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An assessment of research system and policies

Lithuania

Monika Kriaucioniene

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ERAWATCH
COUNTRY REPORT 2008
An assessment of research system and policies
Lithuania

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Executive Summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs which aims to increase and improve investment in research and development, in particular in the private sector. The report aims at supporting the mutual learning process and the monitoring of Member States efforts. The main objective is to characterise and assess the performance of the national research system of Lithuania and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

With Gross expenditure on R&D (GERD) of €191m (2006) Lithuania ranks relatively higher than other small EU new member states, contributing approximately 0.08% of total EU27 GERD. However, at 0.8% GERD as a percentage of GDP (in 2006) Lithuanian R&D intensity is significantly lower than the EU 27 average of 1.84%. The share of GERD financed from abroad at 10.5% has been increasing rapidly since 2000 (reaching €27.3m in 2006 compared to €4.9m in 2000).

The Lithuanian research system is characterised by the asymmetric R&D resource concentration and weak inter-sectoral links. The main strengths in terms of resource mobilisation lies in the upward trend of public R&D funding for research in absolute terms (although EU Structural Funds (SF) have partially replaced national budgetary funds), youth enrolment in tertiary education and relatively high share of S&T graduates. The quantitative strength in human resources for S&T is weakened by the relatively low quality of the public higher education sector. The lack of research careers and their limited attractiveness leads to stagnating numbers of R&D personnel despite an increase in S&T graduates.

The intended increase of public funding for R&D (mainly using EU SF resources) aims at the improvement of the capacity of the research system and its competitiveness. However, the level public funding is not yet sufficient for the development of a sustainable and well performing research system. The systemic inadequacies lie in the exceptional concentration of human and financial R&D resources in the public sector, absence of competitive funding mechanisms and weak participation of the business sector in R&D demand formulation (19% of total R&D funds). The structure of the Lithuanian business sector (dominated by SME's) and industrial specialisation (dominated by low, and mid – high tech industries) leads to a weak absorptive capacity of the business sector, but also imply the need for specific business R&D infrastructures.

The analysis and articulation of the demand for research could be considered as the weakest chain of Lithuanian research system. The few priority setting processes involve actors who are seeking complementary funds in order to accumulate and concentrate resources for R&D. The competitive funds available internationally (ERA

and other programmes) leads to the alignment of national priorities to the international ones. This may help Lithuanian participation in international research programmes, but it does not help to create a critical mass of national resources and ensure sustainability in the long term.

The knowledge production function of the Lithuanian R&D system remains the prerogative of public sector (which is a natural consequence of domination of public funding and public research establishments in the system). Therefore, the majority of knowledge production and its quality assurance is done within public R&D establishments and universities. The currently applied institutional funding mechanisms are related to the scientific performance of the institutions, which in the last five years had a positive impact and also supported the development of scientific specialisation in the field of natural sciences (mainly basic research). However, the volume of scientific production compared to international rates is still very low. The existing initiatives also do not increase the exploitability of knowledge in Lithuanian economy, as they are not linked to the industrial demand. The IPR development initiatives for the public sector are underdeveloped. The capacity to manage IPR in the private sector is close to zero except in a few high technology areas. This weakens the ability of the system to maintain the knowledge, especially in the case of the exploitation of public knowledge.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	Strong public position on increase of R&D funding, but very limited and stagnating business R&D investments
	Securing long term investment in research	Long term investment in research remains the prerogative of public policy, lack of priority based funding hinders the long term impact on the research direction of public institutions,
	Dealing with barriers to private R&D investment	Established and further strengthened schemes to support business R&D, but sill very low business participation in R&D system
	Providing qualified human resources	High share of youth enrolment in tertiary education and also high share of S&T graduates, but low quality of higher education, especially with regard to the modern skills for knowledge economy
Knowledge demand	Identifying the drivers of knowledge demand	The national research priorities are defined in the consultation process with the key stakeholders. National priorities are fully aligned with the FP6, FP7 priorities, which allow to attract additional research funds, but are weakly linked to the business demands
	Co-ordination and channelling knowledge demands	Business R&D needs are weakly tracked and reflected in the priority setting process, with the exception of high tech sector, but there are new measures foreseen to address business R&D demand more precisely
	Monitoring of demand fulfilment	The lack of evaluation at the priority setting and programme level limits the opportunities of policy impact
Knowledge production	Ensuring quality and excellence of knowledge production	Strong specialisation in all fields of natural sciences, but the knowledge production and application is very low in absolute and relative terms Insufficient incentives for R&D at the institutional and individual level compared to teaching and knowledge application alternatives in public sector
	Ensuring exploitability of knowledge	The exploitability of knowledge for national competitiveness is restricted by the Lithuanian industrial profile and weak links of Business and R&D sectors

Domain	Challenge	Assessment of strengths and weaknesses
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	High intention of business sector for innovation cooperation Non specified knowledge supply for business sector Non existing/ineffective knowledge transfer structures between public R&D and business sector
	Profiting from international knowledge	Established mechanisms to support participation in international R&D activities, but the participation rates still restricted by the limited institutional capacities and lack of experience
	Enhancing absorptive capacity of knowledge users	High shares of S&T graduates, continued upward trend, Low absorptive capacity of business sector, Absent incentives for human resources mobility in S&T

The ongoing Science and Higher Education sector reform offers the opportunity to restructure the Lithuanian science sector into a competitive and well-balanced research system. The new initiatives aim at resource concentration for research excellence and the upgrading of research infrastructures. No less importance is given to the development of integrated business and R&D partnership infrastructures, which are considered the main tool for the initiation of closer intersectoral linkages.

New policy opportunities occur with the targeted use of EU SF funds for the development of business and economy development needs related to R&D demand and its fulfilment. This also suggests the chance to reorient public R&D system towards a more balanced international and national demand orientation. However, the processes in some areas might be complicated, especially in well performing science centres and groups, where successful and internationally oriented R&D practices are established.

The current R&D demand structure supports Lithuanian participation in international research, and creates the opportunity to develop international scientific specialisation as the international funding accounts for 50% of total targeted competitive funds available in the country. Thus the Lithuanian science system faces more risks being apart from national research needs than from the European Research Area, as the current linking mechanisms and ties to the national economy are weaker than those relating to European networks. The current R&D policy developments offer great opportunities to restructure the Lithuanian science sector and create highly concentrated and effectively performing public research institutes and universities. However, the main policy related risks are related to the current fragmentation of Lithuanian research system, and its relative isolation and resistance to change. Given the high number of R&D and HE establishments it is difficult to develop concentrated scientific groups which would be competitive at the international level.

The improvement of knowledge circulation within the economy is a complex task, which in the case of Lithuanian R&D policy development is an integrated part of the whole science and HE sector reform. Knowledge circulation “spaces” and processes are created via the development of new integrated science, study and business valleys across the best performing Lithuanian science and HE institutions, establishment of missing linking structures such as technology transfer offices and support to the rise of new technology based firms. However, it means a departure from current institutional practices. A whole new business “generation”, based on the

intensive application of knowledge would need to be created in order to ensure active absorption of the research results and its use in the business processes.

The general risk related to the policy implementation is related to the efficiency of the policy actions. It can be restricted due the limited human resources available for the policy management and implementation, and also unfavourable long term trends in human resources for S&T. Institutional rigidity is an overall risk for the success of policy action, especially with regard to the fact that Lithuanian science sector has undergone relatively limited reforms since 1991.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Restructured and competitive R&D sector with accumulated resources for national development and scientific excellence • Sustainable development of highly skilled human resources • Established business and science cooperation structures, and strengthened business R&D investments	• Insufficient human and management resources for the implementation of actions foreseen • More attractive international research careers and continued brain drain, if implemented measures insufficient • Faster than general population aging amongst the research community
Knowledge demand	• Development of international scientific specialisation due the high impact of international funding in targeted research structure • Science and study system reform offers an opportunity for higher impact on R&D oriented demand • EU Structural Funds will be used for targeted and especially business oriented research, thus facilitating the growth of R&D demand in private sector	• Disconnection of R&D from still non-revealed specific national research needs due to the international orientation • The institutional practices will resist the competitive funding related changes
Knowledge production	• The use of EU SF support to develop research excellence centres and integrated valleys in selected areas • To develop knowledge exploitation mechanisms between Science, Higher Education and Business sectors.	• The lack of critical mass will not allow to achieve research excellence in industry related areas • Lack of scientific specialisation will lead to the distribution and ineffective use of limited resources • Institutional rigidity will resist changes towards research excellence and exploitability of the results • The foreseen development of high tech sectors may not achieve significant volumes in order to induce changes in knowledge exploitation
Knowledge circulation	• To establish linking structures between business and R&D sector • To develop integrated science, study and business infrastructures for knowledge accumulation across public and private knowledge poles • To reinforce the development of knowledge intensive business sector via support of university spin offs and new technology based firm creation	• The institutional rigidity may reinforce the separation of public R&D, Higher Education and Business sectors • Due to weak R&D demand and low absorptive capacity business may fail to establish productive R&D links

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1 - Introduction and overview of analytical framework

1.1 Scope and methodology of the report in the context of the renewed Lisbon Strategy and the European Research Area

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts.

The main objective is to analyse the performance of national research systems and related policies in a comparable manner. The desired result is an evidence-based and horizontally comparable assessment of strength and weaknesses and policy-related opportunities and risks. A particular consideration in the analysis is given to elements of Europeanisation in the governance of national research systems in the framework of the European Research Area, relaunched with the ERA Green Paper of the Commission in April 2007.

To ensure comparability across countries, a dual level analytical framework has been developed. On the *first level*, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions of the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: needs for knowledge have to be identified and governance mechanisms have to determine how these requirements can be met, setting priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of a research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Figure 1: Domains and generic challenges of research systems

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
• Justifying resource provision • Long term research investment • Barriers to private R&D funding • Qualified human resources	• Identification of knowledge demand drivers • Co-ordination of knowledge demands • Monitoring of demand fulfilment	• Quality and excellence of knowledge production • Exploitability of knowledge production	• Knowledge circulation between university, PRO and business sectors • International knowledge access • Absorptive capacity

On the *second* level, the analysis within each domain is guided by a set of generic "challenges" common to all research systems that reflect conceptions of possible bottlenecks, system failures and market failures (see figure 1). The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective, helps to deal with the considerable institutional diversity observed, and eases the transition from analysis to assessment. Actors, institutions and the interplay between them enter the analysis in terms of how they contribute to system performance in the four domains.

Based on this framework, analysis in each domain proceeds in the following four steps. The first step is to analyse the current situation of the research system with regard to the challenges. The second step in the analysis aims at an evidence-based assessment of the strengths and weaknesses with regard to the challenges. The third step is to analyse recent changes in policy and governance in perspective of the results of the strengths and weaknesses part of the analysis; and finally the fourth step focuses on an evidence-based assessment of policy-related risks and opportunities with respect to the analysis under 3) and in the light of Integrated Guideline 7.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory[1] and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains four main subsections in correspondence with the four steps of the analysis. The report concludes in chapter 6 with an overall assessment of strengths and weaknesses of the research system and governance and policy dynamics, opportunities and risks across all four domains in the light of the Lisbon Strategy's goals.

[1] ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home. Other sources are explicitly referenced.

1.2 Overview of the structure of the national research system and its governance

Lithuanian national research system is among the weakest performing systems within the EU (0.8% GERD in 2006). Lithuania, limited to about 3 million inhabitants, is a single region country. Having in mind the small size of the country and a weakly developed R&D system, the need to concentrate R&D policy at the national level seems natural. At its current development stage, regions and municipalities do not play a role in it.

A lack of coordination in science, technology, and innovation policy design and implementation, uncertain performance (World Bank, 2003) have led to the establishment of a single high-level coordination body, Science, Technology, and Innovation Commission. It is supposed to combine the efforts of scientific and business communities and serve the national aim of a faster upgrade of the economy towards a knowledge intensive economy. The Commission is the highest-level policy coordination body, representing science, education, and business communities, as well as the government, and is chaired by the Prime Minister of Lithuania. However, up to now, the Commission has been criticised for its weak performance and a limited impact upon the actual R&D and innovation policy governance coordination.

The science and innovation system governance has been based on the coordination of actions between the two Ministries (see the Figure 1). The function of development and implementation of R&D policies (including knowledge generation and human resource development) lies within the Ministry of Education and Science, while the innovation policy is the prerogative of the Ministry of Economy. The separation of functions is defined by intervention areas. The Ministry of Economy aims at boosting the economy competitiveness, at facilitating the development of higher value-added activities, and at increasing productivity in business. The key policy targets are as follows: the development of R&D processes in the business sector, creation and support of new technology-based businesses, development of science and business cooperation platforms and innovative clusters, and intellectual property development in industry.

