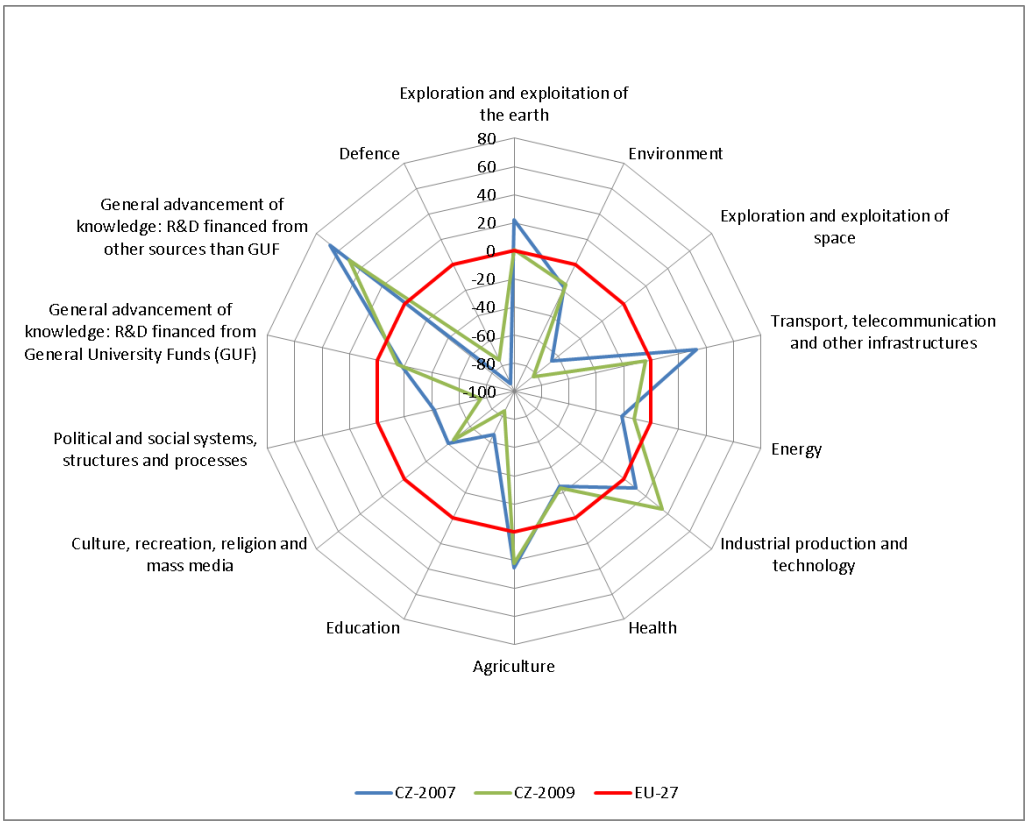
We also have to take into account that specialisation is a relative term. Hence, a benchmark is needed that shows, in which areas a given country is specialised compared to this benchmark. The benchmark might be the world, a selection of countries (e.g. EU-15/EU-27), or a single outstanding country as 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 12 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.

A strong negative specialisation compared with the EU-27 can be seen in the objective-fields Education, Culture, Political and Social Systems, and Exploration and Exploitation of Space. Compared with 2007 (the latest historic year for which GBAORD data by socio-economic objectives for the EU-27 are provided by Eurostat), the Czech Republic lost its GBAORD specialisation in the field of Transport and Telecommunication and Exploration and Exploitation of the Earth.

Figure 12: Specialisation in GBAORD by Socio-Economic Objective compared with the EU-27 in 2009 and 2007



Source: Eurostat, calculations JOANNEUM RESEARCH

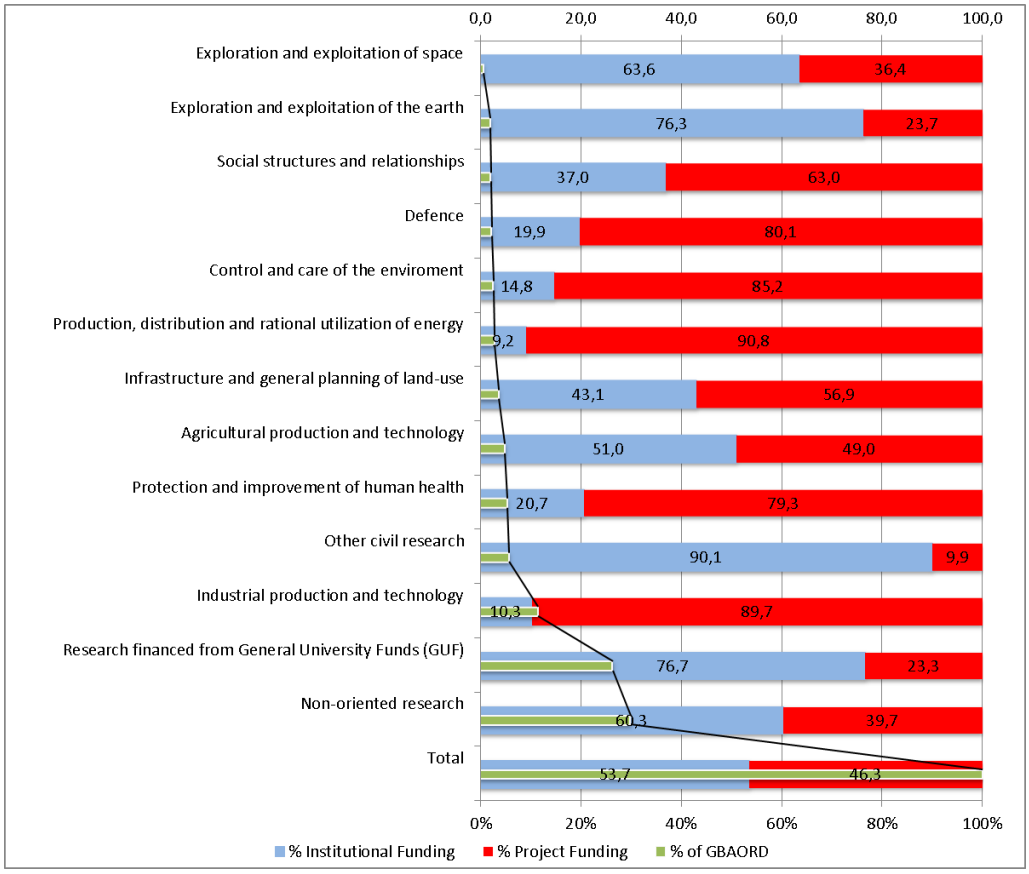
1.3.3 Type of Support: Institutional Funding vs. Project Funding

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 total R&D expenditures are distributed via institutional funding mechanisms and 46% via project funding mechanisms in the Czech Republic.

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

Figure 13: GBAORD by Socio-Economic Objective and Type of Support in % (2008)



Source: Czech Statistical Office (2009), calculations JOANNEUM RESEARCH

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

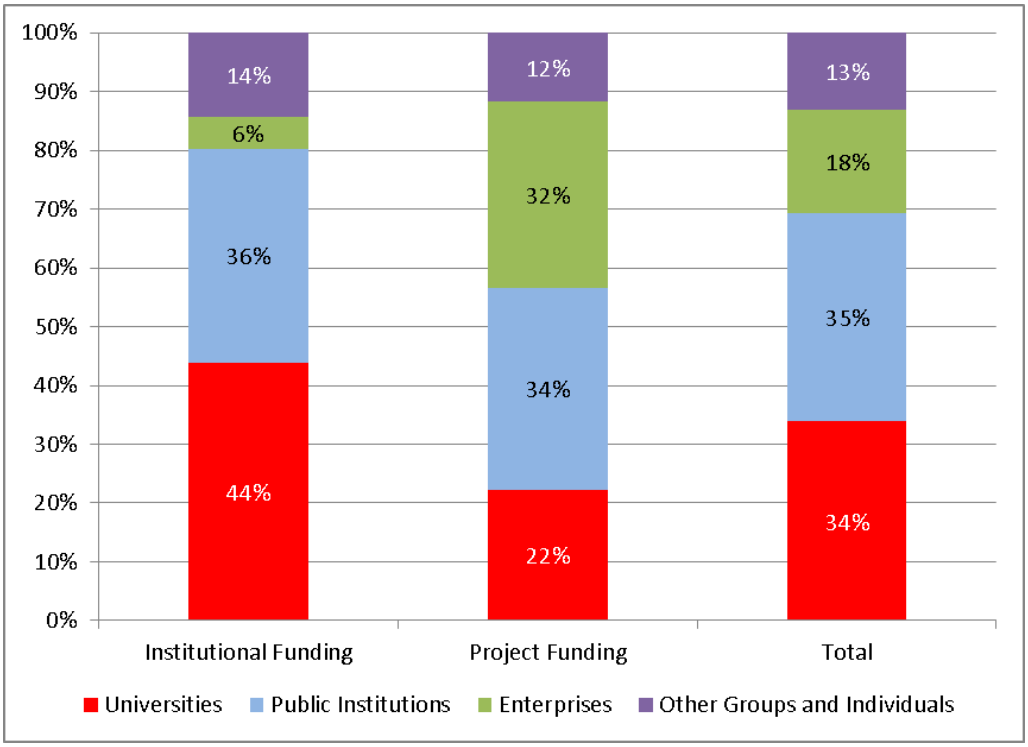
Country	Total Project Funding (Million current PPP USD)	Total Project Funding (% of GBAORD)	Total Project Funding (% of GDP)
Austria	495	31	0,2
France	3459	20	0,2
France (with CNRS)	5262	31	0,31
Italy	2467	24	0,16
Netherlands	1448	33	0,33
Norway	529	42	0,32
Switzerland	464	28	0,19

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 14: 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, 2006a). 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.

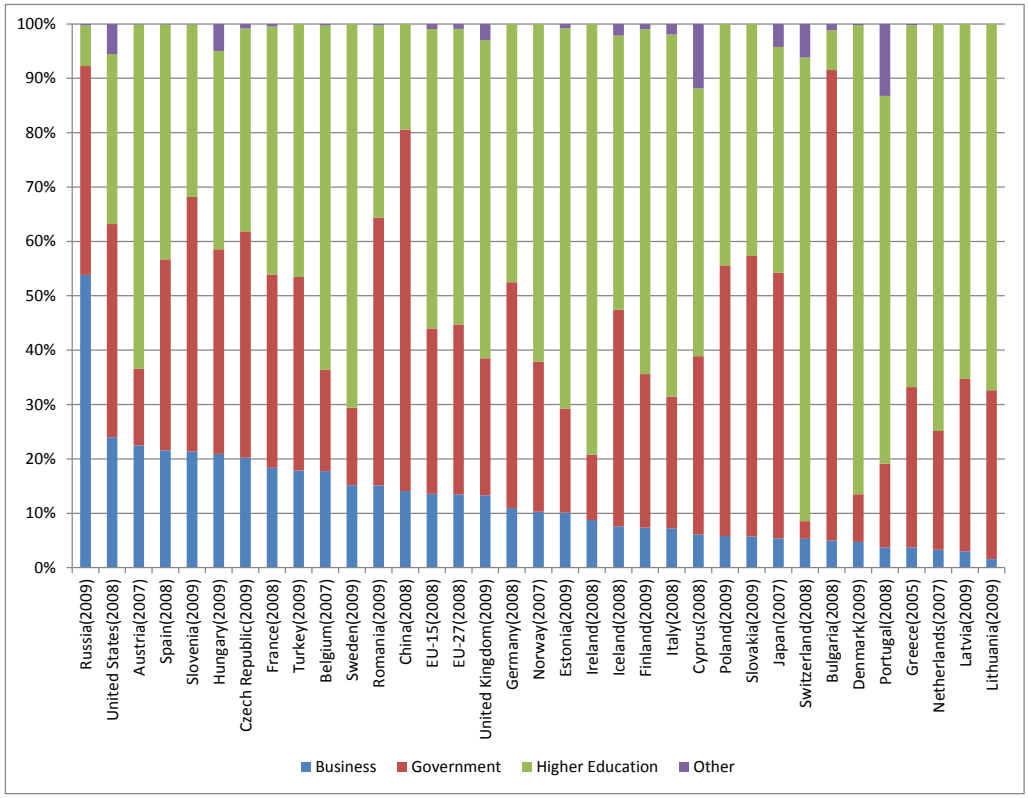
- Norway is also a very specific case, since there is a large sector composed of research institutes, mostly oriented towards applied research; about half the research performed is for industry-relevant purposes, financed by industry and is included in the Private Sector in the R&D statistics.
- The 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.

1.3.4 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.

Figure 15: Government funded R&D by sector of performance (latest available year)



Source: Eurostat (2011)

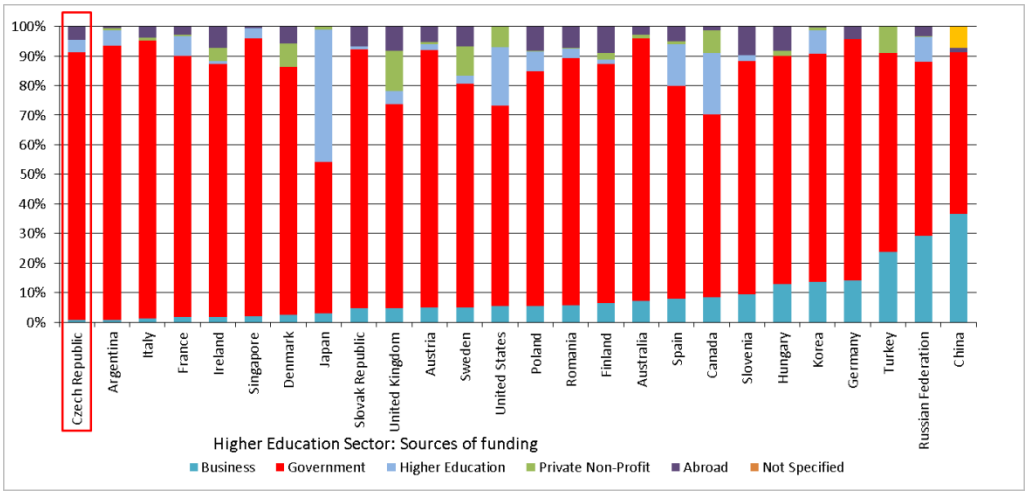
Among EU member states, the Czech Republic has the 4th highest share of public funded R&D performed in the Business Enterprise Sector. In Austria, Spain, Slovenia, Hungary, and France similar shares of public financed R&D performed by the Business Enterprise Sector. The shares of public R&D performed 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.

1.4 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 16: 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[8]. 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.

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

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

financing structure of the Higher Education Sector is considered. The box below defines the different funding sources for universities.

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 20011). 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.

1.4.1 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.

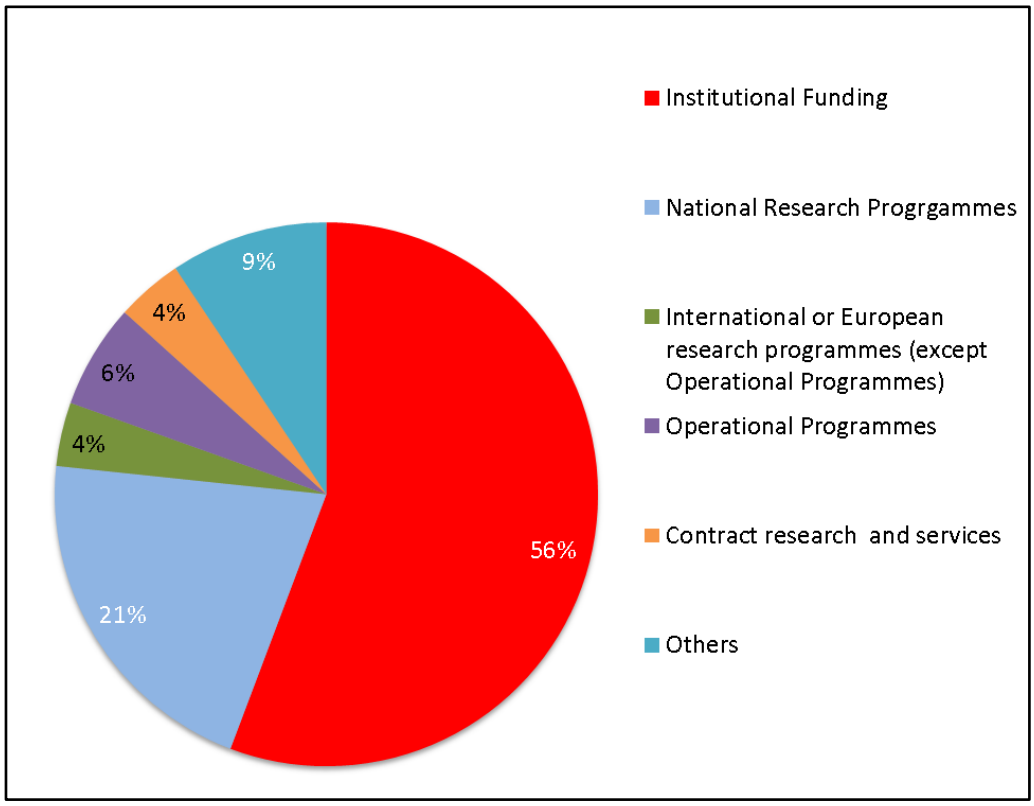
As the international comparison on R&D financing in the Higher Education Sector has shown, direct public funding continues to be the most relevant source of financing for the sector. This holds in particular true for the European Union member countries, in

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 17: Average Income Distribution of Czech Universities

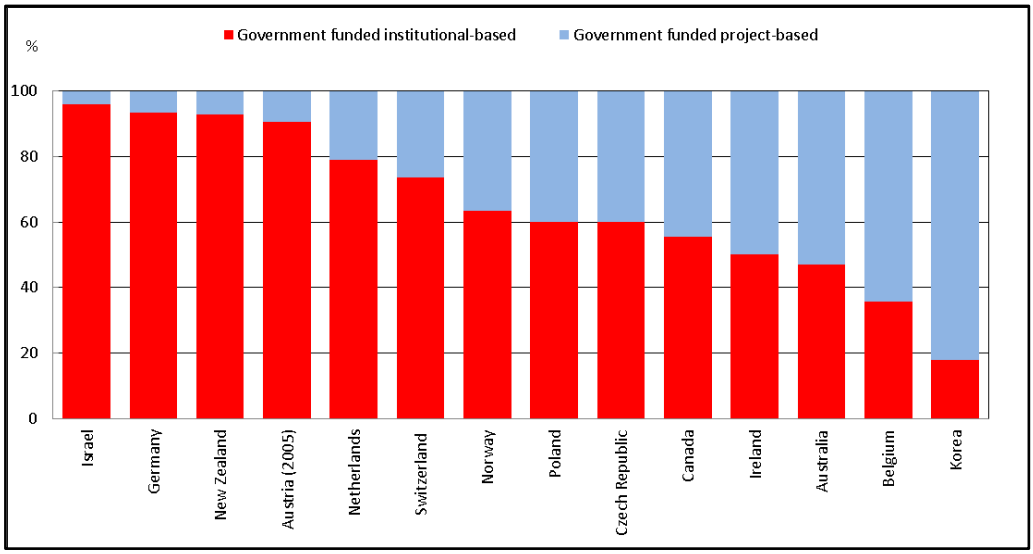


Source: Survey Directors/Deans of Faculties (2010)

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 18: 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 Annex D of this study, 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.

