ERAWATCH COUNTRY REPORTS 2010:

Slovak Republic

ERAWATCH Network – Institute for Forecasting of the Slovak Academy of Science

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The opinions expressed are those of the authors only and should not be considered as representative of the European Commission's official position.

Executive Summary

The Slovak Republic has area of 49,034 square kilometres and population of 5.4 million. It accounts for 1.17% of area and 1.08% of population of the EU27. Slovak GDP per capita (based on purchasing power parities) was €16,900 (72% of the EU27 average) in 2009. Slovakia enjoyed period of spectacular economic growth in 2000s. Average annual rate of growth in GDP was 4.66% in Slovakia, while 1.54% in EU27 in period 2000-2009.

Far less progress was done in developing an efficient system of research and development. Slovak gross expenditure on R&D (GERD) accounted for deep decreases over 1990s. GERD has increased over the 2000s (from €142m in 2000 to €304m in 2008). GERD growth rate, however, was lower than the GDP growth rate and GERD/GDP ratio decreased in 2000s. GERD as percent of GDP was 3.88% by 1989, but 0.65% in 2000 and 0.48% in 2009. Numbers of researchers in head counts dropped from 34,600 to 15,747 and 21,832 in respective years. Slovak GERD as percent of GDP was 0.48%, far below the EU27 average (1.90%) in 2008. Business expenditure on R&D (BERD) as percent of GDP was 0.20% in Slovakia, but 1.21% in the EU27 in 2008.

Slovakia has a dual economy. Branches of the multinational companies (MNCs) provided for significant part of Slovak employment and exports, but did little research in Slovakia. Slovak small and medium enterprises (SMEs) competed with low costs of inputs and invested very little in research an innovation (see chapter 2.2.2). These problems refer to current development stage of the country and are out of remit of research and innovation policies. Slovak government developed and implemented set of science and technology strategies and policy measures aimed at improving national system of research and innovations. Challenges, however, are immense and results may take years to materialise.

The most positive developments relate to improvement in research and innovation system governance in last three years. Slovak government has approved several long and medium-term strategies and policies, and has designed a range of policy measures aimed at building and modernising research infrastructure and support to excellence research. Implementation of R&D/innovation policies and policy measures is monitored on annual basis. The government also created two agencies implementing research and innovation policy measures: respectively the Agency for Structural Funds of the Ministry of Education, Science, Research and Sports (ASFEU) and the Slovak Innovation and Energy Agency (SIEA).

Slovak research policies aimed at stimulation of R&D investment in Slovakia intended increases in R&D in public sector and in R&D performing firms (SMEs in particular). This policy mix has derived from historical developments. In 2000s the applied research system deteriorated and public sector became major research performer. The government decided to improve R&D infrastructure and support human resources in public sector. Some research and innovation policy measures (venture capital schemes, industry-academia co-operation and mobility schemes) coped with low absorption capacity, in particular demand on research and innovation solutions by Slovak SMEs was low.

European money provides significant boost to building and modernising R&D infrastructure and creating linkages for knowledge transfer in Slovakia. Five

Operational Programmes ('Research and Development', 'Competitiveness and Economic Growth', 'Education', 'Bratislava Region' and 'Information Society') invest some €5b in structural change and building knowledge-based society in period 2007-2013. Results may take years to materialise.

Nowadays, major imbalances and risks in research policies include:

- rather excessive role of SMEs envisaged in research policies (compared to their actual weight and role and to their absorption capacity) and neglect of cooperation with branches of MNCs established in Slovakia;
- potentially overoptimistic targets: '1.8% share of GERD in GDP' and '2/3 share of business expenditure in GERD' by 2015;
- fragmentation of limited research resources to 12 thematic priorities.

Knowledge Triangle

Effectiveness of knowledge triangle policies

	Recent policy changes	Assessment of strengths (+) and weaknesses (-)
Research policy	• Long-term strategies for research sector are in place. • Government publishes regular reports on R&D system. • Structural Fund schemes are implemented.	(+) Higher support to R&D from the State budget and Structural Funds positively impacts development of R&D sector. (-) There is low absorption capacity for R&D investments in private sector in general and SMEs in particular. (-) Underdeveloped evaluation culture. (-) Lack of thematic focus, high number of thematic priorities.
Innovation policy	• Long-term Innovation Strategy and medium-term Innovation Policy are in place. • Government publishes regular reports on implementation of innovation policy measures. • The Slovak Innovation and Energy Agency was created. • Structural Fund schemes are implemented.	(+) Improvements in innovation governance. (+) Significant increase in investment by innovation policy schemes. (-) There is low absorption capacity for innovative solutions by SMEs. (-) Underdeveloped evaluation culture. (-) Scheme implementing Regional Innovation Centres accounts for slow progress.
Education policy	• The 131/2002 Law on Higher Education was amended. The HEIs are classified into 3 qualitative categories. The HEIs are encouraged to establish spin-offs and start-ups. The HEIs must provide students with diploma supplement labels in English free of charge.	(+) Continuing high demand on higher education. Numbers of undergraduate and postgraduate students have accounted for high increases in 1989-2010. (+) New Universities established, hundreds of new curricula developed. (-) Improvements in quality of higher education lag behind growth in student numbers. (-) Quality of University research is low. (-) Widespread plagiarism and diploma-selling. (-) Brain drain. High negative balance in international student flows.

	Recent policy changes	Assessment of strengths (+) and weaknesses (-)
Other policies	• Government wants to go on with reform of business environment. • Government announced cuts in public expenditure for 2011.	(+) Flat tax and simple tax environment. (+,-) Low costs of production inputs. (-) The government considers slashing national public resources for research. (-) Defunct capital market discourages venture capital. (-) Widespread corruption and misallocation of public financial resources. The NADSME agency investigated by the OLAF.

European Research Area

Slovakia had limited research capacities and accounted for poor performance in basic and applied research for two decades. Low levels of scientific outputs (in terms of publications, citations and patents), underfinanced research sector, underdeveloped national R&D infrastructure, as well as limited and ageing human capital in research sector are the main challenges for Slovak R&D-system in relation to ERA-development. Most investment by Slovak government supported development of domestic research sector, but importance of the ERA-related policies somewhat increased in 2009 and 2010. Total expenditure on international co-operation in R&D (including FP, COST, ESF, EUREKA, international research infrastructures and collaboration with third countries) amounted to €20.4m, some 12.8% of national public expenditure and 6.7% of total Slovak GERD in 2008.

In theory, Slovak labour market is open to researchers from all EU member states without any restrictions. In fact, Slovak research system is offering highly unattractive working conditions (salaries 3-4 times lower than in developed EU members, lack of project finance). Inward mobility was quite low. Foreigners accounted for some 0.36% of total Human Resources in Science and Technology (HRST) in Slovakia in 2008.

Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main national policy changes	Assessment of strengths (+) and weaknesses (-)
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers	The Decree of the Government of the Slovak Republic No. 391/2004 enables access to Slovak labour market to citizens of all EU member states without any restrictions. Female researchers have right to return to the same position after maternity leave.	(+,-) Moderate supply for science & engineering, to a high extent matching the market demand (-) Overall highly unattractive working conditions for researchers.
2	Increase public support for research	Public budget for R&D increased in nominal value from €136m in 2008 to €160m in 2009. GERD as percentage of GDP, increased from 0.47% to 0.48% (relative increase generated by lower nominal GDP in 2009).	(-) Overall, very low levels of R&D expenditure. (+,-) Increase in public budget (if modest) due to European money.

	ERA objectives	Main national policy changes	Assessment of strengths (+) and weaknesses (-)
3	Increase European coordination and integration of research funding	Increased interest in European co-operation. Major policy documents include chapters on co-operation in science and technology in ERA.	(-) Overall, very low levels of R&D expenditure supporting national teams in participating to FP projects/proposals and other international co-operation projects.
4	Enhance research capacity across Europe	Government passed several policy documents aimed at enhancing research capacity.	(-) Slovak research capacities decayed over two decades. It takes years to rebuild them.
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	The Operational Programme Research and Development allocates some €460m to projects supporting research infrastructure in 2007-2013. Slovak government decided to complete Cyclotron Centre. Information on the centre is classified.	(+) European money provided significant boost to building and modernising R&D infrastructure in Slovakia. (+) National Research Infrastructures Roadmap under preparation. (-) Lack of absorption capacity in regions outside Bratislava.
6	Strengthen research institutions, including notably universities	The Operational Programme Research and Development invests some €1.4b in total to Slovak PROs and HEIs in 2007-2013. The government tries to improve quality of research in Slovak PROs and HEIs. University ranking and evaluation procedure should be reflected in amount of support.	(+) European money increases budgets of PROs and HEIs feasible. (-) University ranking and evaluation procedures have to take into account generally low quality of research and are subject to lobbyist pressures.
7	Improve framework conditions for private investment in R&D	Several schemes encourage private investment in R&D. Tax incentives were first time used in 2010.	(-) Low demand on innovative solutions and research results by Slovak SMEs is main barrier for industry-academia co-operation.
8	Promote public-private cooperation and knowledge transfer	New R&D infrastructure may improve linkages between industry and academia sectors, and between Slovakia and advanced EU members. The Operational Programme Research and Development allocates some €689m to projects supporting innovation culture in Slovak firms and transfer of knowledge in period 2007-2013.	(+) Structural Funds provide considerable resources for building institutions facilitating knowledge transfer between industry and academia sectors, (-) Potential problems with low demand and absorption capacity.
9	Enhance knowledge circulation across Europe and beyond	Slovak government continues supporting limited numbers of projects within the FP, ESF, COST and EUREKA programmes.	(-) Slovakia accounts for one of the lowest participation rates in European research initiatives.
10	Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world	Slovak government continues supporting limited numbers of bilateral and multilateral projects within third countries.	(+) Increased interest by Slovak government and research institutions in participation in European research initiatives. (-) Overall, very low resources provided for international co-operation in science and technology.

	ERA objectives	Main national policy changes	Assessment of strengths (+) and weaknesses (-)
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	Joint programming remains limited in Slovakia.	(-) Joint programming receives relatively low attention by policy-makers (in terms of policy measures and budgets).
12	Develop and sustain excellence and overall quality of European research	Major research policy documents set excellence research priority. Significant part of the Operational Programme Research and Development supports centres of excellence.	(+) Structural Funds provide necessary means for improving extent and quality of research capacities. (-) Slovakia has limited research capacities and accounted for poor performance in basic and applied research.
13	Promote structural change and specialisation towards a more knowledge - intensive economy	Five Operational Programmes ('Research and Development', 'Competitiveness and Economic Growth', 'Education', 'Bratislava Region' and 'Information Society') invest some €5b in structural change and building knowledge-based society in period 2007-2013.	(+) European resources provide significant contribution to development of R&D, innovation and human resources in Slovakia. (-) Dual economy makes structural change difficult.
14	Mobilise research to address major societal challenges and contribute to sustainable development	Slovak government decided to participate in joint programming on combating neurodegenerative diseases, in particular Alzheimer's.	(-) Lack of clear thematic focus. Slovak research policy documents mention 12 priorities.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	The Research and Development Agency continues in implementing 'Support to Human Potential in R&D and Popularisation of Science Programme'.	(-) Resources allocated to popularisation of science are low in Slovakia. (-) Broader public shows limited interest in research.

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1 Introduction

The main objective of the ERAWATCH Analytical Country Reports 2010 is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals and of the 2020, post-Lisbon Strategy. The assessment will focus on the national R&D investments targets, the efficiency and effectiveness of national policies and investments into R&D, the articulation between research, education and innovation, and on the realisation and better governance of ERA. In doing this, the 15 objectives of the ERA 2020 are articulated.

The report builds on the 2009 report streamlining the structure and updating the 2009 policy assessment in the domains of human resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. The information related to the four ERA pillars covered in the 2009 report is also updated and it is extended in order to cover all six ERA pillars and address the corresponding objectives derived from ERA 2020 Vision.

Given the latest developments, the 2010 Country Report has a stronger focus on the link between research and innovation, reflecting the increased focus of innovation in the policy agenda. The report is not aimed to cover innovation per se, but rather the '**interlinkage**' between research and innovation, in terms of their wider governance and policy mix.

2 Performance of the national research and innovation system and assessment of recent policy changes

The aim of this chapter is to assess the performance of the national research system, the **'interlinkages'** between research and innovation systems, in terms of their wider governance and policy and the changes that have occurred in 2009 and 2010 in national policy mixes in the perspective of the Lisbon goals. The analysis builds upon elements in the ERAWATCH Country Report 2009, by updating and extending the 2009 policy assessment in the domains of resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. Each section identifies the main societal challenges addressed by the national research and innovation system and assesses the policy measures that address these challenges. The relevant objectives derived from ERA 2020 Vision are articulated in the assessment.

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

This section gives the main characteristics of the structure of the national research and innovation systems, in terms of their wider governance.

The Slovak Republic has area of 49,034 square kilometres and population of 5.4 million. It accounts for 1.17% of area and 1.08% of population of the EU27. Slovak

GDP per capita (based on purchasing power parities) was €16,900 (72% of the EU27 average) in 2009.

Slovakia enjoyed period of fast economic development. Data by the Eurostat indicate that average annual rate of growth in GDP was 4.66% in Slovakia, while 1.54% in EU27 in 2000-2009.

During the same period, far less progress was done in developing an efficient system of research and development. Nowadays, gross expenditure on research and development (GERD) as percent of GDP was 0.47%, far below the EU27 average (1.90%) in 2008 (Table 1). Numbers of research personnel also were very low (see chapter 3.1.1 for more details).

Main actors and institutions in research governance

The governance structure of the Slovak research system changed little over last decade. The top governance body in the field of science and technology was the Ministry of Education. It was renamed to the Ministry of Education, Science, Research and Sports (MESRS) in 2010, but there were no significant changes in competences and/or budgets.