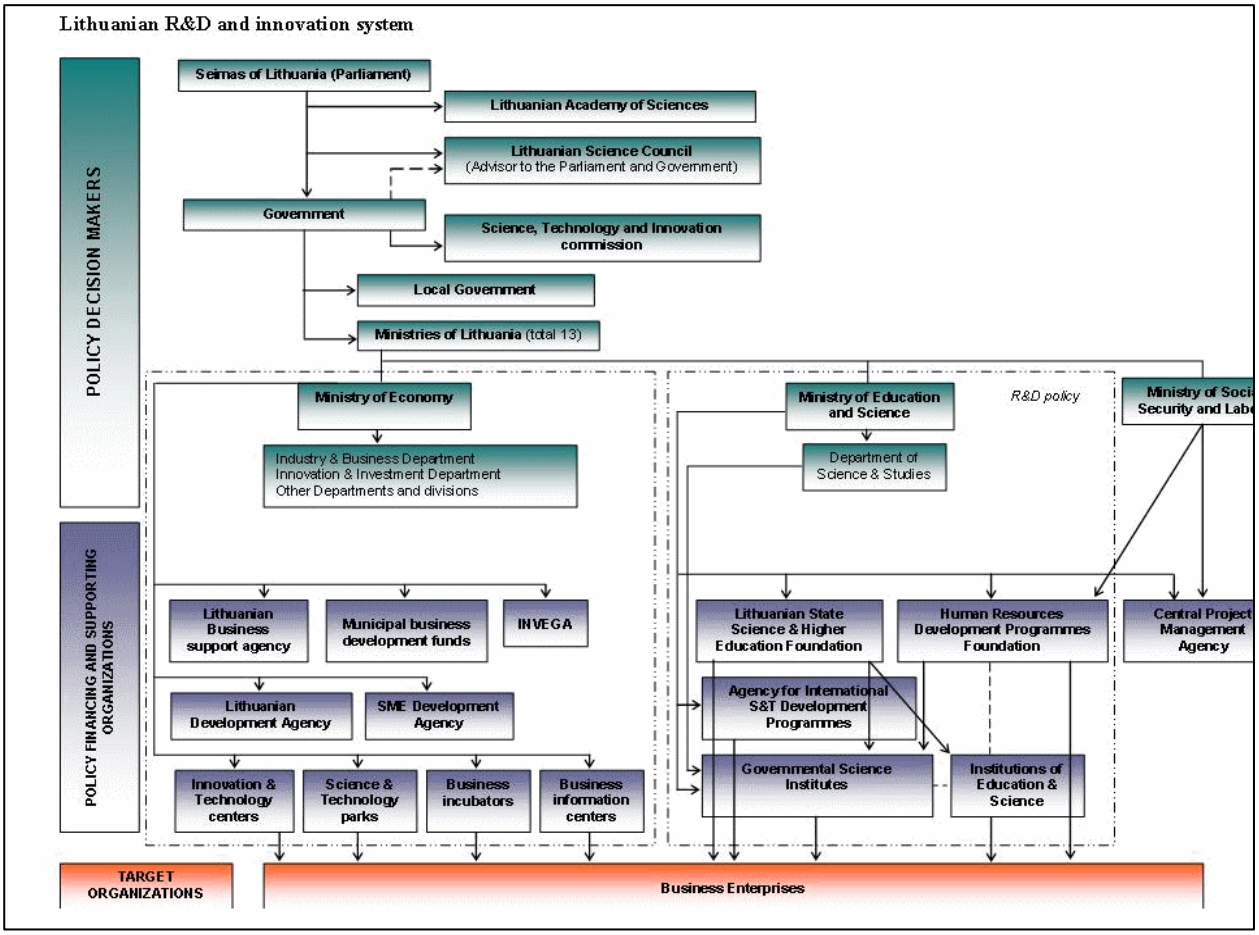
The Ministry of Education and Science deals with research excellence in the public science sector and holds the responsibility for the development of highly-skilled human resource for R&D and innovation. Research and Higher Education Monitoring and Analysis Centre (established in 2007) is an analytic and advisory body to the Ministry when making main decisions, related to the R&D policy development. In order to provide valid recommendations, the Centre attracts external experts form Lithuania and abroad. Changes of the legal base in 2007-2008 gave the Lithuanian Science Council (to the Ministry of Education and Science) the status of a permanently functioning agency, responsible for competitive funding of research programmes. Still, the main responsibility for corporate R&D lies with the Lithuanian Ministry of Economy, as a part of Innovation and Competitiveness Programme.

Vocational training, upgrading of the qualifications of the working population and life-long learning initiatives are mainly the prerogative of the Ministry of Social Security and Labour.

The inter-ministerial coordination of functions is facilitated through the development and implementation of joint programmes (such as High Technology Development Programme (2007-2013), and few others), and coordination of policy development

processes at the strategic level (especially those related to the implementation of Lisbon strategy, and EU SF allocation).

Figure 1: Lithuanian R&D and innovation governance system.



Source: ERAWATCH Research Inventory, http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=35&countryCode=LT&parentID=34

Lithuanian research policy is implemented through the decisions of the Lithuanian Science Council and the implementing institutions: Lithuanian Science and Studies Foundation, the Agency for International Science and Technology Development Programmes, Lithuanian Centre for Quality Assessment in Higher Education, and the Support Foundation European Social Fund Agency. Business R&D-oriented measures, administrated by the Ministry of Economy, are implemented by the Lithuanian Business Support Agency.

Lithuanian State Science and Studies Foundation is responsible for competitive research and experimental development as well as for the implementation of targeted public R&D programmes, set along national priorities and specific programmes, such as High Technology Development Programme (2005, 2007) and Industrial Biotechnology Development Programme (2007).

In order to facilitate the participation of Lithuanian science institutions in ERA initiatives, a specific agency was set up. The Agency for International Science and Technology Development Programmes is responsible for the administration and coordination of EU Framework Programmes, EURATOM, Security Research Programme, EUREKA, COST, as well as other programmes and activities related to

international cooperation in R&D. The agency also participates in shaping the R&D and innovation policy and plays an active role in submitting proposals to the Lithuanian legislature in order to facilitate and strengthen the participation of Lithuania in international R&D programmes.

The Support Foundation European Social Fund Agency (former Lithuanian Fund for Human Resources Development Programmes) supports, coordinates, and administers the EU SF aid and implements measures assigned to the Ministry of Education and Science, developing highly-skilled human resource for science, technology, and industry. Under the responsibility of the Ministry of Social Security and Labour, it also implements the measures of life-long learning and aims at the improvement of human resource quality in the business sector.

There are four major groups of R&D performers. These are the present 15 research-performing state universities with 18 university institutes (founded in 2001 for to secure the research base of universities), 17 state research institutes, and 8 state research establishments. Additionally, there are 7 private universities, but the research function within most of them is barely developed. Business R&D is performed by private companies, the number of which, according to informal sources, remains limited to 300[2].

Actual R&D performance is concentrated in the public sector - higher education institutions (HERD 49.24%, 2006) and state research institutes (GOVERD 22.83%). The share of business R&D in total R&D expenditures reached 27.93% in 2006, which, compared to 2004 (21.40%) and 2005 (20.38%) seems to be an important improvement. However, there isn't any clear or sustainable upward trend. Moreover, the fact itself may have risen from the EU SF direct support measure for R&D performed by business.

2 - Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges related to the provision of inputs for research activities are addressed by the national research system. Its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, with the Barcelona EU overall objective of a R&D investment of 3% of GDP and an appropriate public/private split as orientation, but also highlighting the need for a sufficient supply of qualified researchers.

Four different challenges in the domain of resource mobilisation for research which need to be addressed appropriately by the research system can be distinguished:

- Justifying resource provision for research activities;
- Securing long term investment in research;
- Dealing with uncertain returns and other barriers to private R&D investment; and
- Providing qualified human resources.

[2] Lithuanian Knowledge Economy Forum data base on R&D performing companies. Limited access.

2.1 Analysis of system characteristics

2.1.1 Justifying resource provision for research activities

Lithuania is among the smallest new EU Member States. With the R&D expenditures of €191m (2006) it ranks relatively higher than other small new EU member states, contributing ca 0.08% of total EU27 R&D expenditures. At 0.8% R&D expenditure as a percentage of GDP (in 2006) Lithuanian R&D intensity is significantly lower than the EU 27 average of 1.84%. The share of GERD, financed from abroad at 10.5%, is relatively important in R&D funding, and has been increasing rapidly since 2000 (reaching €27.3m in 2006 compared to €4.9m in 2000). The fact has been related to the Lithuanian accession and the increasing participation in the European Research Area.

Although R&D and innovation-based development are at the core of the *Long term strategy of the state*, the actual implementation has been restricted by the limited funds of national budget allocated for research. GBAORD as a % of total general government expenditure equalled to 0.82 % in 2007, and was slightly lower than in previous years (1.1% in 2004, 1.06 in 2005, and 0.97 in 2006). Still, the efficiency of public spending in all areas became a core debate in 2008. R&D and the higher education sector have been recognised being among the least restructured since 1991. Funding and resource provision for R&D is still based on institutional public funding, although a few important steps towards more dynamic and competitive funding models were made in 2007-2008 upon the restructuring of Lithuanian Science Council.

2.1.2 Securing long term investment in research

The government and the Ministry of Education and Science, in particular, play the main role in securing long-term investment in research. Public R&D funding dominates in national R&D funding (0.42% of GDP in 2006) and comprises 53% of total R&D funds. In 2006, €109m were allocated for research by the government, 1.8% of which were allocated for business R&D. In this way, public funding was secured for the research performed at public universities and public research institutes. Thus, the responsibility for the efficiency of the R&D system performance and long-term investment lies predominantly within the government sector, and, specifically, within public research institutions. *The National agreement to promote economic and social progress* (2002), among the determined priorities of long-term national development, has set the aim to adjust the system of Education and Science in order to create a knowledge-based society and to reflect the European system of higher education and research[3]. Within the *National Reform Programme* (2005) the government has committed to increase annual spending on R&D by 0.1%, and reach 1% of GDP R&D public spending by 2010. However, no upward movement has been noticed yet, which suggests that the target is not to be achieved.

The government extensively uses the EU SF programmes in order to increase R&D funds. The first EU Structural Funds implementation period, defined by the *Single Programming Document for 2004-2006*, aimed at the development of R&D

[3] NACIONALINIS SUSITARIMAS SIEKIANT EKONOMINĖS IR SOCIALINĖS PAŽANGOS (2002) http://www.smm.lt/smt/docs/eksp_stud/Nacionalinis%20susitarimas.doc

infrastructures in the priority areas (€8.7m). The important critique of the 2004-2006 programming period was related to relatively low investments in innovation, S&T activities and in human resource, compared to large spending for infrastructure development. Therefore, in 2007-2013 the largest part – 45.72% – of the total EU SF resources is to be allocated to the "*Operational programme for the Economical Growth for 2007–2013*". €677.3m will be assigned to the research and development for business competitiveness, out of which €386.4m will directly target long term investments in R&D: €74.3m for R&D in research centres; €241.6m for R&D infrastructure, including enterprises and technologies, computer networks between research centres, and technology competence centres; €70.5m for business R&D support, including research performed in public R&D centres.

European research programmes have been and still remain among the most important sources of competitive thematic research funding in Lithuania. In 2007, €5m of national research funds were allocated through competitive R&D grants for research in thematic priorities, and €50m went directly to public universities and research institutes as institutional funding. To compare, FP6 funds, received by Lithuanian institutions in the period 2002–2006, reached €25.7m, or approximately €5m per year. Consequently, the EU Framework Programmes provide 50% of thematic competitive R&D funding in the country and 10% of total R&D funding. In both cases, the mentioned share is extremely important and influential for a research direction within the public R&D sector.

Keeping in mind an extremely small amount of national funds available for competitive R&D, other European research programmes are of not less importance for the development of internationally competitive research. Lithuanian institutions, through participation in EUREKA activities, have attracted €12.8m since 1994. Currently, 27 projects are still running, with the total budget of €6.1m.

In conclusion, provision of resources and long-term investment in research remain unresolved policy questions. The annual growth rate of R&D expenditures (as percentage of GDP) in 2001 through 2007 was very low (starting with 0.67% of GDP in 2001, and reaching 0.79% of GDP in 2007), although the net funds, allocated for research, increased because of the rapid GDP growth rates in the same period (on the average, 7-8% annually). Still, facing decreasing public spending for R&D (0.48% of GDP in 2005, and 0.43% of GDP in 2006) and also decreasing government appropriations for R&D as a share of GDP (0.36% of GDP in 2005, 0.33% in 2006, 0.29% in 2007), which are twice lower than the EU 25 average of 0.76% (2006), Lithuanian R&D system constantly struggles with a lack of resources. Business R&D funds, although slightly increasing - from 0.16% of GDP in 2005 to 0,23% of GDP in 2007 - are not able to compensate for declining public R&D funding. With regard to this situation, ERA research programmes are becoming a very attractive alternative for Lithuanian research institutions and individual researchers, being an important alternate source of R&D funds.