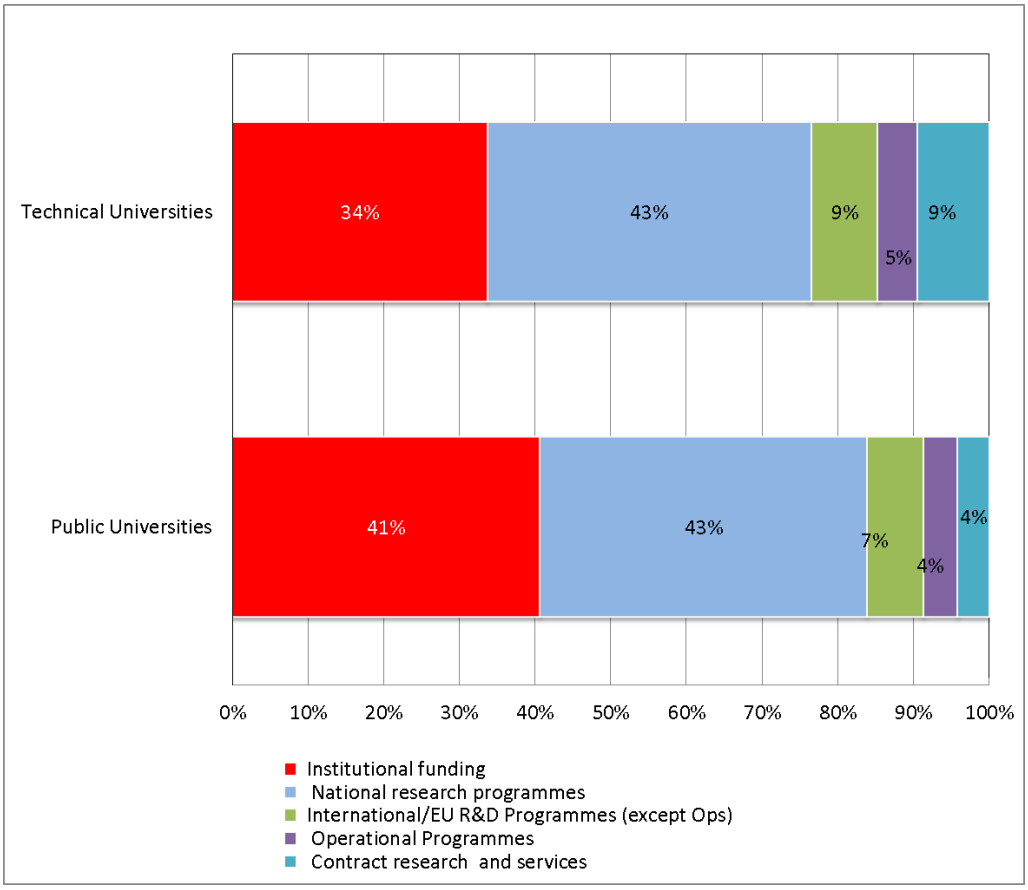
Exempt from some empirical case studies focussing on a limited number of countries, the amount of project funding is rarely covered in analyses. Furthermore no valid international benchmark, regarding an optimal ratio of project funding and institutional funding, both at system level and research group 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[9] 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.

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 19: Research Funding at the Research Group Level



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.

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

Table 5: Evolution of the Research Funding Structure in the Different R&D Entities

Trends: University	Decreased	Unchanged	Increased	N.A	Tot.
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.

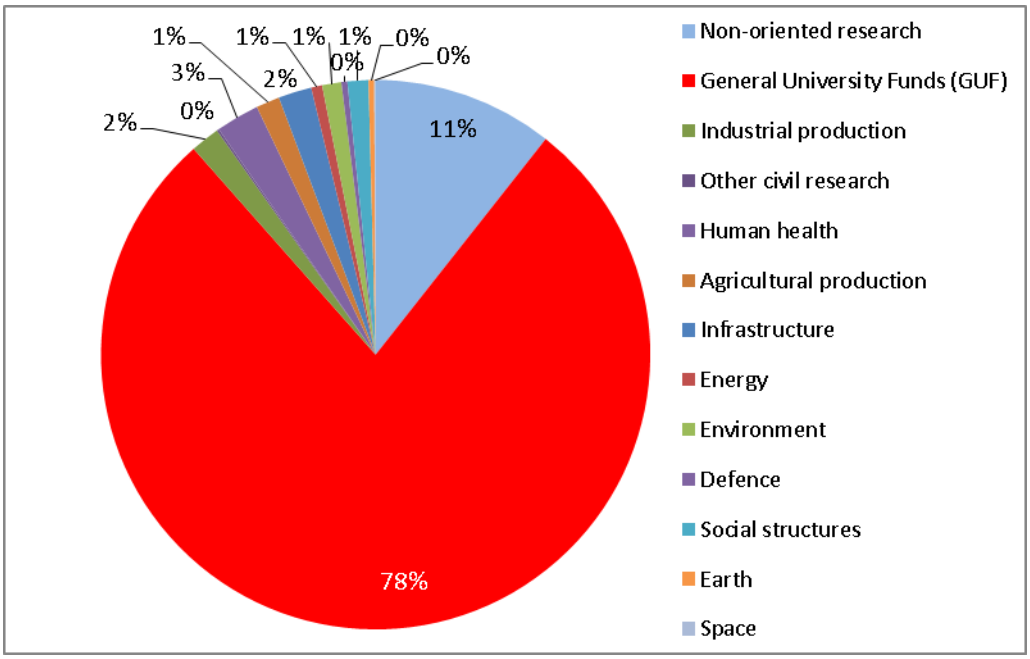
For the public authorities the high level of project funding may be beneficial because of increased levels of competition, which potentially helps to direct funds toward high-potential and high-class researchers. However, most important in this respect, is that the level of national project financing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

1.4.2 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 20: Public R&D Expenditures for the Higher Education Sector: Repartition by Socio-Economic Objective (2008)



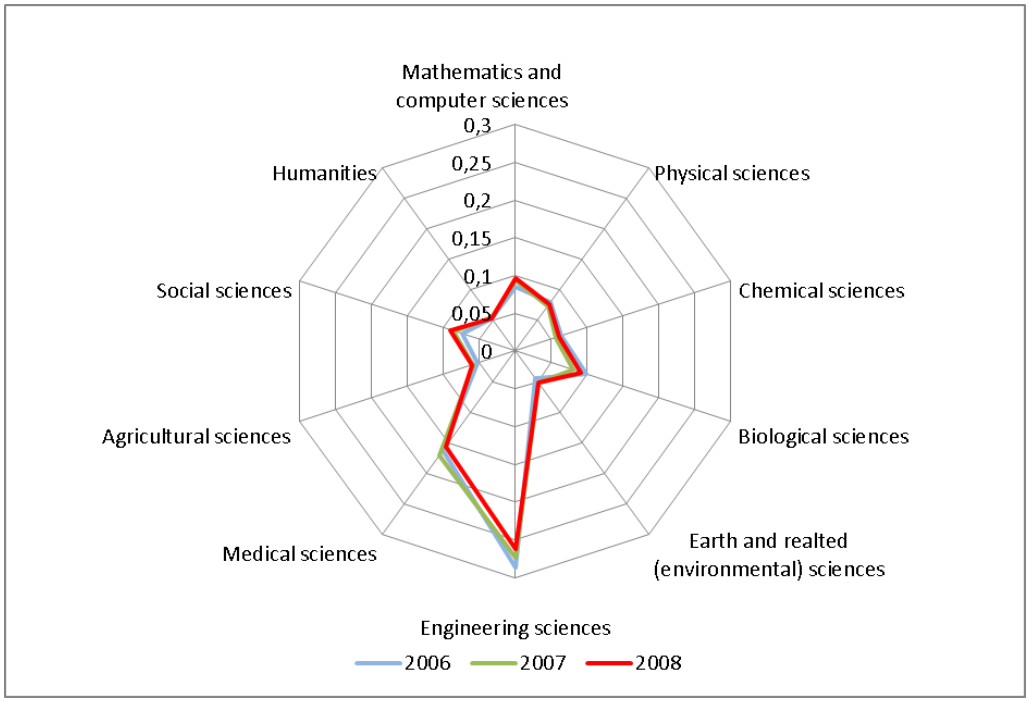
Source: Czech Statistical Office (2010)

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 21: 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.

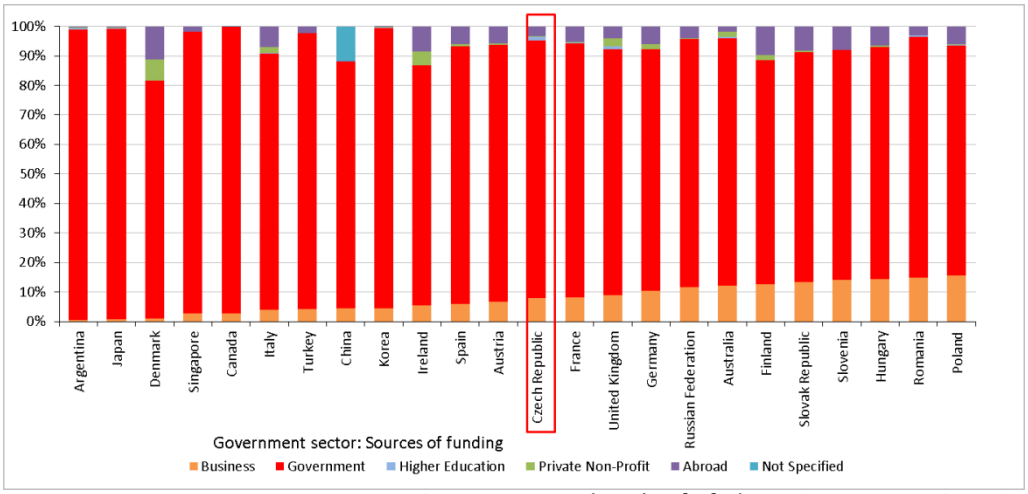
1.5 R&D Financing in the Government Sector

Also the financing structure of the Government Sector shows that only a limited number of countries have shares of business R&D financing that reach 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 from the Public Sector towards the Enterprise Sector.

However, as mentioned before, 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 22: 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 research income for Public Sector stem from institutional funds. However, for the Czech Academy of Sciences a more detailed picture of the financing structure can be provided by recurring to 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.

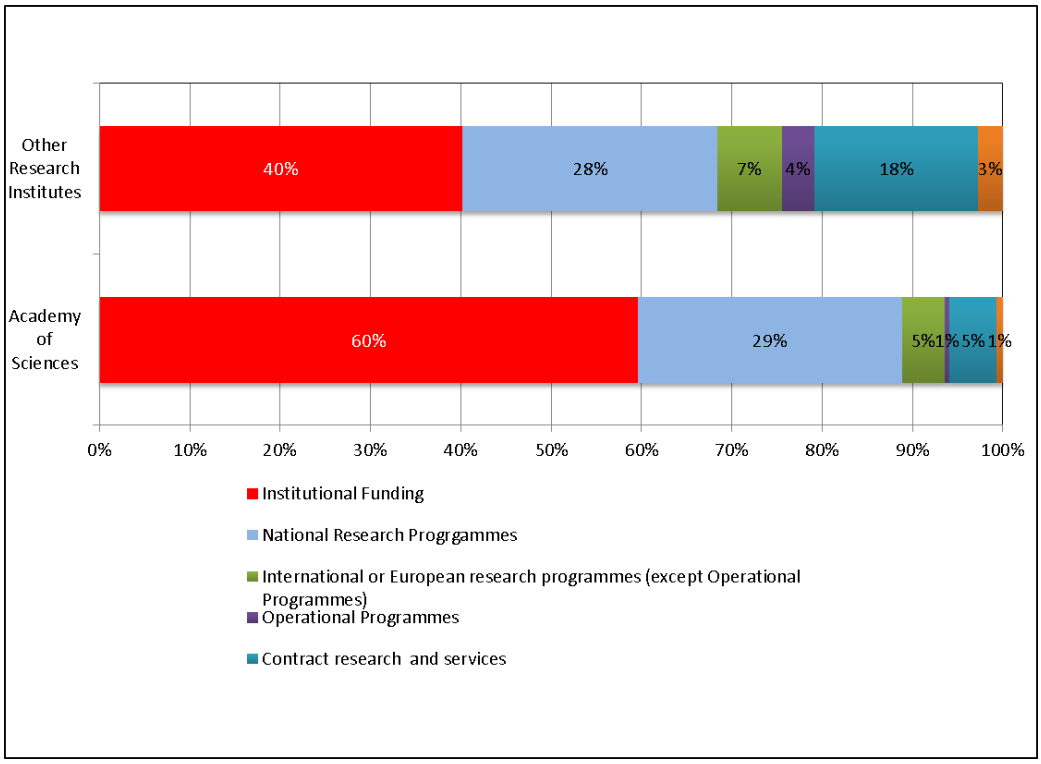
In particular the share of sales and licences, which totalled to 46 million EUR, is extraordinary high, even in international comparison. Licensing income of Public research organisations are not monitored in a systemic way, but some facts regards distribution and relevance for some European and US research 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 (2008) 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. The Operational Programmes do not seem to play a certain role 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 23: Research Funding Structure in the Government Sector

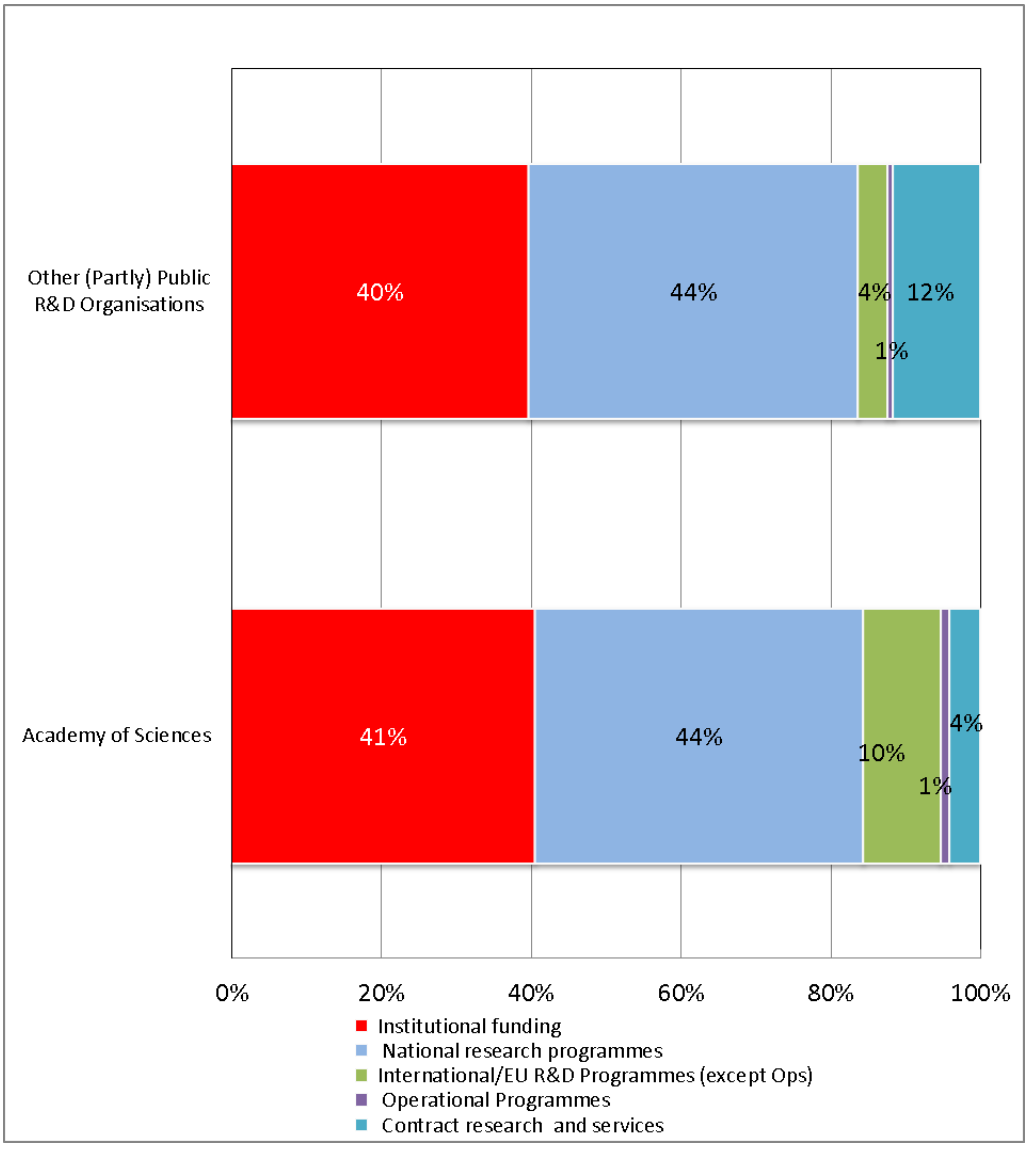


Source: Survey of Directors (2010)

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 24: Research Funding at the Research Group Level



Source: Survey Researchers (2010)

Table 6 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 6: Evolution of the Research Funding Structure: The Academy of Sciences and Other Research Organisations

Trends: Academy	**Decreased**	**Unchanged**	**Increased**	**N.A**	**Tot.**
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**	**Tot.**
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

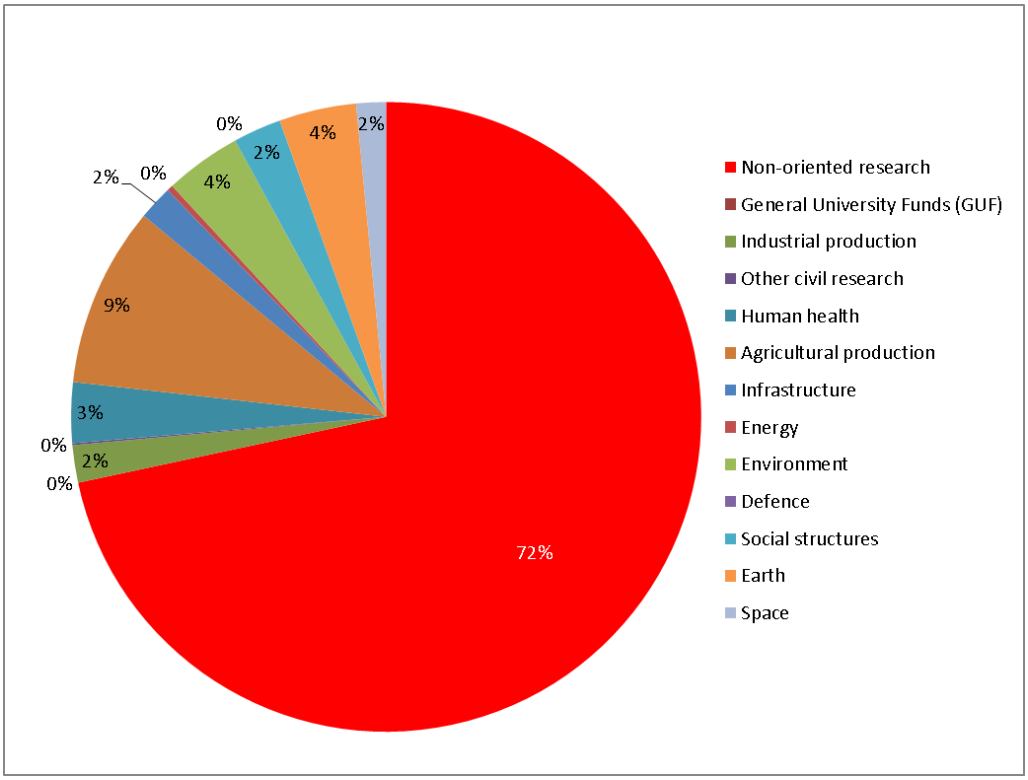
Source: Survey Researchers (2010)

1.5.1 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 25: Public R&D Expenditures for the Government Sector: Repartition by Socio-Economic Objective (2008)



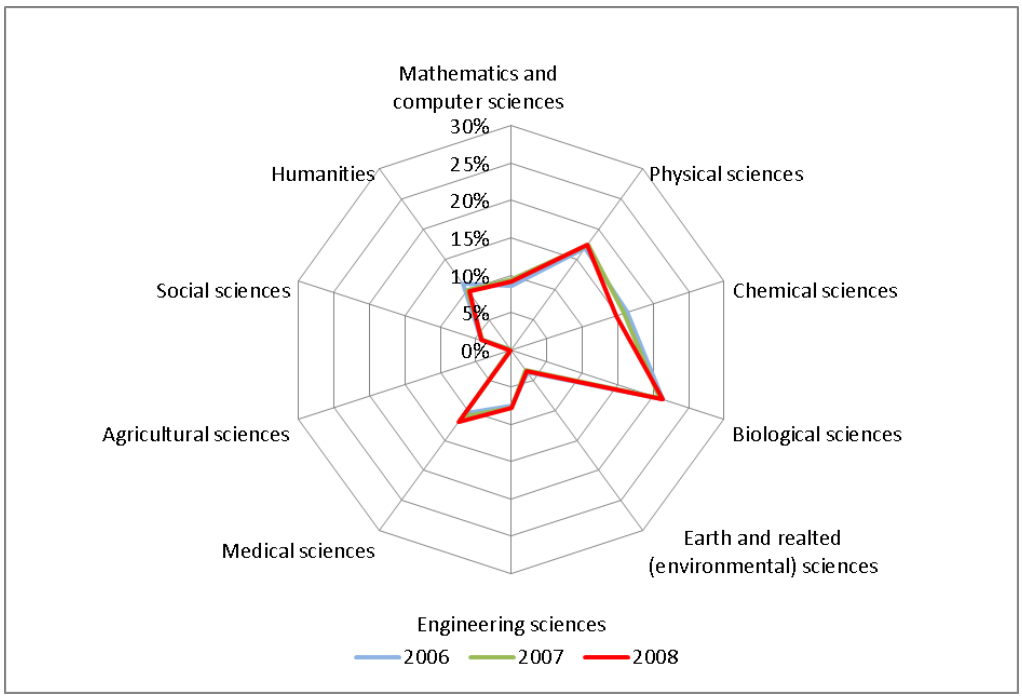
Source: Czech Statistical Office (2010)