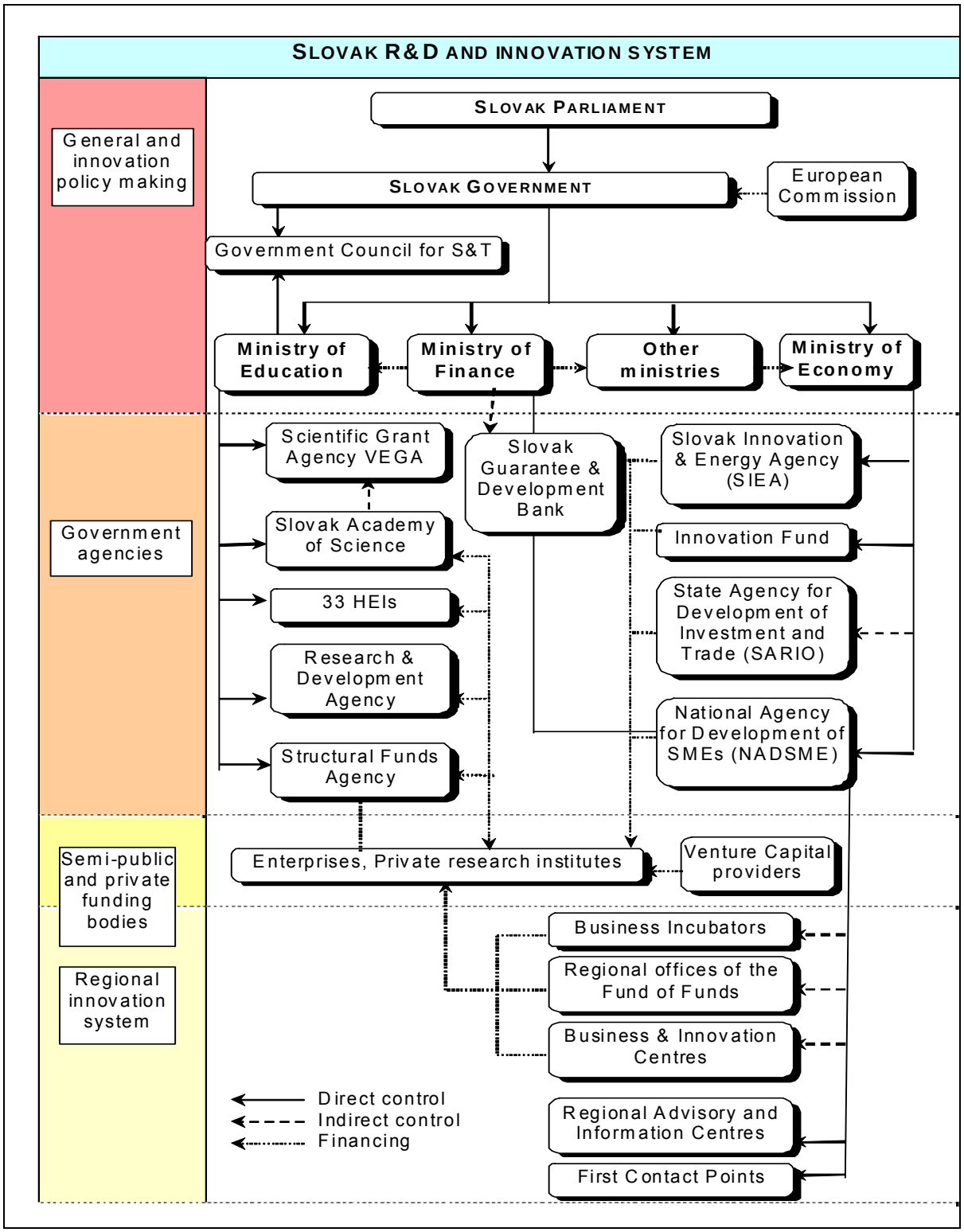
The MESRS is responsible for policy- and decision-making in the field of science and technology (see Figure 1 below). National science and technology policy is prepared and coordinated by the MESRS with co-operation of other ministries (Ministry of Finance and Ministry of Economy and Construction in particular), the Slovak Academy of Sciences (SAS), higher education institutions (HEIs) and associations of employers, and industrial research organisations, respectively.

The MESRS also administers the most important body for coordination of science and technology policies (S&T), the Slovak Republic Government Board for Science and Technology (SRGBST). The Statute of the SRGBST declare that "the Council is a permanent advisory body of the Slovak government in the field of state science and technology policies….It discusses and evaluates conceptual and strategic materials on S&T policies elaborated for the Slovak government, EU organisations or other international organisations". Another body for coordination of the S&T and innovation policy is the Commission for the Knowledge-based Society (CKBS). The body was established in December 2006 and is headed by the Deputy Prime Minister for the knowledge-based society, European affairs, minorities and human rights. Members of the Commission include Ministers of Education, Finance, Economy, Construction and Regional Development, Agriculture, Health and Labour, Social Affairs and Family, plus the president of the Slovak Academy of Sciences. The CKBS is advisory and coordination body of the Slovak Government in matters of knowledge-based society and Structural Fund programmes related to these issues. The CKBS held its last meeting in October 2009. In practice, both the SRGBST and CKBS have relatively weak powers. Most important decisions in S&T policies (drafting legislations and budget) are made by the MESRS and the Ministry of Finance.

Since 2007, responsibilities for the research and innovation policies are separated between the Ministry of Economy and Construction and the Ministry of Education, Science, Research and Sports. Innovation policy measures are implemented by the Ministry of Economy and Construction and its agencies. The Ministry of Economy and Construction drafted the 2007 Innovation Strategy and 2008 Innovation policy documents. It also established the Slovak Innovation and Energy Agency (SIEA). This organisational division was prompted by introduction of the Structural Fund programmes. The Ministry of Economy and Construction implements the Operational

Programme of Competitiveness and Economic Growth (OPCEG). The MESRS implements the Operational Programme Research and Development (OPRD) and the Operational Programme Education (OPE). As to manage the OPRD and OPE, the MESRS established the Agency of the MESRS for the Structural Funds of the European Union (ASFEU).

Figure 1: Overview of the Slovakia's research system governance structure



Source: ERAWATCH Research Inventory

The structure put in place for the design and implementation of research and innovation policies has been stable, however it was furnished with limited financial resources. Slovak research system is being heavily underfunded for years and unable to support development of knowledge-based economy. Slovakia ranked to the poorest research performers in the European Research Area. Slovak GERD and BERD as percent of GDP were one of the lowest in the EU27. Low inputs in research system were reflected in very low levels of research and innovation outputs in terms of publications, patents, exports of knowledge-intensive services, etc. (see chapter 2.4.1 Table 5).

The institutional role of regions in research governance

Slovakia used to be a centralised country since first self-governing regions were created as late as in 2002. No special arrangements were made for research and development, science, technology and/or innovation policies at regional level. These activities have traditionally been considered matters of central government. The university system is an explicitly national affair. Support to innovation and research on regional and local levels is provided via competences in spatial planning and development policies. Regional governments can establish and support regional R&D centres and/or technology parks. They, however, lack financial resources and, in the case of less developed regions, professionals. Bratislava is the major centre of R&D activities, and accounts for about half of the Slovak R&D personnel and of the R&D spending. The R&D capacities in Bratislava mostly are supported by the central government and/or large enterprises.

Main research performer groups

The MESRS supports basic and applied research via state budget allocations and competitive grants given to a network of organisations and agencies important for development of science & technology (S&T) and higher education:

The key research performers include:

- The Slovak Academy of Sciences (SAS) is a research body providing the bulk of basic research in Slovakia. The SAS had budget of €66.9m and employed 3,263 people (1,808 of which held a scientific degree and 348 were PhD students) in 2009.
- Higher Education Facilities: There were 23 public and 10 private higher education institutions in Slovakia (as of 2010). Share of public expenditure on the university system in GDP was 0.79% in 2009.

The key funding agencies include:

- The VEGA grant agency is a funding and advisory body for the Ministry of Education and the SAS. In 2009 the VEGA sponsored 2,269 research grants with €12.3m (€5,852 per project).
- The Research and Development Agency (RDA) provides public and private research bodies with tendering and funding grants. Its budget increased from €0.15m in 2001 to €32.2m in 2010.

Total outlays on R&D are rather modest. Preliminary data by the Statistical Office of the Slovak Republic set Slovak share of GERD in GDP to 0.48% in 2009. Absolute spending on R&D was lower in 2009 (€302.994m) than in 2008 (€304.962m). Increase in the share of GERD in GDP in 2009 was due to decrease in nominal value

of the GDP. The 2010 share of GERD in GDP may increase to some 0.60%, due to higher influx of research funding from the Structural Funds.

The government sector was main sponsor of research. Share of the government expenditure on R&D (by sector of source) in total GERD was 52.3% (including State subsidises to general university funds) in 2008. Share of the business sector in R&D was 34.6% and share of the foreign resources 12.3%. The HEIs and private non-profit sectors were quite unimportant sources of funds, as they generated 0.3% and 0.4% respectively of the total GERD in Slovakia in 2008.

Most research was performed in the business sector (42.9% of total expenditure in the R&D), public research facilities (32.8%) and higher education facilities (24.3%) in 2008. Private non-profit sector accounted for less than 0.1% of total outlays in the same year.

Table 1: Evolution of public support to R&D in Slovakia

	2004	2005	2006	2007	2008	2009
Gross expenditure on research and development						
Total GERD, €m	231.2	249.1	267.7	282.6	316.5	303.0
of which state budget	117.0	124.7	152.2	170.6	179.4	166.7
GERD as percent of GDP	0.51	0.51	0.49	0.46	0.47	0.48
public R&D expenditure as percent of GDP	0.26	0.25	0.28	0.27	0.26	0.28
Share of government budget appropriations or outlays on research and development						
Slovakia	1.56	1.56	1.53	1.55	1.52	x
EU27	0.80	0.74	0.73	0.62	0.79	x

Sources: The 2009 Annual Report on R&D in the Slovak Republic and Eurostat

2.2 Resource mobilisation

Since 2000, Europe has made evident progress towards ERA but at the same time it is clear that Europe's overall position in research has not improved, especially regarding the R&D intensity, which remains low. The lower R&D spending in the EU is mainly a result of lower levels of private investment. Europe needs to focus on the impact and composition of research spending and to improve the conditions for private sector's R&D investments.

This section assesses the progress towards national R&D targets, with particular focus on private R&D and on recent policy measures and governance changes as well as the status of the key existing measures, taking into account recent government budget data. The need for an adequate planning/management of skilled human resources for R&D has been identified as the key challenge since the launch of the Lisbon Strategy in 2000. Hence, the assessment includes also the human resources for R&D. Main assessment criteria are the degree of compliance with national targets and the coherence of policy objectives and policy instruments.

2.2.1 Resource provision for research activities

Major long-term trends in research funding in Slovakia included (a) demise of research funded by private sector and increase of relative importance of government finance, (b) decreasing importance of applied research and increasing importance of basic research, (c) falling shares of engineering and increasing shares of natural

sciences (related to basic research), and (d) disappearing thematic focus and increase in non-oriented research and general University funds (Figure 2). These trends relate to overall fall in research spending, and decline in domestic private research base in 1990s in particular. Slovak gross expenditure on R&D (GERD) accounted for deep decreases over 1990s. GERD has increased over the 2000s (from €142m in 2000 to €304m in 2008). GERD growth rate, however, was lower than the GDP growth rate and GERD/GDP ratio decreased in 2000s. GERD as percent of GDP was 3.88% by 1989, but 0.65% in 2000 and 0.48% in 2009. Numbers of researchers were declining simultaneously with the GERD shares in GDP (see chapter 3.1.1). Slovak governments were keen to declare their commitment to public investments in education, research and innovation. However, the actual commitment has been rather limited.

- The government elaborated several long-term strategies and medium-term S&T and innovation policy documents in 2007. Research policies became better integrated with other related knowledge triangle policies.
- There were significant increases in public investment in research in 2004-2009. Total public support increased by 53.8% in nominal terms in the abovementioned period. Public (national) expenditure as percent of GDP, however, did not change (Table 1). Slovak research system remains one of the least developed in Europe. Shares of government budget appropriations or outlays on research and development (GBAORD) amounted to about half of the EU27 average and remained stable in period 2004-2008.

Slovak research system increasingly relies on European resources. Support to knowledge-based economy accounts for impressive increases in period 2007-2013. Total assistance by Structural Funds to human resources, R&D and innovation was some €436m in planning period 2004-2006. Assistance to these fields should increase to some €5b in planning period 2007-2013. The Slovak 2009 State Budget Law set higher level of financial support to R&D in several key areas. The SAS, which carries out bulk of basic research, had its budget increased by 14.5%, to €63.6m and budget of the Research and Development Agency (RDA), which supports applied research projects, increased by 35.8% to €39.8m.

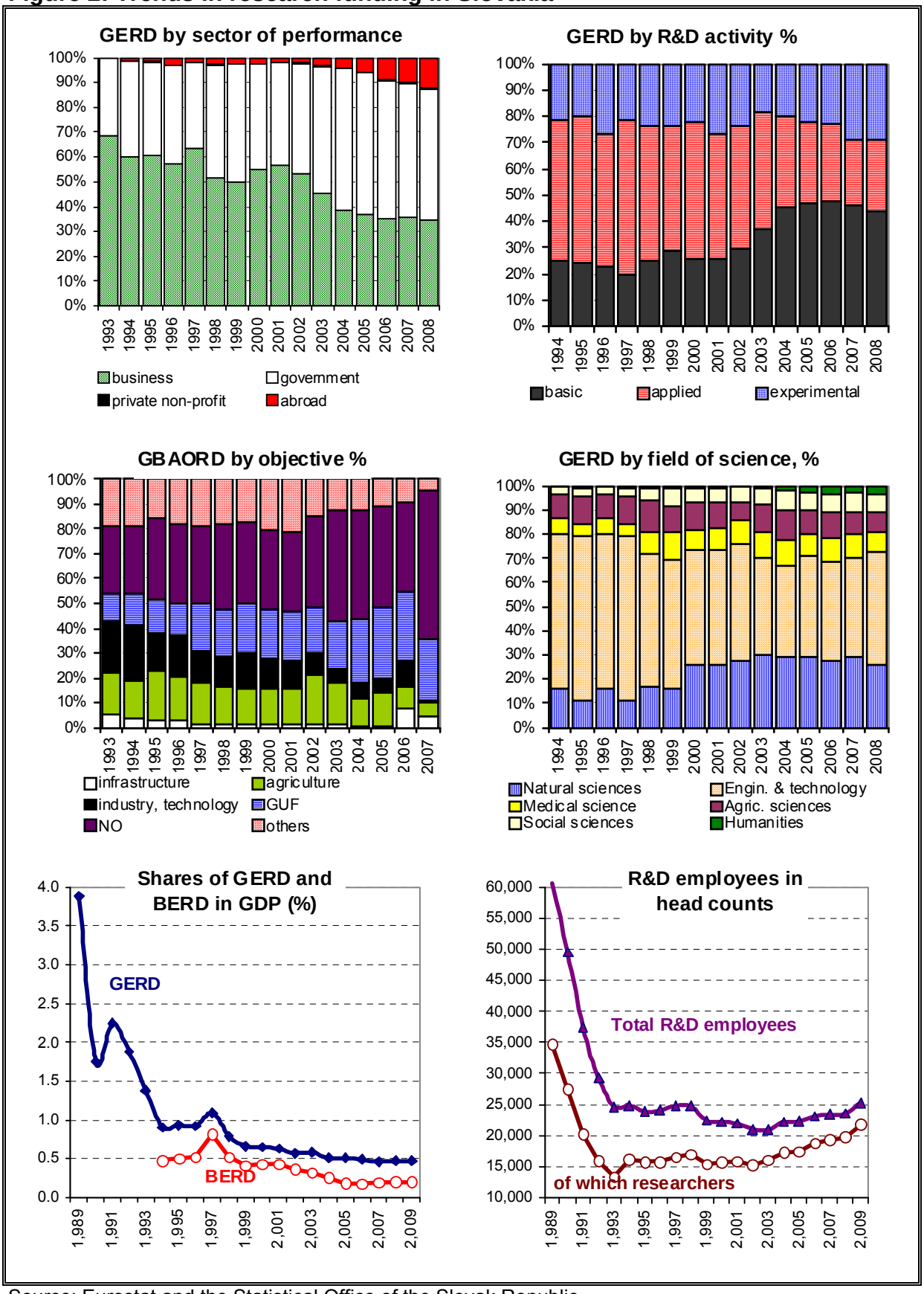
The Ministry of Education (renamed to Ministry of Education, Science, Research and Sports) prepared S&T policy documents in Slovakia:

- the 2007 Long-term Objective of the State S&T Policy up to 2015;
- the 2008 Strategy implementing the 'Long-term Objective of the State S&T Policy up to 2015' in period 2008-2010;
- the 2010 New Model of Financing Science and Technology in the Slovak Republic.