Recent policy changes (see section 2.3) aim at restructuring Lithuanian Science and Higher Education sector, in order to achieve more efficient resource allocation in the mid term, and raise the resource accumulation in the long term through the development of new combinations of the participating actors and funding models.

2.1.3 Dealing with uncertain returns and other barriers to business R&D investment

The framework for private R&D resource mobilisation has changed radically, since 1991, upon the transition from a centrally planned economy to the market economy. Within the planned industrial system, industrial R&D was performed at state Industrial Research Institutes, which were an integral part of the Soviet R&D system, and usually were related to large production factories. The collapse of the system and the transition towards the market economy created a need to develop a National innovation system. The research function, as such (mainly fundamental, and, to a lesser extent, applied research), was maintained at Universities and public Research Institutes (former institutes of the Lithuanian Academy of Science). Industrial Research Institutes were not preserved in the course of the market economy development. In best cases, groups of new technology-based firms or R&D enterprises were formed on the basis of Industrial R&D institutes which closed down (Kriaucioniene, Ragauskas, 2008). Still, the systemic function of industrial R&D was not maintained. As a result, business R&D was left as a "self organising" market function, without policy incentives, without public support until the 2004, when the EU SF support actions were implemented.

Today, the share of total Lithuanian R&D, financed by the business sector, comprise 26.2% (2006), which has increased by 6% points since 2005, and doubled since 2000 in absolute terms (from €23.1m in 2000 to €49.8m in 2006). Despite high increases, business R&D expenditures and outputs remain comparatively low.

A relatively low share of FDI in the national economy, the absence of large R&D intensive firms and multinationals also reinforce business R&D rigidity or inflexibility. According to the 2006 EU Industrial R&D Investment Scoreboard (European Commission, 2007), not a single Lithuanian company was ranked among the European top 500 R&D investors. Lithuanian business R&D is actually concentrated in small and medium size R&D intensive companies (Radosevic at al, 2008).

The ability of such companies to invest in R&D is determined by their capabilities to accumulate internal resources or customer funds for targeted R&D. External private funding mechanisms for R&D neither exist, nor are substituted by a public guarantee or local loan funds. The government has partially attempted to address the problem. 1.8% (2005) of business R&D was financed by the government, which appears to be one of the lowest shares within the EU. The government has also designed special programmes for the competitive business R&D funding under the EU SF for the periods of 2004-2006 and 2007-2013 (further presented in section 2.3). R&D in business was funded by a separate grant scheme of €15.4m (Erawatch Research inventory (2008)) in the period of 2004 - 2006 (with the implementation cycle closed in 2008). All the measures opened the access for business enterprises to public research funds. In addition, this tripled competitive R&D funds available in the country.

A distinguished feature of the business R&D-oriented measures is that the measures allow to spent R&D funds in two ways: for in-house R&D, and for business research performed at public R&D centres. The latter aims at overcoming the weakness of private R&D capabilities and also to support the development of business and public research sector links (total budget €70.5m).

The government has also introduced fiscal mechanisms to support business R&D and innovation. A Tax Law concerning R&D expenses has been changed. Since 2007, R&D expenses can be claimed as costs and are thus tax-deductible (even for the double of nominal expenses). Further incentives focus less on R&D and more on the acquisition of technologies, e.g. a 50% deduction of the cost upon acquiring new technology from taxable income. In addition, general Income Tax exemptions are available for new foreign direct investment in special economic zones, and these also apply to R&D investments. However, these incentives are quite insufficient, having in mind very low business R&D investment levels. The so-called "overnight" tax reform, introduced by the new Government, appointed in November 2008, briefly characterised as an increase of overall tax burden on business (increase of VAT up to 19%, profit tax up to 20%, and other regulations affecting business profitability) will have a negative impact upon business risk-taking behaviour, also including R&D incentives.

To sum up, private actors in Lithuania still have difficulties in coping with the risks of R&D investment. With 0.22% (2006) business-financed R&D as a share of GDP, Lithuania stands significantly lower than the EU average of 1 % (2005). Although the EU average is not an appropriate benchmark, given the socio-economic situation of Lithuania, the intensity of private R&D funding is also lower than in other small Central and Eastern European Countries, such as Slovenia, Estonia and Latvia. Still, statistical figures have to be considered with caution: they can be misleading because of the lack of business R&D tax incentives until recent changes (OMC Mix Report, 2007). However, uncertain returns is not the only limiting factor for business R&D. As noted above, the business R&D infrastructures are still underdeveloped. The promotion of business R&D in a systemic mode, especially within mid and mid-to-high tech SME's, remains an unresolved policy question.

2.1.4 Providing qualified human resources

Lithuania is characterised by a highly diversified higher education system (World Bank, 2003), dominated by relatively small state universities (total of 15). The youth enrolment rate of 88.2% is well above the EU average, and the share of S&T graduates of 18.9% is among the largest in Europe (European Innovation Scoreboard (EIS), 2007). The share of a highly qualified labour force among the working population is also relatively high (26.8%, EIS 2007).

Despite relatively large and sustainable outputs in absolute numbers of graduates, Lithuanian higher education system has been intensely criticised for low performance in terms of the quality of qualifications. This might be explained by the fact that Lithuania ranks among the top EU performers in terms of student enrolment rates, but stands low in terms of funds, allocated per student. A teacher/student ratio has been constantly increasing: in 2000 it was 1 to 14.6, and in 2004 – 1 to 22.3. As a result, researchers, employed in the public higher education sector, are increasingly involved in teaching activities, and, naturally, less in research. Not a single out of the 21 Lithuanian universities is ranked among the top 100 European universities, although there are universities from other post-Soviet countries – New European member states (Czech Republic, Poland, and Hungary) among the top institutions. Therefore, the question of qualifications and quality assurance has been raised in the policy debate; appropriate measures were implemented in the programming period of

2004 – 2006, and new integrated measures have been planned for the period of 2007 through 2013 (see section 2.3).

However, the development of human resource supply side by producing large numbers of graduates does not lead to increasing numbers of the human resource, actually engaged in R&D. In 2006, human resource for R&D totalled 16,379 (or 11443 FTE), or had 10 researchers per 1000 of working population. The number has been stagnating since 2003, although specific incentives to increase the enrolment in doctoral studies have been taken.

The human resource for R&D is not only scarce, but also dispersed in a large number of public research establishments (universities and public research institutes). In order to achieve higher concentration and accumulation of human resource for research excellence, a new initiative to create and support informal High level research competence centres (groups) started in 2007-2008, with the aim to identify and further develop best-performing and most dynamic research groups. Furthermore, in October 2008, the government announced a decision to establish 5 concentrated high-level state-funded research centres in Life sciences, Innovative medicine, Nature research, Physic and Technology sciences, and Agriculture, and Forestry research. The centres are to be based on the existing State research institutes and university research institutes, and related to Science, study and business valleys. These initiatives should lead to the concentration of best-performing scientists in a relatively small number of research institutions, and would allow human resource accumulation for the research excellence. However, these incentives are not likely to contribute to the increase of the total number of researchers, especially the young ones.

A lack of research career possibilities, especially in S&T, obsolete research infrastructures, and limited opportunities to carry out world-class research have been inducing brain drain of highly skilled students, causing emigration to countries offering such careers and infrastructures already during the initial years of studies. A research career as such, compared to other options available in the economy, is of limited attraction, especially in the Public science sector (where, as noted above, the main R&D resources are concentrated). On the other hand, being of relatively low attractiveness, a research career boasts the participation of women in research. 40.7% of Lithuanian doctorate holders are female, and the share of women in total R&D personnel equals to 54% (2006)[4]. In 2006, the three Baltic countries (Latvia, Estonia and Lithuania) registered the highest shares of female HRST for both 45-64 year olds and 25-64 year olds among the EU[5].

Lithuania has little chance to increase the number of researchers also due to its aging population, with the research community aging even faster. The generation gap is obvious: over 40% of the total R&D personnel today are in the age category of 45-60, and 65.5% of the total R&D personnel with a scientific degree are in the age category of 45-65+. With the projected working population drop by 20-30% in the long run, there is no evidence of an upward trend in human resource for S&T as well (Meri, 2008).

[4] Research activities 2006 (2007) Statistics Lithuania.
[5] Meri, T (2008) Senior human resources in science and technology. Statistics in focus SCIENCE AND TECHNOLOGY 26/2008

There is also no rationale for profiting from internationalisation of research careers. Lithuanian R&D human resources remain nationally limited – 99.5% of all PhDs employed in Lithuania are Lithuanian citizens (Statistics Lithuania, 2007)[6]. The fact can be explained by a weakly performing R&D sector, unattractive to international career seekers, by the absence of schemes promoting international research positions, but also by the isolation of higher education institutions, determined by a high autonomy of universities and the Lithuanian language barrier.

In order to ensure long-term accumulation of human resource for R&D, for the programming period of 2007 through 2013, a programme of Researchers Careers (http://www.smm.lt/es_parama/docs/pasirengimas/TKP%20.pdf) was approved in December 2007. It schedules a variety of actions, such as researcher development, the attraction of individual highly-skilled researchers, short-term visits of researchers from abroad, researcher mobility between science and industry, etc. It is expected to support the development of more attractive research careers, and create some dynamics in the research labour market. A larger variety of research career tracks is going to be offered, in order to increase the number of researchers in domains, other than public. The measures also create an opportunity to overcome structural asymmetry in the distribution of researchers between the public and private sector. Furthermore, they contribute to the participation of the younger generation in research. The first steps towards international openness of the Lithuanian research sector in terms of human resource will be made, bearing a primary aim to absorb international research knowledge and practices. However, the implementation of the programme has not started yet.

2.2 Assessment of strengths and weaknesses

Resource mobilisation for the Lithuanian research system is the prerogative of the public policy. It aims at sustainability and development of the public research and a higher education sector. However, public funding, limited to 0.43% of GDP (2006), is not sufficient to develop a balanced and well-performing research system. The business sector weakly participates in R&D in terms of funding and performance. It restricts the availability of resources for research from domains, other than public. Furthermore, a lack of efficient competitive funding mechanisms leads to an ineffective use of severe financial and human resources in the public sector. This results in a fragmented public R&D infrastructure with a far too large number of universities and public research institutes.

The absence of mechanisms enabling the participation of the private sector in the national R&D system weakens the chances of the development of a well-balanced research system in terms of resource mobilisation and long-term investment in research. Not only financial schemes for business R&D facilitation are missing, but also business R&D infrastructures, especially among the SME sector, are insufficient.

The strength concerning the volumes of the human resource for S&T development has been weakened by a relatively low quality of the public higher education sector performance, which, in the light of internationalisation, loses its position to other European universities, first of all, in the ability to attract highly-skilled students.

[6] Professional activity of doctorate holders (2007) Lietuvos statistikos departamentas. http://www.stat.gov.lt/en/pages/view/?id=2366

Because of the resources, dispersed among a large number of higher education and public R&D institutions, the available human resource do not achieve higher levels of accumulation and concentration.

The main strengths and weaknesses of the Lithuanian research system in terms of resource mobilisation for R&D are summarised in the table below:

Main strengths	Main weaknesses
• Increase of public R&D funding for research in absolute terms • High share of youth enrolment in tertiary education and also a high share of S&T graduates	• Ineffective spending of public funds for R&D due a lack of competitive funding mechanisms and the dominating institutional funding. • Extremely low business R&D investment and participation in the R&D system • Low quality of research and higher education sector performance due to insufficient and widely distributed financial and human resources.

2.3 Analysis of recent policy changes

A vital need for the Lithuanian economy to mobilise resources for R&D has been related not only to the end-goal of the national competitiveness, but also to the need of maintaining the existing resources for R&D, first of all, intellectual capital. Restructuring and development of national resources for R&D is among the primary tasks of the government in order to achieve National development goals and implement Lisbon Strategy agenda. The National Lisbon Strategy Implementation Programme (2005) originally set the target of 1.2 % GDP for R&D in 2008, where a public spending should have reached 0.7% of GDP, and business spending – 0.5% of GDP. The target, obviously, was difficult to achieve. Still, it induced the development and implementation of the policy mix to support R&D investments in both domains, public and private.

European membership and the EU Structural funds implementation have provided Lithuania with a historical chance to accumulate and develop resources for the catch up and a further growth of the economy. The SF Economic Growth Action Programme for 2007 through 2013 aims at the promotion of the R&D, related to competitiveness and economy growth. In the new SF programming period, 10% of the general support budget is envisaged for this area. This support would cover investment in the public and private R&D, the infrastructure development and the equipment acquisition, as well as the financing of research activities at research institutes and private companies.