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 26: GBAORD – Research Financed from General Advancement for Knowledge



Source: Czech Statistical Office (2009)

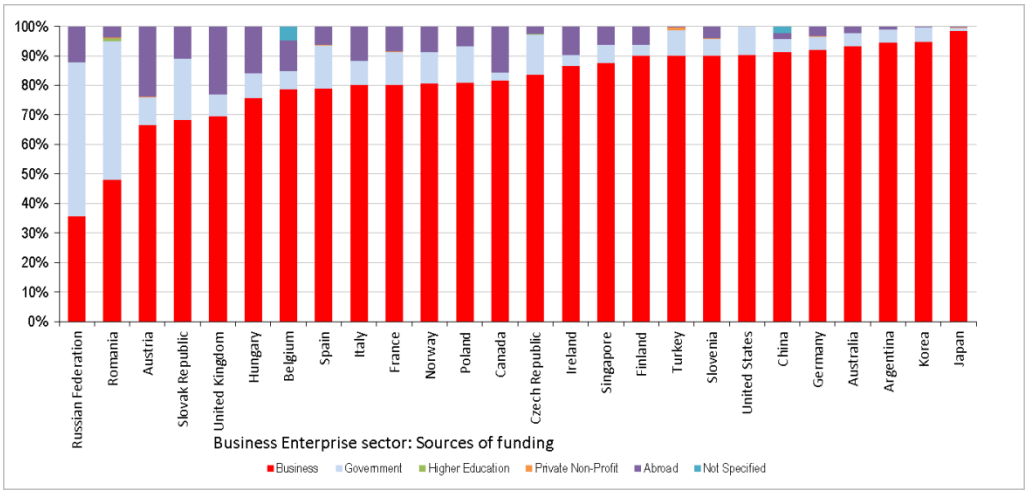
The strategic orientation of public R&D expenditures may be further analysed in a qualitative manner by focussing on public R&D financing in terms of R&D programmes. Thereby, themes and priorities as to be found in the programming documents can be considered. The strategic orientation of national and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

1.6 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 27: Financing Structure of Research Expenditures by Country in the Business Enterprise Sector in % (2007)



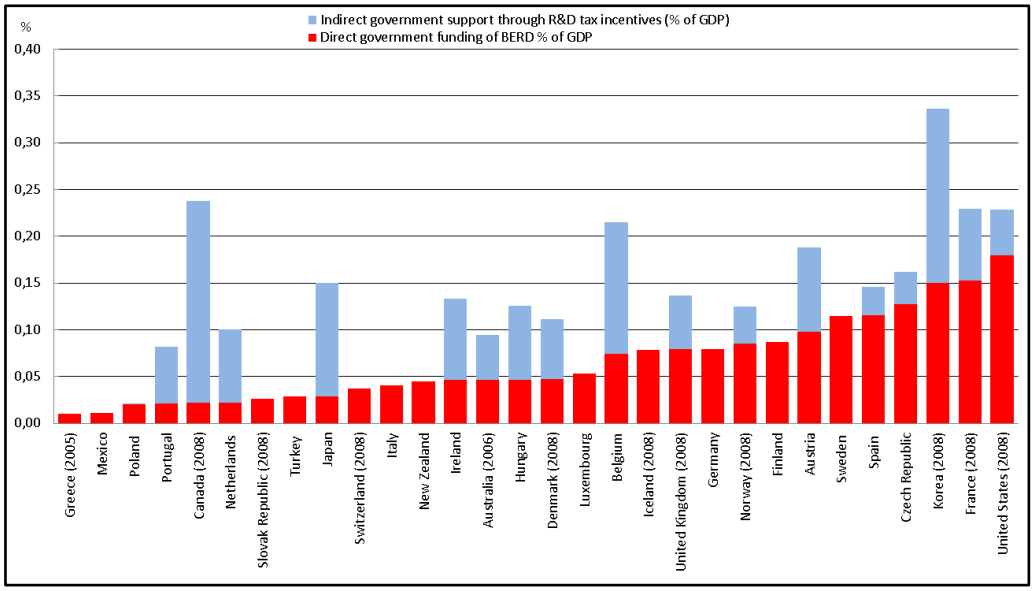
Source: Eurostat (2010), calculations JOANNEUM RESEARCH

This observation also holds true when looking at the level of direct public R&D support measured as % of GDP (Figure 28) 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.

In addition, 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[10] 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.

[10] 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 the costs associated with R&D are generally regarded as tax-deductible, the eligible R&D costs can actually be deducted from the tax base twice. 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.

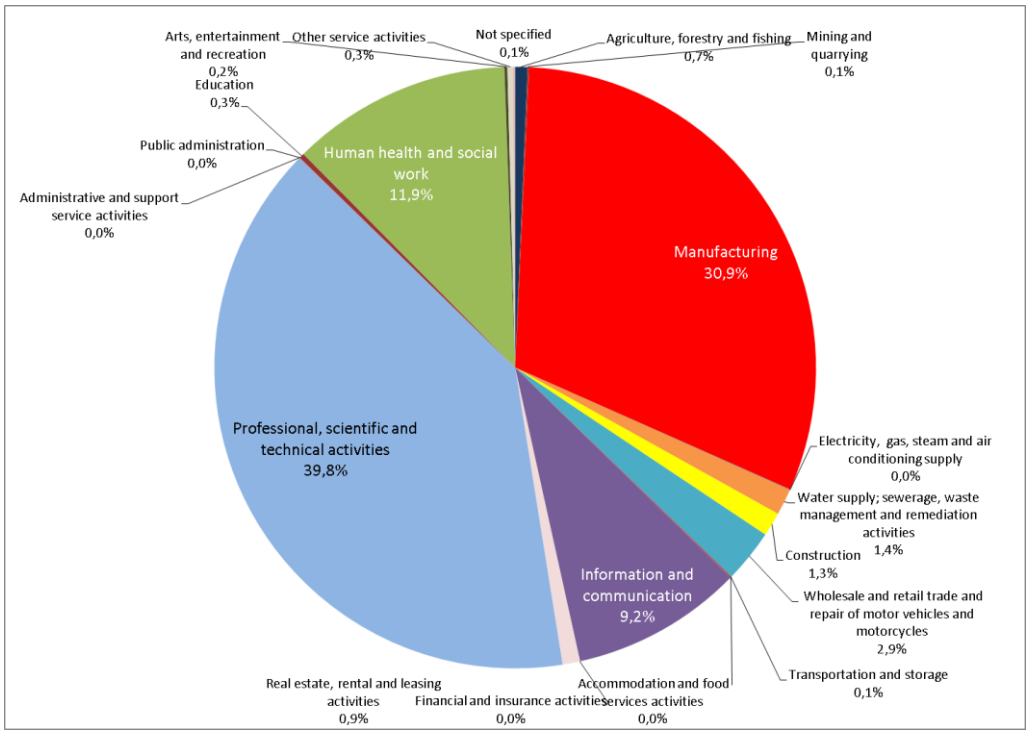
Figure 28: R&D Support to Industry in 2009 (% of GDP)



Source: OECD (2010)

Further information on priority setting for public industrial R&D support is provided in national GBAORD data. National budget data provide information on the socio-economic objective Industrial Production and Technology and GBAORD by Industrial Branch. As these types of data are only available at the Czech national level, no international comparison may be provided.

Figure 29: GBAORD – Government R&D Support for the Business Enterprise Sector by Industrial Branches



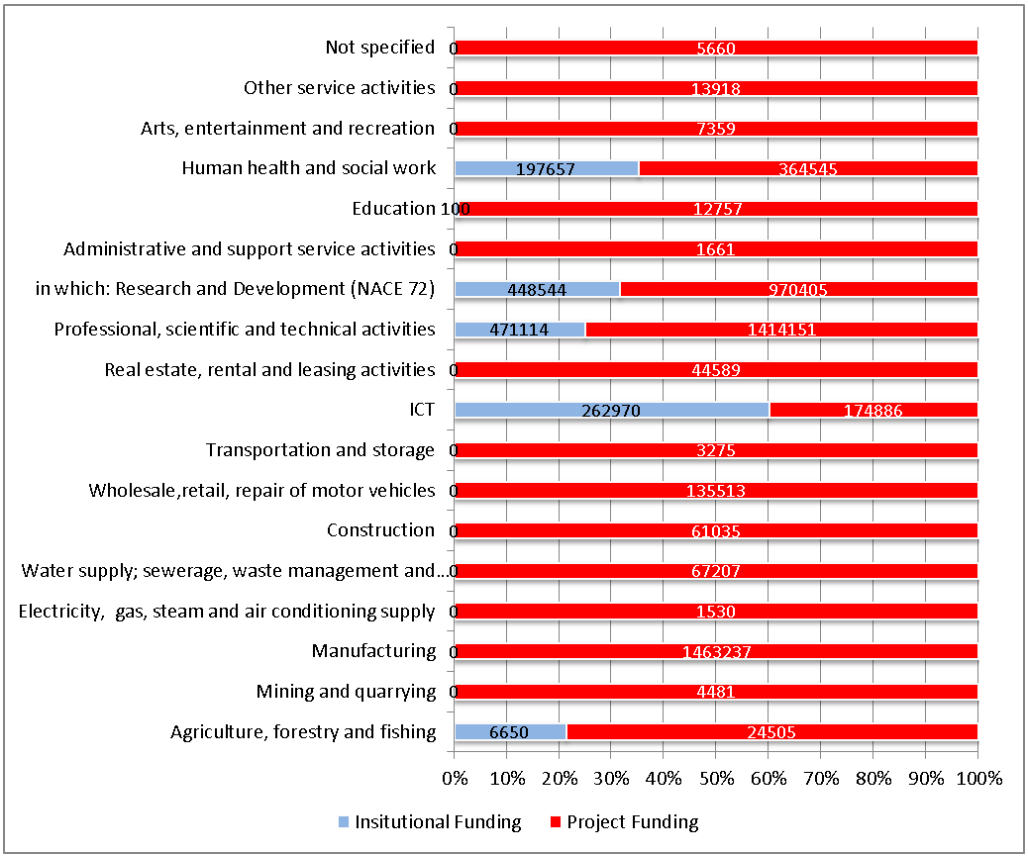
Source: Czech Statistical Office (2010)

Figure 18 shows that 39.8% of total industry support is attributed to the sector providing professional scientific and technical activities. The Manufacturing Sector receives 30.9% of industrial GBAORD and the ICT Sector accounts for 9.2%.

In terms of funding mechanisms, most industrial sectors receive financing via project funding measures exclusively. However, there are some relevant exceptions, as shown in the figure below:

- In the Information and Communication Technology Sector institutional funding is exceptionally high. 61% of GBAORD are institutional funds.
- In the Human Health and Social Services Sector institutional funding accounts for 35% of GBAORD.
- In the Agricultural Sector institutional funding accounts for 21% of GBAORD support.
- In the Research Sector institutional funding accounts for 32% of GBAORD.

Figure 30: GBAORD – Government R&D Support for the Business Enterprise Sector by Type of Funding and Industrial Branches (in tsd. CZK), (2008)



Source: Czech Statistical Office (2009), calculations JOANNEUM RESEARCH

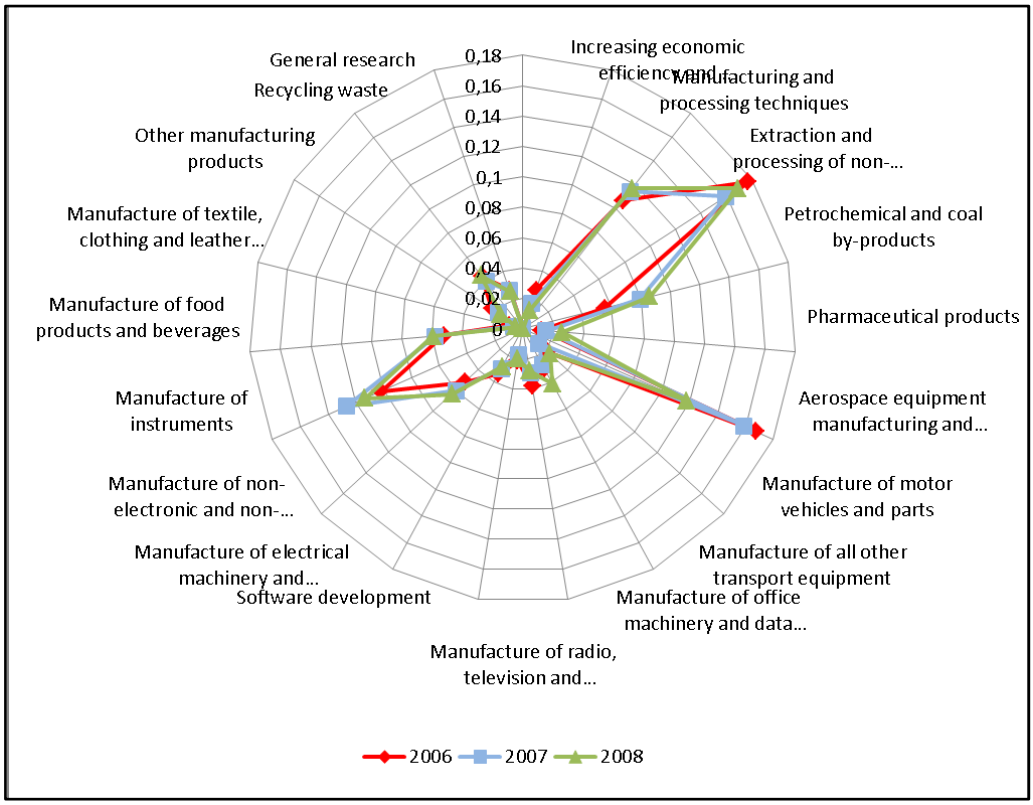
A consideration of the GBAORD socio-economic objective Industrial Production and Technology allows analysing, which technological fields have been addressed by the public sectors' R&D expenditures. In 2008 GBAORD for Industrial Production and Technology was concentrated in the following fields:

- Extraction and processing of Non-Energy Minerals and Derived Products (17%)
- Manufacturing and Processing Techniques (12%)

- Aerospace Equipment Manufacturing and Repairing (12%)
- Manufacture of Non-electronic and Non-electrical Ma chinery (11%).

The shares of GBAORD appropriations have not changed considerably in the last three years, except from the field Aerospace Equipment Manufacturing and Repairing, which decreased from 17% to 12%.

Figure 31: Public R&D Expenditures related to Industrial Production and Technology



Source: Czech Statistical Office (2009), calculations JOANNEUM RESEARCH

In absolute terms, state support for industrial production and technology increased by 9% since 2006. This figure however entails large differences between the different fields.

The following fields showed increased state support larger than 40%

- Pharmaceutical products (+125%)
- Petrochemical and coal by-products (+68%)
- Manufacture of all other transport equipment (+49%).

The following fields showed increased state support larger in between 10% and 40%

- Manufacture of electrical machinery and apparatus (+34%)
- Manufacture of precision instruments (+24%)
- Manufacture of non-electronic and non-electrical machinery (+21%)
- Manufacturing and processing techniques (+19%)
- Manufacture of motor vehicles and parts (+17%)
- Other manufacturing products (+11%).

Fields with low or even decreasing public investment levels were:

- Recycling waste (+9%)
- Extraction and processing of non-energy minerals and derived products (+4%)
- Manufacture of radio, television and communications equipment and apparatus (+3%)
- Software development (-8%)
- Manufacture of office machinery and data processing equipment (-20%)
- Manufacture of textile, clothing and leather goods (-21%)
- Aerospace equipment manufacturing and repairing (-24%)
- Manufacture of food products and beverages (-40%)
- General measures increasing economic efficiency and competitiveness (-49%).

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

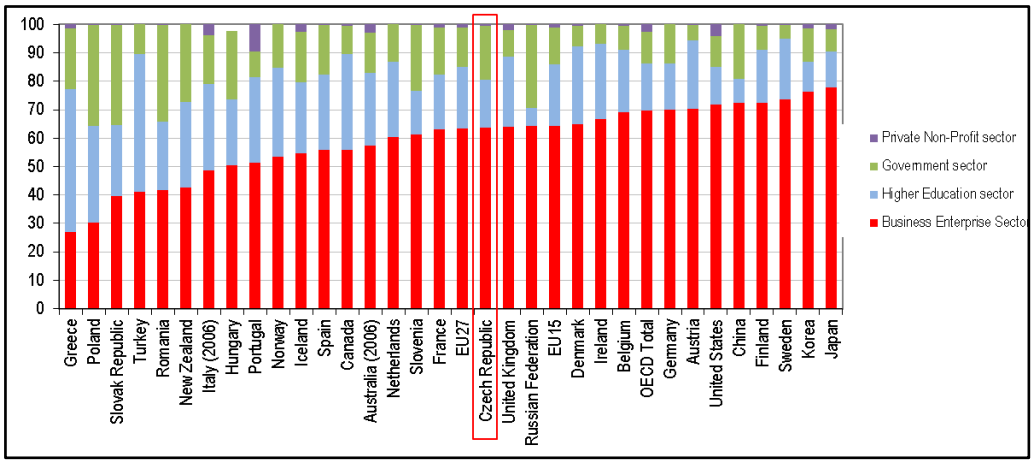
Regarding the performance structure of R&D, the international comparison shows that the Czech Republic nowadays can be characterised as a country which has considerably closed the gap towards the EU-27 average and the OECD member states.

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 32: 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.

2.1 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.

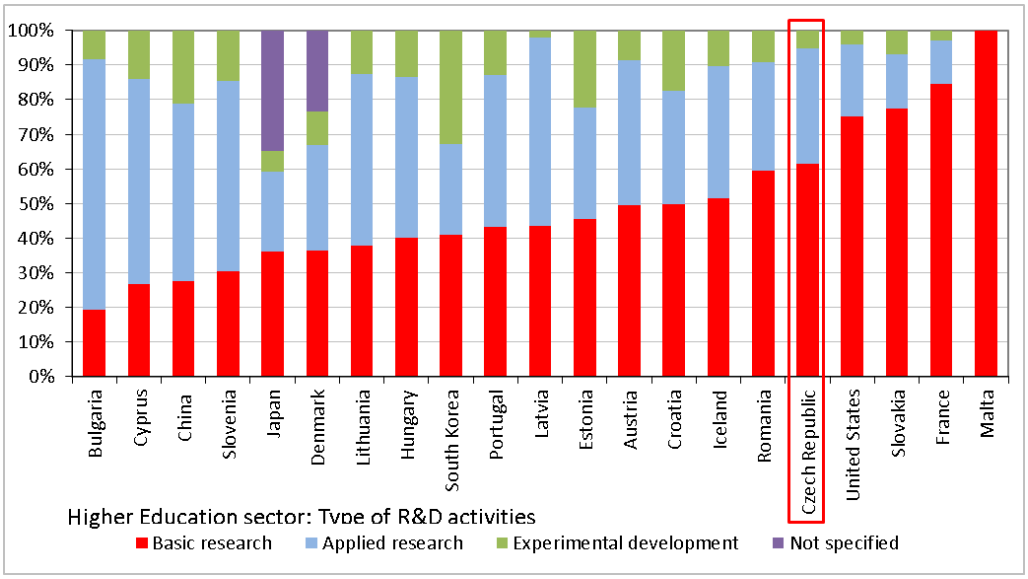
The fact that knowledge does not only encompass information that can be codified. but has also a strong tacit component, subsequently leads to the need for (research departments of) enterprises to co-operate closely with academic research units in order to have the absorptive capacity required to make 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.

2.1.1 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 33: 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.

By large, the group of countries with very low basic research activities are countries, in which a clear differentiation between 'Teaching Universities' and 'Research Universities' prevailed, whereas the latter are predominantly countries in which the Government Sector accounts for larger shares of applied research activities and in particular experimental development, which also reflects a supporting role of industrial R&D activities and market oriented R&D activities in itself.

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 excepted 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 Annex E of the second interim report. Chapter 3 provides an overview on public support mechanisms that allow for knowledge intensive science industry collaborations.

2.1.2 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 7).