The above-mentioned documents contain analytical chapters discussing strengths and weaknesses of the Slovak research system. The 2010 ‘New Model’, for example, states that ‘science and technology is a basic factor for increasing economic competitiveness and long-term economic growth and the science and technology system must receive sufficient inputs’. The 2007 ‘Long-term Objective’ contains 12 thematic priorities (health, new materials and technologies, biotechnologies, ICT, social infrastructure, energy, civilisation challenges, culture and art heritage, defence & security, biological resources, environment and efficient use of domestic raw

materials). Priorities are rather broadly defined. Their number and scope probably do not fit to a small and underfunded research system.

Figure 2: Trends in research funding in Slovakia



Source: Eurostat and the Statistical Office of the Slovak Republic

The 2007 'Long-term Objective' mentions several important societal challenges to be addressed by research, but specifies no budgets for specific priorities/challenges. In fact, over 80% of public support is channelled to non-oriented research and general University funds. Two State R&D Programmes (SRDP) targeted healthy lifestyles and culture heritage. The SRDPs expired in 2010.

Slovak research funding relies almost exclusively on grants. In 2009 the tax stimuli were first time used though to a limited extent:

- **Institutional funding** supports basic research and is provided directly (via block grants) from the state budget divisions (ministries and other central authorities, e.g. the Slovak Academy of Sciences) and also via the competitive grants awarded by the VEGA and KEGA grant agencies. Higher education institutions and the Slovak Academy of Sciences only are eligible for the VEGA and KEGA grants. Total volume of institutional funding from state budget was €39.7m in 2009 (Table 2). In nominal terms, the volume of institutional funding increased by 12.1% in the period 2005-2009.
- **Project finance** is provided from the national and European resources (Table 3). The national support is channelled via calls launched by the Research and Development Agency (general calls, seven specific programmes, bilateral and multilateral cooperation). The European resources are provided via open calls and national projects. The latter instrument targets research infrastructure and is implemented by pre-selected public agencies. The most importance national projects include the National information system supporting research and development in Slovakia and the Infrastructure for research and development – Data centre for research and development. The total volume of public support to project finance increased by 5.7 times in the period 2007-2009. The increase is related to the financing of programmes through the Structural Funds. Two operational programmes ('Research and Development' and 'Competitiveness and Economic Growth') accounted for 71.0% of the total public support to R&D in 2009 in Slovakia.
- The Slovak Parliament passed the 185/2009 R&D Stimuli Law in April 2009. The law provides tax breaks for specific activities in applied research. Five firms were supported with €1.3m in 2009.

Table 2: Institutional finance in Slovak R&D system, provided by the State budget in 2005-2009, €m

	2005	2006	2007	2008	2009
Universities, of which	8.8	9.9	11.5	12.4	12.9
VEGA grants	7.2	8.0	9.2	10.0	10.3
KEGA grants	1.6	1.9	2.3	2.5	2.6
Slovak Academy of Science, of which	43.3	46.5	51.3	61.7	61.2
VEGA grants	1.4	1.7	2.1	2.5	2.9
VEGA and KEGA grants total	10.22	11.6	13.5	14.9	15.8
Institutional finance total	35.4	37.1	39.3	41.1	39.7

Source: The 2009 Annual Report on R&D

Table 3: Project finance supported by the Slovak state budget and the European Union in 2007 and 2008, €m

	2007		2008		2009	
	public	private	public	private	public	Private
RDA - general calls	19.4	4.3	20.1	2.3	22.7	9.3
RDA – seven specific calls	3.7	0.9	1.6	0.1	11.7	4.7
State R&D programmes	5.4	1.3	1.8	0.4	1.2	0.3
Bilateral international cooperation	0.3	0.0	0.3	0.0	0.4	0.0
6th and 7th Framework Programmes	4.2	0.0	13.0	0.0	7.2	0.0
ESF, COST and Eureka	0.3	0.0	0.5	0.0	0.3	0.0
SOPIS [1,2]	0.5	n.a.	0.7	n.a.	0.0	0.0
Norwegian and EEA funds [3]	n.a.	n.a.	2.2	n.a.	1.7	0.0
R&D tax stimuli	0.0	0.0	0.0	0.0	1.3	0.0
Structural Funds [4]	0.0	0.0	14.5	0.0	115.9	0.0
Total	33.8	6.5	54.6	2.7	162.4	14.3

Sources: The 2007-2009 Annual Reports on R&D. Notes: 1 = Sectoral Operational Programme Industry and Services for 2004-2006/9. 2 = refers to contribution by the State Budget only. 3 = Norwegian Financial Mechanism and the European Economic Area grants. 4 = Refers to Operational Programmes Research and Development and Competitiveness and Economic Growth, and project spending. Differences due to rounding.

The recent policy changes affecting the funding of research refer to (1) the government efforts aimed at increasing the efficiency of public support to R&D and (2) financial developments in the State budget. The 2010 'New Model' document, for example, sets that public financial inputs into the S&T must (a) be combined with the support by a private sector, (b) attract international financial resources, and (c) generate outputs applicable in the Slovak economy.

Major research policy documents contain references to major societal challenges such as energy/climate change, health, ageing and sustainable development, but do not specify targets and/or budgets related to these issues.

Slovak public finance was affected by the financial crises. Government of Mrs. Iveta Radičová, in charge from July 2010, announced extensive budget cuts, including national support to R&D for 2011.

2.2.2 Evolution of national policy mix geared towards the national R&D investment targets

Slovakia has one of the weakest business R&D sectors in Europe. The business expenditure on R&D (BERD) as percent of GDP in 2008 was 0.20% in Slovakia but 1.21% in the EU27. Nominal volume of BERD increased twice in the period 2004-2009 in Slovakia but BERD as percent of GDP in the same period decreased from 0.32% to 0.20% (Table 4). Growth in the nominal GDP outpaced growth in the private R&D spending.

The Long-term Objective of the State S&T Policy up to 2015 adopted in the 2007 set the target for GERD as 1.8% GDP by 2015. Public sector should provide 0.566%, private sector 1.130% and foreign resources 0.104%. Targets for GERD and BERD do not seem realistic, given actual developments in research funding. BERD as

percent of the GDP, for example, would have to increase six times in period 2010-2015.

Slovakia has a dual economy. Branches of multinational companies (MNCs) form one sector, typical with world-class technology imported from abroad and high productivity levels. Some 110 thousands of Slovak small and medium enterprises (SMEs) and few large companies owned by domestic investors form the second sector, typically with low productivity levels and the low R&D intensity. Dual economy probably is the most important barrier for developing a strong private R&D sector in Slovakia. Branches of the MNCs provide for significant part of Slovak industrial output and exports (Samsung, Volkswagen, Siemens, Hyundai-Kia, Peugeot-Citroen, US Steel). However, none of these MNC has its headquarters in Slovakia. The MNCs were attracted by low cost of inputs (labour in particular), geographical location of Slovakia and favourable tax conditions. The MNCs do research in their headquarters and have limited interest in shifting their applied/industrial research to Slovak Universities and research institutes. The 2009 EU Industrial R&D Investment Scoreboard contains no Slovak company. Lack of strong Slovak-based MNC (like Nokia or Volkswagen) significantly affected private spending on R&D. The R&D investment by the Volkswagen group (€5,926m), for example, was 19.5 times higher than total Slovak GERD and 56 times higher than Slovak BERD in 2008 (source: the 2009 EU Industrial R&D Investment Scoreboard). There were some 90 thousands Slovak small and medium enterprises by 2009. They competed with low costs of labour and good price/quality ratio. Average monthly labour costs in industry, construction and services were €1,005 in Slovakia, but €3,847 in Austria, €3,945 in Germany, €4,579 in Denmark and €4,067 in Belgium in 2008 (source: Eurostat). Most Slovak SMEs considered investment in research and innovation risky and with uncertain result. Some 17.9% Slovak enterprises innovated in-house, while 40.8% of enterprises are engaged into such innovation activities in Belgium and 41.1% in Austria in 2006 (source: the 2009 European Innovation Scoreboard).

The ERAWATCH Country Report 2009 identified six ‘routes’ to stimulate investment to R&D: (1) stimulating greater R&D investment in R&D performing firms; (2) promoting the establishment of new indigenous R&D performing firms; (3) stimulating firms that do not perform R&D yet; (4) attracting R&D-performing firms from abroad; (5) increasing extramural R&D carried out in cooperation with the public sector and (6); increasing R&D in the public sector. Two routes have dominated policies aimed at stimulation of R&D investment in Slovakia in 2000s: (a) increasing R&D in public sector and (b) stimulating greater R&D investment in the R&D performing firms (SMEs in particular). This policy mix was derived from some historical developments. Maintaining remnants of the pre-1989 network of some 40 (domestic) industry research institutes was preferred to promoting new indigenous R&D firms and/or stimulating firms that do not perform R&D yet.

Research and innovation in businesses are supported by the national and European resources. National assistance schemes are few, but account for relatively simple procedures and easy access. They are increasingly replaced by schemes funded by the Structural Funds (Operational Programmes ‘Research and Development’, ‘Competitiveness and Economic Growth’, ‘Education’, ‘Information Society’ and ‘Bratislava Region’). Slovak SMEs consider schemes supported from the European resources rather complex, bureaucratic and difficult to access. Besides, Slovak government and OLAF investigated charges in corruption and misallocation of resources in agencies managed by the Ministry of Economy and Construction in 2010.

Funding schemes are regularly evaluated, but the evaluation is rather formal and descriptive. Evaluation and monitoring reports concentrate on reporting numbers of projects supported, but provide little analytical insight into the efficiency of these support schemes.

Given the lack of strong domestic private research spenders, public procurement of innovative technologies may stimulate private investment in R&D. The state research orders (published by particular ministries of central government) resembled to public procurement of innovative technologies, but were abolished by 2007. Slovak government procured some innovative technologies (in field of e-government in particular), but procurement was oriented towards purchasing rather than development. Like other Slovak economic policies, procurement policies were fairly general and non-discriminative. No policy for innovation-oriented procurement was in force by the end of 2010.

Slovak economy enjoyed spectacular growth in 2000s. Economic growth was driven by the Foreign Direct Investment (FDI) and, paradoxically, was accompanied by a relative decrease in private investment in R&D. The MNCs benefited from low costs of inputs and favourable business environment in Slovakia. Transfer of technologies and organisational innovation from the MNCs to the domestic companies proved more important than (domestic) investment in research and innovation. The Slovak government designed and implemented system of 19% flat income tax for businesses and individuals in 2004. The system was aimed at creating simple and transparent tax framework and accounted for a few derogations and exceptions. The R&D tax stimuli law was designed as late as in 2009 and accounted for minimal expenditure (€1.285m).

Table 4: Trends in business expenditure on R&D

	2004	2005	2006	2007	2008	2009
BERD, €m	66.6	71.1	75.7	89.7	105.8	136.3
BERD as percent of GDP						
Slovakia	0.32	0.25	0.25	0.21	0.20	0.20
EU27	1.16	1.15	1.18	1.19	1.21	x

Sources: Eurostat, Statistical office of the Slovak Republic and author's own computation. Note: The 2009 data are preliminary and include BERD from abroad.

2.2.3 Providing qualified human resources

There has been a boom in the tertiary education in Slovakia since 1989. Enrolment rate in tertiary education increased from 12% to 60% and numbers of University students from 66 thousands to 225 thousands in period 1989-2009. The boom was most pronounced for social science and humanities, but science and technology also enjoyed great increases in numbers of tertiary students. Numbers of the tertiary students in nature science, and science & engineering increased from 25,195 to 43,854 in the abovementioned period (source: Ministry of Education, Science, Research and Sports of the Slovak Republic).

The Eurostat data indicate that numbers of human resources in science and technology (HRST) were growing by higher rates in Slovakia than in the EU27 (34.5% versus 29.2%) in period 2000-2009. The share of HRST in economically active population in Slovakia, however, still was below the EU27 average in 2009 (see Table 5, chapter 2.4.1). Moreover, increases in HRST numbers were not

matched by increases in numbers of R&D workers. Most young people preferred employment in financial and IT sectors. Unintended and negative consequences of economic transition and structural reforms in the 1990s included decline in national R&D and innovation systems in general and business research systems in particular. In 1989 Slovakia had an extensive and well-funded research system, with over 35 thousand researchers in headcounts and GERD as 3.88% of GDP. The collapse of central planning was immediately reflected in the disintegration of the research and innovation systems. The 'shock therapy' model of economic and social transition encouraged short-term horizon in the planning of the enterprises. The demand for traditional company-level research has declined in favour of technology imports. Many research institutes have been closed or severely cut back. Falling public spending was also linked to a brain-drain and the exodus of scientists from the public sector. Numbers of R&D workers accounted for significant decreases (see chapter 3.1.1).

National data on structure of researchers indicate contrasting developments in public and private sectors. Numbers of researchers (in full-time equivalent) increased from 7,535 in 2000 to 10,756 in 2007 (latest available data). Numbers of researchers in private sector dropped from 2,420 to 1,599 in the same period.

Human resource policies stated in the 2007 Long-term Objective of the State S&T Policy up to 2015 promote (a) flexible adjustment and creation of new curricula according to the needs of the economy, (b) support to industry-academia mobility by PhD students and young researchers, (c) return migration by Slovak scientists from abroad, (d) life-long learning by Slovak R&D workers, (e) policies aimed at attracting foreign researchers to Slovakia, and (f) policies promoting mobility of Slovak scientists in the European Research Area. A major instrument for implementing these policies was the ‘Support to Human Potential in R&D and Popularisation of Science’ programme. The programme was implemented by the Research and Development Agency. It supported 289 projects with €4.2m in 2009. The University sector received 60% of the programme assistance.

Human resource policies alone cannot solve problems with low numbers of HRST in Slovak research system. Low wages, underdeveloped research infrastructure and meagre budgets for project finance did not promote individual decisions to pursue a research career. Average (gross) monthly wage for University R&D workers, for example, was €932 in 2009. Interest by young people in careers in science & technology firms is unlikely to increase without significant increases in researchers’ pay and investments in R&D infrastructure. Talented young people are more attracted by career opportunities in finance and IT sectors.

Increase in quality of education ranks to main societal challenges in Slovakia. Education curricula formally take into account aspects as creativity and critical thinking and problem solving, but these goals cope with problem of mass education. Growth in numbers of students outpaced growth in expenditure on education. Numbers of tertiary students rose three times, but public expenditure on higher education, as percent of GDP, decreased from 0.98% to 0.79% in the period 1992-2009. Low funding of higher education had negative consequences on the quality of teaching and research. The best Slovak HEI (Comenius University in Bratislava) ranked No. 520 in the list of World Universities in July 2010 (source: Webometrics).

2.3 *Knowledge demand*

This section focuses on structure of knowledge demand drivers and analysis of recent policy changes.

Slovakia has a small open economy and is strongly dependent on manufacturing exports. Manufacture of cars, car components and consumer electronics, and production of machinery, metals and metal products are major export-oriented Slovak industries. Influx of the Foreign Direct Investment (FDI) was a major factor behind Slovakia's economic success. Arrival of the FDI was accompanied by massive transfers of top technologies and organisational innovations, but no MNCs shifted its research centres to Slovakia. The MNCs publish very little about their expenditure in Slovakia. The Eurostat data on GERD by sectors source of funds indicate that foreign enterprises spent some €25m in Slovakia, i.e. 8.2% of the total Slovak GERD in 2008. Both absolute and relative spending on R&D by foreign companies was low, given high dependence of Slovak economy on foreign capital.