The development of a well-balanced and sustainable research system is a key target of the Lithuanian Science and Higher Education Sector Reform. Recent policy changes reflect a preparatory work and the first stages of reform implementation, which are directed towards the improvement of resource allocation and concentration of research activities, which would result in higher efficiency and productivity. In order to increase the volume of resources, allocated for research, the EU SF support in the period of 2007-2013 will be used extensively for the development of research infrastructure and the improvement of R&D funding in both domains, public and private. Since public resources dominate Lithuanian R&D funding structure and are mainly allocated through institutional non-competitive funding mechanisms, major policy changes are related to the development of a competitive funding model for

R&D. The application of the model should not only secure more efficient use of public resources for research, but also should facilitate the participation of a private sector in the research system. The Research Council was reorganised (2007) into a state agency, responsible for competitive funding and for designing competitive R&D programmes for public science sector.

Dealing with uncertain returns for business R&D might be considered as an early-timed question for the Lithuanian R&D system, as the business sector has neither capacity nor infrastructure for R&D yet. The first incentives to promote business R&D were introduced with direct research grants for business by the Lithuanian Ministry of Economy in the period of 2004-2006, and later induced by the introduction of Tax Law changes, which facilitate business R&D. A variety of schemes is foreseen for the future in order to facilitate business R&D investments (the in-house research activities, and also research performed in public research centres). During the programming period of 2007 through 2013, €677.3m will be allocated to research and development for business competitiveness, out of which:

- €70.5m - for R&D support in business, including research performed at R&D centres;
- €128.2m - investment in new technology-based firms, spin offs of R&D institutions, and the like;
- €38.5m - for other R&D-, innovation-, and entrepreneurship-oriented- measures.

The measures are supposed to cover the two steps of R&D activities - feasibility studies on R&D projects with the aim to reduce risks, related to the R&D development ("Idea LT") as well as the actual implementation of R&D projects and development of research infrastructures ("Intellect LT", limited to SME's only, and "Intellect LT+" for large R&D projects and developments).

A more proactive approach has been also taken with regard to business R&D investment. The Investment Promotion Programme for the 2008-2013 (Government Resolution No. 1447 of 19 December 2007)[7] was approved, which seeks to create an environment, favourable for investment in high value added sectors. Tax incentives for business R&D and education investments were also considered.

Programmes concerning assimilation of the EU structural assistance aimed at the development of R&D and human resource were approved by the Order of the Minister of Education and Science: Researchers' Career Programme, the General National Integrated Programme, and the General National Programme aimed at Cooperation between Research, Science and Business. The programmes provide opportunities for the private sector to cooperate with the public R&D sector both in the fields of research and in human resource development. Finally, the following new schemes are worth mentioning: Centres of high scientific level, Joint science and business centres, Set up and maintenance of science-incentive business (technology) incubators and infrastructure (buildings and premises) of science and technology parks; founding of National shared usage equipment and information centres, implementation of National scientific programmes, Grant schemes for scientists in business enterprises, etc. European Social Fund granted support to the

[7] http://www.ukmin.lt/en/investment/legislation/1447-2007-12-19%20Investiciju%20skatinimo%20programa%20EN20080314.doc

preparation of the project Preparation and Implementation of the Brain Drain Prevention Programme.

Challenges	Main policy changes
Justifying resource provision for research activities	• Recognition of the role of research; increased share of public funding has been allocated to research (2007-2013). • The General National Integrated Programme (2007)
Securing long-term investment in research	• Restructuring the research system governance and establishment of new funding mechanism under the Law on Restructuring Lithuanian Science Council (Dec 2007). • Investment Promotion programme for the 2008-2013. • Measures to develop business R&D infrastructures ("Intelektas", "Intelektas+").
Dealing with uncertain returns and other barriers to business R&D investments	• Changes in the Tax Law promoting private R&D investments • Development of new public support schemes for private R&D • General National Programme aimed at Cooperation between Research, Science, and Business (2007) • Support feasibility studies for R&D activities "Idea LT"
Providing qualified human resource	• A new programme on Researchers Careers approved in December 2007. • Brain Drain Prevention Programme (draft). • Increasing funding for the development of human resource in research. • Selection of Highest Competence Research centres (started in 2007-2008).

2.4 Assessment of policy opportunities and risks

The introduced policy mix, combined with the resources of national and European funds, lends new opportunities for policy actions towards a competitive and sustainable Lithuanian science sector. The upward tendency in human resource for S&T supports the opportunity to develop a critical mass of R&D human resources in both sectors, public and private. The establishment of new structures provides a chance to develop business and research sector partnerships, and also to introduce new models and structures for R&D cooperation.

Major risks related to policy implementation are those concerned with the efficiency of policy actions which can be restricted by limited amounts of human resource, available for policy management and implementation, and also by unfavourable long-term trends in demography and supply of human resource for R&D.

Main policy opportunities	Main policy-related risks
• Restructured and competitive R&D sector with accumulated resources for national development and scientific excellence. • Sustainable and concentrated highly-skilled human resource for R&D. • Established business R&D infrastructures and strengthened business R&D investment • Developed and strengthened public R&D infrastructures	• Insufficient human and management resources for the implementation of actions foreseen. • Continued brain drain of highly skilled labour in favour of international research careers.

2.5 Summary of the role of the ERA dimension

The development of the ERA dimension and Lithuanian participation in it have raised the question of Lithuanian research system relevance in the international context. Key debates concerning Lithuanian integration in ERA were related to the evaluation of Lithuanian participation in ERA initiatives, seen as unsatisfactory from the FP5, and FP6 perspective. Lithuanian science sector appeared to be unable to compete and cooperate in the international research platform; moreover, it also revealed major problems and immediate tasks to be performed, at the core of which was the Reform of Science and Higher Education sector. Consequently, distinct steps towards the accumulation of financial and human resources as well as the establishment of sustainable and competitive R&D funding mechanisms might ensure both Lithuanian participation in ERA and the maintenance of Lithuanian science sector in general. As a matter of fact, the pressure of international research competition, including the sphere of human resource, is becoming very high, especially for Lithuania with undeveloped and outdated research infrastructures and the lack of attractive research careers.

ERA has not only significantly contributed to the Lithuanian R&D policy development, but also directly impacted on the development of competitive research, as 50% of competitive funds attracted by Lithuanian research institutions are those of ERA research programmes.

3 - Knowledge demand

The purpose of this chapter is to analyse and assess how research related knowledge demand contributes to the performance of the national research system. It is concerned with the mechanisms to determine the most appropriate use of and targets for resource inputs.

The setting and implementation of priorities can lead to co-ordination problems. Monitoring processes identifying the extent to which demand requirements are met are necessary but difficult to effectively implement due to the characteristics of knowledge outputs. Main challenges in this domain are therefore:

- Identifying the drivers of knowledge demand;
- Co-ordinating and channelling knowledge demands; and
- Monitoring demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D targeted in IG7 of the Lisbon Strategy.

3.1 Analysis of system characteristics

3.1.1 Identifying the drivers of knowledge demand

Private demands for R&D have been constrained by a sectorial structure of the Lithuanian economy. Lithuania's economic specialisation has been limited to a few sectors. In the primary and secondary sectors, Lithuania appears to be specialised in agriculture, food, textiles, petroleum, plastics, shipbuilding, transport equipment, and

furniture. In the tertiary sector, the main economic activities are transportations and telecommunications, financial intermediation and other business activities (Erawatch Network, 2007). In this way, key sectors of the Lithuanian economy are of low-to-mid tech profile, dominated by traditional technologies and based on other, not R&D-based drivers of competitiveness, such as productivity and costs (in WEF terms).

Main R&D investing sectors were medium and high-tech industry and services. The year 2006 might have marked a shift when R&D investments in services overcome R&D investments in manufacturing in absolute and relative terms. In 2006, R&D spending in services almost tripled, compared to 2005, and reached €38.9m, which made up 73% of total BERD in 2006. In fact, the BERD growth in 2006 was achieved only because of the R&D spending growth in services, as the industrial R&D spending in the same year dropped by 25% and reached €13.03m compared to €17.4m in 2005.

The main R&D investors in service sector were:

- Wholesale and retail trade - €17.2m or 32% of total BERD,
- Financial intermediation - €12.3m or 23% of total BERD,
- Real estate, renting and business activities - €4.2m or 7.8% of total BERD,
- Research and development - €3.6m or 6.8% of total BERD.

Industrial R&D investment, as noted above, went down in absolute terms, and comprised 24,5% of total BERD, compared to 54.4% of total BERD in 2005. A significant drop occurred because of cutting investments from dominating traditional industries: textile, food as well as wood and paper product industries, and also manufacturing of radio, television, and communication equipment and apparatus. Many of other industry branches slightly reduced R&D investments as well. The only two industry branches have been demonstrating stable and even slightly increasing R&D investments:

- manufacture of chemicals and chemical products - €4.4m or 8.2 % of total BERD,
- manufacture of medical, precision and optical instruments - €2m or 3.7% of total BERD.

The sectors mentioned above actually drive a private R&D demand. However, the service-related R&D has been and still sits somehow outside the R&D policy agenda, which traditionally remains industry oriented. Additional research is needed in order to explain the direction and profile of the service sector related R&D.

The two industrial sectors that kept investing in R&D are among the selected priority sectors of high technologies: biotechnologies, lasers, nanotechnologies, and mechatronics (High Technology Development Programme, 2005).

A public R&D demand is rather unspecified. The bulk of government appropriations and outlays for R&D are attributed to general university funds. Total GBOARD on research reaches 0.29% of GDP (2007), which is significantly lower than EU27 level of 0.76% of GDP in 2006. 31.2% of total budget appropriations is reserved for the research of social structures and relationships, 13.6% - for the environment control and care, 11.9% - for industrial production and technology, 9.4% - for the protection and improvement of human health and 8% - for agricultural production. Other areas

receive much lower budget appropriations. Changes in the distribution of public funding among fundamental, applied, and experimental research intended to decrease fundamental research funding and increase funds for other types of research, especially experimental research. In 2006, public funds were distributed equally between fundamental (32.3%), applied (38.7%), and experimental research (29%). To compare, the latter received only 7.8% of public funding in 1995.

As the Lithuanian Country R&D Specialisation Report (2007) shows, the highest number of publications was achieved in the fields of materials, engineering, computer science, chemistry, physics, and mathematics. With regard to scientific specialisation, Lithuania exhibits strong specialisation in all fields of natural sciences, such as physics, mathematics, materials, engineering, computer science, and chemistry. Furthermore, during the period of 2001-2003, Lithuania's technological specialisation was only limited to two sectors, namely, to electronic equipment and office machinery. This fact partially correlates with scientific specialisation in natural sciences (physics, mathematics, and materials) as well as engineering and computer science. However, as we see from the analysis in further sections, scientific knowledge only marginally leads to the development of technological knowledge (that is, patents). In conclusion, the demand stemming from economic specialisation of the country has been very limited.

Business sector's ability to articulate its demands to political actors is not very strong, with a partial exception of individual large companies, formulating their research requests, which are later administrated by the Lithuanian Science Foundation. Since 2005, business participation in shaping R&D demand has increased through the activities of integrated Commission of Science, Technologies and Innovation. Industry representatives, especially those from the high-tech sector, belong to the Commission. However, as it was already noted in the previous section of the report, the Commission was criticised for a weak impact on the actual R&D and innovation policy formulation.

Still, the facilitation of research, oriented towards economy needs, is an important step in the development of a national research system. The first steps in business and economy related R&D demand analysis were made in 2007 with a foresight exercise. "*Foresight for the Lithuanian Economy in the light of regional and global tendencies*" (2007) (*further referred to as* The Foresight) was prepared in order to determine priority directions in Lithuanian economy and R&D policies. Prepared by an international working group of scientists and consultants, the Foresight attempted to assess country's economic and R&D potential and to identify realistic priority directions for the advancement in the areas of consistent and rapid economic growth; these areas were characterized by (i) accumulation of internal intellectual, financial, and material resources, (ii) aggregation of financial support provided by the European Union and (iii) additional foreign direct investment attracted. Having appraised the impact of various economy sectors upon Lithuanian gross domestic product (GDP) from the macroeconomic perspective, their capacities to absorb innovations and the potential of real value-added growth, members of the research working group selected manufacturing industry, which represents the biggest share of exports and determines international competitiveness of the Lithuanian economy, as a key research object. The conclusions and the recommendations provided in The Foresight are taken into account when formulating country's economic and R&D development policy directions, updating the Long Term Development Strategy of the State and other key documents which define the economic development of Lithuania.

However, entire conclusions and recommendations are of a general type, as it is too early to appraise specific R&D demand from industry, which has been concentrated in medium and medium-high tech sectors, and as the latest statistical data shows, is cutting R&D investments.