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 7: R&D Expenditures by Research Field and Country in the Higher Education Sector (2007)

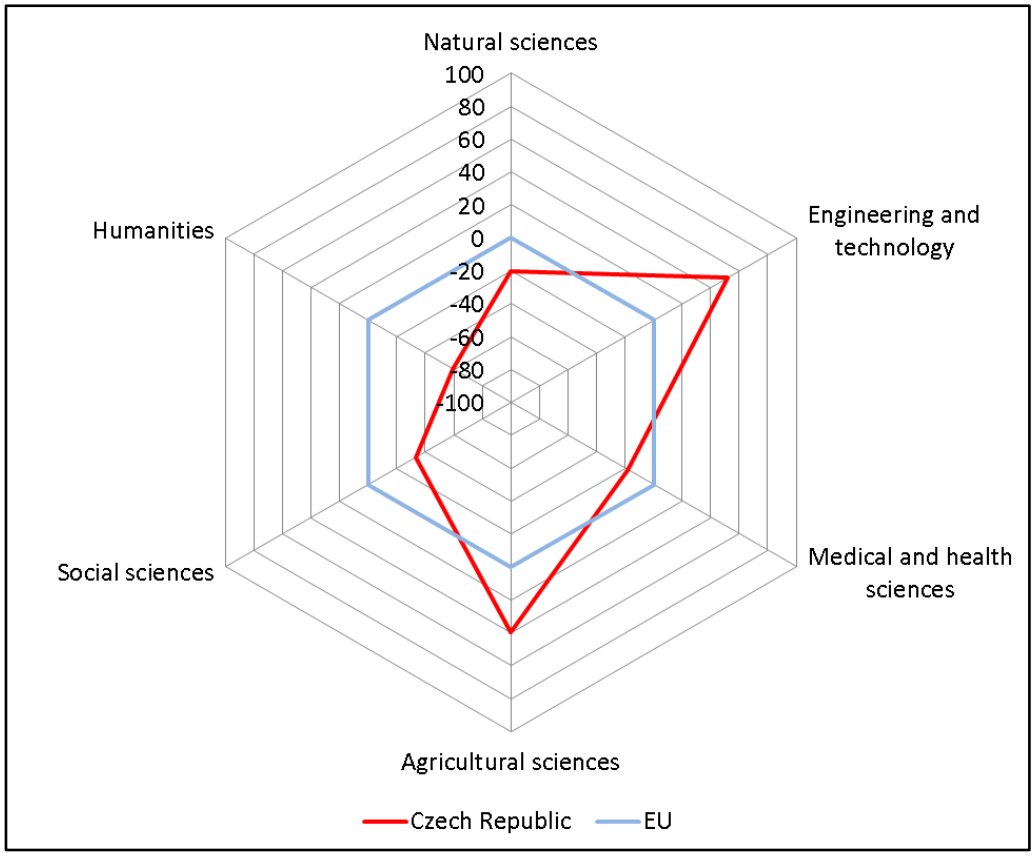
	Natural sciences	Engineering and technology	Medical and health sciences	Agricultural sciences	Social sciences	Humanities	Total (Mio Euro)
EU-Total (20 available countries)	26	21	24	4	14	11	22662.8
Bulgaria	10	58	7	2	15	8	13.5
Czech Republic	*21*	*37*	*20*	*7*	*10*	*5*	*329.8*
Denmark	21	12	31	12	15	9	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 34 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 34: Scientific Specialisation in the Higher Education Sector (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

2.2 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.

2.2.1 R&D Expenditures by Type of Research

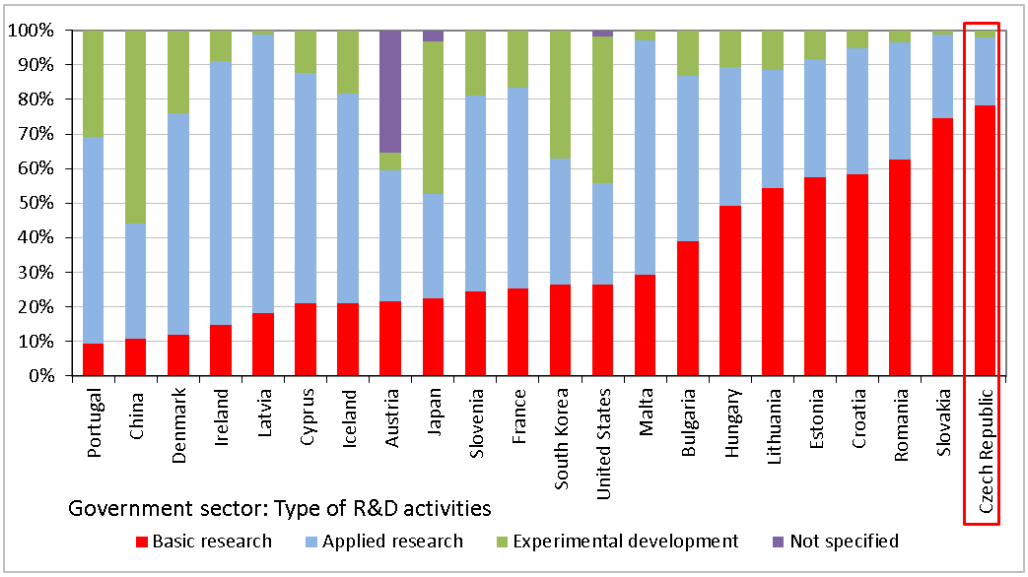
The EARTO has defined the PRO's main activity as 'to provide research and development, technology and innovation services to enterprises, governments and other clients'. Thereby, the EARTO seeks to differentiate the different types of research organisations in an innovation system by a division of labour – 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 35: R&D Expenditures by Research Type and Country (Government sector)



Source: Eurostat (2010)

2.2.2 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 8: R&D Expenditures by Research Field and Country in the Government Sector (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

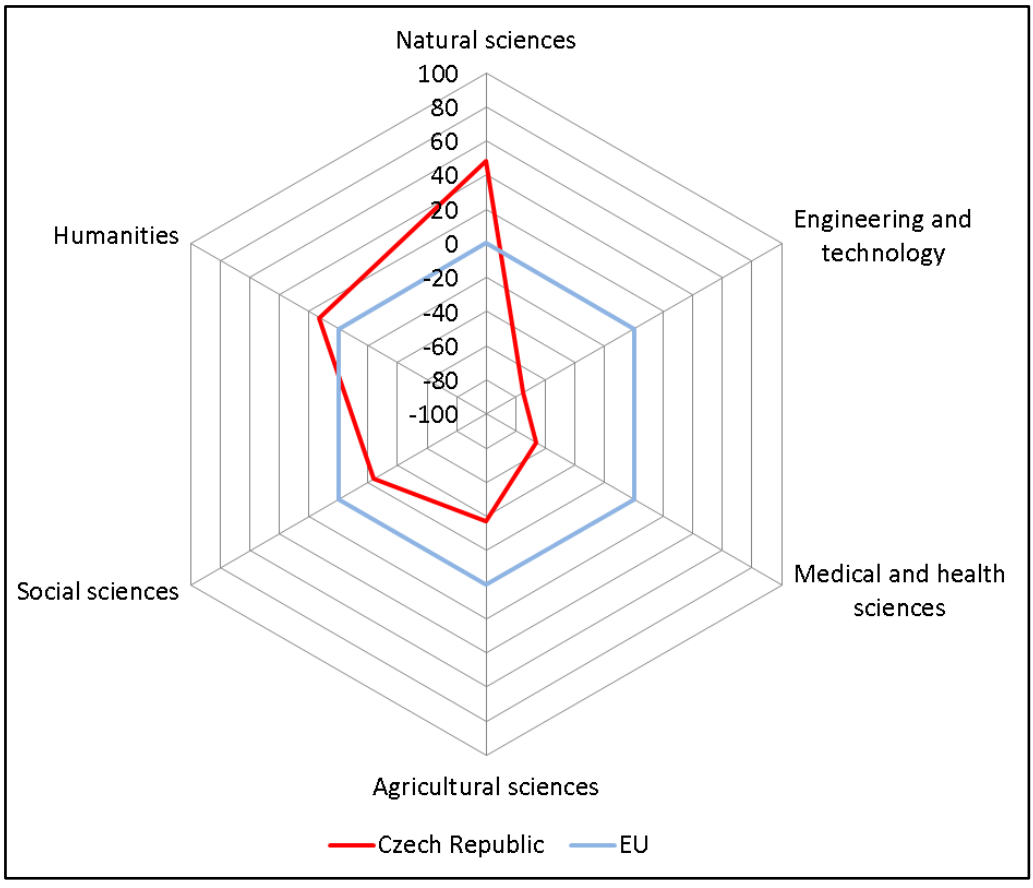
Finland	17%	41%	16%	19%	13%	2%	528.3
Iceland	12%	16%	20%	33%	11%	7%	71.5
Norway	20%	17%	13%	23%	23%	3%	714.5
Croatia	44%	10%	7%	8%	17%	13%	88.7
Russia	38%	44%	7%	5%	3%	3%	3083.7
Japan	27%	47%	6%	17%	na	na	8554.2
South Korea	12%	62%	3%	12%	11%	0%	2866.0

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 36: Scientific Specialisation of the Czech Government Sector (2007)



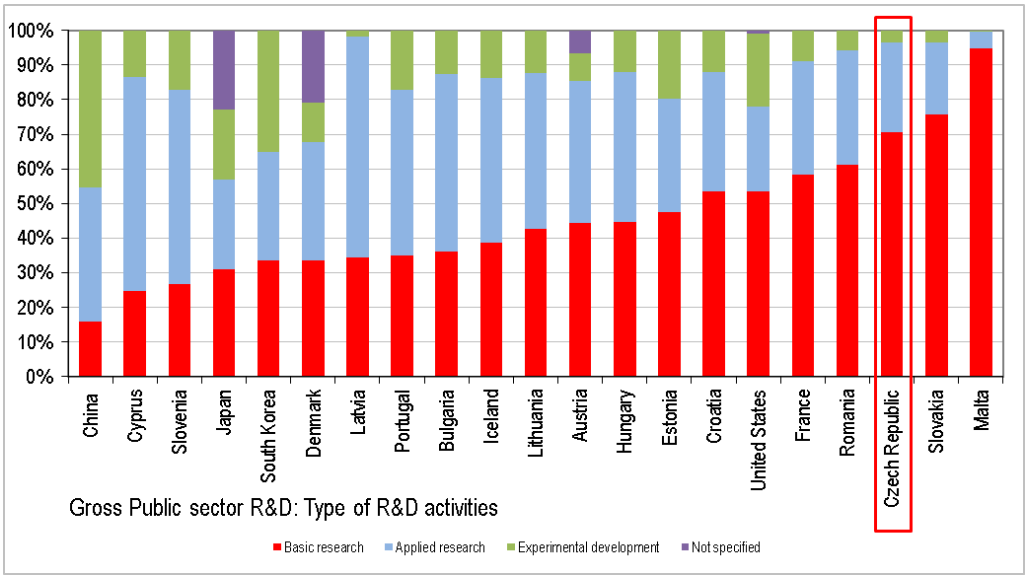
Source: Eurostat (2010), calculations JOANNEUM RESEARCH s

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.

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.

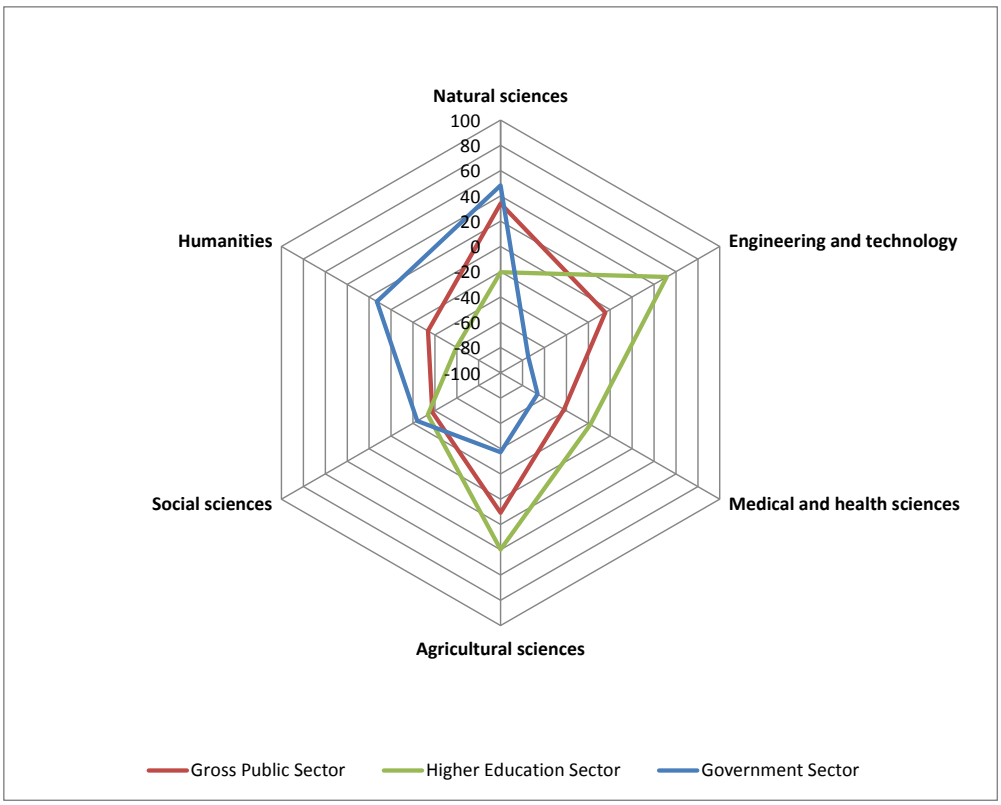
Figure 37: R&D Expenditures by Research Type and Country in the Gross Public R&D Sector (2007)



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 complementary 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 38: Scientific Specialisation of the Gross Public Sector (2007)



Source: Eurostat (2010), calculations JOANNEUM RESEARCH

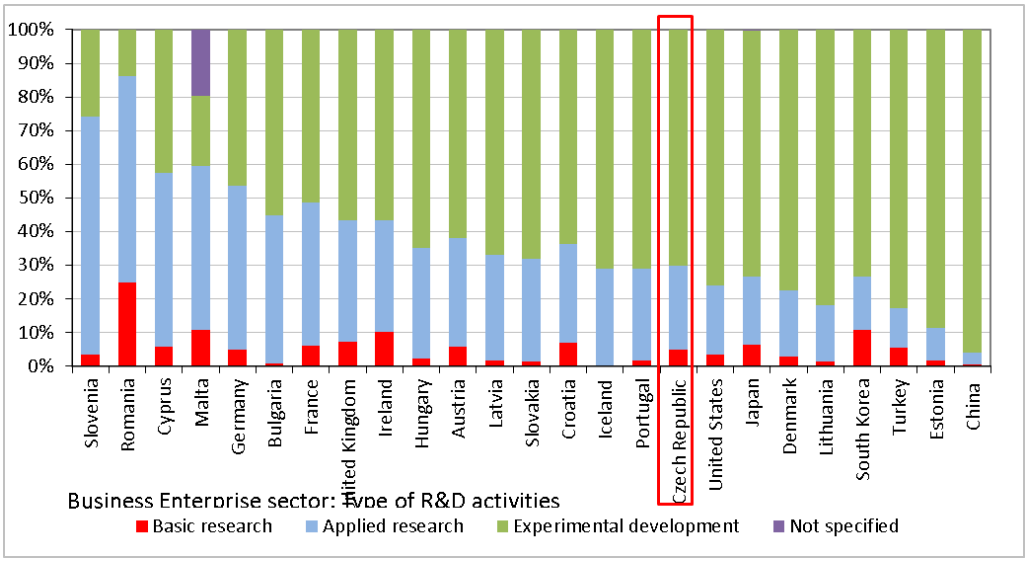
However, a merged analysis for the Gross Public Sector reveals that only positive specialisations in Natural Sciences and Agricultural Sciences remain. R&D expenditures in the Social Sciences and the Humanities are clearly below the shares of the benchmarking countries, and also the Medical Sciences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

2.3 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).

Figure 39: R&D Expenditures by Research Type and Country (Business Enterprise Sector)



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 9: 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 proofs 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.

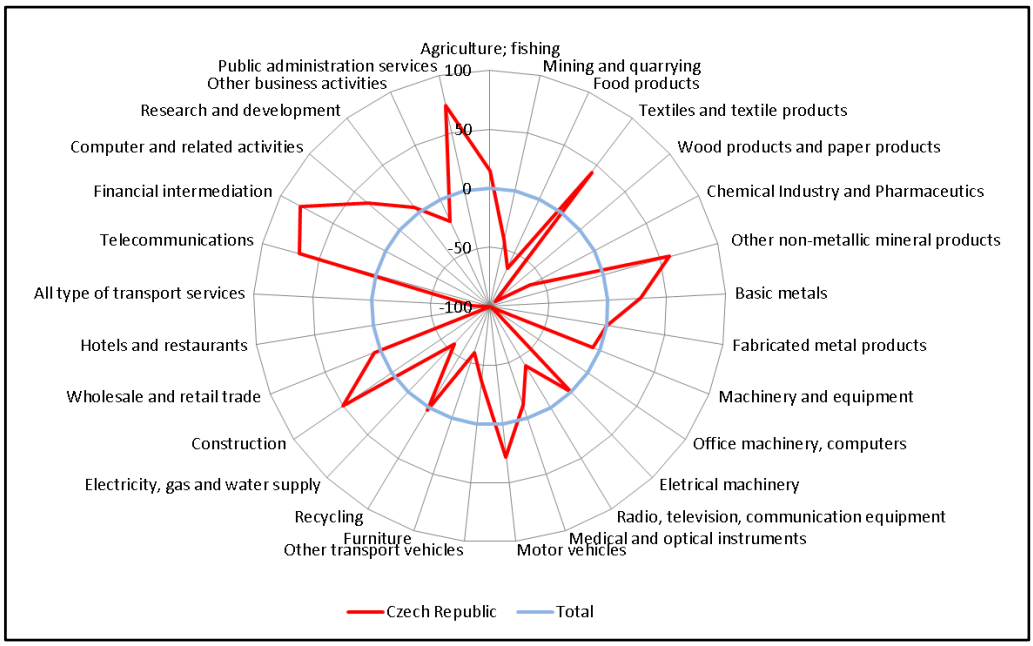
Table 10: R&D Performed in the Business Enterprise Sector by Industrial Branches and Selected Country (2007)

	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 40 is based upon disaggregated sectoral R&D performance data for the 12 EU member states displayed in Table 10. 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 40: 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.

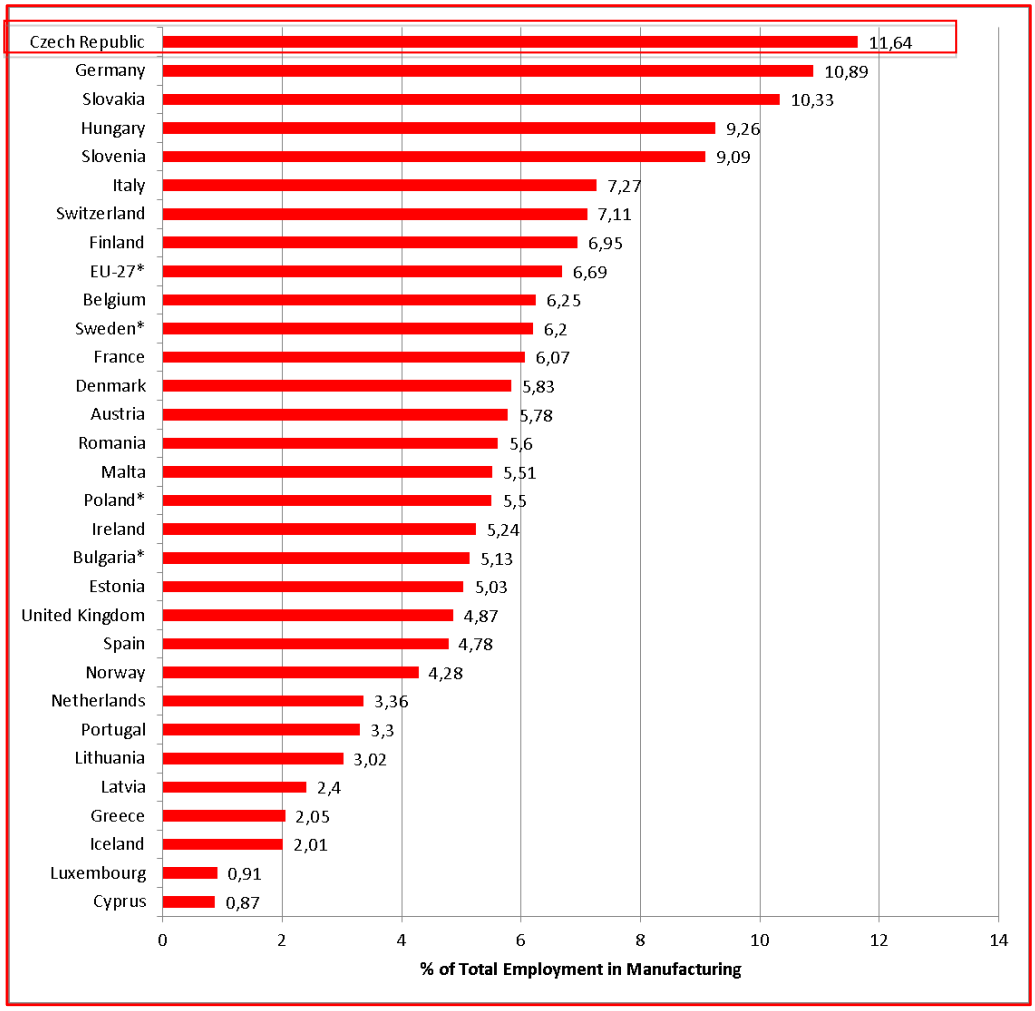
Within the services sector, positive specialisations are observed in the branches Public Administration and Related Services, Financial Intermediation, Computer and Related Services, and Telecommunications.