Allocation of GBAORD to socio-economic objectives reflected neither the sector structure of the economy nor the knowledge demand. The ERAWATCH Report on country specialisation found that 'Slovakia's economic specialisation spreads over a large number of sectors', but there are 'no strong correlation in terms of economic specialisation, BERD and technological specialisation'. The report also founds that 'regarding BERD specialisation Slovakia is specialised on a limited number of sectors, such as business activities, research and development, basic metals and plastics. Public support for R&D in Slovakia is also limited on a very small number of sectors the majority of which coincide with those where Slovakia is specialised in terms of BERD, i.e. agriculture, plastics, other business activities and research and development'.

The Slovak research lacked strong thematic focus. Data on total GBAORD by NABS 2007 socio-economic objectives reveal that three most important themes (industrial production, health and agriculture) accounted for some 18.5% of the total GBAORD in 2009 in Slovakia. Investment in general advancement of knowledge, on the other hand, accounted for some 63.8% of total GBAORD. No significant R&D investment was made in the key Slovak industries (manufacturing of cars, car components and consumer electronics).

Structure of research spending by the sector ministries also indicates lack of thematic focus and weak industry research. Expenditure by the HEIs, the Slovak Academy of Sciences and other bodies managed by the Ministry of Education, Science, Research and Sports accounted for some 89.5% of the total national public support to R&D in 2009. Most of this support was channelled to basic research and general advancement of knowledge. Sectoral projects managed by the Ministry of Agriculture accounted for 4.7% and projects by the Ministry of Environment for 3.1% of total national public support to R&D in Slovakia in 2009.

2.4 *Knowledge production*

The production of scientific and technological knowledge is the core function that a research system must fulfil. While different aspects may be included in the analysis of this function, the assessment provided in this section focuses on the following dimensions: quality of the knowledge production, the exploitability of the knowledge creation and policy measures aiming to improve the knowledge creation.

2.4.1 Quality and excellence of knowledge production

Slovakia accounts for low level of R&D inputs and outputs. Total Slovak GERD and BERD as percent of GDP were respectively about four times and six times lower than those in the EU27 in 2008. In the same year the number of total R&D personnel per million inhabitants was two times lower and number of business R&D personnel five times lower in Slovakia than in the EU27. Low levels of R&D inputs corresponded with low level of R&D outputs. In 2007 Slovakia produced 14 times less EPO patent applications per million inhabitants than the EU27 (Table 5). The average annual number of scientific publications per million inhabitants was about two times lower and number of citations about four times lower than those in Germany in the period 2005-2009[1].

The Slovak rates of employment in the knowledge-intensive services (KIS) accounted for two thirds and rates of exports by the knowledge-intensive services for one half of those in the EU27. Better input/output ratios for KIS employment ratios and exports than those for basic and applied research are due to the fact that these knowledge-intensive services benefited from foreign direct investment while basic and applied research heavily relied on the national resources.

Table 5: Selected indicators of quality and excellence of knowledge production

Indicator	Slovakia	EU27	Year
GERD as percent of GDP	0.48	1.90	2008
BERD as percent of GDP	0.20	1.21	2008
Total R&D personnel per million inhabitants in FTE	2,884	4,910	2008
Total R&D personnel in business sector per million inhabitants in FTE	508	2,552	2008
Share of HRST in economically active population (%)	32.0	40.1	2009
Numbers of EPO patents per million inhabitants	7.83	116.54	2007
Scientific publications per million inhabitants	435	899[a]	2005-2009[b]
Citations of scientific publication per million inhabitants	1,482	6,100[a]	2005-2009[b]
Public-private co-publications per million population	7.0	36.0	2007
Technology Balance of Payments flows (% of GDP)	0.53	1.03	2008
Employment in knowledge-intensive services (% of workforce)	10.5	14.9	2008
Knowledge-intensive services exports (% of total services exports)	23.0	48.8	2007

Sources: Eurostat, Thompson Scientific Database and the 2009 European Innovation Scoreboard.
Note: a = refers to Germany; b = annual average for period 2005-2009.

2.4.2 Policy aiming at improving the quality and excellence of knowledge production

Excellence of knowledge production is a problem in Slovakia. Knowledge production concentrates in the public sector. The Slovak Academy of Sciences is the main performer of basic research. Higher education institutions focus on teaching and

[1] Aggregate data for the EU was not available.

devote little effort to research. Evaluation culture is underdeveloped in Slovakia and had so far a limited impact on fostering of the excellence in research.

Four major types of evaluations were applied in Slovakia in 2000s.

(a) Systemic evaluations

The Ministry of Education, Science, Research and Sports (MESRS) performs monitoring, analysis and evaluation of the Slovak research system. Since 2005, the MESRS has been producing an annual report on R&D. The reports list (a) volumes of R&D resources, (b) R&D input/output indicators, (c) policy measures related to public support to R&D developed by the Ministry of Education and other central government agencies, and (d) activities by the Slovak R&D bodies in the area of international cooperation in R&D (including FP and ERA). The annual reports provide details on programmes implemented by the Research and Development Agency (RDA). Several programmes of the RDA support R&D in SMEs and/or cooperation between academia and industry sectors. The 2005-2009 annual reports provided quite detailed lists of various financial flows related to the above mentioned policy measures, but did not try to compute their socio-economic impacts. Information included in the annual reports on R&D is in theory important for decisions on further orientation of research in different areas and the allocation of financial means to researchers and institutions. The overall level of the R&D funding in Slovakia, however, remains very low (2009 share of GERD in GDP was 0.48%). Evaluation activities are thus of a limited importance concerning the volume of financial support.

(b) Evaluations of research performers and individual researchers

The HEIs are evaluated by the Accreditation Commission of the Slovak government every six years. Research excellence, numbers and quality of teaching staff and technical infrastructure are the main factors of evaluation. By the end of 2010 the Accreditation Commission awarded 11 HEIs (out of 33) with the University status. Institutes of the Slovak Academy of Sciences (SAS) have been evaluated regularly from 1992 onwards by their own Accreditation Commission. These internal evaluations rely on a mix of quantitative indicators and qualitative expert judgement. The latest (2007) evaluation distinguished institutes with ‘excellent’, ‘good’ and ‘satisfying’ performance. Institutes with the ’excellent’ performance enjoyed increases in their salary mass by 4% and other operating costs by 10-20%. Slovak HEIs and the SAS institutes are evaluated by domestic and international experts. Research projects are selected on the basis of the quality of proposals and are subject to external peer review. International criteria and benchmarking are used for evaluation, but their impact on levels of funding is limited, given low level of financial inputs for domestic projects.

(c) Evaluation of R&D policy measures

Several agencies manage projects supported by the national public resources and Structural Funds. The agencies publish the regular monitoring and evaluation reports related to particular measures, and in addition some sector analytical reports. The National Agency for Development of Small and Medium Enterprises (NADSME), for example, has published annual reports on the ‘State of Small and Medium Enterprises in the Slovak Republic’ since 2000. Monitoring and evaluation reports for schemes supported from national public resources and Structural Funds mostly list numbers of projects applications, successful projects and support disbursed, but provide no analytical insight in efficiency of support.

(d) Independent evaluations

Since 2006, the main scientific performers are evaluated by an independent organisation, namely the Academic Ranking and Rating Agency (ARRA) which is a charitable foundation established by the former Rector of the Comenius University and some World Bank experts. The ARRA reports focus on HEIs and rank Slovak faculties by particular science fields. Evaluation of the Slovak Academy of Sciences is irregular and so far, excluded institutes in social science and humanities. The Slovak government did not consider ARRA activities important up to now. The ARRA evaluations have had so far little impact on the formulation of research policies and the identification of best research performers in Slovakia.

The 2007 Long-term Objective of the State S&T Policy up to 2015 and the 2010 New Model of Financing Science and Technology in the Slovak Republic set priorities in support to the excellence in research. Support is provided via several policy instruments. The most important one is the Operational Programme Research and Development. It contains two priority axes aimed at fostering quality of knowledge production via establishing centres of excellence in all Slovak regions. The priority axes allocate €689.478m, of which €586.057m is provided by the Structural Funds and €103.422m by the Slovak state budget in the period 2007-2013. The abovementioned documents also refer to importance of the international benchmarking and evaluation based on the international criteria.

2.5 Knowledge circulation

Tackling the challenges that the European society faces in the 21st century will require a multi-disciplinary approach and coordinated efforts. Many debates and conferences, e.g. the Lund Declaration, recognise that such complex issues cannot be solved by single institutions, technology sectors or MS acting alone. Hence strong interactions within the "knowledge triangle" (education, research and innovation) should be promoted at all levels. Moreover, in the context of increasing globalisation, cross-border flows of knowledge are becoming increasingly important. This section provides an assessment of the actions at national level aiming to allow an efficient flow of knowledge between different R&D actors and across borders.

2.5.1 Knowledge circulation between the universities, PROs and business sectors

Most important trends in the Slovak research system included decrease in industry and applied research and the increasing concentration of GERD in public research institutions. The system of industry research institutes dilapidated and industry-academia linkages weakened in 1990s and 2000s. Slovak SMEs account for the low levels of R&D expenditure and co-operation with research institutions. BERD as percent of GDP in 2008 was 0.20% in Slovakia, while 1.21% in the EU27. Numbers of public-private co-publications per million inhabitants was 7.0 in Slovakia, but 36.1 in the EU27 in 2007 (source: the 2009 European Innovation Scoreboard). Slovak government tried to improve co-operation between the industry and academia sectors, and implemented several measures aimed at: (a) direct support to knowledge circulation and (b) infrastructure for knowledge circulation.

Most important schemes for direct support to knowledge circulation included:

- The ‘Support to Cooperation between the Universities and Slovak Academy of Sciences, and Businesses’ programme is funded by the Slovak state budget and

managed by the Research and Development Agency. It allocates grants reimbursing costs of partnership creation and operation, and costs of basic research in centres established under this scheme. The programme invested €7.6m in the period 2007-2010.

- The State R&D programmes (SRDP) are funded by the Slovak state budget. They involve participants from private and public sectors and are dedicated to applied research and development. Ten SRDPs allocated some €16.7m in the period 2006-2009.
- The Supporting innovative activities in enterprises scheme is identical with the measure 1.3 'Supporting innovative activities in enterprises' of the Operational Programme Competitiveness and Economic Growth. It implements measure 3.3 'Supporting innovative activities in enterprises' of the Innovation Strategy and allocates some €154m to projects on applied research, intellectual property rights and organisational innovations in period 2007-2013.
- The Operational Programme Research and Development contains priority axis 2 'Support to research and development' and priority axis 4 'Support to research and development in the Bratislava region'. Two priority axes allocate some €466m and €223m respectively to projects supporting innovation culture in the Slovak firms and transfer of knowledge from research institutions to the firms in the period 2007-2013.

Policy measures developing infrastructure for knowledge circulation include:

- The National information system supporting research and development in Slovakia programme aims at 'promoting transfer of technologies and improving collaboration networks (a) between SMEs, and (b) between SMEs on one hand and other enterprises and HEIs, research centres and regional bodies on the other hand'. The support measure will invest some €19.7m and implements measures 2.2 and 4.2 of the Operational Programme Research and Development in the period 2007-2013.
- The Infrastructure for research and development – Data centre for research and development programme aims at 'increasing ability by R&D organisations to cooperate with the EU and foreign organisations of R&D, and also with other private and public bodies via transfer of knowledge and technologies'. The measure will invest some €33.2m from the Operational Programme Research and Development in the period 2007-2013.

Share of policy measures supporting knowledge circulation in the total public funding is rather difficult to compute, as most Slovak policy measures aim at several targets. The bulk of funding is provided by the Structural Funds. The abovementioned schemes account for about half of the total R&D and innovation-related expenditures by the Operational Programmes 'Research and Development' and 'Competiveness and Economic Growth' in the period 2007-2013.

2.5.2 Cross-border knowledge circulation

The Research and Development Agency manages several programmes developing bilateral and multilateral co-operation in R&D and individual mobility of researchers:

- The 'Support to Framework Programmes' scheme involves organisational and administrative resources (20 representatives in programme committees and 21 national contact points) plus financial support to the Slovak bodies involved in the

Framework Programmes. Total national support to 51 projects in FP7 amounted to €7.2m in 2009 (source: the 2009 Annual Report on R&D).

- The 'Bilateral Co-operation in Science and Technology' scheme supports mobility costs (travel, accommodation, subsistence). Some 177 projects with 12 countries were supported with €0.4m in 2009.
- The 'ESF, COST and Eureka' scheme supports costs of participation of the Slovak scientists in selected multilateral co-operation programmes. Some 21 projects were supported with €0.3m in 2009.
- The 'Slovak participation in European and International R&D Centres' scheme supports costs of the Slovak scientists' participation in the selected multilateral research initiatives (EUROSTARS, ENIAC, ESFR, CERN, Russian Centre for Nuclear Research, etc.). Approximately 12 participation projects were supported with €10.7m in 2009 (of which participation in CERN with €4.0m).

Except the national schemes, cross-border knowledge circulation is supported by the particular higher education institutions and research organisations. The Slovak Academy of Sciences, for example, managed 68 bilateral agreements with 44 countries and 19 international research organisations (as of 2010). There is no evaluation report on these schemes, but bilateral and multilateral exchange provides Slovak scientists with welcome opportunities to keep in touch with the top-notch science initiatives.

2.5.3 Main societal challenges

The New Model of Financing Science and Technology in the Slovak Republic adopted at 2010 contains the list of cross-border initiatives to be co-financed from the national public resources. Most initiatives refer to science & engineering (participation in European Institute of Technology, European Space Agency, ENIAC – European Initiative in Nanoelectronics, ARTEMIS Embedded Computing Systems Initiative, FAIR Facility for Antiproton and Ion Research, ETP - European technology platforms). There is only one pilot joint programming initiative addressing grand societal challenges – participation in joint programming on combating neurodegenerative diseases, in particular Alzheimer's. The Ministry of Education, Science, Research and Sports is responsible for participation in this cross-border initiative and invests €1m. No details of participation were published.

2.6 *Overall assessment*

In terms of inputs and outputs, Slovakia manages one of the weakest research systems in the European Union. Major factors behind the decline, and later stagnation, of the research system (dual economy, low-cost, low-value added mode of competition by Slovak SMEs) are outside of scope of the research policies. There is, however, significant space for the government intervention. Increase in research funding and in supply of highly skilled researchers fall within the remit of R&D and innovation policies. Policy documents and measures adopted since 2007 respond to the weaknesses in the Slovak research and innovation systems, and tried to address the major challenges in funding, supply of human resources and strengthening industry-academia linkages.

A financial support to the Slovak research and innovation system by public and business sectors decreased considerably in the period 1989-2009. Structural Funds

provide impressive amount of funding and seem to replace the (admittedly inadequate) national policy initiatives. Whether these initiatives are sufficient to improve quality of research in Slovakia remains to be seen. There are potential problems with the absorption capacity and mismatches between supply and demand for knowledge in academia and industry sectors. Creation of efficient links between public research and the private sector research institutes may take years. Efficient use of European support requires improvements in evaluation practices and broader use of the international benchmarking and quality standards.