In order to facilitate business R&D demand articulation and development, an initiative to develop national technology platforms was taken by the Lithuanian Ministry of Economy. These were initiated in 2006 -2007, in response to the EU's FP6 and FP7 activities on technology platforms. Today, there are 25 Lithuanian Technology Platforms which attempt - with a varying level of activity - to integrate the most dynamic and competitive companies as well as research units for technological development.

Given the current industrial profile of the country and, as a result – very limited and specialised business R&D demand in a few high technology areas (namely, lasers and biotechnologies), generated by the spin offs of public R&D establishments, it becomes evident that the main demand-generators for R&D are the government and the related governmental programmes. However, as noted in the section 2.1, public demand until recently had only a few tools to condition R&D demand formulation, since major funding flows were institutionally based. It could be stated then that the oriented socio-economic objectives of R&D in Lithuania are weakly specialised (ERAWATCH Network, 2006).

Lithuanian Science Council is basically responsible for formulating research priorities. Other consultation mechanisms are occasionally used (e.g. during preparation of the Operational Programmes of the National Strategic Reference Framework 2007-2013). Think tanks, such as the Knowledge Economy Forum, the Lithuanian Academy of Sciences, the Council of the R&D Institute directors and the Conference of Rectors of Universities, usually take part in debate on the planned research policy measures.

Since foreign funding is an important income source for Lithuanian R&D system (approx. 10 % of all R&D funds in the country) and it constitutes 50% of all competitive funds, available in the country, knowledge demand, generated and articulated internationally, is a very important source of shaping public R&D activities (at least, not less important than national funding). National research priorities are fully aligned with ERA framework activities, and more influenced by ERA priorities than by the analysis of national needs. In this way, Lithuanian researchers, in most cases, are engaged in international cooperation and R&D, and much less interested in fulfilling national demands, especially those stemming from industry.

3.1.2 Co-ordinating and channelling knowledge demands

As the research demand is obscurely expressed and weakly articulated by private and public sectors, the coordination of actions for its implementation is hardly possible. Several attempts to achieve higher coordination of research and innovation activities were made with the development of Lithuanian White Paper on Science and Technologies (2002). Lithuania has launched “The High technology development programme” (in 2005, continued for the period of 2007 through 2013), pertinent with the ‘Lithuanian White Paper on Science and Technologies Implementation Programme”, where R&D priorities have been related to the development of priority high-tech areas, i.e. biotechnologies, laser technologies, mechatronics, ICT, and nanotechnologies. Industrial biotechnology development programme, as a separate

programme to support R&D for the industrial development, was approved by the Lithuanian government in 2007. Implementation of the entire programmes has been coordinated by two ministries, as described in section 1.2.: the Ministry of Economy and the Ministry of Education and Science. The Ministry of Economy takes responsibility for business R&D development in the selected areas, while the Ministry of Science and Education is liable for research excellence. Programmes are implemented and administrated by the Lithuanian Science Foundation which also coordinates national priority-oriented research. However, priority setting is mainly an administrative process, organised by the Ministry of Education and Science and based on consultations of the Lithuanian Science Council. The funding of targeted R&D programmes is very limited, compared to institutional funding (5-8% of total public R&D funding), therefore, their implementation is actually unable to induce higher coordination among the research policy and performing actors.

Channelling of the private demand has been limited to high-tech sector companies, which express their needs through participation in Science, Technology and Innovation Commission, by research representatives in the Science Council and by active participation in shaping Lithuanian R&D strategies.

The development of a new competitive R&D funding model was also an important attempt to increase the coordination of demand-oriented research activities. With regard to success stories of other countries, the Science Council, the Ministry of Education and Science, and the Ministry of Economy proposed a two-agency model, where fundamental and applied scientific research would be administered separately. In this way, fundamental research activities and implementation of national research priorities remain the prerogative of the reorganised Lithuanian Science Council, while business R&D is to be administrated by the Technology Agency (not established yet, but foreseen in NRP (2005)).

A higher level of coordination, joining the efforts of different Ministries and research bodies to secure national progress, has not been observed in Lithuania. The need for a National R&D and Innovation Strategy was expressed in various public debates and at discussion tables; the need for a systematic technology foresight has also been voiced. However, no specific actions have been taken yet.

3.1.3 Monitoring demand fulfilment

Monitoring R&D demand fulfilment is not yet a part of R&D policy making practices in Lithuania.

The evaluation of the impact of targeted state R&D programmes has been limited to ex ante and ex post evaluation of the research projects funded within them. It is also known that each research programme undergoes ex ante evaluation, based on situation analyses and limited scope projections, as well as interim implementation reports and audits ex post. The whole evaluation cycle is not embedded in national policy making. Only a few programmes have undergone the entire evaluation cycle, for instance, the Innovation in Business Programme 2003-2006, for which the evaluation report was prepared by the State Control Service (2008).

A more sophisticated demand monitoring was conducted in the course of preparing documents, related to the implementation of EU Structural Funds: the Single programming document 2004-2006, and Structural Funds Implementation Strategy for 2007-2013, and relevant Operational programmes. The impact of the measures

foreseen is evaluated ex ante. Structural funds for 2004-2006 were not targeted at a specific research area, but limited to the development of research infrastructures and human resources for R&D and innovation. In addition, funds for R&D in business were allocated, with the expected impact of rising business R&D capacities. The same practice will be repeated also in the programming period of 2007 through 2013.

First attempts to assess the performance of Lithuanian R&D system and the impact of R&D policy were made in order to develop general policy documents, such as the *White paper on science and technologies* (2002). The World Bank Report "*Lithuania. Aiming for the Knowledge Economy*" (2003) had an important impact on further evaluations and discussions, related to the national knowledge economy development goals.

The Lisbon agenda also serves as an important annual evaluation driver. Some specific studies to evaluate Lithuanian R&D sector in relation to the Lisbon agenda were carried out (e.g., "*Lithuanian Opportunities and Necessary Works in Order to Achieve EU Lisbon Strategy Target – 3% of GDP for R&D*"), which has grounded the national response to Guideline No. 7. An important R&D and innovation policy "peer review" was performed by the OMC policy mix review board (http://www.smm.lt/smt/docs/eksp_stud/OMC_LT_review_report%20final%20June%2028.pdf). However, the all above mentioned documents were of general system assessment type, but not specifically targeting the monitoring of R&D demand fulfilment.

3.2 Assessment of strengths and weaknesses

The understanding and articulation of the research demand could be considered as the weakest chain of the Lithuanian research system, although the national priority setting processes continue on a regular base. Business demand for R&D is rather unspecified and not sophisticated, if present, in comparison with international knowledge demand. Thus, national R&D demand has been lending its positions to international R&D demand, which is clearly specified and channelled through competitive funding programmes. As a consequence, Lithuanian actors, involved in international R&D programmes and, at the same time, in national priority setting processes, seek complementary R&D funds to perform internationally oriented R&D. This is also possible because of the existing public R&D institutions evaluation standards, which are based on scientific excellence and ignore the demand side of R&D production. Since international R&D demand (ERA and other programmes) is clearly articulated and based on competitive resource allocation, national priorities, if any, are basically “aligned” to the international ones.

Main strengths	Main weaknesses
• National research priorities defined in the process of consultations with key stakeholders. • Measures foreseen to more precisely address business R&D demand. • National priorities fully aligned with the FP6, FP7 priorities, which allows the attraction of additional research funds.	• Limited competitive funds for research along the national priorities, if compared to institutional funding. • Business R&D needs weakly tracked and reflected in the priority setting process, with the exception of high-tech sector. • Opportunities of policy impact limited, due to a lack of evaluation at the priority setting and programme level.

3.3 Analysis of recent policy changes

Since the understanding and channelling of the research demand is very weak in Lithuania, the recent policy changes are oriented towards understanding and shaping business R&D demand and fulfilment. State support for R&D demand will be based not on the specific demand promotion, but on boosting business R&D in general. The new measures, foreseen in the "*National general strategy: the Lithuanian Strategy for the use of European Union Structural Assistance for 2007-2013*" (approved by the European Commission on the 26th of April, 2007) and the Operational programme for the Economical Growth for 2007–2013, Priority 1: Research and Development for Competitiveness and Growth of the Economy, targets the demand oriented research. However, the demand itself, as noted above, is not specified. Measures under this priority will support research conducted by public research organisations and universities that are expected to produce positive impact upon and are relevant to business development and economic growth (in the short or long term). Furthermore, such research will be funded within the framework of the aforesaid national (comprehensive) R&D programmes or in the number of other areas identified, as a rule, by international experts. The support for business R&D development will be provided under the same priority with the implementation of measures Idea LT, Intellect LT and Intellect LT+, which aim to detect business R&D needs and also support the R&D activities leading to applicable results (patents, industrial design, etc.).

The international research orientation will be further maintained. To encourage Lithuanian researchers to join the EU research area and to raise the standards of research conducted in Lithuania, support will be provided for preparations to participate in the EU 7th Framework Programme and Eureka, and to create opportunities to implement projects on the development of products and processes based on state-of-the-art technologies and able to compete in global markets.

The national research priority setting will not undergo radical changes, neither steps are foreseen for the improvement of the demand fulfilment monitoring.

Challenges	Main policy changes
Identification of knowledge demand drivers	• National economy foresight (2006- 2007) • New measures to support business R&D demand development (Idea LT, Intellect LT, Intellect LT+, see section 2.3)
Co-ordination of knowledge demands	• Development and implementation of integrated R&D programmes in priority areas • Support for the Lithuanian orientation towards international knowledge demand fulfilment • Restructuring of the governance of the research system and establishing of new funding mechanism with Law on Restructuring Lithuanian Science Council (Dec 2007).
Monitoring of demand fulfilment	• No specific measures were taken except the general system evaluations and quality control of research performed under the targeted R&D programmes

The state demand was specified in the selected priority areas and the Research programmes, list of which was approved by Lithuanian Science Council in 2007. Currently, the Research programmes are drafted in the following areas - The State and the Nation: heritage and identity; Social challenges for national security; Chronic non infection diseases; Lithuanian ecosystems: clime changes and human impact;

Sustainable energy. The development and implementation of targeted programmers should also enable the demand fulfilment monitoring processes.

3.4 Assessment of policy opportunities and risks

Current R&D demand structure supports Lithuanian participation in the international research area and builds opportunities to create international scientific specialisation, as international funding builds 50% of total targeted competitive funds, available in the country. In addition, new policy opportunities arrive with the targeted use of EU SF funds, available for the elaboration of business and economy development related R&D demand and its fulfilment. This also allows the re-orientation of public R&D system towards a balanced international and national demand oriented research. However, the processes in some areas might be complicated, especially in well performing science centres and groups, where successful and internationally oriented R&D practices have been established. The question recently raised in the policy debate, clearly reflects a policy risk: why Lithuanian researchers, performing R&D for multinationals based abroad (for example, Siemens), should be interested in small or medium size Lithuanian companies with limited and relatively unsophisticated R&D demands?

Main policy opportunities	Main policy-related risks
• International scientific specialisation development due to a high impact of international funding in the targeted research structure. • Science and study system reform, offering an opportunity for a higher impact on R&D oriented demand. • EU Structural Funds use for targeted and especially – for business oriented research, thus facilitating the growth of R&D demand in the private sector.	• Gap between R&D and still unrevealed specific national research needs, influenced by the international orientation. • The institutional practices, resisting the competitive funding related change

3.5 Summary of the role of the ERA dimension

ERA and the Lithuanian participation in it have tremendously impacted Lithuanian research priority settings. First of all, the ERA orientation of the Lithuanian research system is defined by a very important share of international funds among the total R&D competitive funds – up to 50% of competitive funding, available for research. Secondly, ERA related research funds are clearly related to specific targets and demands, while Lithuanian priority-setting mechanisms have been weakly developed. Thus, although public consultation progresses, research priorities actually reflect the ERA dimension. Consequently, Lithuanian R&D reflects the demand, articulated by ERA programmes. However, Lithuanian participation in ERA cannot be assured in the long term if a nationally-generated demand for R&D is not clarified, since R&D returns for the national economy are likely to form a base for national R&D funding directions. The forthcoming period and implementation of measures (see section 3.4) aimed at the business R&D development should develop links between science and business system, and identify a national economy related R&D demand.

4 - Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role to create and develop excellent and useful scientific and technological knowledge. A response to knowledge demand has to balance two main generic challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis for scientific and technological advance. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities which often emerge at the frontiers of scientific disciplines. Quality assurance processes are here mainly the task of scientific actors due to the expertise required, but subject to corresponding institutional rigidities.
- On the other hand there is a high interest in producing new knowledge which is useful for economic and other problem solving purposes. Spilovers which are non-appropriable for economic knowledge producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to a corresponding exploitability challenge.

Both challenges are addressed in the research-related Integrated Guideline and in the ERA green paper.