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).

Figure 41: Employment in High- and Medium-High Technology Manufacturing Sectors (2008)



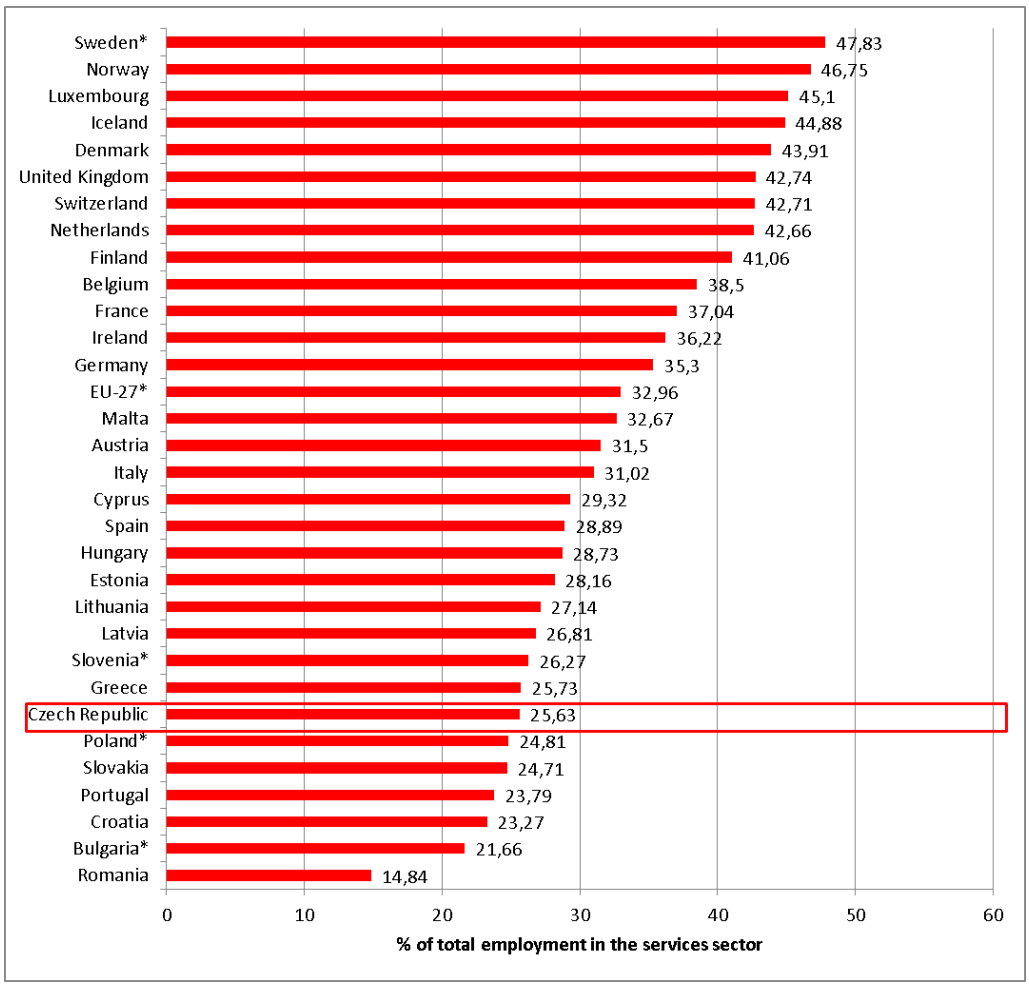
Source: Eurostat (2010)

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 42: 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. 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. In total, SMEs account for 36.2% of 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 particular 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, the data reflect that the nationwide R&D intensity increasingly depends upon the R&D activities of large firms.

Figure 43: 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

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

Whereas chapter 2 and chapter 3 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.

The chapter provides a stock-taking about the current portfolio of instruments and financing measures, the corresponding priorities, and the planned investments as indicated in the budget proposals of the national accounts. In addition to the national R&D financing, also a description of themes and priorities of the operational programmes of the EU structural funds are provided.

As the portfolio of funding instruments in the Czech Republic is currently in a phase of dramatic change, an assessment on the appropriateness of the instrument portfolio and the potential impact of the measures may only be fully assessed once interviews and additional data gathering have been completed. A complete analysis on the instrument portfolio, including the potential impact of the operational programmes will be provided for the final report.

3.1 Organisation of Public R&D Funding in the Czech Republic

This part provides a brief overview on the present governance system for public R&D funding in the Czech Republic, in order to provide short but concise information about the main ministries providing support for R&D activities and the main funding bodies, the respective responsibilities and the relevance in terms of research funding via R&D projects and programmes. A detailed analysis on the governance structures and its functions is provided in the work packages B&C (R&D Governance and Management).

3.1.1 Ministries and Agencies Responsible for Targeted R&D Funding

In the Czech Republic research and development is qualified as a public good, thus the public funding of R&D is stipulated by a separate R&D act (adopted in 2002), which describes the conceptual framework of public funding in detail and sets the general financing mechanisms.

At the federal government administration level, each ministry is responsible for research in its own area of competence; e.g. the Ministry of Health is responsible for research agendas in the field of health research. Hence, in order to provide room for co-ordination, there exists a main co-ordinating body – the Research and Development Council. According to the R&D act, the Council is an advisory body to the Government of the Czech Republic. The 2008 document, 'Reform of the R&D system' and the national R&D policy for 2009-2015 have foreseen, that the Council is transferred into the central and single co-ordination body at national level, dealing with the entire R&D area. Already today, the Council operates almost as a 'virtual' science ministry, coordinating R&D policies top-down and having a strong say in budgeting.

Until recently the federal R&D budget contains 22 budgetary chapters, including the specific ministries and their R&D agenda plus some of the main funding bodies, which are at present: the Grant Agency of the Academy of Sciences (GA-ASCR) – a funding body within the Academy of Sciences –, the Czech Science Foundation (Grant Agency of the Czech Republic) (GA-CR), and the Technology Agency (TA).

In the course of the national R&D reform act from 2008 the budgetary chapters were being reduced from 22 to 11 entities, which provide targeted R&D funding measures. As regards delivery mechanisms for R&D projects, the following changes in the funding system have been implemented at present:

- In July 2009, the role of the Academy of Sciences and its Grant Agency changed[11]. The Academy will gradually cease to be the provider of special-purpose public support in research and development, which will lead to its gradual ending of the activity of 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.

Although a large number of ministries are at present active providers of R&D project funding measures, the following ministries play a particular role in the R&D funding system at present:

- Ministry of Education, Youth and Sports (MEYS): This ministry bears the responsibility for participation of the Czech Republic in multilateral and bilateral international cooperation (7th Framework Programme, COST, EUREKA, etc.) as well as for the participation of the Czech Republic in international R&D organisations (European Science Foundation, etc.). The MEYS has a multi-facetted role in R&D, e.g. it administers the programme 'R&D Centres' that currently covers 33 research centres. Each centre e.g. 'Centre for Integrated Genomics', is based on co-operation of several research institutes, universities and industry, which is supported by a considerably high budget. At present, the ministry is the biggest provider of competitive funding in the Czech Republic. The majority of these funds is provided within the framework of research programmes whereby the ministry organises thematic calls on the topics defined under the National Research Programme II and subsequently manages the projects. The recipients are most frequently universities and other research organisations.
- The Ministry of Industry and Trade (MIT): 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.

In addition to the Ministry of Industry and Trade and the Ministry of Education, Youth and Sports, the Ministry of Culture, the Ministry of Interior Affair, the Ministry of Defence, and the Ministry of Agriculture have sector specific competencies in managing targeted R&D funding measures:

- 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.

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

- 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.

3.1.2 Intermediary Agencies – Funding Bodies

In most ministries, there exist specific sub-departments which are responsible for R&D programmes. These departments report directly to their head of department who then reports to the minister. As exceptions, the Ministry of Health and the Ministry of Agriculture have internal grant agencies.

Although the responsibility for programme development and programme management is performed in specific departments of ministries, there exist at present three relevant grant agencies, which currently have, or are supposed to have main responsibilities regarding R&D programme management in the future, once the 2008 reform of the R&D promotion system will be fully implemented[12]. The present responsibilities and respective programmes of these agencies are detailed in the following, according to their self-presentation in the web.

3.1.2.1 Technology Agency of the Czech Republic (TA CR)

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 fundamental research and development (R&D) reform in the Czech Republic, which pursued the main aim to simplify the national R&D support system.

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.

At present, the Technology Agency operates one active R&D programme, the ALFA Programme. The programme supports projects of applied research and experimental development and stimulating increased intensity and effectiveness of R&D cooperation between businesses and research organisations. Three additional programmes have currently been approved by the Government: Beata, Omega and Centres of Competence.

3.1.2.2 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). The Czech Science Foundation – GACR (Grantová agentura České republiky) was established in 1993 as an independent institution.

[12] The activities of the Grant Agency of the Academy of Sciences are not presented in this study, as the Grant Agency does not launch any new programs or funds new projects as its funding activities are phasing out.

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). At present, the Czech Science Foundation provides support via the following funding mechanisms:

- STANDARD PROJECTS**:** aim to promote excellence in non-oriented basic research. Scientists of any discipline who are working at Czech research institution may apply for such projects; the topic of research is chosen by the applicant, hence the project portfolio purely is created in a bottom-up process, and resource allocation is based upon high scientific quality, originality and innovativeness. Average funding per project is 34 thousand EUR per year, for a maximum duration of 5 years.
- POST-DOCTORAL PROJECTS: aim to increase the interest of graduates of doctoral studies at work in institutions with a high professional level and to contribute to alleviate problems associated with their salaries. As for the standard projects, there is no top-down process regarding themes/fields of research being funded. Applicants of any discipline may address this fund within 4 years following their doctoral defence. Duration of projects may last up to three years, average funding per year are 12.560 EUR.
- INTERNATIONAL PROJECTS: In addition to the two national funding mechanisms, the Czech Science Foundation engages in the following international R&D programmes:
  - EUROCORES, established by the European Science Foundation seeks to create conditions for financing basic research at a pan-European level and to coordinate the choice of topical scientific subjects on a supra-national principle.
  - BILATERAL GRANT PROJECTS, based upon cooperation agreements between the Czech Science Foundation and DFG (Deutsche Forschungsgemeinschaft), KRF (Korea Research Foundation), and the NSC (National Science Council of Taiwan). These bilateral-agreements seek to support joint projects allowing participating scientific teams from both countries in international cooperation in the framework of interdisciplinary and promising topics and the directions of contemporary science.

3.1.3 CzechInvest

CzechInvest, the Investment and Business Development Agency, is an agency established by the Ministry of Industry and Trade in 1992. The agency contributes to attract foreign investment and developing domestic companies through its services and development programmes. CzechInvest also promotes the Czech Republic abroad and acts as a mediator between the EU and small and medium-sized enterprises in implementing structural funds in the Czech Republic.

CzechInvest is exclusively authorized to file applications for investment incentives at the competent governing bodies and prepares draft offers to grant investment incentives. Its task is also to provide potential investors current data and information on business climate, investment environment and investment opportunities in the Czech Republic.

CzechInvest´s services include:

- comprehensive services for investors
- full information assistance
- handling of investment incentives
- business properties identification
- supplier identification
- aftercare services
- business infrastructure development
- access to structural funds

Within the framework of financial support for investments, CzechInvest provides aid programmes for both Czech and foreign investors on behalf of the Ministry of Industry and Trade. These programmes are focused on various areas of business and are financed from European Union structural funds – Operational Programme Enterprise and Innovation, Operational Programme Human Resources and Employment – as well as from the Czech Republic's national budget in form of investment incentives for the manufacturing industry:

- Investment incentives for manufacturing industry: Since 2007 this predominantly tax-incentive measure offers both Czech and foreign investors who are introducing new production or expanding existing production the following incentives:
  - Corporate tax relief: A full tax relief for 5 years (newly established companies), and a partial tax relief for 5 years (expanding companies).
  - Job-creation grants: 50,000 CZK per employee in the regions worst affected by the unemployment.
  - Training and re-training grants: 25% of training and retraining costs in the regions worst affected by the unemployment.

    The total amount of the afore mentioned investment incentives (with the exception of training and re-training grants) must not exceed 40% (50% in case of medium enterprises, 60% in case of small enterprises) of the investment made into long-term tangible and intangible assets.
- The International Cooperation Programme between the Czech Republic and the State of Israel in applied research and experimental development GESHER/MOST is designed to support the participation of Czech companies of all sizes involved in research and development in cooperation with their partner companies in the State of Israel in applied research and/or experimental development projects. Research organisations can participate in the project only as a partner of a company. Projects shall cover the fields ICT, sustainable technologies, agricultural and food-technologies, and engineering (new materials, nanotechnologies, cybernetics and robotics).
- Until 2009 CzechInvest supported also the creation of technology centres and business support services centres of companies.

- The technology centres supported focused on the development and innovation of high-tech products and technologies, including the development of specific software and applications.
- Centres of business support services are centres engaged in the selected activities of companies, which are characterized by their close ties to information technologies and distinct international focus, in particular on shared services centres, high-tech repair centres, software development centres and ICT expert and solution centres.

The level of state funding for these centres was dependent on a) investment levels of the company, b) the number of new created jobs, c) the geographic location. The purpose of the subsidy was to cover payroll costs. Depending on the geographic location of the centre, funding was in the range of 10% to 40% of eligible costs.

Apart from the above mentioned programmes, the main activity of CzechInvest is to manage the Operational Programme Enterprise and Innovation of the EU-Structural funds on behalf of the Ministry of Industry and Trade. A description of this programme is provided in the analysis of R&D programmes.

3.2 Targeted R&D Funding: Current State and Development of the Programme Portfolio

3.2.1 Theoretical Framing

Direct R&D funding measures, which provide support via grants and loans, remain the preferred type of public support to business research and account for increasingly large shares of R&D performed in the Higher Education Sector and the public sector.

Research funding via 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. Hence, they allow encouraging i.e. science-industry collaborations, technology transfer or research capacity building. Typically, the underlying rationales for direct R&D government interventions are:

- Market failures: arising from imperfect appropriability of social and private returns (Arrow 1962)
- Uncertainty: requires high risk premium
- Financial constraints (in particular relevant for SME´s and start-up enterprises)
- Agent failures: asymmetric information -> moral hazard and adverse selection; principal-agent -> opportunistic behaviour, free-riding, and
- Systemic failures: wrong institutional frame and organisation, lock-in problems and transition/adaptation problems, insufficient collaboration, insufficient infrastructure (Smith 1998).

While market failures constitute the basic rationale for state funding of R&D in general and measures promoting higher education, the main underlying rationale of most of R&D support measures geared towards the private sector seek to tackle systemic failures, and its micro-level manifestation of seeking behavioural additionality: '*Wherever possible resources, financial or otherwise, should be used to guide firms strategies towards behaviour which will strengthen their innovative capacities and hence their motives to perform R&D.*' (European Commission 2003).

For analysing the targeted R&D support measures of the Czech Republic, we follow a definition of direct financial R&D measures as involvement of direct transfer of financial support for R&D from public to the private and/or public sector in terms of grants and loans:

- Grants cover a percentage of the costs of an R&D process or project depending on several numbers of factors like level of risk, nature of expenses or geographical location. Typically they are competitive financial awards. So they may generate a clear targeted behavioural change in business R&D. Depending on the conditions for getting the grant a sequential adaptation of the private R&D activities, either in organisational or behavioural terms as well as in orientation and direction of R&D may be the consequence. Grants therefore have a selection mechanism working. Changing the possibilities of financing a R&D project through reducing the private costs is the guiding element of grants. In combination with the fine tuning of the criteria for getting them, their strength exactly lies herein.
- Loans may be aimed at the finance of newly established firms or established firms. The former are often called 'soft loans' to support young high-tech firms. Conditional reimbursable loans have to be paid back in case of a successful innovation. Because they are at least partly recorded as liabilities, they have a limited incentive effect. While large firms do not need them really, and small firms have to be aware of paying them back and have them recorded as liability they are not a first choice. There may even be a disincentive to succeed or at least declare success.

(Source: EC 2003)

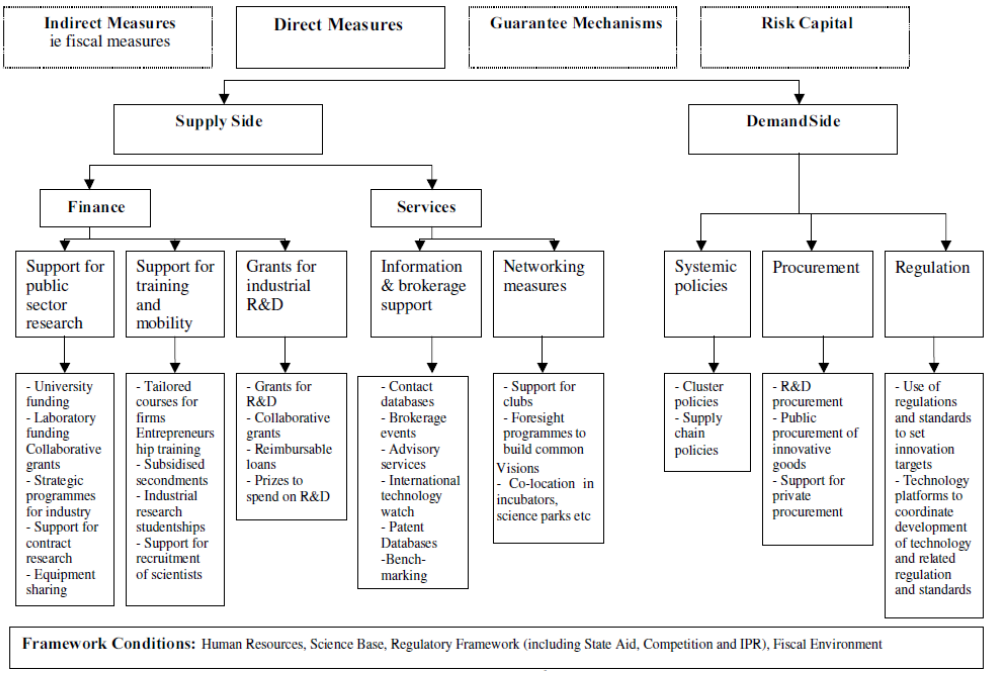
Grants, loans (and prizes) may be aligned towards the supply-side of direct R&D support measures, whereas on the demand side procurement measures constitute a direct R&D promotion mechanism: By specifying the functions of a product or system and financing at least parts of the R&D activities in these cases, public procurement measures may provide an important incentive for firms to undertake the necessary R&D.

However, the specific roles of direct R&D funding mechanisms are large. The EC (2003) study developed a typology of such measures and a framework to classify the policy types by the deficiencies they seek to address. The study summarised these deficiencies as follows:

- Resources: Where there is insufficient resource, usually money, to undertake the work, without public funds. This is generally the case for academic research and is accepted to be so for certain areas of business R&D which are highly uncertain and/or where social returns justify an investment which does not meet private criteria.
- Incentives: Where the scientific structures or the market do not provide sufficient incentives for socially desirable behaviour, for example academic-industrial collaboration.
- Capabilities: Where organisations lack key capabilities needed for the innovation process, for example the ability to write business plans or raise venture capital.
- Opportunities: This refers to the generation of opportunities for innovation and provides one of the main justifications of public science.

A general classification of direct R&D support measures is provided in the figure below.

Figure 44: General Classification of Direct R&D Support Measures



Source: European Commission (2003)

On the supply side of direct R&D promotion measures, one may distinguish between grants for industrial R&D, support measures focusing on the development of human resources and mobility and support for training, and grants for public sector research. Among support measures for public sector, research strategic programmes, which seek to foster science-industry collaboration, play a crucial role in terms of policy interventions.

3.3 National Targeted R&D Funding

In the following we provide an overview about the level of targeted R&D funding in the Czech Republic and its thematic orientation in terms of target groups, objectives and intervention mechanisms.