Table 6: Summary of main policy related opportunities and risks

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Higher support to R&D from the Structural Funds will positively impacts inputs to R&D sector.	• There is low absorption capacity for R&D investments in private sector in general and SMEs in particular.
Knowledge demand	• Links between science & technology and innovation policies (including co-operation between public and private sectors) may be strengthened via building Regional Innovation Centres (RICs).	• Introduction of RICs is lagging behind. The initiative may be met with low demand by SMEs. Multinational companies show little interest in establishing research centres in Slovakia. • Thematic research lacks strong focus. Research themes are too broadly formulated and lack exact targets and budgets.
Knowledge production	• Policies implemented under the 2010 'New Model of Financing Science and Technology in the Slovak Republic' and resources provided by the Structural Funds may improve excellence of the public research system. New set of performance indicators may increase role of socio-economic impacts of research.	• Support to all R&D disciplines may continue disregarding excellent disciplines, workplaces and national thematic R&D priorities; potential rigidity of the new evaluation system may disregard differences among individual research disciplines.
Knowledge circulation	• New R&D infrastructure may improve linkages between industry and academia sectors, and between Slovakia and advanced OECD members.	• Low demand and absorption capacity by knowledge users (SMEs in particular) remain a challenge.

Table 7: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities (+) and Risks (-) generated by the policy mix
Dual economy and low wages generate low supply of and low demand for R&D solutions.	(-) Tackling this problem is outside of scope of explicit R&D policies. Barriers are likely to be removed by market forces and framework supportive policies. These developments can take years to materialise.

Barriers to R&D investment	Opportunities (+) and Risks (-) generated by the policy mix
Limited sources of R&D funding.	(+) Operational Programmes 'Research and Development', 'Competitiveness and Economic Growth' and Education' provide great volume of R&D funding. (-) Significant increases in public support to R&D need not necessarily be reflected in corresponding investment by private sector. (-) Increased public investment in human resources and R&D infrastructure may prove unsustainable, once Structural Funds assistance stops.
Limited attention paid to R&D issues in period 1990-2004; low understanding of importance of R&D for economic and social development.	(+) Importance of R&D and innovation issues in government rhetoric increased. (-) Schemes funded from Structural Funds replace national funding. European finance is much more generous, but also rather bureaucratic, difficult to get and account for slow implementation. (-) Incumbent stock of human capital is low and ageing, and may not generate a critical mass needed for transition towards a knowledge-based economy. Brain-drain by young researchers remains a threat for development of highly skilled human resources in Slovakia.

3 Interactions between national policies and the European Research Area

3.1 Towards a European labour market for researchers

The Communication Better careers and more mobility: A European Partnership for Researchers proposed by EC in May 2008 aims to accelerate progress in four key areas:

- Open recruitment and portability of grants;
- Meeting the social security and supplementary pension needs of mobile researchers;
- Providing attractive employment and working conditions;
- Enhancing the training, skills and experience of researchers

The Commission has also launched concrete initiatives, such as dedicated information services for researchers, in particular through the activities grouped under the name of EURAXESS – Researchers in Motion. Based on the assessment of the national situation in the four key dimensions detailed above, this section will conclude if national policy efforts are supporting a balanced 'brain circulation', with outward mobility levels matching inward mobility levels. High levels of outward mobility coupled with low levels of inward mobility often signal an unattractive national labour market for researchers and unsuitable research infrastructures. This may trigger, despite the policy efforts supporting the mobility the 'brain drain' rather than brain circulation.

3.1.1 Stocks and mobility flows of researchers

Slovakia and the EU27 accounted for contrasting trends in numbers of researchers and R&D personnel. Numbers of researchers (in full-time equivalent) versus total population in Slovakia decreased from 0.09% to 0.06% in the period 2001-2009. Respective numbers increased from 0.25% to 0.29% in the EU27 in the same period (source: Eurostat). Labour market for researchers accounted for a dramatic though not always positive changes in the past two decades in Slovakia. There were some 60,548 R&D workers (of which 34,685 researchers) in headcounts in 1989. Demise of central planning and introduction of a market economy immediately were reflected in deep fall in GERD and stocks of human resources in R&D in the early 1990s (Figure 2). In the period 1989-1994, numbers of R&D workers and researchers dropped to one third. By 2009 there were some 25,388 R&D workers (of which 21,832 researchers) in headcounts in Slovakia. Two major factors were behind the fall in human resources in R&D:

- The 'shock therapy' model encouraged short-term considerations in the planning of companies, whereas R&D requires long-term perspectives. The demand for traditional company-level research has declined in favour of technology transfer. The collapse of communist regimes lifted ideological and strategic constraints on knowledge diffusion between the East and West. The inflow of FDI, linked to privatisation, has often been followed by substitution of imported management and technology for in-house R&D, as part of wider corporate division of labour. Reduced public expenditure was related to the neo-liberal stabilisation programme, and led to a direct decline in R&D. The re-internalisation of trade has also had a negative impact on the R&D. The collapse of the former Council of Mutual Economic Assistance has meant reduced opportunities for exporting more technologically sophisticated goods, including military products. Many research institutes have been closed or severely weakened and the financial squeeze imposed on the privatised enterprises has reduced the(ir) R&D capacity. The indirect impacts were reflected in difficulties in finding complementary sources of R&D finance by the private firms, as the business sector itself was undergoing a period of privatisation and thorough corporate restructuring.
- The economic and social transition generated a strong demand for business, marketing, management, trade, finance and engineering skills. Shortages on these skills, as well as low salaries in R&D sector, prompted exodus of scientists from the public research organisations and Universities to business and politics. The Slovak R&D workforce was aging while young people did not consider research careers attractive.

Data on the Human Resources in Science and Technology (HRST) indicate that Slovakia was unable to attract foreign professionals. Foreign nationals accounted for some 0.36% of total HRST in Slovakia in 2008. In Austria (Slovakia's developed neighbour), for example, foreign nationals accounted for 9.51% of total HRST in the same year (source: Eurostat). Data on the levels of inward versus outward flow of researchers is not available, but brain-drain is considered a serious problem for the development of human resources in Slovakia. Two basic research policy documents (the 2002 Concept of the National Science and Technology Policy by 2005 and the 2007 Long-term Objective of the State S&T Policy up to 2015) contained priorities on:

- creating conditions for human resources development, with particular regard to careers of young research workers and their professional growth;

- creating working conditions (salaries, training, modern infrastructure) for R&D workers to stop a brain drain to more attractive jobs in Slovakia and abroad;
- supporting mobility of R&D workers between different R&D sectors;
- supporting international mobility of R&D workers via attracting foreign professionals to Slovakia and supporting return migration by Slovak nationals;
- developing careers of young researchers and supporting excellent mentors of PhD students.

The Research and Development Agency implements the 'Support to Human Potential in Research and Popularisation of Science' programme. The programme aims at 'improving attractiveness and increase in interest by young people in careers in research'. Some 289 projects were supported in 2009 with €4.2m from the state budget and €0.4m from other national resources (source: the 2009 Annual Report on R&D).

The OECD data on migration by tertiary students indicate negative balance by numbers of PhD student flows from/to Slovakia. Numbers of the Slovak PhD students participating in the advanced research programmes rose from 366 in 2004 to 1572 in 2008. Numbers of foreign students participating in the advanced research programmes in Slovakia increased from 113 to 588 in the same period (source: OECD StatExtracts: Education Skills). Slovak national statistics state some 811 foreign postgraduate students in Slovak higher education institutions (as of 31 October 2009). Germany (35.1%), the Czech Republic (21.5%) and Poland (6.2%) were most important countries of origin (source: the Institute for information and Forecasting in Education of the Ministry of Education).

3.1.2 Providing attractive employment and working conditions

Employees in public sector are considered as the civil servants. Their remuneration is regulated by the official salary schemes set in the 553/2003 Law on Remuneration of Civil Servants. These are based on education level, type of jobs and length of experience. The Law sets a special wage tariff scale for the University teachers and R&D workers. Tariff wage can be complemented by bonus, if available. In a theory, higher education institutions and research institutes may determine salaries of the academic staff via allowances and extra remuneration. In practice, salaries are determined by amount of funds provided from the state budget. The Slovak government decided to cut the budget deficit in 2011 from which decreases in numbers of research staff and volume of bonuses are expected. Salaries for the Universities and the Slovak Academy of Sciences may drop by 8-12%.

The average (gross) monthly wage was €925 for science and technology workers, but €1,517 in financial services, €1,368 in information and telecommunication technologies and €1,285 in energy sector in July 2010. The national average wage was €758 (source: Statistical Office of the Slovak Republic). The average gross annual earnings in 'professional, scientific and technical activities' were vastly different in Slovakia and in developed EU members. The average annual earnings were €13,131 in Slovakia, but €59,374 in Denmark, €51,882 in the Netherlands and €42,666 in Sweden in 2008 (source: Eurostat).

No special provisions are made for equal gender representation in academic and research committees, boards and governing bodies in Slovakia. Women, however,

are rather underrepresented in top managerial posts. There were, for example, only 3 female rectors in 33 Slovak higher education institutions in 2010.

However, all women in Slovakia are entitled to the 3 years of the maternity leave. The Labour Code (Law No. 311/2001) guarantees return to the same type of work after that leave. The only exception from this rule is the fixed-term contract.

Slovakia accounted for the above-average rates of female employment in R&D sector. The shares of female R&D personnel (in full time equivalent) in the total R&D personnel were 44.8% in 2000 and 44.7% in 2009 in Slovakia, while 31.8% in 2000 and 33.1% in 2007 the EU27 (sources: Eurostat and Statistical Office in the Slovak Republic).

An increased competition is being formed for the most talented R&D workers, however unfortunately mostly by the foreign R&D institutions, and domestic financial and IT sectors. In conclusion, low wages and unattractive working conditions (aged R&D infrastructure and lack of research funding) were major factors causing the low interest of young people for the careers in the research sector.

3.1.3 Open recruitment and portability of grants

The access to the Slovak national labour market depends on origin of an applicant. On the basis of the Treaty of Accession of the Slovak Republic to the European Union and the Decree of the Government of the Slovak Republic No. 391/2004, from 1 May 2004, the Slovak Republic enables access to its labour market to citizens of all the EU member states without any restrictions. According to the Law on Employment Services No 5/2004 a citizen of an EU member state and his/her family members shall have the same legal position in legal relations occurring pursuant to this Act as do citizens of the Slovak Republic. The rights relating to a citizen of an EU member state and his/her family members also refer to citizens and family members of states within the European Economic Area. Nationals from third countries have the same legal status as Slovak citizens, if they were issued a work permit and a temporary residence permit for the purpose of employment. The employer with a seat in the territory of the Slovak Republic may accept a foreign person in employment only if that person was issued a temporary residence permit for the purpose of employment and a work permit by the competent Office. Temporary work and residence permit effectively preclude researchers from third countries to apply for tenured position.

An EU researcher may, in theory, apply for any research job and/or post in Slovakia. In real life, some managerial posts require fluent Slovak, which few foreign applicants can prove. There were examples (if only a few) of foreigners applying and winning top posts in Slovak University system. A Polish catholic priest and polyglot, for example, is rector of the Catholic University in Ružomberok.

The 172/2005 Law on Organisation of State Support to R&D regulates provision of finance to public sector. Slovakia transposed the Council Regulation on special methods of accepting the citizens of third countries (outside the territory of the EU) into scientific research through the 2008 amendment of the 172/2005 Law. The amendment specified the terms and conditions under which R&D organisations can accept researchers from third countries. Bodies established in Slovakia are eligible for support. Individual researchers (including citizens of the EU and third countries) may hold grants and transfer these within Slovakia, but they have to produce work permit and acceptance documents by Slovak research institutions. Transfer of funds

provided by the Slovak state budget to bodies/persons residing outside Slovakia is not allowed.

3.1.4 Meeting the social security and supplementary pension needs of mobile researchers

Slovakia opted for a simple and generic tax environment. A flat income tax of 19% has been applied to all employees and businesses since 2004. There are no special tax incentives for researchers or any other groups of R&D personnel. Employees also had to pay health and social insurance taxes. As for the pension insurance, an employee can opt either to pay 18% of gross income to the (pay-as-you go) Social Security system or split his/her payment between the Social Security system and funded pillar managed by the private pension companies. There is also a private supplementary pension scheme. Foreign researchers are free to participate in funded pillar and supplementary pension scheme, and can transfer their contributions to their home countries.

PhD students are offered two types of jobs, depending on their choice and availability of funding. Regular employment, usually fixed-term, is the first option, fellowship the second one. PhD students on fellowship pay no social insurance taxes. Net income from regular employment sometimes is lower than that from fellowship. Employers are allowed to renew fixed-term contract in three consecutive years as a maximum. After three years an employee must be offered a tenured job. For employers it is sometimes easier to get funds for fellowships than for regular employees. They also pay no health insurance taxes up to age of 30. Remuneration in regular employment, however, is higher. Foreign PhD students enjoy the same rights and duties as the Slovak nationals.

No distinction is made legally between the EU and non-EU researchers and PhD students.

3.1.5 Enhancing the training, skills and experience of European researchers

The 131/2002 Law on Higher Education distinguishes between postgraduate training and awarding PhD degrees. The postgraduate training is provided by (a) the accredited higher education institutions and (b) accredited training places. The latter category refers to institutes of the Slovak Academy of Sciences in particular. All HEIs and training places other than HEIs must be accredited by the Ministry of Education, Science, Research and Sports. Accredited training places other than HEIs must prove compliance with qualitative standards (research infrastructure, research excellence and availability of scientific staff) and sign co-operation agreement with an accredited HEI. The HEI only can award the PhD title.

Two types of PhD courses are provided. ‘Internal’ PhD students get fellowships paid by the state, and distributed via HEIs and accredited training places. Fellowships are awarded for three years. Internal PhD students are expected to participate in teaching and research. ‘External’ PhD programmes are designed for people employed outside the research and HEI sectors and do not involve any direct financial support. External PhD students are expected to defend their theses within five years since commencement of their studies. Internal and external PhD students pay no fees for their studies within regular period of studies (three and five years respectively).

Some postgraduate programmes are taught in English. Postgraduate students can submit their PhD thesis in several World languages, including English.

The Slovak PhD students and researchers can and want to participate in the European and other international mobility programmes. The OECD database on foreign students indicates significant increases in numbers of the Slovak researchers participating in the advanced research programmes, from 366 in 2004 to 1572 in 2008. Some 13.5% of Slovak PhD students participated in the advanced research programmes abroad. The Czech Republic (75.7%), Austria (5.4%), UK (3.6%) and Hungary (3.3%) were the most important destinations for the Slovak PhD students abroad in 2008.

International mobility by PhD students and young and experienced researchers is generally encouraged and enabled via a number of multilateral and bilateral programmes. Some 44 Slovak scientists, for example, obtained support €5.5m under the Marie Curie Actions programme in the period 2004-2009. Participation in the mobility scheme is unfortunately not reflected in wage and/or career incentives.

3.2 *Research infrastructures*

Research infrastructures (RIs) are a key instrument in the creation of new knowledge and, by implication, innovation, in bringing together a wide diversity of stakeholders, helping to create a new research environment in which researchers have shared access to scientific facilities. Recently, most EU countries have begun to identify their future national RI needs, budgets and priorities in the so called National Roadmaps for Research Infrastructures. These strategic documents also set out a strategic view on how to guarantee and maintain access to research facilities. Although some countries invest heavily in RIs, none can provide all the required state-of-the-art facilities on a national basis. Several large RIs have already been created in Europe. While optimising the use and development of existing RIs remains important, new infrastructures are needed to respond to the latest research needs and challenges. European Strategic Forum for Research Infrastructures (ESFRI) was established in April 2002 to support a coherent approach to policy-making on RIs in Europe and to act as an incubator for international negotiations on concrete initiatives. This section assesses the research infrastructures national landscape, focusing on the national RI roadmap and national participation in ESFRI.