4.1 Analysis of system characteristics

4.1.1 Improving quality and excellence of knowledge production

Research intensity and quality is ensured with the help of institutional funding mechanisms, which are partially related to research performance. There has been a shift in recent years towards a more performance-based funding, when lump sums are allocated according to the output (publications) and to the volumes of competitive research funds received (industry funded R&D and public grants for targeted research programmes) (input). While this scheme sets performance-oriented criteria, it is still not able to influence the direction of research. Budget assignations to Lithuanian public science and study institutions (universities and public research institutions) in 2008 reached €218m, one-fourth of which, or €50m, were dedicated to research. Of this sum, 2/3 were direct assignations to maintain the existing staff, facilities, and equipment; and 1/3 was allocated according to scientific performance results, for instance, depending upon the number of scientific publications, patents, and international and private R&D funds attracted. Quality control is performed by the Lithuanian Science and Study Quality Control Centre according to reports on scientific activities, annually produced by Lithuanian R&D and HE establishments.

As Lithuanian Country R&D Specialisation Report (2007) shows, the highest numbers of publications (or scientific specialisation) were achieved in the fields of materials, engineering, computer science, chemistry, physics, and mathematics. Lithuania has demonstrated significant growth rates in the period of the last 5 years (over 12 percent) in the numbers of scientific publications, but still remains among the EU outsiders. In 2004, Lithuanian Science sector produced more than 700 publications, or 200 publications per million inhabitants, whereas the EU average has been over 600, and in more technologically advanced NMS (such as Hungary, Estonia, and the Czech Republic) – over 400. Advanced small countries produce

about (close to, or over) 1500 publications per million inhabitants (Finland, Sweden, and Denmark). With regard to these numbers, it is quite clear that significant changes in the development of scientific excellence and specialisation will not be achieved without specific policy initiatives. The development of European Research Excellence Centres is not yet to be considered in Lithuania, except in a few well developed areas, lasers and light physics. Accumulation of resources and competences for a possible development of national research excellence centres started with the process of identifying best-performing formal or informal scientific groups which was done by Lithuanian Science and Study Quality Control Centre.

Evidently, scientific excellence is an important prerogative for the maintenance of funding flows and the existing staff. However, R&D establishments, especially universities, have been also engaged in other functions, such as higher education and knowledge application. Financial incentives for R&D at the institutional and individual levels have been resigning to other activities, such as teaching and non scientific research related activities (counselling, development of practical applications, and the like). From a long-term perspective this should be considered as positive development as it is likely to enhance the role of universities as knowledge generators and knowledge diffusers. In a short-term perspective, this re-orientation has been driven by the lack of demand for R&D in business enterprise sector, by reductions in public R&D funding and by large increases in the number of students and, hence, increased demand for teaching. Up to now, Bologna-related reforms have not changed the situation, although new incentives, such as reducing study cycles (currently, Lithuania applies 4-year bachelor and 2-year master level studies), or linking postgraduate studies to research at a higher level, have been planned. The processes foreseen for the improvement of the study quality should also support the link between research and education functions.

4.1.2 Improving exploitability of knowledge production

The exploitability of knowledge production is rather limited in Lithuania, at least when analysed in classical terms. Intellectual property rights have been underdeveloped in the Lithuanian R&D and business sector. Lithuanian patenting rates were as low as 9.62 EPO patents in absolute numbers, or 2.7 EPO patent per million inhabitants in 2004; high tech patents were 0.67 in absolute numbers. The gap between Lithuania and the EU 15 (old member states), with over 300 patents per million of labour force, and the NMS, with over 17 patents per million of labour force, remains tremendous. Lithuania still lags behind the NMS average significantly, with only 5.95 patents per million of labour force.

If measured patenting efficiency by the level of business R&D expenditures, Lithuanian patenting rate is close to the EU NMS level. However, with reference to total R&D expenditures, Lithuania stands significantly lower than the EU average, and also twice as low as a NMS average. Taking into account the fact that Lithuanian R&D level (0.48 % of GDP in 2007) is getting close to the EU average (which is 0.64 percent GPD), the efficiency of public spending in terms of generating productive technological knowledge, i.e., patents, is more than unsatisfactory. Consequently, a major challenge to be addressed here is the development of IPR mechanisms within the public sector. By now, there have been neither specific rules for the use of knowledge, produced by public sector institutions, nor specific incentives with regard to its exploitation created. Usually, knowledge, developed within public institutions,

remains under the ownership of a definite researcher or a scientific group, or, as a consequence of participation in international networks, is transferred to international consortia or customers. Since business demand for knowledge has been very limited, the demand (see section 3.1.1.), and consequently, the market for IPR in Lithuania remains especially tenuous.

During the period 2001-2003, Lithuania's technological specialisation was limited to two sectors: that of electronic equipment and of office machinery. In other words, only those two sectors were demonstrating original technological knowledge-based growth and development. The fact partially correlates with the scientific specialisation in natural sciences (physics, mathematics, materials) as well as engineering and computer science.

Recent incentives on networking and increasing the focus on national/industrial clusters can be seen as a way to improve the exploitability of research. As private demand for scientific knowledge is rather low, the new incentives of the Ministry of Economy and the Ministry of Education and Science are aim at the development of collaboration structures, which would also link the R&D supply and demand activities and would increase exploitability of knowledge both in industry and in higher education. The development of Science, Technology and Study Centres, based on the concept, approved by the government in 2007, should foster better exploitation of knowledge within the R&D system and promote its wider application in business and higher education. The development of Technology platforms also aims at better knowledge exploitation for the national competitiveness.

4.2 Assessment of strengths and weaknesses

The knowledge production function in Lithuanian R&D system remains a prerogative of the public sector (which is a natural consequence, with the domination of public funding and public research establishments in the system). Therefore, major knowledge production and its quality assurance lies within public R&D establishments and universities. The currently-applied institutional funding mechanisms have been related to the scientific performance of the institutions which, in the last 5-year period, had a positive impact upon institutions' scientific performance and quality, and also supported the development of scientific specialisation in the field of natural sciences (mainly fundamental research). However, the volumes of scientific production, compared to the international level, are still very low. The existing initiatives do not increase the exploitability of knowledge in the Lithuanian economy, as they are not linked to the industrial demand. The IPR development initiatives for the public sector are underdeveloped, and the capacity to develop IPR in the private sector is almost non-existing, except of a few high-technology areas. This weakens the ability of the system to maintain knowledge development within it, especially in relation to public knowledge, which is exploited in international networks or given out to foreign partners under secrecy agreements.

Main strengths	Main weaknesses
• Specialisation achieved in all fields of natural sciences. • Some R&D and quality assurance mechanisms integrated in institutional funding schemes.	• Knowledge production and application still very low in absolute and relative terms. • Exploitability of knowledge for the national competitiveness restricted, due to the Lithuanian industrial profile and weak links between business and public research sectors. • Insufficient incentives for R&D at the institutional and individual level, compared to teaching and knowledge application alternatives. • Insufficient IPR development initiatives for the public sector.

4.3 Analysis of recent policy changes

Research excellence and quality, with regard to its exploitability in the economy, has been questioned in many policy studies and reports. The definition of research excellence has been assigned to the research community and its representing body, the Lithuanian Science Council. During the last 5 years, research quality evaluation standards have been aligned with the international ones. For social sciences, given a short history of their development in Lithuania (since 1991), a new measure was implemented – a national reviewed data base "Lituanistika" was established in 2007, with the aim to collect and post publications, reflecting some relevance to Lithuania, in the areas of social sciences and the humanities.

The Science and Study system reform plan (2007) addressed research quality and competence development at the system level. It has been planned to develop National Research universities (no more than 2 or 3), and to support only best-performing research groups, in order to ensure resource accumulation and the increase of competitive R&D production. Targeted changes in the science funding model are also expected to encourage increases in research production and in the development of incentives for socio-economic incentive oriented research.

The exploitability of knowledge created has been an important target for R&D and innovation policies. Lithuanian National Reform Programme (2005) set an objective to create conditions for businesses enabling to make use of the public sector's R&D results and to invest in R&D by developing R&D capacities of the public sector (with the response to Guideline No.7). Among other scheduled tasks, it projected the "increasing efficiency of R&D, carried out by the education and study system, as well as its matching to the needs of the economy". The entire objective and the related tasks were deployed in the "National General Strategy: the Lithuanian Strategy for the Use of European Union Structural Assistance for 2007-2013" (approved by the European Commission on April 26, 2007) and the Operational programme for the Economical Growth for 2007–2013, Priority 1: Research and Development for Competitiveness and Growth of the Economy. It is aimed at the improvement of knowledge production – objective 1: Reinforce public and private R&D facilities and objective 2: Increase efficiency of R&D by the public sector as well as its accessibility to businesses. New programmes for R&D sector were developed within the new programming period, namely a General National Complex Programme (2008) and a General National R&D and Science and Business Partnership Programme (2008).

These programmes aim at developing sustainable high-tech intensive businesses and research activities to support its competitiveness. That is, they address both scientific knowledge supply and demand, in order to facilitate further development of the national innovation system. Within the programmes, a variety of measures have been foreseen for both boosting research excellence, accumulation of R&D resources for knowledge production, creation of infrastructures, further development of research quality standards, etc., as well as creating high technology spin offs and businesses. The complexity of the task upsurges due to the fact that the processes start almost from nothing. In order to facilitate them, the establishment and development of integrated science, study, and business centres (valleys) was approved by Lithuanian government on March 21, 2007. Selected initiators of the centres were officially invited to submit detailed proposals for the establishment and development of five science, study, and business integrated centres in specified priority areas of Lithuania. Two centres are to be established in Vilnius ("Sunrise Technology Valley" in laser and light technologies, nanotechnology and materials, semiconductor physics, electronics and organic electronics, and civil engineering; and "Santara Valley" in biotechnology, molecular medicine, and ICT); two in Kaunas ("Santaka" in sustainable chemicals and pharmacy, mechatronics and related electronics, biomedical engineering, future energy, and ICT; and "Nemunas" in agro-biotechnologies, bio-energy and forestry, food technology, safety, and health), and one in Klaipeda (a centre in the sea environment and maritime technologies). The development of these centres will be supported by Lithuanian national funds, EU (SF), and private funds. http://www.smm.lt/teisine_baze/docs/nutarimai/2007-03-21-321.doc The centres will form a national base for the exploitation of scientific knowledge in the development of high value added business activities and will serve as a starting base for the development of R&D intensive businesses.

Challenges	Main policy changes
Quality and excellence of knowledge production	• Development of internationally harmonised research quality assessment standards and the related funding mechanisms. • Development of National Research Universities • General National Complex Programme (2007)
Exploitability of knowledge production	• General National R&D and Science and Business Partnership Programme (2007). • Development of Integrated science, study, and business centres (valleys).

4.4 Assessment of policy opportunities and risks

Current R&D policy developments offer great opportunities for restructuring Lithuanian Science sector and create highly concentrated and effectively performing public Research Institutes and Universities. Processes which facilitate the creation of research centres in the selected areas have already started. However, the main policy-related risks concern the current fragmentation of the Lithuanian research system, and its relative insularity and resistance to change. Given a high number of R&D and HE establishments, it is difficult to develop high level scientific groups, which would be competitive on the international level. Therefore, institutional reforms are needed, which will be resisted by the current R&D establishments. In this case, resources will be distributed among many institutions and small research groups, unable to achieve large volumes of knowledge production. The development of integrated Science, Study and Business valleys and the implementation of related

General National Complex (2007) and General National R&D and Science and Business Partnership Programmes (2007) offers an opportunity to develop a sustainable knowledge production and exploitation system, in spite of the fact that, because of the limited research and human resources, it might not reach sufficient development levels. Dominating national industry is quite diversified, therefore, research excellence cannot be achieved in all industry-related areas.

Main policy opportunities	Main policy-related risks
• Develop research excellence centres and integrated valleys in the selected areas, using the EU SF support. • Develop knowledge exploitation mechanisms between science, higher education, and business sectors.	• Lack of critical mass not allowing to achieve research excellence in industry related areas. • Lack of scientific specialisation leading to the dispersion and ineffective use of the limited resources. • Institutional rigidity resisting change related to research excellence and results exploitability. • Planned development of high tech sectors probably not achieving significant volumes, sufficient to induce change in knowledge exploitation

4.5 Summary of the role of the ERA dimension

Europeanisation of the Lithuanian research system and the integration into ERA have raised the question of the national knowledge production quality and its relevance on the international scale. The development of internationally aligned knowledge production evaluation standards was one of the first steps to ensure the quality of knowledge production. Today, the development of European Excellence centres has been limited to one Centre in Physics (CEBIOLA at Vilnius University). The possibility to establish more such centres is quite limited because of the distributed research resources. At the same time, however, Lithuanian researchers have succeeded in establishing international links and in contributing to international research projects. Naturally, it has increased research quality and volumes. Nevertheless, Lithuanian R&D results have been weakly exploited in the national economy, first of all, due the lack of facilitating infrastructures.