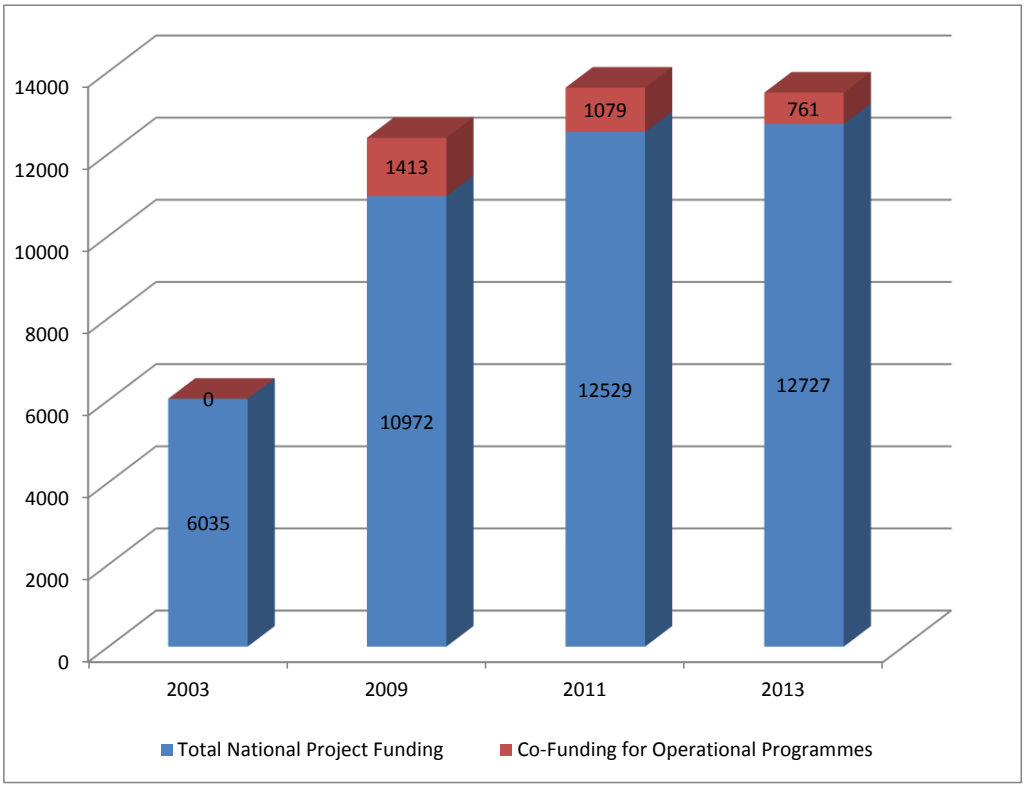
3.3.1 The Level of Targeted R&D Funding

The medium-term outlook of the National Public R&D outlays for 2013 is currently estimated at a total of 25,392 million CZK[13] (approx. 1.024 million Euro), of which 50% are foreseen to be spent via targeted R&D funding mechanism, 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 (see figure below). Co-funding of international programmes (operational programmes) accounts for about 11% in 2009 and levels are expected to stay roughly at these levels.

Main changes are foreseen as regards the allocation of targeted funding over the different funding bodies.

[13] Source: Příloha k čj.: 13877/10-RVV

Figure 45: Trends in Level of National Targeted R&D Funding, including Co-funding of Structural Funds (in tsd. CZK)



Source: National Accounts and Forecasts, calculations JOANNEUM RESEARCH

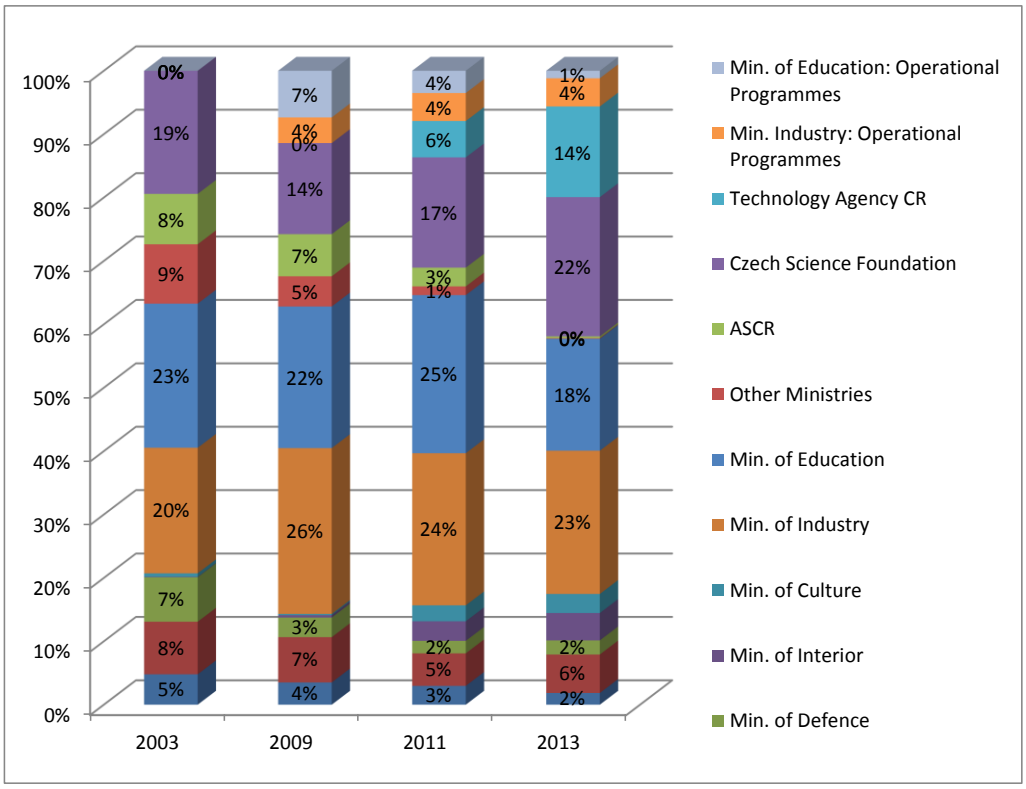
After setting up the Technology Agency and widening the scope of R&D funding of the Czech Science Foundation (Grant Agency), the two agencies are expected to account for 36% of total targeted funding in 2013. While the Czech Science Foundation is supposed to mainly address basic research activities, the main task of the Technology Agency is to provide funding for specific technologies/sectors and policies fostering linkages between science and industry.

In addition to the funding agencies, the Ministry of Industry and Trade and the Ministry of Education, Youth and Sports are still foreseen to play major roles in targeted R&D funding on their own behalf.

Excluding co-funding for operational programmes, 23% of targeted R&D funding in 2013 are foreseen for the Ministry of Industry and Trade, which concentrates all targeted budget in one sole programme TIP, which was launched in 2009 and is scheduled to continue until 2017. After that period, the Ministry of Industry and Trade is supposed to stop its funding activities. Taking into account co-funding of operational programme, 27% of total targeted funding are hence preserved for industrial R&D purposes only. The Ministry of Education, Youth and Sports seems to delegate some, but not all funding activities to the Science Foundation, as the share of total targeted R&D funding is expected to decrease from 23% to in 2009 to 18% in 2013, once the Technology Agency and the Science Foundation are fully implemented.

The figure below shows further that the Grant Agency of the Academy of Sciences ASCR, which distributed about 8% of total targeted R&D funding for researchers of the entire R&D sector, is fading out its financing activities as it stopped funding new projects in 2009. Also the role of other ministries in targeted R&D funding is expected to vanish in the targeted R&D funding system. Only the Ministry of Health (6%), and the Ministries of Defence, the Ministry of Interior and the Ministry of Culture (2%-4%) will still play a role in targeted R&D funding.

Figure 46: Trends in Allocation of Targeted Funding over the Funding Bodies



Source: National Accounts and Forecasts, calculations JOANNEUM RESEARCH

3.3.2 Targeted R&D Funding: Programme Portfolio

The portfolio of R&D programmes in the Czech Republic is in a phase of considerable change. Several programmes are phasing out, responsibilities of ministries and funding agencies are changing, and a number of research programmes are in a planning phase. Hence, this part of the report tries to capture the current state of the targeted R&D financing portfolio, and sketches its future development. The main source for the description of the relevant programmes at place is the proposed government budget on targeted R&D financing for the years 2011-2013.

For providing an overview on the targeted R&D funding system, we consider different types of programmes according to the following categorisation:

- Programmes which are in a phasing out phase: no new calls are launched, but some projects are still in a finalisation phase and therefore receive funding;
- Programmes which launched calls in 2009/2010, and plan to launch new programmes in the future (running programmes);
- New programmes that have been opened in 2010 or will be opened in subsequent years.

3.3.2.1 Programmes which are currently phasing out

The table below provides an overview about programmes which are currently in a phasing out phase.

Table 11: Programmes which are Currently Phasing Out

Org.	Activity Name	Start	End	Funding in 2009 (in tsd. CZK)
ASCR	Grants of distinctly investigative character focused on the sphere of research pursued at present particularly in the ASCR	2002	2013	320,863
ASCR	The research grant projects for juniors	2003	2011	102,475
ASCR	Information Society (National Research Programme)	2004	2009	37,174
ASCR	The support of targeted research projects (National Research Programme)	2005	2009	47,838
ASCR	Nanotechnologies for Society	2006	2012	315,493
MD	Branch research (Support to the development of sustainable transport)	2007	2011	98,669
MD	Safety and economical transport (National Research Programme)	2004	2009	56,242
MK	Research and scientific evaluation of cultural and historic values of our environment	2006	2011	4,158
MK	Protecting cultural, artistic and scientific resources and making them accessible	2006	2011	10,472
MK	Scientific documenting and evaluation of the development of music, theatre and visual arts, literary history, theory and criticism;	2006	2011	3,214
MK	Research and scientific evaluation of cultural values of the environment, identification, protection , processing and presentation of historical monuments	1996	2010	1,300
MMR	Research into Solutions to Regional Disparities	2007	2011	29,210
MO	Possibility - The achievement of declared NATO´s requirement	2006	2011	130,717
MPO	ADVANCEMENT (National Research Programme)	2004	2009	30,386
MPO	Sustainable welfare	2006	2011	465,397
MPO	Digital Broadcasting, Electronic Communication and Development of Information Systems in the public administration	2008	2012	5,600
MPO	IMPULSE	2004	2010	868,630
MPO	TANDEM	2004	2010	564,034
MPSV	Modern society and its transformation	2004	2009	3,721
MPSV	Research for government administration in the field of social policy, social affairs, employment and occupational safety	2005	2009	18,489
MS	Society, sanction policy, crime	2008	2011	6,000
MŠMT	The research centres (National Research Programme)	2005	2009	830,000
MŠMT	Health and quality of life	2006	2011	504,043
MŠMT	Information Technology for the Knowledge based Society	2006	2011	59,295
MŠMT	Social-economic development of the Czech Society	2006	2011	36,342
MŠMT	Human Resources	2006	2011	40,844
MŠMT	Centres of Basic Research	2005	2011	592,601
MŠMT	INFOZ (Information resources for research)	2009	2011	150,000
MV	Departmental research and development			1,300
MV	Security Research	2006	2010	42,882
MZ	Departmental Programme of Research and Development - MH II from 2008 to 2011	2008	2011	560,168
MZ	Population Health (National Research Programme)	2004	2009	14,767
MZ	Branch programme of research of the Ministry of Health	2004	2009	306,551
MZe	Using of natural sources (National Research Programme)	2004	2009	23,959
MZe	Research programme of Ministry of Agriculture 2005 - 2009	2005	2009	32,500
MZe	The Research Programme in the Agricultural Sector 2007 – 2012	2007	2012	319,952
MŽP	Research Programme of the Ministry of Environment for 2007 – 2011	2007	2011	270,866
MZV	Modern Society and Its Changes - Scientific projects in the sphere of international relations	2004	2010	7,373

Source: State Budget

The table shows, that the programmes ,which are currently in a phasing out phase (no new calls launched since 2008/2009), mainly consist of the programmes of the Grant Agency of the Academy of Sciences, the National Research Programme I and the National Research Programme II.

A second group of large programmes which stop its financing activities are the programmes TANDEM and IMPULSE of the Ministry of Industry and Trade. Furthermore, some programmes of the Ministry of Education, Youth and Sports are in a closing phase.

Due to the re-organisation of responsibilities as regards research financing, also specific branch programmes of certain ministries cease its funding activities in 2010. For some of them new programmes are currently being set-up or just have launched (i.e. The Ministry of Interior just has started to launch a new programme on security research).

In terms of funding volume, the largest programmes which stop its funding activities are IMPULSE, the National Research Programmes I+II (which consist of a series of sub-programmes), the Centres of Basic Research and the Research Centres, TANDEM, and the Departmental Programme of the Ministry of Health.

In the following we provide more detailed information on targets and beneficiaries of these R&D financing schemes.

The National Research Programmes I+II

According to INNO-Policy Trendchart, the main objectives of the National Research Programmes were:

- to increase the performance and effectiveness of Czech research and thus increase its contribution to the economy and society; to concentrate the support and research; to focus on a limited number of selected problems, for which the solution is regarded as urgent by a broad public and where the exploitation of achieved research results has a high potential;
- to ensure a dynamic renewal and development of research capacities in the Czech Republic using all possibilities of international cooperation in research;
- to strengthen and develop a positive relationship of public to research and development;
- to increase the professional level of research work and exploitability of research results in practice.

The whole programme was planned to consist of five thematic programmes and their sub-programmes:

- Quality of Life: Human Health, Quality and Safe Nourishment of Population, Landscape and Settlements of the Future, Environment and Protection of Natural Resources.
- Information Society: Intelligent Systems for Decision Making, Management and Diagnostics, Knowledge and Information Management, Communication Infrastructure and Technology, Computer Modelling and Design of Systems and Processes.
- Competitiveness at Sustainable Development: Safe and Economic Transport, Utilisation of Natural Resources, Production Processes and Systems, Buildings and Constructions, Advanced Materials, Emerging Technologies.
- Energy for Economy and Society: Safe and Effective Nuclear Power Engineering, Power- and Non-Power-Producing Utilisation of Coal and Carbonaceous Raw Materials, Rational Use of Energy and Renewable Energy Sources
- Modern Society and Its Transformation: Performance-Oriented, Safe and European-Integrated Society, Social Cohesion, Social Differentiation and National Identity.

Furthermore three cross-sectional programmes and their sub-programmes existed, including a) human resources for research, b) integrated research (research centres), and c) regional and international cooperation in research.

Notably, not all the thematic programmes and their sub-programmes were really launched. Sub-programmes that were launched included Support to Young Scientists

to Start Research, Research Centres, Information Research Infrastructure, Human Health, Landscape and Settlement of the Future, Utilisation of Natural Resources, Modern Society and its Transformation.

The follow-up programme, the National Research Programme II seeked to choose a more problem-oriented approach to its programmes, i.e. research is to be focused on areas of needs/opportunities (not on what is interesting and/or possible). Also, a lower number of priorities were to be arrived at and the NRP II has to be focused on applied research to be co-financed by the application sector (industry).

In organisational terms this is reflected by the fact that in addition to the Ministry of Education, Youth and Sports, also the Ministry of Industry and Trade played an important role in this programme and relevant other ministries were included in the management board of the programme, and again had a role in programme management.

The Programme consisted of the following thematic and cross-sectional programmes:

Thematic programmes:

- Sustainable Prosperity – implemented by the Ministry of Trade and Industry
- Healthy and Quality Life – implemented by the Ministry of Education, Youth and Sports
- IT for a Knowledge-based Society – implemented by the Ministry of Education, Youth and Sports
- Socio-economic Development of the Czech Society – implemented by the Ministry of Education, Youth and Sports.

Cross-cutting programmes:

- Human Resources – implemented by the Ministry of Education, Youth and Sports
- International Cooperation – implementation is being prepared
- Support to the Preparation and Implementation of a National Policy including Technical Assistance – implementation is being prepared.

In addition to these programmes parts of NRP I and NRP II were reserved for the Grant Agency of the Academy of Sciences. The Agency operated the thematic programmes Nanotechnology for Society, and projects of targeted research in the field Information Society.

The NRP II also funded the 'National Research Centres', which were introduced already in 2000. According to Sima (2008) the aims of this funding instrument are concentration of capacity and means into the selected spheres of research and into the limited number of centres, research oriented to the long-term requirements of the application sphere and regional development, early-stage researchers support and cooperation between different types of institutions. For the 2005-2009 there were 35 centres established with budget ranging from 80 to 300 mil CZK (2.8-10.7 million Euro). The Research Centres programme should be replaced by a new programme operated by the Technology Agency (Competence Centres) in 2012.

Both national programmes I+II were geared towards higher education institutions, research institutes and business enterprises. In total, the NRP accounted for about 10% of total targeted R&D funding in the Czech Republic. Due to the thematic orientation of the programme, it seems that NRP II was intended to replace departmental programmes of other ministries. However, as Sima (2008) states, the other departments/ministries adhered to their specific programmes, which were very similar in scope, had about the same allocation mechanisms, criteria and conditions, so that there could not be a meaningful reason to distinguish between them.

The Grant Agency of the Academy of Sciences

The Grant Agency of the Academy of Sciences was an internal funding body of the Academy of Sciences, which received state funding for performing targeted R&D projects. The table below provides an overview on the funding activities of the Grant Agency.

Table 12: Funding Schemes of the Grant Agency of the Academy of Sciences

	Standard Grant Projects	Junior Grant Projects	Publication Grants	Nano-Technology; ICT
Purpose	Disciplinary and interdisciplinary research in all fields of study basic research	Basic research grants for young scientists	Support for printing costs	Thematic orientation
Eligibility Criteria	No specific criteria	Early stage researchers with small research teams	Scientific relevance	Project in specific thematic field
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	Scientific relevance Peer review	Peer review Funding panel of the programmes

Source: Based upon Sima (2008)

As can be seen, the main programmes of the Grant Agency resemble the standard financing mechanisms of the Czech Science Foundation. In total, the funding schemes of the Grant Agency accounted for about 7.5% of total targeted R&D funding in the Czech Republic.

TANDEM and IMPULS

The programmes TANDEM and IMPULS were operated by the Ministry of Industry and Trade. Both programmes were launched in 2003 and focused on co-operation between research institutes and business entities in R&D.

The main goals of TANDEM were:

- improved cooperation between industrial and research organisations,
- provision of technology support to SMEs, and hence an increased competitiveness of products and technologies,
- significantly enhanced transfer of basic research results towards industrial research and development / applications.

The main selection criteria for the projects were that projects had to be carried out by teams covering both research and industry and all project participants had to be registered in the Czech Republic. Furthermore 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.

Also the IMPULS programme was supposed to foster the interconnection of research and industry, but, taking the innovation process as a point of reference, the main goal of the IMPULS programme was to transfer R&D results coming out of TANDEM into the development of models, prototypes, and semi-operational equipment. The programme is focused on industrial research and development of new materials,

industrial products, production technologies, information products and technologies. Hence, the programme supported projects that lead to concrete tangible results, such as prototypes or pilot operations.

For both IMPULS and TANDEM, the PRO-INNO Policy Measure Database comments that the demand for support in this programme exceeded the means of the state budget available. In 2009, the TANDEM programme accounted for 13% of total targeted R&D funding in 2009.

Additional programmes & relevance of phasing out programmes

In addition to the main phasing-out programmes operated by the Ministry of Industry and Trade, the Ministry of Education, Youth and Sports and the Grant Agency of the Academy of Sciences, also several branch programmes of other ministries are currently phasing out:

- Research programmes of the Ministry of Health were channelled through one programme included in National Research Programme ('Health of the population') and through the departmental programmes with a wide range of thematic definition. These programmes were usually announced annually, and managed by an internal grant agency, which operates and administrates its departmental programmes.
- Research programmes of the Ministry of Agriculture were geared to a large extent to the relatively large research infrastructure under its provision (8 institutes). The financing of these institutions are based mainly on core funding called 'Research Plans' (Sima 2008). The Ministry managed three sub-programmes of the National Research Programme and several thematic oriented departmental programmes that were usually approved biannually with duration of maximum 5 years.
- The Ministry of Environment also established research institutions (4) which were funding via core funding measures. In addition, three programmes of the National Research Programme in the field of environmental studies were financed by the Ministry of Environment. Since 2007 there is only one programme for project funding with four sub-programmes aiming at climate change, sustainable using of sources, and technology for observation and assessment.
- The targeted R&D budget of the Ministry of Defence is in particular specified for the modernisation and development of the Czech army and for the cooperation within NATO. Its present programmes are in a phasing out phase, but new strategic research plans for security research and defence have been set up and approved.

(Source: Based upon Sima (2008) and adapted by JOANNEUM RESEARCH)

The individual branch programmes of these ministries are each relatively small in size. However, in total they account at present for quite a large share of targeted R&D funding the Czech Republic, more than 30% of total targeted R&D support. Hence, altogether the phasing out programmes (National Research Programmes, Grant Agency of the Academy of Sciences, TANDEM and IMPULS, and National Research Centres), accounted for about 63% of total targeted R&D funding in the Czech Republic.