3.2.1 National Research Infrastructures roadmap

The 2007 Long-term Objective of the State S&T Policy up to 2015 set priorities in 'human resource infrastructure' and 'technical infrastructure' for Slovak R&D system. The latter item includes ICT technologies, technology and laboratory equipment, purchase of intangible assets and creation of science & technology parks ('large technical infrastructure').

Development of research infrastructure is supported from national and European resources. National resources are provided via the State Programmes for Development of R&D Infrastructure. One programme, devoted to the development of infrastructure in field of biology and new materials, received support €1.3m from the state budget and €0.3m from private sector in 2009.

The Cyclotron Centre probably is the largest national research infrastructure project. The centre was established by the Slovak Government Resolution No. 659/99 of 4 April 1999. The Slovak Office of Standards, Metrology and Testing (SOSMT) has

been building the centre and co-operating with the Ministries of Education, Economy and Defence. The initial building costs of the centre were €108m and were foreseen to be paid from recovered loans provided to Russia in the early 1990s (the same source was used for financing space flight of the first Slovak astronaut in 1999). The International Atomic Energy Agency and the Framework Programmes also contributed to the centre building. Nuclear medicine, industrial applications, and research in particle physics, and material science should be the main centre activities. The centre, however, encountered problems related to recovering Russian debt and it was far from completed by the end of 2010. The Slovak Ministry of Economy and Construction and the Russian Ministry of Energy signed the memorandum of understanding in July 2010 considering the creation of joint Slovak-Russian cyclotron research centre. The research activities should target 'micro- and nanotechnologies, new materials and research education projects'. The SOSMT estimated costs needed for completion and running the centre in next 10 years to €100m. The centre project generated lukewarm reactions by Slovak public. Local citizen activists opposed the centre construction. The Slovak Academy of Sciences (SAS) expressed doubts about centre's value for scientific research. Chairman of the SAS said that 'costs are high, utility very low. Slovakia cannot do research on everything' (source: Trend Weekly, 7th May 2009). The Slovak Government considers issues related to centre operations and handling nuclear material sensitive and does not publish any details on the centre, its budget, staff, technology equipment, etc.

European resources provide bulk of assistance to development of research infrastructure in Slovakia in period 2007-2013. The Operational Programme Research and Development contains priority axis 1 'Infrastructure of research and development' and priority axis 3 'Infrastructure of research and development in the Bratislava region'. Two priority axes allocate some €311.0m and €149.0m respectively to projects supporting purchase of tangible and intangible assets for research centres and building broadband networks. Most support from the European resources is channelled to generic infrastructure. Two important infrastructure projects have been developed since 2010: (a) National information system supporting research and development in Slovakia and (b) Infrastructure for research and development – Data centre for research and development (see chapter 2.5.1 for more details).

Share of infrastructure expenditure in total GERD and/or GBAORD is difficult to compute. Many policy initiatives cover multiple targets in Slovakia. As for the European support to research, about one third is channelled to infrastructure projects in the period 2007-2013.

Slovakia participates also in development of international infrastructures, but amount of support is modest. The 2009 Annual Report on R&D mentions Slovak participation in the ESFRI initiatives. The most important activities include (a) European X-ray Free Electron Laser Facility, (b) the Institut Laue-Langevin (ILL) projects, (c) Facility for Antiproton and Ion Research (FAIR), (d) European Social Survey and (e) European Synchrotron Radiation Facility (ESRF). Cost of participation in the abovementioned initiatives was €4.7m in 2009.

Four Slovak projects targeted the FP7 Capacities programme and were supported with €0.8m. Support amounted to some 9% of the total Slovak expenditure on the FP7 projects in 2009.

3.2.2 National participation in the *ESFRI roadmap*. Updates 2009-2010

The 2009 ESFRI Report provided overview of the national roadmaps. Five countries took no action in this policy area, including Slovakia. The Ministry of Education, Science, Research and Sports (MESRS) submitted draft of the 'National Research Infrastructures Roadmap' (NRIR). The NRIR should define funds and areas of specialisation for national research infrastructure. The most important body for coordination of science and technology policies - the Slovak Republic Government Board for Science and Technology (SRGBST) - discussed the NRIR draft on 11 May 2010. The SRGBST members deemed the draft incomplete. Targets set in the draft were considered 'very general' and 'policy instruments for achieving targets missing'. The SRGBST members asked for a 'better analysis of incumbent infrastructure' and 'definition of resources and options'. The members asked for changes in structure of expert council for the NRIR. The structure of experts should reflect 'diverse fields of science'. The roadmap also should contain targets, priorities and funds up to 2013, and include qualitative and quantitative evaluation indicators and 'targets for underdeveloped regions'. The MESRS should submit amended draft of the NRIR (source: minutes of the SRGBST meeting).

3.3 *Strengthening research institutions*

The ERA green paper highlights the importance of excellent research institutions engaged in effective public-private cooperation and partnerships, forming the core of research and innovation 'clusters', mostly specialised in interdisciplinary areas and attracting a critical mass of human and financial resources. The Universities/ research institutions should be embedded in the social and economic life where they are based, while competing and cooperating across the Europe and beyond. This section gives an overview of the main features of the national higher education system, assessing its research performance, the level of academic autonomy achieved so far, dominant governing and funding models.

3.3.1 Quality of National Higher Education System

As of November 2010, there were 33 higher education institutions, of which 20 public, three state and 10 private in Slovakia (see Annex). Numbers of HEIs students were strictly limited under central planning and it took long time to offset this problem. Access to higher education widened during transition to a market economy in the 1990s. Several new HEIs were established and, although of variable quality, partly satisfied increasing demand for higher education. The number of undergraduate students, for example, increased from 60,000 to 220,000 between academic years 1989/1990 and 2009/2010. There was an even sharper increase in the number of postgraduate students, from about 974 in academic year 1990 to 10,949 in 2009/2010 (Figure 3).

Main evaluation body for Universities is the Accreditation Commission of the Slovak Ministry of Education, Science, Research and Sports. It evaluated 20 public, four private and three state HEIs in 2009-2010. The HEIs were allocated to three categories: (i) Universities, (ii) Higher Education Institutions and (iii) Professional Higher Education Institutions. The Ministry of Education, Science, Research and Sports deemed there are too many HEIs and rejected proposals for establishing several new private HEIs in 2010.

Slovakia was catching up with European standards in provision of tertiary education. Numbers of tertiary students (ISCED 5-6, all ages) as percent of 20-24 years old in the population rose from 26.0% to 52.7% in Slovakia and from 47.3% to 59.5% in the EU27 in the period 1999-2008. Rapid growth in student and University numbers, however, has not been matched by adequate financial support. While numbers of undergraduate and PhD students rose 3.5 times in academic years 1989/1990-2009/2010, total public expenditure on education as percent of GDP, at tertiary level of education (ISCED 5-6) fell from 0.98% to 0.79% in the same period. The 497/2009 Law on the 2010 State Budget set public support to higher education at €456.5m, some 0.72% of GDP estimated for 2010. Fall in real spending on higher education had significant effect on deteriorating quality of higher education. Development of higher education has been much more quantitative than qualitative one since 1989. Slovak HEIs had very limited resources for R&D activities. The share of HERD in GDP was 0.14% in 2008. The business sector was investing almost nothing in University research. Share of HERD financed by industry in total GERD was 2.4% in 2008 (source: Eurostat). The quality of research was mostly poor due to the low investment in University research in general. The Shanghai list of top World Universities does not contain any Slovak University. The Webometrics Ranking of World Universities contains two Slovak Universities in list of top 1000 World Universities: the Comenius University in Bratislava (no. 520) and the Slovak University of Technology (no. 837, as of July 2010):

- The Comenius University had some 27,416 undergraduate and postgraduate students, of which 1,735 foreign in academic year 2009/2010. The Accreditation Commission found 'excellent research'[2] for medicine and pharmacology, social and behavioural sciences, physics and geosciences, mathematics and informatics.
- The Slovak University of Technology had some 18,253 undergraduate and postgraduate students, of which 495 foreign in academic year 2009/2010. Excellent research was found for nature science (physics, chemistry, mathematics), engineering (metallurgy, machinery, electrical engineering) and informatics.

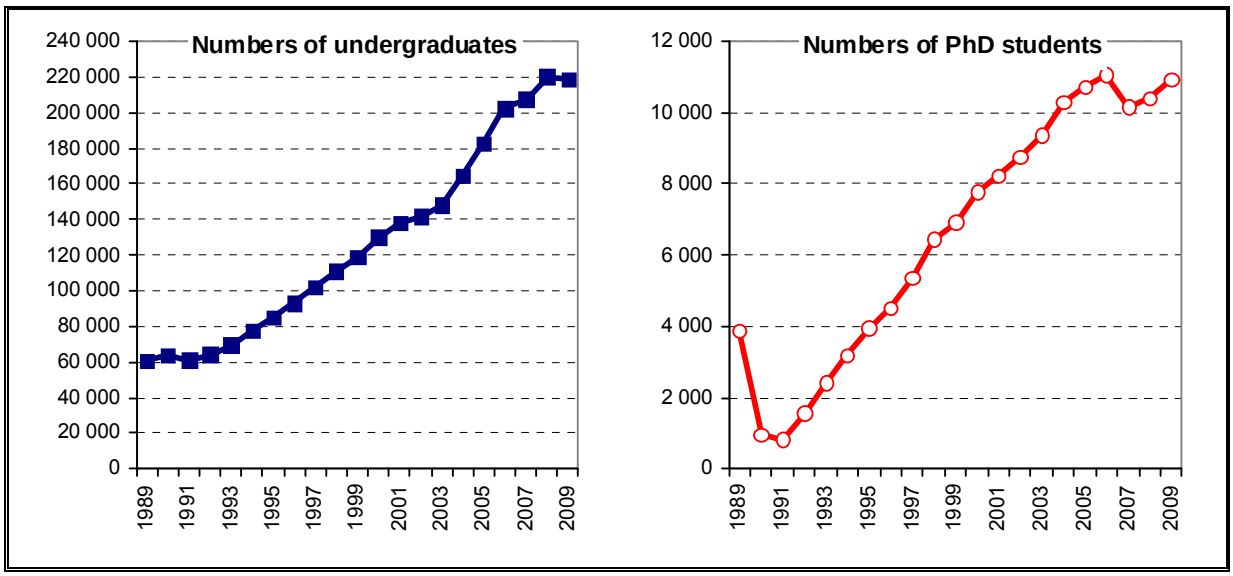
The Comenius University in Bratislava and the Slovak University of Technology also are most frequent Slovak participants in the FP7, COST and Eureka programmes (the 2008 Annual Report in R&D mentions eight and the 2009 report five participations).

The post 1989 transformations in Eastern Europe generated considerable outflows of students from the new Member Countries, especially following the consecutive EU enlargements to 10 and later 12 new member states. The total numbers of tertiary students from these countries studying abroad in 2007 compared to 1998 increased most in Slovakia (8.1 times), Poland (3.5 times) and the Czech Republic (3.2 times) (source: OECD StatExtracts: Education Skills). Four new member states (the Czech and Slovak Republics, Hungary and Poland) generated the fastest growing flows of international students in Europe: whereas they generated 7.6% of intra-European student migrants in 1998, this had increased to 18.0% in 2007. Slovakia ranked

[2] Research outputs (usually papers, monographs and/or citations) are assigned to four qualitative categories, form 'top-notch international quality (i.e. published in recognized journals included in the Current Contents database) to 'international', 'national' and 'lower than national' quality. Each category is given different weight. Total quality of research outputs is computed as weighted average of output numbers in particular categories.

among countries with the highest emigration rates. Some 10.2% of total Slovak tertiary students studied abroad in 2007. Most Slovak students headed for the Czech Republic, Austria and Hungary. Foreign students, on the other hand, accounted for 0.5% of total tertiary students in Slovakia in the same year (source: Eurostat).

Figure 3: Development of higher education in Slovakia



Sources: Ministry of Education, Science Research and Sports

3.3.2 Academic autonomy

The 131/2002 Law on Higher Education awarded Slovak higher education institutions (HEIs) significant degree of autonomy. The HEI is represented by its rector. The rector is elected by the academic senate and appointed by the President of the Slovak Republic. The academic senate has at least 11 members. At least one third of these are students and the rest is elected by the academic staff. The rector is advised by the scientific board, the disciplinary board, the rector's collegiums and the management board. The management board discusses and approves HEI budget, all other important financial issues, and examines HEI's long-term development plans and annual reports. The management board has 14 members, six of whom are appointed by the rector, six by the Minister of Education, Science, Research and Sports, one by academic staff and one by students. The board members are elected from outstanding representatives of the business sector, regional government and central government. Faculty deans are elected by the faculty academic senates and appointed by the rector.

Broad autonomy sometimes conflicted with ethical standards. Some HEIs were reluctant to fire their staff even in cases of outright plagiarism and diploma-selling. The Minister of Education, Science, Research and Sports may criticise unethical conduct, but has no power to take punitive action. The Slovak Parliament discussed proposal for amendment of the Law on Higher Education in October 2010. The amendment aimed at fighting plagiarism and misconduct in awarding academic degrees. It sets that all diploma works, PhD theses and professor degree works should be published on the internet.

The HEIs are free to select and hire researchers and other research personnel for fixed-term contracts and/or tenure, as much as they have enough financial resources. Salaries consist of tariff wages and bonuses. Tariff wages are set by

national regulations and depend on experience and excellence of the researchers. Bonuses depend on amount of financial resources available.

Candidates for directors of institutes in the Slovak Academy of Sciences are elected by the academic staff and appointed by the SAS presidium. Any EU national may apply for the post, but so far only Slovak directors were elected.

3.3.3 Academic funding

Slovak higher education institutions (HEIs) and public research organisations (in particular the Slovak Academy of Science, SAS) receive institutional funding and project finance.

- As far as HEIs are concerned, they received €39.7m of the (national) institutional funding in 2009. Institutional funding was distributed via (a) block grants for research infrastructure grants (€26.7m) and (b) competitive VEGA and KEGA grants (€10.3m and €2.6m respectively in 2009). The 2009 Annual Report on Higher Education states that block funding was related to 'research capacities, amount of domestic and foreign research grants obtained by particular HEI, numbers of PhD students and publication activity'. The KEGA grants support arts and humanities, the VEGA grants other fields of science.
- Project finance for HEIs was supported from the State R&D Programmes (€0.6m), the Research and Development Agency grants (€13.8m) and foreign grants. Project finance (except private and European resources) generated 36.3% of national research funding in Slovak HEIs in 2009. Slovak HEIs derived little income from business activities. Total revenue of 20 public HEIs was €578.5m, of which state subsidy €442.7m and 'revenue for services provided' €51m.
- As far as the Slovak Academy of Sciences is concerned it received block grant from the state budget €66.9m in 2009. Project finance was obtained from the VEGA grants (€2.9m), the Research and Development Agency grants (€4.3m), foreign grants (EU Framework Programmes, €1.5m) and private sector.
- The Slovak Academy of Sciences also was given project finance €66.9m in 2009, which corresponded to 11.5% of total support to research in 2009. The SAS also obtained additional €1.7m from occasional and/or one-time activities (consultancy, analyses, certifications) in 2009.