5 - Knowledge circulation

The purpose of this chapter is to analyse and estimate how a research system ensures appropriate flows and sharing of the knowledge produced. This process is vital for the economy and society, as the basis for subsequent advances in knowledge production. To some extent, knowledge circulation is supposed to happen naturally, due to the mobility of knowledge holders, e.g., university graduates entering industry realms, and because of comparatively low costs of the knowledge reproduction, once it has been codified. However, there remain three challenges, related to specific barriers to this circulation, which need to be addressed by a research system in this domain:

- Facilitating knowledge circulation among the university, PRO, and business sectors to overcome institutional barriers;

- Profiting from the access to international knowledge by reducing barriers and increasing openness;
- Enhancing absorptive capacity of knowledge users to mediate limited firm expertise and learning capabilities.

Effective knowledge sharing is one of the main axes of the ERA Green paper and significant elements of IGL 7 relate to knowledge circulation. To be effectively addressed, these require a good knowledge of the system responses to the above challenges.

5.1 Analysis of system characteristics

5.1.1 Facilitating knowledge circulation among university, PRO and business sectors

In the Lithuanian case, knowledge circulation among the university, PRO and business sector has been rather limited. Limitations, first of all, concern the industrial structure and a limited demand from the business sector. The HERD funded by the business sector (3.8%) is twice as low as the EU average (6.28%). The R&D funded by the business sector and performed by the government research institutes again is below the EU average (8,19%) and in Lithuania it equals to 6.19% (2006). However, even these kinds of cooperation do not achieve significant results – according to the Community Innovation Survey (2006), only 1 percent of manufacturing enterprises reported a cooperation type, related to higher education and R&D institutions, as a valuable one.

In order to facilitate knowledge circulation between public research establishments and the private sector, a few initiatives were implemented by the initiative of the Ministry of Economy. Among them, there have been the creation of Science and Technology parks (starting in 2002), and the development of Technology platforms (started in 2006).

The establishment of Science and Technology parks aimed at the facilitation of the development of New technology based businesses, working in close cooperation with the universities. However, the assessment of Lithuanian Science and technology parks activities (Lithuanian Ministry of Economy, 2008) has revealed that a typical Lithuanian park is a small public institution with a complicated or insufficiently active structure of partners, with 2,400 sq.m. of space, almost all rented out. The revenue from the rent makes up to 50 percent of the total budget, while the remaining financing most often comes in the form of project support from EU or Lithuanian funds. The share of regional support or contributions from the private business are very small. A typical Lithuanian park has no specialised premises for R&D and production, no title to the land or buildings, but has potential development opportunities to expand either within the existing territory, or in the areas adjacent to the park. Most often, there are about 50 companies established in an actively operating park. Small (1-10 employees) companies prevail. Thus, it is evident that S&T parks do not much contribute to the knowledge circulation between the university and the businesses, but feature as NTB firms, “business incubators”.

The most recent trend, reflecting the idea of the “knowledge-based city”, has been exploited by the developers of Lithuanian integrated centres (valleys) of science,

studies and business (2007), which suggest higher integration of individual elements and parts, than it was achieved by the development of S&T parks. The National R&D and Science and Business Partnership Programme (2007) was developed in order to facilitate effective links between research establishments and businesses with systematic development of knowledge-intensive businesses and targeted R&D activities. Within the General National Complex Programme (2007), the establishment of Technology transfer offices has been assigned to universities, which should also support a better knowledge circulation among the universities and other sectors.

New EU SF implementation incentives to support NTB firm creation and spin-offs will be implemented according to the General National Complex Programme (2007) and the measure aimed at NTB business development is "Idea LT", "Intellect LT", and "Intellect LT+" (see section 2.3.) which eventually supports better knowledge circulation between the public and private sector.

A supporting programme "Researchers careers" (2007) aims at developing new work places for the researchers in both public R&D and private R&D intensive sector, and also strives to enable intersectoral circulation of researchers, as today major human resources in research are still concentrated in the public sector, which limits the absorptive capacity of businesses.

5.1.2 Profiting from access to international knowledge

The issue of limited gains from the international knowledge of the Lithuanian R&D system was approached by a wide range of documents addressing the National Competitiveness, Innovation and R&D system. The participation of Lithuanian R&D establishments in European research programmes was marked as unsatisfactory.

As a matter of fact, integration into the European R&D agenda (i.e., participation in international R&D programmes) has been and still remains one of the key priorities of the Lithuanian science sector. The need has been driven by limited national resources, unable to maintain competitive R&D programmes and by a relatively small science sector. The ERA integration has been facilitated at the policy and implementation level. Lithuanian national R&D priorities fully cohere with the FP7 priorities, namely, with the research to ensure human life quality, knowledge society, nanotechnologies, and nuclear safety. R&D in the priority areas has been funded by national programmes, but an important role has also been given to ERA programmes. The International R&D Programmes Development Agency (www.tpa.lt) has been established for a specific purpose - assisting national participation in international R&D programmes. ERA importance is strengthened by the absence of national, but internationally open, research programmes. In fact, all national R&D programmes are first designed for Lithuanian R&D institutions (eligible for funding), and limit the participation of foreign partners. Although Lithuania has participated in FPV and FPVI programmes, the results were less than satisfactory; through projects operated by national science institutions, it was unable to retrieve even the funds contributed. As a consequence, the benefits of ERA – participation in international networks, openness and integration of the research system – have not been not fully exploited by the Lithuanian R&D sector. The initiatives for human resource mobility, ERA nets, are only moderately exploited by Lithuanian science institutions. Lithuanian S&T institutions have operated 324 FPVI contracts, receiving research grants of €25,514,387. Participation in other European programmes, such as COST

or Eureka, is considered an important tool complementing national science policy in support of the development and maintenance (in certain areas) of the national science international competitiveness. In 2006, support was provided for seven institutions of science and studies, successfully participating in the Sixth Framework Programme for Research, Technological Development and Demonstration Activities, and for 83 projects in the international EUREKA and COST programmes. Lithuania also delegated three representatives to the EU technology platforms, allocating the total of LTL77.03m for their activities to the Agency for International Science and Technology development programmes.

5.1.3 Absorptive capacity of knowledge users

The development of human resource for S&T, traditionally, is considered to be the strength of the Lithuanian Science and Higher Education system. 17.8% of university graduates are in the field of engineering and science (EIS, 2007). However, some of the newly trained specialists do not stay in engineer after graduation. Human resource for R&D in business has been limited to 5,4 % of the total human resource for R&D in Lithuania. 1.7% of all doctorate holders were employed in the business sector. This extremely low share of R&D personnel in business hinders its absorptive capacity. This fact might explain the above-presented analysis of the R&D and business cooperation in innovation activities failure. Only few sectors of the economy can be noted for higher R&D personnel employment, namely machinery and equipment, optical and medical devices, chemicals (including pharmaceuticals) and R&D intensive services as well as ICT. According to the country specialisation analysis, Lithuania is labelled as a country dominated by the 'specialized suppliers' sectors (in the typology by Pavitt, 1984), or the 'complex systems' and 'product engineering' regimes (in the typology by Marsili, 2001), where innovation is mainly the result of development (as opposed to research) or engineering activities. Therefore, networks, partnerships and collaborations become of crucial importance, since 'innovation capacities of firms are based mainly on specific, and, to a large extent, tacit collective capabilities, formed by internal collective learning process. This does not imply that relations with academic research are unimportant, but it concerns mainly engineering disciplines (mechanical and electrical engineering, computer science) or general scientific knowledge (mathematics), which is, in fact, the actual scientific specialisation of Lithuania. One of the key problems within this regime for firms is the capacity to have access and to combine various kinds of technical knowledge and capabilities. In the Lithuanian case, these capabilities, first of all, are hindered by insufficient human resource and inefficient networking activities. The new programme of "Researchers Careers" (2008) aims at creating new work places for the researchers in both public R&D and private R&D intensive sector, at encouraging the mobility of researchers between the public sector and industry.

The Cluster Concept was undertaken as an important tool to facilitate the development of innovative businesses, also involving public R&D institutions (or public knowledge sources). New measures related to the development of innovative clusters with the original R&D and partnership infrastructures are to be implemented in the programming period of 2007 through 2013 ("Innocluster LT" and "Innocluster LT+").

However, HE institutions are not yet ready to establish knowledge transfer mechanisms because of the unregulated mode of university knowledge

commercialisation and due to the lack of relevant structures (such as Innovation and Technology Relay Offices).The new initiatives to foster university knowledge transfer for industry were supported by the EU SF 2004-2006, and will be further facilitated within the new programming period for 2007-2013 under the General National Complex Programme (2007) and National R&D and Science and Business Partnership Programme (2007).

The existing partnership and cooperation infrastructures for business and science sectors, such as technology parks, technology platforms, technological business incubators and intermediary institutions will be strengthened with the implementation of measures "Innogeb LT-1" and "Innogeb LT-2". The measures specifically aim at strengthening ("Innogeb LT-1") the above mentioned structures, and fostering their internationalisation ("Innogeb LT-2").

5.2 Assessment of strengths and weaknesses

As it was already mentioned, a typical strength of the Lithuanian Science and Higher Education system is the development of high shares of S&T graduates, important knowledge holders and the intersectoral transfer actors. However, the assumption cannot be supported by actual business innovation activities, which fail to profit from the cooperation with universities in spite of all the attempts taken. The established business and R&D partnership structures, first of all S&T parks and Technology Business Incubators have been evaluated as not efficient enough to implement the knowledge circulation function. Among the reasons there might be underdeveloped cooperation mechanisms both in parks and at universities. The lack of international experience in Lithuania is also among the obstacles to the participation in international research programmes which, consequently, deprives our institutions of the international knowledge gains. One more barrier to participation in international research programmes is the type of funding, still based on the institutional funding schedule (see section 2.1), applied to public institutions. Finally, businesses are not able to participate due the low absorptive capacities, and especially the lack of highly skilled people, first of all, PhD holders.

Main strengths	Main weaknesses
• Possible aspirations of the business sector for innovation cooperation. • High shares of S&T graduates, continued upward trend. • Established network of S&T parks. • Established mechanisms to support participation in international R&D activities.	• Low absorptive capacity of the business sector. • Non existing or ineffective knowledge transfer structures between R&D and the business sector. • Non-existent incentives for the human resource mobility in S&T. • Insufficient participation in international programmes, restricted by limited institutional capacities and by lack of experience.

5.3 Analysis of recent policy changes

The National Reform programme (2005) has emphasised the importance of applying research knowledge for industrial and business competitiveness. It states that R&D and innovative development should not be separated from commercialization of scientific research results. Different methods of commercialization could be possible,

ranging from co-operation with companies, interested in research results, to carrying out their orders, to science institutions commercializing their own research results, and to the establishment of advance technology start-up and spin-off (companies establishing on the basis of the units of science and scientific research institutions or researchers' groups) companies. The planned tasks had to be put into practice within the EU SF Programming period for 2007-2008, where a mix of related programmes is to be implemented, namely, a General National Complex Programme (2007), General National R&D and Science and Business Partnership Programme (2007), Researchers Career Programme (2007), as already mentioned in the previous sections.

Development of the integrated Science, study, and business centres (valleys) (started in 2007) is aimed at the development of integrated knowledge circulation infrastructures, where R&D knowledge would be tightly linked not only to NTB firm creation and development, but also to highly-skilled human resource development processes.

The Cluster Concept has been taken as an important tool to facilitate the development of innovative businesses, also involving public R&D institutions (or public knowledge sources). The new measures related to the development of innovative clusters with the original R&D and partnership infrastructures are to be implemented in the programming period of 2007-2013 ("Inocluster LT" and "Inocluster LT+").

The existing partnership and cooperation infrastructures, linking business and science sectors, such as technology parks, technology platforms, technological business incubators, and intermediary institutions will be consolidated with the implementation of measures "Inogeb LT-1" and "Inogeb LT-2". The above measures specifically aim at strengthening ("Inogeb LT-1") these structures, and at their internationalisation ("Inogeb LT-2").

A mix of newly designed measures is expected to build up new partnership networks of various types, which would ensure knowledge flows between academia and business.

Challenges	Main policy changes
Knowledge circulation among university, PRO, and business sectors	• General National Complex Programme (2008). • General National R&D and Science and Business Partnership Programme (2008). • Development of Integrated science, study, and business centres (valleys). • Development of knowledge transfer infrastructures ("Inogeb LT - 1", "Ingoeb LT – 2"). • Development of innovative clusters ("Inocluster LT", "Inocluster LT+").
International knowledge access	• Support to Lithuanian participation in international research programmes. • Support to the internationalisation of business and science partnership platforms (technology parks, etc.; measure "Inogeb LT 2").
Absorptive capacity	• Researchers Career Programme (2008). • Development of innovative clusters (Inocluster LT, Inocluster LT+).