3.3.2.2 Currently Open Programmes

An overview about current programmes, which continue to launch calls is provided in the table below.

Table 13: R&D Programmes in the Czech Republic which continue to launch Calls

Org	Activity Name	Start	End	2009	2012	2013
GA ČR	Standard projects	1993	-	1392262	2202983	2486802
GA ČR	International projects	2007	-	38221	52488	38170
GA ČR	Doctor grants	2003	-	154656	72818	66798
GA ČR	Eurocores	2003	-	13871	32818	28628
GA ČR	Post-graduate (doctorate) grants	1998	-	179807	248936	257649
MO	Support of the operation capabilities of the Armed Forces	2008	2012	169314	47703	0
MO	Development - of attained operational capabilities of the Armed Forces	2008	2012	80000	57255	0
MPO	TIP	2009	2017	1298301	3047888	3047888
MŠMT	INGO + INGO II	1998	2017	168873	264281	133596
MŠMT	EUREKA + EUREKA II + EUROSTARS	1993	2017	112895	104681	103060
MŠMT	COST + Cost CZ	1993	2017	77048	74866	98288
MŠMT	Contact + Contact II	1996	2017	102861	242469	86837
MŠMT	EUPRO + EUPRO II	1994	2017	81417	77100	61072

Source: State Budget

As can be seen in the table above, the number of organisations, which continue to launch new calls in their respective programmes, is limited. Basically, the programmes are restricted to the following units:

- The Science Foundation/Grant Agency, which continues to fund its R&D programmes;
- The Ministry of Education, Youth and Sports, which continues to fund its international R&D activities;
- The Ministry of Industry and Trade and trade, which has introduced the TIP Programme in 2009/2010 and is expected to carry it on until 2017,
- The Ministry of Defence, which is operating its programmes for the development of the operational capabilities of the Czech Armed Forces.

Financing from the Science Foundation will continue to adhere to the mechanisms described in the sections above in this report and the standard projects of the Science Foundation will continue to be the most important financing mechanisms.

The budget foreseen for the Science Foundation is expected to rise by almost 100% until 2013. However, this figure is misleading, as the Grant Agency of the Academy of Sciences has discontinued its financing, and researchers from the Academy will increasingly address the programmes of the Science Foundation. Hence, taking into account the financing volume of the Grant Agency of the Academy, the level of financing is about to increase by a mere 12% only.

The Ministry of Industry and Trade has launched its new programme TIP in 2009. The programme is about the replace the programmes TANDEM and IMPULS, although

significant differences between the programmes exist. 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:[14]

- *New Materials and Products*. The applied research & experimental development is focused on the development of new competitive materials as well as on the development of new or improved industrial products and equipment. This may include the acquisition and testing of samples, prototypes or demonstrations and the testing of new technologies. 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*. Aim of this sub-programme 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*. This sub-programme supports applied research and experimental development that allows for more cost efficient, environmental-friendly, flexible, safer and faster production processes. This may include products and technologies with multiple application fields or potential applications in different markets; complex technologies and innovations that address current needs for the design, manufacturing, distribution and production processes and management, as well as technologies for an improved cost management (controlling). 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.

Subsidies are provided for applicants who use their own staff to do at least 50% of the work on project solution. Capital expenditures (in noncurrent intangible assets) should not exceed 20% of total approved costs. According to the call description, 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, and software. Hence, TIP is quite closer to the IMPULS Programme than to TANDEM.

Significant differences also exist as regards the composition of project teams. Whereas TANDEM required the participation of research organisations, the call documents on the Ministry's website do not provide specific indications on the constitution of the project teams (e.g. collaboration industry-research) nor on their size. Both industry and public or private research organisations can apply, assumed they can clearly prove that co-financing of the project costs will be provided for through their own private funds or other private funds.

In terms of programme size, TIP is expected to account for a large share of targeted R&D funding in the Czech Republic. In 2009 it already accounted for 12% of total targeted R&D funding. In absolute term R&D financing is going to increase by 234% and its share is expected to rise to 24% of total targeted R&D funding in 2013.

On behalf of the Ministry of Education, Youth and Sports, only the international R&D co-operation programmes are continued for financing. All five co-operation programmes together account for 5% of targeted R&D funding in 2009.

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

The R&D programmes of the Ministry of Defence are purely geared towards military R&D purposes. In total, both operating programmes account for 2% of targeted R&D funding in 2009.

3.3.2.3 Planned Programmes

Due to the restructuring of the system of targeted R&D support a large number of R&D programmes are currently being planned and set up. The Table below provides some basic information on the R&D programmes which are in its setting-up phase.

Table 14: New and planned R&D Programmes 2011-2013

Org	Activity Name	Start	End	2010	2011	2013
TAČR	ALFA	2011	2017	0	780102	1574523
TAČR	BETA	2011	2016	0	0	134550
TAČR	OMEGA	2011	2016	0	0	51530
TAČR	Programme of Applied R&D for the support of cooperation between research organisations and industry	2012	2018	0	0	167485
MV	Security Research for the Needs of the State 2010-2016	2010	2015	296804	420485	582096
MZ	Ministry of Health's Departmental R&D Programme III	2010	2015	0	266656	818767
GAČR	Centres of basic research	2012	2018	0	0	84219
MK	Applied R&D programme of the national and cultural identity Programme(NAKI)	2011	2017	0	331543	405559
MŠMT	Projects of large R&D Infrastructures	2011	-	0	597613	758037
MŠMT	ERC-CZ	2012	2019	0	0	57255
MŠMT	Comeback	2012	2019	0	0	76340
MO	Technology–development of high-tech defence technologies	2012	2018	0	0	0
MO	Defence: Applied R&D programme	2011	2017	0	66309	300591

Source: State Budget

As can be seen from the table above, the newly funded Technology Agency is about to become a main provider of targeted R&D support. At present, the Technology Agency is in the phase of establishing three programmes: ALFA, BETA, and OMEGA.

The ALFA programme 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, 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)

The first call of public competition of the ALFA programme was announced on the 24th of March 2010 and ended after two months on the 24th of May 2010. Results of the first call were published on the 19th of November 2010. Altogether, 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. 780 million CZK were allocated in the first year.

In addition to the ALFA programme, the following other programmes are currently being planned at the Technology Agency:

The first 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:

- Optimisation of processes of governance and formation of a legal and political system, including EU common policy,
- Creation of an environment for qualitative and quantitative development of human potential applicable in a knowledge based society,
- Strengthening of the competitiveness of Czech society in an international context, and
- Creation of information and a data base for modelling the socio-economic development of the Czech Republic in an international context.

The second is a programme of public tenders in research, development and innovation required by organisations included in the national governance system. Similar to the previous one this is a smaller programme with the budget of approx. 4 million EUR allocated for the first year. The programme is also approved for the period 2012 – 2016. Its main objective is the creation and analysis of new multifaceted systematic decisions, integrated systems, rules and norms, and the implementation of new information tools and infrastructures.

The third programme to be established is focused on supporting 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 2012 – 2019, which corresponds to the aim of the programme to promote long-term cooperation. This entails a considerable budget amounting to 6 billion CZK for the whole period.

In total the programmes of the Technology Agency will account for 14% of total targeted R&D financing in the Czech Republic.

In addition to the programmes of the Technology Agency, the Science Foundation is supposed to fund specific centres of basic research from 2012 onwards. The programme is to be seen as a follow-up programme of the 'Centres of Basic Research' currently operated by the Ministry of Education, Youth and Sports. The programme aims at fostering the cooperation of different types of institutions active in basic research activities. One of the applicants must be a Higher Education Institution; Projects should also comprise activities which allow involving PhDs and master students. Grants are provided by judgements on the scientific excellence of the researchers involved (peer reviews) and international cooperation activities of the institutions. The eligible costs are personnel costs with the exception of a small amount for institutional infrastructure.

The Ministry of Education, Youth and Sports also plans a project for supporting projects of large R&D infrastructures, and two programmes aimed at individual researchers (ERC-Czech, Comeback) [15].

Furthermore, all branch ministries (i.e. the Ministry of Health, the Ministry of Culture, the Ministry of Defence, and the Ministry of Agriculture) currently plan again departmental research programmes. All these programmes are based upon conceptual documents, which have been drafted from 2008 onward and are at present still in a development phase.

3.4 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. The main focus of the cohesion policy, which is financed via the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund (CF), is to contribute to sustainable growth, innovations and competitiveness. Additionally, the creation of an open, flexible and cohesive society with a high employment rate is a core objective of the policy.

3.4.1 Level of R&D Funding via Structural Funds

For the funding period 2007-2013, the Czech Republic has negotiated and agreed to set up 26 operational programs (OP) with the European Commission. In total EUR 26.69 billion are available from the European funds throughout the funding period, which is according to the information system on the structural funds, approximately three quarters of the annual state budget of the Czech Republic.

Eight of the operational programmes are focused thematically (for example on transport, science and education, employment, environment) and seven of them geographically (on the regions of Central Bohemia, Central Moravia, Moravia-Silesia, etc.) The other OPs allow cross-border, interregional and supra-regional cooperation or provide a technical, administrative and research background for cohesion policy implementation.

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

[15] For these planned programmes of the Ministry of Education, Youth and Sports no description of the main scope of these programmes could be obtained until today. A consideration of these programmes will be integrated in the final report of the study.

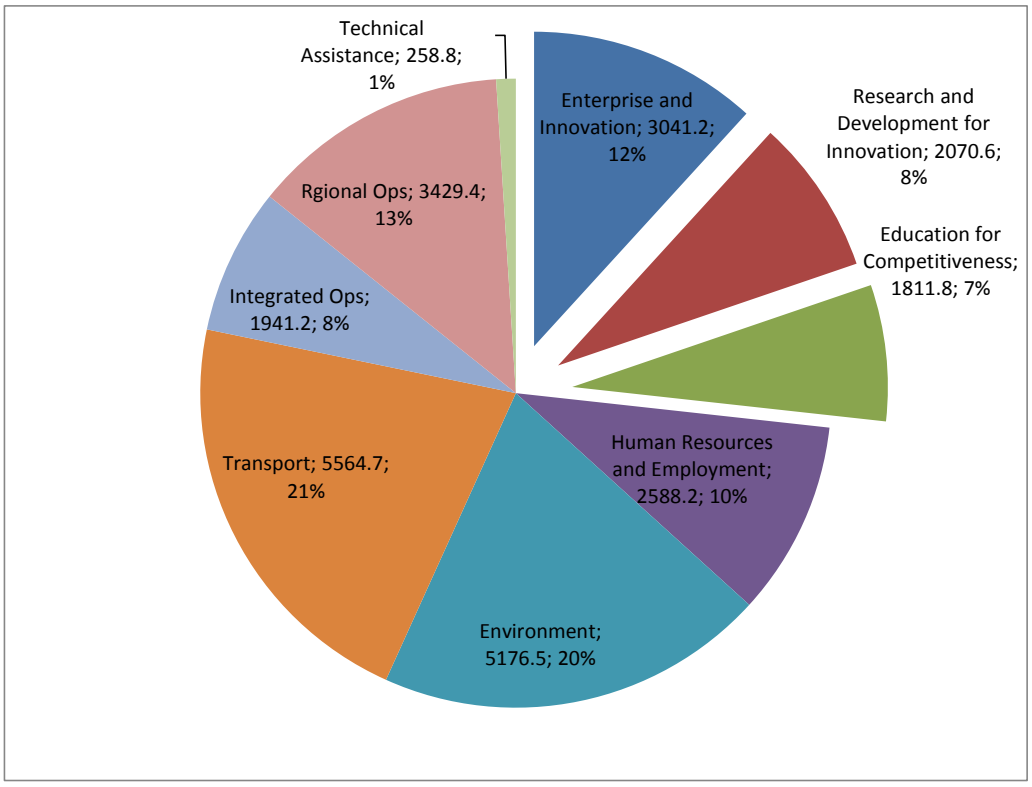
both business and abroad during the creation and implementation of innovated educational programmes,

- 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 private and public sectors, cooperation among tertiary educational institutions, research and development institutions and public sector etc.

In addition to these programmes which operate at a national level and exclude the city of Prague due to structural funds regulations, two small 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 are:

- In the Prague Competitiveness Programme, the priority axis innovation and enterprise of the programme 'Competitiveness' the amount of EUR 96.7 million has been reserved, i.e. 35% of the OP. Within this priority axis support is provided for 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 addition the development of small and medium-sized enterprises will be supported in the form of direct subsidies.
- 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.

Figure 47: Allocation of Thematic Operational Programmes in Mio Euro, 2007-2013



Source: Ministry of Industry and Trade and Transport, calculations JOANNEUM RESEARCH

The figure above shows the allocation of financing over all national thematic operational programmes, and it shows, that 20% of all thematic operational programmes, i.e. 5111.8 million EUR are explicitly reserved for R&D relevant funding measures.

The Operational Programme Enterprise and Innovation (OPEI) is the third largest Czech operational program: from the EU Funds, the amount of EUR 3.04 billion has been reserved for OPEI, which is approximately 12% of all finances intended for the Czech Republic.

Within the thematic programme education for competitiveness the amount of EUR 626.5 million (35% of the OP) is reserved for the priority axis 'Tertiary Education, Research and Development'.

Assuming an aliquot distribution over the funding period 2008-20013 (as most of the programmes started to fully operate only in 2008), this means that each year about 956.2 million EUR are reserved for targeted R&D funding measures within the operational programmes.

Compared with the national level of targeted R&D funding which is foreseen to be approximately 512 million EUR in 2013, the level of EU funding is by far exceeding national levels of targeted R&D funding.

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, descriptions of the priority axis and the respective programmes, including objectives and funding are provided for the OP Enterprise and Innovation and the OP Research and Development for Innovation. The relevant information is synthesized from the information site of the EU-Structural Funds in the Czech

Republic and information provided by the Ministry of Education, Youth and Sports and the Ministry of Industry and Trade.

3.4.2 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 managing authority of the OPEI is the Ministry of Industry and Trade.

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. The support areas define the types of projects that may be supported within the respective priority axis.

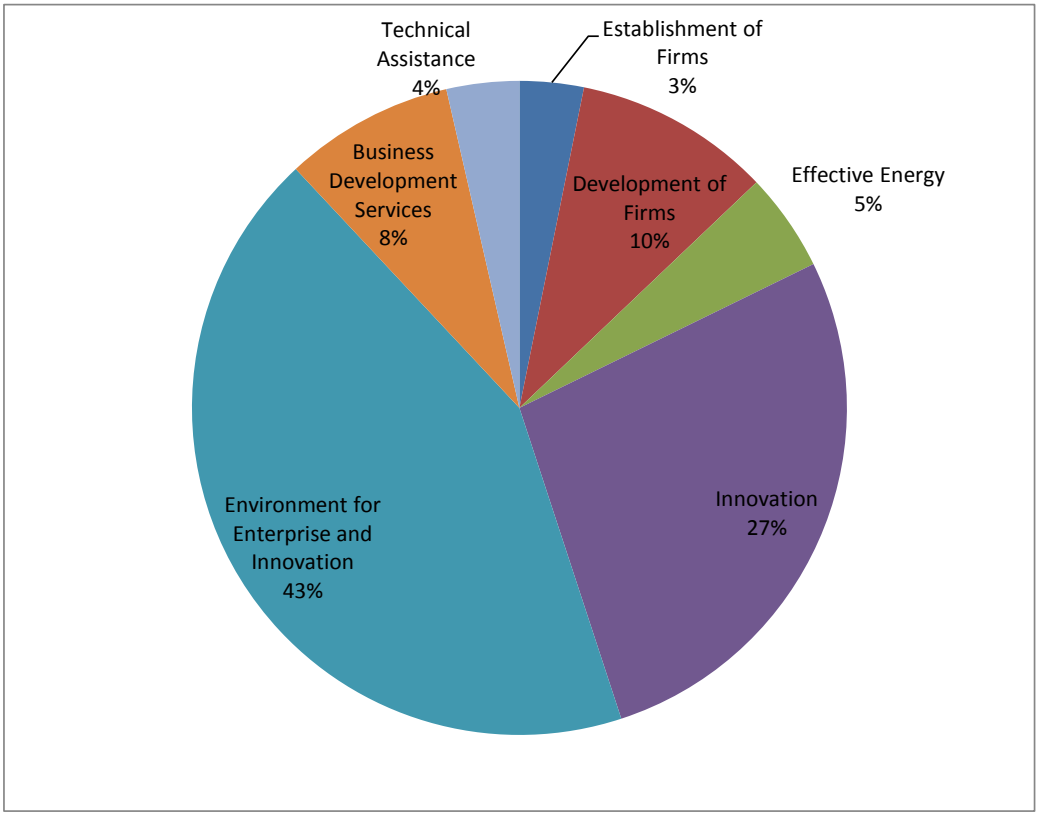
The following table provides a short description of the priority axes, the foreseen actions and programmes, and the level of financing provided in the period 2007-2013.

Table 15: 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

Figure 48 shows the distribution of financing in OPEI over the different priority axis.

Figure 48: OPEI – Distribution of financing over the different priority axis



Source: Information System on the Structural Funds in the Czech Republic

With a financing volume of 43% of the total OPEI, the priority axis 'Environment for Enterprise and Innovation' is by far the largest priority of the scheme. The programmes within the priority axis show a strong focus on the development of research infrastructures via the creation of technology parks and technology transfer centres, development of enterprise zones and education facilities:

- 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. Eligible costs are:
  - Acquisition of machinery and other facilities
  - Buildings (up to the amount of 40% of eligible investment costs)
  - Land (up to the amount of 10% of eligible investment costs) and long-term intangible assets
  - Acquisition of licenses and know-how
- 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. Eligible costs are the same as for the programme *Prosperity*.

Furthermore, the programme *Cooperation* seeks to provide incentives for clustering of firms to branches, and the development of joint technology platforms.

The second largest priority axis – called *Innovation*, which incorporates the two programmes *Innovation* and *Potential* focuses on both R&D infrastructure development within firms and on product- and process innovation and technology transfer:

- The programme *Innovation*, which accounts for about 60% of the priority axis' financing, 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.

The third largest priority axis is the priority 'Development of Enterprises'. The priority axis development of firms consists of four relatively small programmes *Guarantee*, *Progress*, *ICT-Business and Support Services*, and *ICT in Companies* The programme *Guarantee* acts as a risk-capital provider for SMEs to get easier access to finance, and the programme *Progress* provides loans for SMEs in order to allow for an expansion of its business activities. Both are operated by the Czech-Moravian Guarantee and Development Bank. In addition to these risk-capital measures, the programme *ICT-Business and Support Services* and *ICT in Manufacturing Companies*, operated by CzechInvest, finance the implementation and upgrading of ICT technologies in companies in order to increase the efficiency of their internal processes and spur their innovation potential.

Support includes:

- Introduction and expansion of information systems for increasing the internal efficiency of companies
- Introduction and expansion of information systems in the development of new products and technologies or improvement of existing products and technologies
- Introduction and expansion of information systems for increasing the efficiency of supplier-customer relationships
- Development and improvement of technical infrastructure and basic software
- Introduction and expansion of outsourcing of information systems or their part in companies.

Eligible costs for these programmes are mainly investment costs: the purchase of hardware and software, consulting and training measures, feasibility studies, as well as patents, know-how and licenses associated with the project.

3.4.3 The Operational Programme Research and Development for Innovations

According to the structural funds information system, the Operational Programme Research and Development for Innovations is focused on reinforcement of the research, development and pro-innovation potential of the Czech Republic, in particular through universities, research institutions and their cooperation with the private sector. It supports equipping the research workplaces with modern technologies, development of new research workplaces and increasing the capacity of tertiary education.

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.

With a total financing volume of over 2 billion EUR, it is the fourth largest Czech operational programme. As the OPEI, the Operating Programme Research and Development for Innovations (OPRDI) 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 following table provides an overview about the priority axes and their support measures.