Institutional funding accounted for about two thirds and project funding for one third of the total support from the state budget in 2000s. The 2007 Long-term Objective of the State S&T Policy up to 2015 set that shares of institutional and project funding should be reversed by 2015. The target does not seem realistic by 2010.

3.4 Knowledge transfer

The importance of knowledge dissemination and exploitation in boosting competitiveness and contributing to the effectiveness of public research has been increasingly recognised by the EC and the EU Member States. Following the publication of the ERA Green Paper in April 2007, the EC Communication "Improving knowledge transfer between research institutions and industry across Europe" was issued, highlighting the importance of the effective knowledge transfer between those who do research, particularly HEIs and PROs, and those who transform it into products and services, namely the industry/SMEs.

Several Member States have taken initiatives to promote and facilitate knowledge transfer (for instance new laws, IPR regimes, guidelines or model contracts) and many others are planning to intensify their efforts in this direction. However, these initiatives are often designed with a national perspective, and fail to address the trans-snational dimension of knowledge transfer. This section will assess the national policy efforts aimed to promote the national and trans-national public-private knowledge transfer.

3.4.1 Intellectual Property Policies

Information on knowledge-transfer-offices is scarce in Slovakia. The most important body is the Technology Institute of the Slovak Academy of Sciences (SAS). The institute was founded by nine institutes of the SAS in 2009. It aims at (a) support to interdisciplinary research in the field of new materials and technologies, (b) joint procurement of expensive equipment, and (c) complex services in commercialisation and management of R&D results and intellectual property rights. The institute 'wants to act as broker for patent rights', 'provide support to spin-offs' and 'manage transfer of knowledge'. No details on particular activities were provided. HEIs support exploitation of research outcomes via technology incubators and science and technology parks.

3.4.2 Other policy measures aiming to promote public-private knowledge transfer

Involvement of private sectors in the governance bodies of HEIs and PROs

Private sector is involved in a governance of the Slovak R&D system in several ways:

- The most important body for coordination of science and technology policies– Slovak Republic Government Board for Science and Technology (SRGBST) – includes several members representing Slovak industry. Mr Jozef Uhrík was former director of the Volkswagen Slovakia and is chairman of the Slovak Association of Automotive Industry. Mr Ľubomír Palčák is director of the Transport Research Institute. Mr Peter Weber is director of the Hewlett-Packard Slovakia.
- The management boards of Slovak higher education institutions involve members drawn from outstanding representatives of the business sector.
- The State R&D Programmes are managed by the programme councils. Members of the councils include representatives of Slovak businesses.

Inter-sector mobility

There is no special programme aimed at the inter-sector mobility in Slovakia. The 'Support to Human Potential in R&D and Popularisation of Science Programme' which is implemented by the Research and Development Agency has multiple targets and supports (among other goals) also mobility of R&D workers between industry and academia sectors. Details on assistance to this particular activity are not available.

Promoting research institutions - SME interactions and spin-offs

The Research and Development Agency implements two programmes aimed at promoting interaction between research institutions and SMEs in 2007-2010:

- The 'Support to Cooperation between the Universities and the Slovak Academy of Sciences and Businesses' programme assists costs of partnership creation and

operation, and costs of basic research in centres established under this scheme. The programme supported 11 projects with €0.3m in 2009. Private sector provided support €0.03m.

- The 'Support to R&D in SMEs' programme targets micro-enterprises, spin-offs and start-ups and supports feasibility studies, technology transfer and R&D project finance. Some 115 projects received support of €5.4m from the state budget and €3.7m from the private sector in 2009.

EU cohesion policy

Two major policy instruments are designed to disperse the funding from the ERDF via supporting incubators and science parks and fostering creation of university spin offs:

- The Supporting innovative activities in enterprises scheme developed under the Operational Programme Competitiveness and Economic Growth;
- Priority axes 2 and 4 of the Operational Programme Research and Development.

Please see chapter 2.5.1 for more details.

3.5 *Cooperation, coordination and opening up national research programmes within ERA*

The articulation between the R&D Framework Programmes, the Structural Funds and the Competitiveness and Innovation Programme is still underdeveloped in terms of coordination, synergies, efficiency and simplification. The policy fragmentation at the EU and national level and between the EU and national policies can hinder the building of critical masses of research excellence, and leads to the duplication of efforts, sub-optimal impacts of different instruments as well as to unnecessary administrative overheads. Differences between research selection procedures and criteria can also be an obstacle to the overall spreading of excellence. This section assesses the effectiveness of national policy efforts aiming to improve the coordination of policies and policy instruments across the EU, all part of the drive to create an integrated ERA.

3.5.1 National participation in intergovernmental organisations and schemes

The 2007 Long-term Objective of the State S&T Policy up to 2015 contains a chapter on international co-operation in science and technology. The rationale for national participation in inter-governmental schemes is 'benefits for economic and social development of Slovakia'. The 2008-2010 National Reform Programme explicitly refers to priority 'increased participation of Slovak organisations in the solution of European research and development programmes and European research centre programmes'.

National participation in intergovernmental organisations and schemes was managed by the Research and Development Agency (RDA). Slovakia participated in some 51 projects of the FP7 in 2009. The total budget of support was €7.2m (Table 8). Most important research fields included nanotechnologies and new materials (€1.1m), transport (€0.8m), and food and biotechnologies (€0.5m). The annual reports on R&D mention project numbers and budgets, but give little details on rationale and results of the schemes supported.

The RDA launched no calls related to the COST initiative in period 2007-2009. The 2009 RDA annual report mentioned monitoring six projects concluded in 2007 and 2008 and gave some details on project results (numbers of co-publications and citations by the Slovak and foreign partner and numbers of business solutions generated). Six projects launched in 2007 were supported with €0.08m in 2009.

Two EUREKA projects were supported with €0.03m in 2009.

Table 8: Slovak participation in intergovernmental organisations and schemes

	2006	2007	2008	2009
6th and 7th Framework Programmes				
numbers of projects	n.a.	30	74	51
support, €m	n.a.	4.12	13.0	7.2
ESF, COST and Eureka				
numbers of projects	7	35	28	21
support, €m	0.03	0.33	0.45	0.29

Sources: The 2006-2009 annual reports on R&D. n.a. = not available

The 2009 Annual Report on R&D refers to 12 participations in important intergovernmental organisations and schemes (including inter-governmental research infrastructures), where Slovakia was a member. Participation was supported with €10.7m in 2009. Membership in the European Organization for Nuclear Research (CERN) was the most important initiative. Ministry of Education, Science, Research and Sports is guarantor of Slovakia's membership in the CERN. The Ministry recognised that Slovakia's share in the total CERN budget was low (about 0.34%), but 'numbers of Slovak scientists and value of technology equipment delivered by Slovak enterprises surpassed volume of contribution several times'. See chapter 3.6.1 for more details.

3.5.2 Bi- and multilateral agreements with other ERA countries

Information on bi- and multilateral agreements with other ERA countries is limited in Slovakia. The Slovak Republic has signed a number of bi- and multilateral agreements. The Research and Development Agency managed the 'Bilateral Co-operation in Science and Technology' scheme and supported 118 projects (€0.23m) with seven ERA countries (Austria, Bulgaria, the Czech Republic, France, Hungary, Italy, and Slovenia) in 2009. The mobility scheme covered costs of travel, accommodation and subsistence. Details on distribution by research fields are not available.

Multilateral agreements targeted participation in research infrastructure projects (see chapters 3.2.1 and 3.6.1 for more details).

3.5.3 Other instruments of cooperation and coordination between national R&D programmes

Support to other instruments of cooperation and coordination between national R&D programmes is relatively low and information on the programmes is scarce. The Research and Development Agency (RDA) supports activities developed within the European Science Foundation via calls related to the Research Networking Programmes (RNP) and EUROCORES projects. Nine RNP projects were supported with €0.02m in 2009. Participating organisation involved the Institute of Experimental Physics, Institute of Chemistry and Institute of Art History of the Slovak Academy of

Sciences and several higher education institutions involved in nature science research. The Institute of Experimental Physics and the Institute of Physics of the Slovak Academy of Sciences, and the Natural Sciences Faculty of the Comenius University developed four EUROCORES projects (supported with €0.15m) in 2009.

The Slovak Academy of Sciences (SAS) was a member in two ERA-NET initiatives. The Institute of Materials & Machine Mechanics was member of the NanoSci ERA-NET initiative. The initiative aims at development of new materials and technologies. The Institute of Physics, Institute of Materials & Machine Mechanics, Institute of Materials and the Institute of Experimental Physics were members in the Micro and Nano Technologies ERA-NET (MNT-ERA.NET) initiative. The SAS supports this scheme with €0.05m in 2009.

The Slovak government decided to participate in joint programming on combating neurodegenerative diseases, in particular Alzheimer's. The Ministry of Education, Science, Research and Sports is responsible for participation and invests €1m. The Slovak Academy of Science attended the meeting on 'Health, food and prevention of diet related diseases' joint programming initiative. Participation in the initiative is considered.

3.5.4 Opening up of national R&D programmes

This issue has been not covered by Slovak research policies so far. The 172/2005 Law on Organisation of State Support to R&D in theory enables participation by foreign researchers in Slovak research programmes, but there is little experience with this issue, given limited interest by foreign researchers in working in Slovakia. Low salary and poor R&D equipment are major barriers for attractiveness of research careers in Slovakia both by the Slovak and foreign nationals. The Slovak law also does not allow for transfer abroad of funds provided by the Slovak state budget.

3.6 *International science and technology cooperation*

In 2008, the European Commission proposed the Strategic European Framework for International Science and Technology Cooperation to strengthen science and technology cooperation with non-EU countries. The strategy identifies general principles which should underpin European cooperation with the rest of the world and proposed specific orientations for action to: 1) strengthen the international dimension of ERA through FPs and to foster strategic cooperation with key third countries through geographic and thematic targeting; 2) improve the framework conditions for international cooperation in S&T and for the promotion of European technologies worldwide. Having in view these aspects, the following section analyses how national policy measures reflect the need to strengthen the international cooperation in S&T.

3.6.1 International cooperation

Co-operation with third countries is promoted both via the central government authorities and in particular by higher education institutions and public research organisations. The Slovak Ministry of Education, Science, Research and Sports has signed co-operation agreements with partner ministries in 41 countries. Most of these agreements contain chapters on co-operation in science and technology. Co-operation agreements with third countries used to be generic and did not focus on particular science fields. Time horizons for projects developed under the agreements

vary from country to country, but typical project is planned for three years. Typical projects support following activities:

- joint research proposals;
- joint publications;
- joint participation on international conferences and workshops;
- joint use of research infrastructure and laboratory equipment;
- joint data collection.

Most important third countries involve Slavonic language countries (Serbia, Ukraine, Russia), major economic and scientific powers (USA, Japan, India, China) and some important emerging markets (South Africa, Turkey).

As for the important international research programmes, Slovakia was involved in two large-scale initiatives aimed at nuclear research:

- Slovakia is founding member (1956) of the Joint Institute for Nuclear Research in Dubna (Russia). The institute had 18 full members from Europe and Asia, and two associate members (Germany and Hungary). The research targeted theoretical physics, physics of heavy ions, solid materials physics, neutron physics and mathematics. Over one hundred Slovak scientists from four institutes of the Slovak Academy of Sciences, 11 faculties and two industry research institutes took part in the research and were supported with €1.0m in 2009.
- Since 1993, Slovakia has been member of the European Organization for Nuclear Research (CERN), one of the world's largest and most recognized centres for scientific research. Slovak scientists focus on proton and particle research. Some 21 scientists and engineers and five PhD students were involved in the ATLAS experiment in 2009. Research was supported with €4.0m in 2009. The experiment investigates a wide range of physics, including the search for the Higgs boson, extra dimensions, and particles that could make up dark matter.

3.6.2 Mobility schemes for researchers from third countries

Mobility schemes for researchers are supported via bilateral and multilateral agreements signed by central government authorities, higher education institutions and the Slovak Academy of Sciences.

Mobility grants support only the travel costs (fare, accommodation and subsistence). Numbers of bilateral mobility grants and volume of assistance provided within bilateral co-operation agreements increased in the past four years, but was quite low anyway (€0.4m in 2009, Table 9). As for the non-ERA countries, 59 projects with five countries (China, Russia, South Africa, Serbia and Ukraine) were supported with €0.2m in 2009. Details on thematic breakdown were not available. The annual reports on R&D and annual reports by the Research and Development Agency use to list numbers of projects and volume of assistance provided by the state budget, but do not provide for impact evaluation.

There is no central database on mobility projects supported by HEIs. The Slovak Academy of Sciences signed 68 bilateral agreements with 44 countries. The agreements enable for mobility up to 5500 man/days per year. Some 392 scientists spent 3564 days in foreign research institutions in 2009. The EU countries (the Czech Republic in particular) were major destinations. The most important third

countries included Russia, China, Japan, Turkey and India. Total support to bilateral projects was €1.5m in 2009.

Table 9: Bilateral agreements in science and technology supported by the Research and Development Agency (all partner countries)

	2006	2007	2008	2009
Number of projects	130	160	141	177
Assistance, €m	0.20	0.26	0.31	0.41

Source: The 2006-2009 annual reports on R&D

4 Conclusions

4.1 *Effectiveness of the knowledge triangle*

Slovakia has a dual economy. Branches of multinational companies (MNCs) form one sector, typical with world-class technology imported from abroad and high productivity levels. Some 90 thousands of Slovak small and medium enterprises (SMEs) and few large companies owned by domestic investors form the second sector, typical with low productivity levels and low R&D intensity. Dual economy and low wage levels are major barriers for developing knowledge-based economy in Slovakia. These problems refer to the current development stage of the country and are out of remit of research and innovation policies.

Research policy objectives set by Slovak government are coherent and so are proposed and/or implemented policy measures. Challenges posed by long-term neglect of R&D and innovation systems, however, are immense

The most positive developments relate to improvement in the governance of research and innovation system in the past three years. The government approved several long and medium-term strategies and policies, and designed a range of policy measures aimed at building and modernising research infrastructure and support to excellence research. Implementation of R&D/innovation policies and policy measures is monitored on an annual basis. The government also created two agencies implementing research and innovation policy measures (ASFEU and SIEA).

Most national support to research is distributed via institutional funding (partly based on competitive VEGA and KEGA grants) and channelled to general university funds and non-oriented research. Slovak public research organisations, higher education institutions are evaluated on the basis of both domestic and international criteria. Research projects are selected on the basis of the quality of proposals and subject to external peer review. The government tries to distinguish between HEIs and provide more funding for Universities with higher quality of research. National support to research, however, is very low and evaluation results are thus of limited importance concerning the volume of financial support.

European money provides significant boost to building and modernising R&D infrastructure and creating linkages for the knowledge transfer in Slovakia. Five Operational Programmes ('Research and Development', 'Competitiveness and Economic Growth', 'Education', 'Bratislava Region' and 'Information Society') will invest some €5b into the structural change and into building of knowledge-based society in the period 2007-2013. Most assistance is distributed via competitive grants

(except for national projects, which are implemented by pre-selected government agencies).

Research infrastructure policies are assisted significantly by the Structural Funds, but results may take years to materialise. Some research and innovation policy measures (venture capital schemes, industry-academia co-operation and mobility schemes) are encountering the low absorption capacity. Demand of the research and innovation solutions by the Slovak SMEs is low.