Table 16: OP Research and Development for Innovations

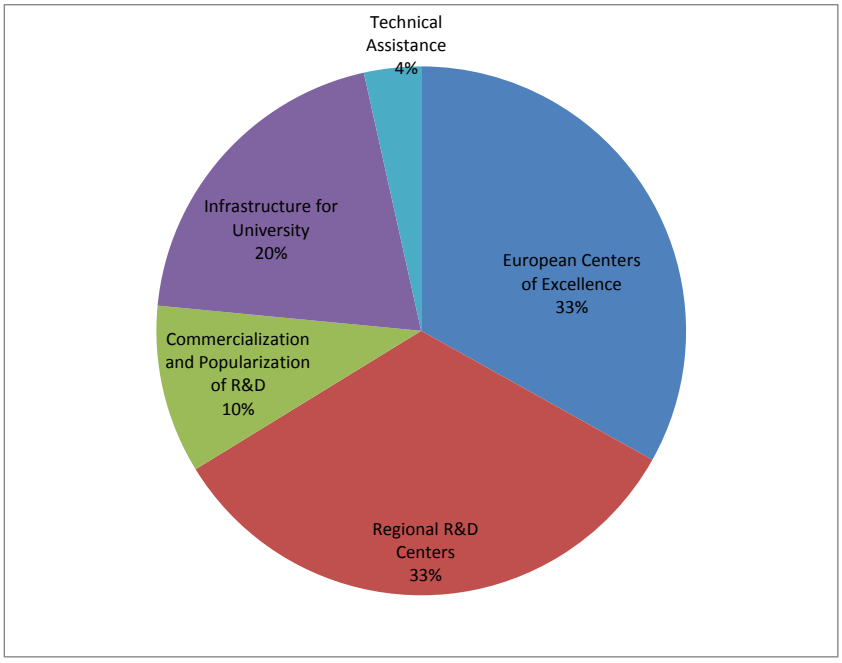
Priority Axis	Foreseen Actions	Total Funding (Mio EUR)
European Centres of Excellence	Reconstruction and extension of R&D capacities or possibly an economically justified construction of new capacities, including the necessary project documentation, acquisition of instrumental, laboratory and information 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

The two largest priority axis *European Centres of Excellence* and *Regional R&D Centres* 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 deemed to foster science industry linkages.

Figure 49: Operating Programme Research and Development for Innovation – Distribution of Financing over the different Priority Axis



Source: National Co-ordination Authority Structural Funds, calculations JOANNEUM RESEARCH

Additionally, the priority axis commercialisation and popularisation of R&D provides financial support for the commercialisation of R&D – up to the proof of concept stage and in consequence also deals with intellectual property protection.

Finally, the priority axis *Infrastructure for Universities* has a clear focus on upgrading the technical equipment of universities, especially for teaching.

4. Main Findings and Conclusions

This section lays out the findings of the analyses performed in the previous sections. In detail, the main findings focus on:

- The level of public and private R&D financing in the Czech Republic, the distribution of public R&D financing in terms of institutional funding versus project funding, the socio-economic priorities of public R&D financing, and the distribution of support to industry and the public sector
- The level of R&D performance in the different performance sectors and its specialisation (i.e. existence of critical mass in industry R&D).

In addition, this section presents preliminary findings on the adequacy of the current portfolio of national and international R&D programmes, its thematic priorities and beneficiaries.

4.1 On the Overall State of R&D Financing in the Czech Republic

Despite the recent economic downturn the Czech Republic has undergone a period of constant increases in R&D investments, which lasted for more than 15 years. Since 1995 total R&D expenditures of the Czech Republic have more than quadrupled, and compound annual growth rates of R&D intensity have by far exceeded the average rates of the EU-27. A comparison with the EU-member states shows that the Czech Republic exhibits the second highest share of R&D investments among the new member states and has already a higher R&D intensity at present than many of the Southern-European member states (notably Spain, Italy, Greece and Cyprus). While these member states by large have joined the EU much earlier than the Czech Republic and have received considerable structural support from EU funds, they are still far away from reaching R&D investment ratios of many northern member states.

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. In this respect, 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 national Business Enterprises Sector accounts for 45.8% in 2009 only. This however, is mainly due to the fact, that funding from abroad 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 financing for the Government Sector considerably (+58%) and of 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, as business R&D expenditures are closely linked to the business cycle: despite some counterfactual theoretical arguments, businesses tend to invest more in R&D in times of an economic upswing, whereas R&D expenditures are cut in times of a recession.

Given these fluctuations, the data of the last decade show, that the Czech Republic has at present the potential, that about 60% of total R&D financing may stem from private

sources, if funding from abroad is taken into account. The present financing structure in terms of performance sectors is thereby similar to that of France and the UK.

We may therefore conclude, that nowadays there is a solid base for the provision of both public and private R&D investments in the Czech Republic. There is of course room for improvement, but the overall development can be assessed to be very positive.

4.2 On the Distribution of Public R&D Support among Different Beneficiaries

R&D performance in the Czech Republic is characterised by three performance sectors among which the Business Enterprise Sector accounts for 60% of R&D performance, the Government Sector accounts for 21.4%, and the Higher Education Sector accounts for another 18.4%.

To varying degrees all three sectors receive public R&D support with a certain reason. R&D financed by public sources account for about 90% of R&D activities in the Higher Education Sector, 87% in the Government Sector , and 14% in the Business Enterprise Sector. Due to this strong dependence on public income sources in all three performance sectors, the study took a deeper look into the thematic orientation of public R&D financing and the mechanisms of allocation for national R&D funds.

Compared with other countries the share of government funding in the Higher Education Sector is very much comparable with most European Union member states, which have considerable higher shares of government funded income than a number of OECD countries, which can largely be attributed to the low shares of income generated via student fees. Also the low level of business funded R&D in the Higher Education Sector increases the role of government funded R&D. Although this might be interpreted as an indication for low science-industry linkages, the findings have to be interpreted with caution. The international comparison shows that only a very limited number of EU and OECD countries exhibit rates in between 10% and 20% of business financing in the Higher Education Sector and in most countries science-industry collaborations are heavily co-funded by public authorities.

For the Government Sector public financing is the most relevant income source as well. However, in international comparison the share of private funded R&D is considerably higher than in the Higher Education Sector (approximately 10%). In this respect data stemming from the Academy of Sciences have shown that the academy receives very considerable amounts of 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 and shows that distinct capacities for commercialisation exist in the Academy.

For the Business Enterprise Sector, government R&D financing accounts for 13% of total R&D activities, which is 6% points higher than the EU average. In 2009 20% of public R&D investments were performed in the Business Enterprise Sector. This relatively high share can be attributed to high shares of public funding towards the private R&D services sector, in which institutes have the form, but not the function, of private companies.

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 lower levels of GUF and relatively higher levels of other measures for General Advancement of Knowledge due to the large government R&D sector. 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, which points to the strong emphasis on industry support in public R&D expenditures.

In terms of GBAORD specialisation, the Czech Republic displays a strong positive specialisation in the objectives general advancement of knowledge, industrial production and technology, agriculture, and exploration and exploitation of earth. A strong negative specialisation compared with the EU-27 can be seen in the objective-fields education, culture, political and social systems, and exploration and exploitation of space. Additional national GBAORD data allowed identifying the main beneficiaries of public R&D funding, a repartition by scientific fields for the Government Sector and the Higher Education Sector, and for the Business Enterprise Sector the main targeted branches of state support.

In the Higher Education Sector, the largest part of General University Funds is reserved for engineering (26%) and medical sciences (17%). mathematics and computer sciences, the social sciences and the biological sciences receive about 9% of GUF. In the Government Sector GBAORD in the category general advancement of knowledge is strongly directed towards the physical sciences, the chemical sciences and the biological sciences. Also the medical sciences and the humanities receive slightly more than 10% of public funds. Hence, public funding for the both sectors is complementary in terms of research fields addressed. However, the international specialisation patterns of R&D performed in the Higher Education Sector and the Government Sector reveal, that the Czech Republic only shows a positive specialisation in the natural sciences and the agricultural sciences. In particular in the social sciences and the humanities we see clear patterns of underinvestment. In addition, also in engineering no clear positive specialisation exists. As the Czech Business Enterprise Sector shows a very distinct specialisation in a number of engineering and manufacturing related sectors, more attention should be paid to these sectors as well, as these are rather mature in their development (high shares of R&D expenditures and high relevance in terms of employment) and may be able to join endeavours with the public sector in terms of new research endeavours.

The high level of public R&D support geared towards the Business Enterprise Sector is strongly concentrated in the R&D sector, which provides professional, scientific and technical activities (40%). The Manufacturing Sector receives 31% of industrial GBAORD, and the ICT sector accounts for 9%. Also the sector human health and social work receives considerable amount of R&D support (11.8%). A consideration of GBAORD in the objective industrial production and technology shows which technical fields have been addressed by public funds. A strong concentration on engineering related fields was identified: Manufacturing and Processing Techniques, Aerospace Equipment Manufacturing, and Manufacturing of Non-Electronic and Non-Electric Machinery accounted for 35% of public expenditures. In particular the support of Pharmaceutical Products, Software Development, and Office Machinery and Data Processing Equipment, which are all sectors with a large growth potential, account for limited shares of public R&D support (2%-4%). Compared with the R&D expenditure structure and business R&D specialisation in the Czech Republic, we witness that the chemical and pharmaceutical industry, computer and related activities, which account for relatively large shares of investment, receive comparatively low levels of public R&D support. Hence, government R&D financing concentrated on fields of traditional strengths within the manufacturing sector. While this made sense in terms of upgrading existing technologies in order to sustain and further strengthen competitiveness in these sectors, which are also of high relevance in terms of employment, increased efforts should be put on sectors in which positive specialisations with a high growth potential prevail (i.e. computer and related services, financial intermediation), and in sectors, in which not yet a positive specialisation exists, but potential for growth exists (i.e. the pharmaceutical industry).

4.3 On the Level of Project Funding vs. Institutional Funding

The main direct allocation mechanisms in the Czech Republic are institutional funding measures and project funding measures. The allocation mechanism for institutional funding is portrayed in detail in Annex 3 of this study and is therefore not discussed in

here. Instead, the report focuses on project funding and its relevance for the different performance sectors.

At present 54% of public R&D funds are distributed via project financing mechanisms. Institutional funding accounts for 46% of total public R&D expenditures and is mainly geared towards the Higher Education Sector and the Government Sector.

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 the public 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).

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 on cost of institutional funding, because project funding mechanisms also have certain drawbacks that need to be considered:

- 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, and the programme implementation and its success has 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 show 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 (see Bourke and Butler 1999, Melin and Danell 2006).

These findings on the general level also hold true when looking at the different performance sectors. Research group leaders from universities, technical universities and the Academy of Sciences state, that about 60% of their 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. Thereby, 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 gross public R&D sector the operational programmes 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.

Another interesting finding, which needs to be taken into account, is 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 is perceived to have remained unchanged in the last three years. As the relative share of project funding is 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.

In the Business Enterprise Sector, project financing constitutes the main source of government support in addition to tax incentives. At present, the most important funding scheme is the TIP programme, which was launched by the Ministry of Industry and Trade just recently. The programme has a strong sector oriented focus on research for new materials and products, new advanced technologies, and new information & controlling systems. It is supposed to be the single programme for which industry R&D support is going to be provided. As opposed to the previous programmes 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. In addition to TIP, the Technology Agency launched its first programme called ALFA, which seeks to support projects of applied research and experimental development and stimulating increased intensity and effectiveness of R&D cooperation between businesses and research organisations. While these two programmes provide opportunities for business enterprises to engage with research organisations on a project basis, longer-term co-operations will be made available by means of the Operational Programmes and a planned Competence Centre Programme.

As all these programmes are at present in a starting phase, we may only present preliminary findings and general conclusions on Business R&D support while a systematic portfolio analyses on Business R&D support including the impact of the operational programmes will be integrated in the final report.

The general level of business R&D support in the Czech Republic is comparatively high. Nevertheless it needs to be stressed that a level of support of 14% means that public R&D expenditures may influence business decisions only in areas, where public support is necessary to launch R&D activities at all ,because, i.e. the risk for companies to engage in R&D activities, is too high. This holds in particular true for SMEs, start-up and risk-capital measures. For R&D active institutions the main focus of technology policy in the past seemed to be technological upgrading (i.e. facilitation of new equipment, material etc.). As opposed to this, measures tackling behavioural change and increased knowledge flows need to be fostered in order to allow for an increased circulation and upgrade of new knowledge.

4.4 On the State of R&D Performance in the Czech Republic

In terms of the R&D performance structure, the international comparison of R&D expenditures shows that the Czech Republic has considerably closed the gap towards the EU-27 and the OECD member states.

4.4.1 R&D Performance in the Higher Education Sector and the Government Sector

In the Czech Republic, 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 also concentrates to a large extent on the performance of academic oriented research activities, aiming at high shares and high quality of scientific publications.

The low shares of experimental development within the Higher Education Sector and the Government Sector point towards the direction that none of the sectors is a provider of business R&D services. This is worrying to some extent. Overall, the gross public R&D sector in the Czech Republic has one of the lowest shares of experimental development activities among all countries under consideration.

However, in terms of research fields covered, the two sectors can be considered as complementary. The Higher Education Sector shows specialisations in Engineering Technologies, Medicine, and Agricultural Sciences, while the Government Sector is strongly specialized in the Natural Sciences and the Humanities. A merged analysis for the gross public sector shows that only positive specialisations in natural sciences and agricultural sciences remain. This means in particular, that public R&D investments geared towards the Higher Education Sector and the Government Sector, show too little focus on the field of Engineering, which is of particular relevance for R&D activities of the Czech Manufacturing Sector.

Overall, the fact that the Higher Education Sector and the Government Sector have both competencies in conducting academic research and have a similar size does not necessarily mean that this hampers the creation of knowledge-intensive science-industry relations or increases duplication. The usefulness of the two sectors depends by large on the complementarity of tasks fulfilled in the different types of organisations and the cooperation 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 took up its role in tertiary education in a complementary manner as nearly all workplaces of the ASCR were involved in tertiary education and the employees of the Academy guided a considerable number of students (in particular at the doctoral level) through their qualification.

Scientific knowledge is further 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 (Laredo 2007). 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 (ibidem).

This increased complexity of the knowledge creation and application process means that policy instruments have to focus on measures that allow facilitating this dual flow. Long term technological programmes and university-industry research centres on the one hand, and so-called triangular doctoral allocations provide opportunities for the state to foster these relationships.

4.4.2 R&D Performance in the Business Enterprise Sector

Although only a limited number of countries provide data for the distribution of R&D expenditures by research field in the Business Enterprise Sector, data show that the majority of countries concentrate their 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.

In the Czech Republic, the high shares of engineering and technology research in the Business Enterprise Sector point to the relevance of sectors producing fabricated metal products, machinery and equipment, instruments, transport and motor vehicles. In total, these branches account for more than 43% of all business R&D activities in the republic. On the other hand, the comparatively low levels of private R&D expenditures in the natural sciences and the medical and health sciences reflect a rather limited role of the pharmaceutical industry and chemical production. However, in particular the chemical industry has shown strong increase of R&D investments in the last years.

Considering the distribution of R&D activities among different branches, the data reveal that R&D activities are strongly concentrated in the manufacturing sector. Within the manufacturing sector in particular 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, the 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. According to our interviews with both industry members and research institutions, it seems that the common practice of enterprises is to set up affiliated SMEs, in order to be able to gain access to government funded business R&D support measures.

The international specialisation analyses showed that positive R&D specialisation exist in some manufacturing branches and in some service branches. Within the services sector, positive specialisations are only observed in the branches Public Administration, Financial Intermediation, Computer and Related Services, and Telecommunications. 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. 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 international 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. 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. In total, SMEs account for 36.2% of 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 particular high in countries with highest R&D ratios in the European Union and in 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, the data reflect, that the nationwide R&D intensity increasingly depends upon the R&D activities of large firms.

4.5 On the State of Public Programmes and Priorities

As the portfolio of funding instruments in the Czech Republic is currently in a phase of dramatic change, the analysis so far concentrated on a stock-taking of past, current and planned programmes in order to grasp the knowledge base for an assessment of the appropriateness of the instrument portfolio and the potential impact of the measures. A full-fledged analysis, including in particular the Operational Programmes, is currently being performed and its results may only be provided for the final report. Hence, the following findings are still preliminary.

4.5.1 Instrument Portfolio

In terms of programmes and measures an analysis of the portfolio of instruments is 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.

The present reform is definitely geared towards the right direction and will channel about 80% of targeted R&D financing activities via 4 intermediary bodies. However, if it the several branch ministries will continue to set up and also implement their programmes within their departmental bodies (as it seems to be the case as to our knowledge today) this may leave little room for capacity building of knowledge at the operational level of research funding and administration. As the share of funds distributed via project funding is already high in the Czech Republic, it would be important to facilitate such capacity building processes.

In order to systematically present the targeted R&D funding portfolio, the study structured the programmes as follows: a) programmes which are currently phasing out (still provide funding for running projects but no new calls launched), b) programmes which are operating and continuing to launch calls in 2011/2012, and c) programmes which are planned and currently being set up.

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. The most important programmes which discontinued its financing activities recently were:

- The National Research Programmes I+II
- 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.

In addition to the thematic approach, the NRP II also provided financing for the 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 co-operation 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. To which extent this may live up expectations will be analysed in the final report.

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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 was launched just recently. As opposed to TANDEM and IMPULS, the programme has a stronger sector oriented focus on research for New Materials and Products, New Advanced Technologies, and New Information & Controlling Systems. As opposed 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.

In addition to these programmes, thematic oriented branch programmes of several ministries are also phasing out. Although each single programme accounts for sub-critical shares of targeted R&D support only, and a duplication of efforts in terms of programming can be identified, in total they accounted for more than 30% of total targeted R&D support in 2009.

The portfolio of currently operating programmes mainly consists of the above mentioned TIP programme, the standard programmes of the Czech Science Foundation and a number of small international co-operation programmes, which are managed by the Ministry of Education, Youth and Sports.

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%.

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.

Whereas the relevance of measures from the Science Foundation is about to stay the same, the TIP programme of the Ministry of Industry and Trade is expected to account for 24% of total targeted R&D financing in 2013. Given that the programme does not provide incentives or even require science-industry collaborations and has limited thematic steering, this poses the risk of reaching low levels of behavioural change within the actors of the system.

The restructuring of the system of targeted R&D support also leads to the introduction of new programmes, aimed at supporting business R&D and research organisations.

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In particular the Technology Agency, which was founded in 2009, is to become a major provider of targeted R&D programme. The first programme of the Technology Agency, the ALFA programme, has a thematic focus aiming at progressive technologies (new technologies, materials and system, energy development and sustainable development of transport). In this respect, particular the technological focus of "new technologies" has similarities with the TIP programme, but the programme has a distinct science-industry collaboration mission outlined in its self-description.

Three other programmes are currently being launched. OMEGA will be aimed at supporting applied socio-economic research in a broad sense and BETA will be geared at research, development and innovation studies required by organisations included in the national governance system. Another programme to be established, the Competence Centre Programme, is focussed on supporting the creation and operation of centres of research, development and innovation in advanced industries, aimed at increasing the competitiveness of the Czech Republic. Long-term institutional science-industry interrelations are to be supported with the programme, which is approved for the period 2012-2019. In total the programmes of the Technology Agency, which is going to be the sole provider of thematic oriented R&D programmes, will account for about 14% of total targeted R&D financing in the Czech Republic in 2013.

In addition to the programmes of the Technology Agency, the Science Foundation is supposed to fund specific centres of basic research from 2012 onwards, which seek to increase co-operation within the research sector.

What is striking in the planned division of tasks between the various financing agencies, is that it seems to continue to separate between 'applied' industrial R&D and pure, curiosity driven basic research.

In particular the financing portfolio of the Science Foundation contains only traditional bottom-up funding measures at present. While these measures are also part of many alike organisations in the other European Union member states, the Science Foundation lacks measures which focus on strategic oriented research activities.

Apart from the institutional division between the Technology Agency, the Science Foundation, and the Ministry of Industry and Trade, the present programme portfolio leans strongly towards measures of direct support.

The thematic priorities which are at place, mainly address fields in which the Czech industrial system shows particular strengths: materials and engineering. Programmes focussing on sectors, which seek to build up competencies in specific knowledge domains with high levels of growth in terms of scientific output and potential for commercialisation, are not addressed by the present programme portfolio.

4.5.2 Interactions of the National Programmes with the Operational Programmes

The preliminary analysis of the Operational Programmes has shown, that the portfolio of financing instruments of the Operational Programmes *Enterprise and Innovation* and *Research and Development for Innovation* are complementary in large part.

The Operational Programmes put a strong focus on setting up new infrastructures for research, development and innovation, whereas the national R&D programmes focus on the provision of project financing measures, which support labour costs. For the industry domain also measures, that seek to enhance cooperation between industrial

actors, are foreseen. For new start-ups and spin-offs risk financing measures also are made available.

In total, research and innovation relevant financing measures of the structural funds more than double national spending on targeted R&D financing measures each year. However, the main risk associated with the type of financing provided by the Operational Programmes, is that financing is almost exclusively aimed at the provision of research infrastructure, machinery, and equipment:

- Within the *Operational Programme Enterprise and Innovation*, the *Innovation* programme, 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.
- 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.

The problem which may arise due to this vast increase in research infrastructure is that its' financing has to be sustained, and that the level of national R&D programmes is big enough in order to allow, that these institutions may fully take up its operations.

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