Nowadays, major imbalances and risks in research policies include:

- rather excessive role of SMEs envisaged in research policies (compared to their actual weight and role and to their absorption capacity) and neglect the cooperation with branches of MNCs established in Slovakia;
- potentially overoptimistic targets: '1.8% share of GERD in GDP' and '2/3 share of business expenditure in GERD' by 2015;
- fragmentation of limited research resources to 12 thematic priorities.

Table 10: Effectiveness of knowledge triangle policies

	Recent policy changes	**Assessment of strengths (+) and weaknesses (-)**
Research policy	• Long-term strategies for research sector are in place. • Government publishes regular reports on R&D system. • Structural Fund schemes are implemented. The Information System and Data Centre policy measures facilitate knowledge transfers between academia and industry sectors.	(+) Higher support to R&D from the State budget and Structural Funds positively impacts development of R&D sector. (-) There is low absorption capacity for R&D investments in private sector in general and SMEs in particular. (-) Underdeveloped evaluation culture. (-) Lack of thematic focus, high number of thematic priorities.
Innovation policy	• Long-term Innovation Strategy and medium-term Innovation Policy are in place. • Government publishes regular reports on implementation of innovation policy measures.. • The Slovak Innovation and Energy Agency was created. • Structural Fund schemes are implemented.	(+) Improvements in innovation governance. (+) Significant increase in investment by innovation policy schemes. (-) There is low absorption capacity for innovative solutions by SMEs. (-) Underdeveloped evaluation culture. (-) Scheme implementing Regional Innovation Centres accounts for slow progress.
Education policy	• The 131/2002 Law on Higher Education was amended. The HEIs are classified into 3 qualitative categories. The HEIs are encouraged to establish spin-offs and start-ups. The HEIs must provide students with diploma supplement labels in English free of charge.	(+) Continuing high demand on higher education. Numbers of undergraduate and postgraduate students have accounted for high increases in 1989-2010. (+) New Universities established, hundreds of new curricula developed. (-) Improvements in quality of higher education lag behind growth in student numbers. (-) Quality of University research is low. (-) Widespread plagiarism and diploma-selling. (-) Brain drain. High negative balance in international student flows.

	Recent policy changes	Assessment of strengths (+) and weaknesses (-)
Other policies	• Government wants to go on with reform of business environment. • Government announced cuts in public expenditure for 2011.	(+) Flat tax and simple tax environment. (+, -) Low costs of production inputs. (-)The government considers slashing national public resources for research. (-) Defunct capital market discourages venture capital. (-) Widespread corruption and misallocation of public financial resources. The NADSME agency investigated by the OLAF.

4.2 *ERA 2020 objectives - a summary*

Slovakia has had limited research capacities and accounted for poor performance in basic and applied research for two decades. Low levels of scientific outputs (in terms of publications, citations and patents), underfinanced research sector, underdeveloped national R&D infrastructure, and limited and ageing human capital in research sector are the main challenges for Slovak R&D-system in relation to the ERA-development. Importance of the ERA-related policies somewhat increased in 2009-2010. Some ERA-related priorities and policies explicitly are referred to in the 2008-2010 National Reform Programme and major research policy documents ('Long-term Objective', 'New Model'). Among these (a) support to participation of the Slovak organisations in international R&D projects, particularly in the Framework Programmes, (b) establishing Central information portal supporting mobility by the Slovak scientists within the ERA, and (c) implementation of the European legislation on researcher mobility rank to most important.

Most investments by the Slovak government supported development of domestic research sector. Total expenditure on international co-operation in R&D (including FP, COST, ESF, EUREKA, international research infrastructures and collaboration with third countries) amounted to €20.4, some 12.8% of national public expenditure and 6.7% of total Slovak GERD in 2008.

In theory, the Slovak labour market was open to researches from all the EU member states without any restrictions. In fact, the Slovak research system offered highly unattractive working conditions (salaries 3-4 times lower than in developed EU members, lack of project finance). Inward mobility was quite low. Te foreign nationals accounted for some 0.36% of the total HRST in Slovakia in 2008.

Table 11: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers	The Decree of the Government of the Slovak Republic No. 391/2004 enables access to Slovak labour market to citizens of all EU member states without any restrictions. Female researchers have right to return to the same position after maternity leave.	(+, -) Moderate supply for science & engineering, to a high extent matching the market demand (-) Overall highly unattractive working conditions for researchers.
2	Increase public support for research	Public budget for R&D increased in nominal value from €136m in 2008 to €160m in 2009. GERD as percentage of GDP, increased from 0.47% to 0.48% (relative increase generated by lower nominal GDP in 2009).	(-) Overall, very low levels of R&D expenditure. (+-)Increase in public budget (if modest) due to European money.
3	Increase European coordination and integration of research funding	Increased interest in European co-operation. Major policy documents include chapters on co-operation in science and technology in ERA.	(-) Overall, very low levels of R&D expenditure supporting national teams in participating to FP projects/proposals and other international co-operation projects.
4	Enhance research capacity across Europe	Government passed several policy documents aimed at enhancing research capacity.	(-) Slovak research capacities decayed over two decades. It takes years to rebuild them.
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	The Operational Programme Research and Development allocates some €460m to projects supporting research infrastructure in 2007-2013. Slovak government decided to complete Cyclotron Centre. Information on the centre is classified.	(+) European money provided significant boost to building and modernising R&D infrastructure in Slovakia. (+) National Research Infrastructures Roadmap under preparation. (-) Lack of absorption capacity in regions outside Bratislava.
6	Strengthen research institutions, including notably universities	The Operational Programme Research and Development invests some €1.4b in total to Slovak PROs and HEIs in 2007-2013. The government tries to improve quality of research in Slovak PROs and HEIs. University ranking and evaluation procedure should be reflected in amount of support.	(+) European money increases budgets of PROs and HEIs feasible. (-) University ranking and evaluation procedures have to take into account generally low quality of research and are subject to lobbyist pressures.
7	Improve framework conditions for private investment in R&D	Several schemes encourage private investment in R&D. Tax incentives were first time used in 2010.	(-) Low demand on innovative solutions and research results by Slovak SMEs is main barrier for industry-academia co-operation.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
8	Promote public-private cooperation and knowledge transfer	New R&D infrastructure may improve linkages between industry and academia sectors, and between Slovakia and advanced EU members. The Operational Programme Research and Development allocates some €689m to projects supporting innovation culture in Slovak firms and transfer of knowledge in period 2007-2013.	(+) Structural Funds provide considerable resources for building institutions facilitating knowledge transfer between industry and academia sectors, (-) Potential problems with low demand and absorption capacity.
9	Enhance knowledge circulation across Europe and beyond	Slovak government continues supporting limited numbers of projects within the FP, ESF, COST and EUREKA programmes.	(-) Slovakia accounts for one of the lowest participation rates in European research initiatives.
10	Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world	Slovak government continues supporting limited numbers of bilateral and multilateral projects within third countries.	(+) Increased interest by Slovak government and research institutions in participation in European research initiatives. (-) Overall, very low resources provided for international co-operation in science and technology.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	Joint programming remains rare in Slovakia.	(-) Joint programming receives relatively low attention by policy-makers (in terms of policy measures and budgets).
12	Develop and sustain excellence and overall quality of European research	Major research policy documents set excellence research priority. Significant part of the Operational Programme Research and Development supports centres of excellence.	(+) Structural Funds provide necessary means for improving extent and quality of research capacities. (-) Slovakia has had limited research capacities and accounted for poor performance in basic and applied research in terms of patents, publications and citations for two decades. Significant improvement may take years.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
13	Promote structural change and specialisation towards a more knowledge - intensive economy	Five Operational Programmes ('Research and Development', 'Competitiveness and Economic Growth', 'Education', 'Bratislava Region' and 'Information Society') invest some €5b in structural change and building knowledge-based society in period 2007-2013.	(+) European resources provide significant contribution to development of R&D, innovation and human resources in Slovakia. (-) Dual economy makes structural change difficult. Slovakia has high unemployment rates and is happy to attract job-creating foreign investment. Quality of investment has been less important so far.
14	Mobilise research to address major societal challenges and contribute to sustainable development	Slovak government decided to participate in joint programming on combating neurodegenerative diseases, in particular Alzheimer's.	(-) Lack of clear thematic focus. Slovak research policy documents mention 12 priorities.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	The Research and Development Agency continues in implementing 'Support to Human Potential in R&D and Popularisation of Science Programme'.	(-) Resources allocated to popularisation of science are low in Slovakia. (-) Broader public shows limited interest in research. Unemployment rates and regional disparities are considered more important problems than dysfunctional research system.

References

Baláž, V. (2008): INNO-Policy TrendChart, Policy Trends and Appraisal Report: Slovak Republic, European Commission, DG Enterprise. http://www.proinno-europe.eu/extranet/upload/countryreports/Country_Report_Slovak_Republic_2008.pdf

Baláž, V. (2009): ERAWATCH Country Report 2009, Analysis of policy mixes to foster R&D investment and to contribute to the ERA: Slovak Republic, JRC Scientific and Technical Reports.

Eurostat (2009): http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home

ERAWATCH Network (2009): Research Inventory.

INNO-Policy TrendChart (2008): Policy Trends and Appraisal Report: Slovak Republic, European Commission, DG Enterprise.

MESRS, Slovak Ministry of Education, Science, Research and Sports (2010): The 2010 Annual Report on Higher Education. http://www.minedu.sk/data/USERDATA/VysokeSkolstvo/VyrSprav/vyrspravavs2009.zip

Research and Development Agency (2010): The 2009 Annual Report. http://www.apvv.sk/buxus/docs/agentura/vyrocne-spravy/apvv-vs-2009.pdf

Slovak Government (2007): Návrh Inovačnej stratégie SR na roky 2007 až 2013 - upravené nové znenie {*Proposal for the Slovak Innovation Strategy for period 2004-2013, amended text*}, in Slovak. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=5904

Slovak Government (2007): 'Operačný program Výskum a vývoj' {*Operational Programme Research & Development*}. http://www.asfeu.sk/operacny-program-vyskum-a-vyvoj/op-vyskum-a-vyvoj/

Slovak Government (2007): 'Operačný program konkurencieschopnosť a hospodársky rast' {*Operational Programme Competitiveness and Economic Growth*}, in Slovak. http://www.opkahr.sk/

Slovak Government (2007): Proposal for the Long-Term Objective of the State S&T Policy up to 2015, Government Resolution No 766/2007 of 12th September 2007. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=1246

Slovak Government (2007): The 2006 Annual Report on R&D. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=528

Slovak Government (2008): The 2007 Annual Report on R&D. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=14431

Slovak Government (2009): The 2008 Annual Report on R&D. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=1921

Slovak Government (2010): The 2009 Annual Report on R&D. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=18700

Slovak Government (2008): Návrh inovačnej politiky SR na roky 2008 až 2010 - upravené nové znenie {*Proposal for Innovation Policy for period 2008-2010, amended text*}. http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=1139

Slovak Parliament (2008): The 2009 State Budget Law 596/2008.

Slovak Parliament (2009): The 2010 State Budget Law 497/2009.

Statistical Office of the Slovak Republic (2008): Careers of the PhD degree holders – first results, April 2008.

List of Abbreviations

ARRA	Academic Ranking and Rating Agency (Akademická rankingová a ratingová agentúra)
ASFEU	Agency for Structural Funds of the Ministry of Education, Science, Research and Sports (Agentúra pre štrukturálne fondy Ministerstva školstva, vedy a výskumu SR)
BERD	Business Expenditures for Research and Development
CERN	European Organisation for Nuclear Research
CKBS	Commission for the Knowledge-based Society (Komisie pre vedomostnú spoločnosť)
COST	European Cooperation in Science and Technology
ERA	European Research Area
ERA-NET	European Research Area Network
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EU27	European Union including 27 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HEI	Higher education institutions
HEIs	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
IP	Intellectual Property
KEGA	KEGA Grant Agency (Grantová agentúra KEGA)
NADSME	National Agency for Small and Medium Enterprises (Národná agentúra pre malé a stredné podniky)
NRIR	National Research Infrastructures Roadmap
OECD	Organisation for Economic Co-operation and Development
OLAF	European Anti-Fraud Office
OPBR	Operational Programme 'Bratislava Region' (Operačný program Bratislavský kraj)
OPCEG	Operational Programme 'Competitiveness and Economic Growth' (Operačný program Konkurencieschopnosť a hospodársky rast)
OPE	Operational Programme 'Education' (Operačný program

	Vzdelávanie)
OPIS	Operational Programme 'Information Society' (Operačný program Informatizácia spoločnosti)
OPRD	Operational Programme 'Research and Development' (Operačný program Výskum a vývoj)
PRO	Public Research Organisations
R&D	Research and development
RDA	Research and Development Agency (Agentúra pre výskum a vývoj)
RI	Research Infrastructures
RNP	Research Networking Programmes
RTDI	Research Technological Development and Innovation
S&T	Science and technology
SAS	Slovak Academy of Sciences (Slovenská akadémia vied)
SF	Structural Funds
SIEA	Slovak Innovation and Energy Agency (Slovenská inovačná a energetická agentúra)
SME	Small and Medium Sized Enterprise
SOSMT	Slovak Office of Standards, Metrology and Testing (Úrad pre normalizáciu, metrológiu a skúšobníctvo)
SRDP	State Research and Development Programmes (Štátne programy výskumu a vývoja)
SRGBST	Slovak Republic Government Board for Science and Technology (Rada vlády SR pre vedu a techniku)
VC	Venture Capital
VEGA	VEGA grant agency (Grantová agentúra VEGA)

Annex: List of Slovak higher education institutions

Public higher education institutions

Univerzita Komenského v Bratislave
Univerzita Pavla Jozefa Šafárika v Košiciach
Prešovská univerzita v Prešove
Univerzita sv. Cyrila a Metoda v Trnave
Univerzita veterinárskeho lekárstva a farmácie v Košiciach
Univerzita Konštantína Filozofa v Nitre
Univerzita Mateja Bela v Banskej Bystrici
Trnavská univerzita v Trnave
Slovenská technická univerzita v Bratislave
Technická univerzita v Košiciach
Žilinská univerzita v Žiline
Trenčianska univerzita Alexandra Dubčeka v Trenčíne
Ekonomická univerzita v Bratislave
Slovenská poľnohospodárska univerzita v Nitre
Technická univerzita vo Zvolene
Vysoká škola múzických umení v Bratislave
Vysoká škola výtvarných umení v Bratislave
Akadémia umení v Banskej Bystrici
Katolícka univerzita v Ružomberku
Univerzita J. Selyeho v Komárne

State higher education institutions

Akadémia ozbrojených síl generála Milana Rastislava Štefánika v Liptovskom Mikuláši
Akadémia Policajného zboru v Bratislave
Slovenská zdravotnícka univerzita v Bratislave

Private higher education institutions

Vysoká škola manažmentu v Trenčíne
Vysoká škola zdravotníctva a sociálnej práce sv. Alžbety v Bratislave, n. o.
Vysoká škola ekonómie a manažmentu verejnej správy v Bratislave
Paneurópska vysoká škola
Vysoká škola v Sládkovičove
Vysoká škola medzinárodného podnikania ISM Slovakia v Prešove
Stredoeurópska vysoká škola v Skalici
Dubnický technologický inštitút v Dubnici nad Váhom
Bratislavská medzinárodná škola liberálnych štúdií
Vysoká škola bezpečnostného manažérstva v Košiciach

Source: Ministry of Education, Science, Research and Sports