5.4 Assessment of policy opportunities and risks

The improvement of knowledge circulation within the economy is an integral part of the whole Science and HE sector reform. Specific opportunities to create knowledge circulation "spaces" and processes have been generated through the development of new integrated Science, study and business valleys, functioning across the best performing Lithuanian Science and HE institutions, through the establishment of the missing linking structures, such as Technology Transfer Offices, and through the support to the rise of NTB business sector. However, this means that completely new action and behaviour models are to be developed and implemented, and current institutional practices have to be changed. The whole new business "generation", based on the intensive application of knowledge, has to be created in order to ensure active absorption of research results for the creation of economic value. It is quite obvious that the currently present industrial structure has been based on complex engineering knowledge, but not on science and research as such.

Main policy opportunities	Main policy-related risks
• Establish linking structures between the business and R&D sectors • Develop integrated science, study and business infrastructures for knowledge accumulation across public and private knowledge poles. • Reinforce the development of a knowledge intensive business sector through the support of university spin-offs and by new technology-based firm creation.	• Productive R&D links may not evolve due to weak business R&D demands and low absorptive capacity.

5.5 Summary of the role of the ERA dimension

The role of the ERA dimension in ensuring knowledge circulation manifests itself, first of all, in Lithuanian participation in international R&D networks, which, although evaluated as insufficient, have already been operating for a decade. For the creation of national knowledge circulation processes, ERA dimension server as an important driver towards the establishment of integrated knowledge circulation infrastructures. Lithuanian R&D system is far too underdeveloped in order to operate as an important actor at the European level. However, the creation of national structures has been an important step towards the creation of knowledge poles for international competitiveness and towards attracting foreign knowledge. Already operating, Lithuanian S&T parks are open for international companies, and aim at attracting foreign potential, in order to facilitate knowledge-based business development in Lithuania, which would make an integral part of international technology chains.

6 - Overall assessment and conclusions

6.1 Strengths and weaknesses of research system and governance

Lithuanian research system is peculiar for the asymmetric R&D resource concentration and for weak intersectoral links. Resource mobilisation for the Lithuanian research system is mainly a prerogative of the public sector and public policy. It primarily aims at the sustainability and development of public research and higher education sector.

The main strengths, concerning resource mobilisation, lie in the sustainable upward trend of the public R&D funding for research, in youth enrolment in tertiary education, and in a relatively high share of S&T graduates. The strength related to high volumes of human resource for S&T development has been weakened by a relatively low quality of the public higher education sector performance, which, in the light of internationalisation, is giving up its positions to most European universities, first of all, due to the inability to attract highly-skilled students. The lack of research careers and their limited attractiveness also leads to the fact that, despite the increasing numbers in S&T graduates, the actual number of researchers in the country has not been changing.

Increase in public funding for R&D, the improvement of public research infrastructures, and the emphasis on research excellence have improved the capacity and competitiveness of the research system. However, public funding is not sufficient to be able to develop a balanced and a well-performing research system. The business sector faintly participates in R&D in terms of demand formulation, funding, and performance, which not only block resources for research, but also restrict the applicability of research results in industry. In addition, the level of competitive public funding has been extremely low, which leads to ineffective use of resources in the public sector. The absence of mechanisms to enable the participation of the private sector in national R&D system also weakens chances of its development into a well-balanced research system, when speaking of resource mobilisation and long term investments in research. There are several factors, irrelevant for effective business R&D facilitation. Those are not only financial schemes, but also business R&D infrastructures, especially regarding the SME sector which dominates Lithuanian economy. As a result, we have a fragmented public R&D infrastructure with far too large number of universities and public research institutes, and also very fragmented and dispersed business R&D resources.

Understanding and articulation of research demands could be considered the weakest part of the Lithuanian research system, although national priority setting processes are ongoing on a regular basis. The rationale for such a statement has been grounded by the fact that business demand for R&D is rather weak, and if present - not sophisticated, in comparison to the international knowledge demand, where Lithuanian public R&D and Higher Education institutions actively participate. In this way, the national public R&D demand and priority setting supports Lithuanian participation in the fulfilment of international R&D demand, but devaluates nationally generated specific research demand (which has not been analysed in depth). The actors involved in priority setting processes actually seek complementary funds in

order to accumulate and concentrate resources for R&D. Since international R&D demand (ERA and other programmes) has been clearly articulated and based on the competitive resource allocation, the existing national priorities (if any) are basically "aligned" to international ones. In this way, the current R&D demand structure supports Lithuanian participation in international research area, and builds the opportunity to create international scientific specialisation. On the other hand, it has little to do with the real national research needs (not specified yet).

The knowledge production function in the Lithuanian R&D system remains the prerogative of the public sector (which is a natural consequence of domination of public funding and public research establishments in the system). Therefore, the main knowledge production potential and its quality assurance possibilities lie within public R&D establishments and universities. Institutional funding mechanisms, currently applied, are related to scientific performance of the institutions, which, in the last 5-year period, had a positive impact upon institutions' research performance and quality, and also supported the development of scientific specialisation in the field of natural sciences (mainly fundamental research). However, the volumes of scientific production, compared to the international level, are still very low. The currently existing initiatives do not increase the exploitability of knowledge in Lithuanian economy, as they are not linked to the industrial demand. The IPR development initiatives for the public sector are underdeveloped, and the capacity to develop IPR in the private sector is close to nothing, except for a few high technology areas. It weakens the ability of the system to maintain the knowledge developed within it, especially in the case of public knowledge, exploited in international networks or given away to foreign partners under secrecy agreements.

Among the traditional strengths of Lithuanian Science and Higher Education system is the development of high shares of S&T graduates, who are considered to be the key knowledge holders and intersectoral transfer actors. However, the above assumption is not supported by actual business innovation activities, which results in the failure to profit from the cooperation with universities, despite some attempts made. The established business and R&D partnership structures, first of all S&T parks and Technology Business Incubators are rated as not efficient enough, when considering the implementation of the knowledge circulation function. This inefficiency has been determined by the underdeveloped processes within the parks and at universities. Profiting from the international knowledge is also limited which may be partially explained by the lack of experience and triggers facilitating the participation in international research programmes, with the funding still based on the institutional funding mode favouring public institutions, whereas businesses themselves are not able to participate, due their low absorptive capacities, and especially because of the lack of highly skilled people, PhD holders.

New trends in the research system governance actually aim at changing the current system orientation and structure, making it a more interactive and interrelated R&D system, embedded in the national economy. The Science and Higher Education reform being only at the initial stage, seems to be appropriate for the analysis in section 6.2.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	Strong public position on the increase of R&D funding, but very limited and stagnating business R&D investment
	Securing long term investment in research	Long term investment in research, as a prerogative of the public policy; lack of priority-based funding hindering a long term impact on the research direction at public institutions
	Dealing with barriers to private R&D investment	Schemes to support business R&D established and further strengthened; business participation in R&D system still very low
	Providing qualified human resource	High share of youth enrolment in tertiary education, also high share of S&T graduates, but low quality of higher education, especially concerning modern skills for knowledge economy
Knowledge demand	Identifying the drivers of knowledge demand	The national research priorities defined in the consultation process with key stakeholders. National priorities fully aligned with the FP6, FP7 priorities (which allow attracting additional research funds), but weakly linked to business demands
	Co-ordinating and channelling knowledge demands	Business R&D needs weakly tracked and scarcely reflected in the priority setting process (exception – a high tech sector); new measures foreseen to more precisely address business R&D demand
	Monitoring the demand fulfilment	Lack of evaluation at the priority setting and programme level limiting the opportunities of policy impact
Knowledge production	Ensuring quality and excellence of knowledge production	Strong specialisation in all fields of natural sciences , but very low knowledge production and application (in absolute and relative terms). Insufficient incentives for R&D at the institutional and individual levels, compared to teaching and knowledge application alternatives
	Ensuring exploitability of knowledge	Exploitability of knowledge for national competitiveness restricted by the Lithuanian industrial profile and weak links of Business and R&D sectors
Knowledge circulation	Facilitating circulation among university, PRO, and business sectors	High business sector intention for innovation cooperation Non existing/ineffective knowledge transfer structures between R&D and the business sector
	Profiting from international knowledge	Mechanisms established to support participation in international R&D activities; participation rates still restricted by limited institutional capacities and the lack of experience
	Enhancing absorptive capacity of knowledge users	High shares of S&T graduates, continued upward trend, but still low absorptive capacity of the business sector, incentives for human resources mobility in S&T absent, until recent changes

6.2 Policy dynamics, opportunities and risks from the perspective of the Lisbon agenda

The policy mix, currently developed and introduced, combined with the resources of national and European funds, provides new opportunities for policy actions towards competitive and sustainable Lithuanian Science sector. New opportunities, first of all, have been related to resource concentration for research excellence and for upgrading research infrastructures. Not less importance has also been assigned to the development of integrated business and R&D partnership infrastructures, as a tool for the initiation of closer intersectional linkages, and for a balanced resource accumulation in the long term. The main risks related to the policy implementation

are those concerning the efficiency of policy actions which can be restricted due the limited human resources available for the policy management and implementation, and also unfavourable long term trends in human resources for S&T. Institutional rigidity and inflexibility are among overall risks to the success of policy action, especially when considering the fact that Lithuanian Science sector has been among the least reformed sectors since 1991.

New policy opportunities occur with the use of EU SF funds, targeted for the development of business and economy development needs related R&D demand and its fulfilment. This also suggests the chance of reorienting public R&D system towards a balanced international and national demand-oriented research. However, the processes in some areas, especially in well performing science centres and groups, might be complicated, especially where successful and internationally oriented R&D practices have already been established.

Improvements in research excellence and quality of knowledge production, first of all, result from Lithuanian participation in ERA. Current R&D demand structure supports Lithuanian participation in the international research area, and builds the opportunity to create international scientific specialisation, as international funding builds about 50% of total targeted competitive funds, available in the country. However, the greatest risk has been related to its possible disconnection from still unrevealed specific national research needs. The current R&D policy developments offer great opportunities for restructuring Lithuanian Science sector and for creating highly concentrated and effectively performing public research institutes and universities. The processes which facilitate the creation of concentrated research centres in the selected areas have already started. However, the main policy-related risks concern the current fragmentation of the Lithuanian research system, its relative reticence and resistance to change. Given a high number of R&D and HE establishments, it is difficult to develop high-level scientific groups, which would be competitive at international level. If this scenario works, the scarce resources will be distributed across many institutions and small research groups, which will not achieve larger volumes of knowledge production.

Weak performance in both public and private domains naturally limits knowledge circulation between the sectors. The improvement of knowledge circulation in the case of Lithuanian R&D policy development is an integral part of the whole Science and HE sector reform. Specific opportunities to create knowledge circulation “spaces” and processes have been created through the development of new integrated Science, study and business valleys across the best-performing Lithuanian Science and HE institutions, through the establishment of missing linking structures, such as Technology Transfer Offices, and through support to the rise of a NTB business sector. However, these measures imply a departure from current institutional practices. A whole new business “generation”, based on the intensive application of knowledge, would need to be created in order to ensure active absorption of the research results for the creation of economic value. Today, the present industrial structures, based on traditional low and mid tech sectors, have limited opportunities to participate as key industrial R&D drivers.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Restructured and competitive R&D sector with accumulated resources for national development and scientific excellence. • Sustainable development of highly skilled human resource. • Established business and science cooperation structures and strengthened business R&D investments.	• Human and management resources insufficient for the implementation of the actions foreseen. • Numerous attractive international research careers and continued brain drain, if implemented measures do not work. • Research community aging faster than the general population
Knowledge demand	• Development of the international scientific specialisation resulting from a high impact of international funding in a targeted research structure. • Science and study system reform, offering an opportunity for higher impact on R&D oriented demand. • EU Structural Funds used for targeted and business oriented research, thus facilitating the growth of R&D demand in the private sector.	• Disconnection of R&D from specific national research needs, still unrevealed due the international orientation. • Institutional practices resisting competitive funding-related changes.
Knowledge production	• Development of research excellence centres and integrated valleys in selected areas, using the EU SF support • Development of knowledge exploitation mechanisms among Science, Higher Education, and Business sectors.	• Lack of critical mass, not allowing the achievement of research excellence in industry related areas. • Lack of scientific specialisation leading to the distribution and ineffective use of limited resources. • Institutional rigidity resisting change in research excellence and exploitability of research results. • Development of high tech sectors envisaged, but not necessarily resulting in significant volumes, in attempts to induce change in knowledge exploitation
Knowledge circulation	• Establishing linking structures between business and the R&D sector. • Developing integrated science, study and business infrastructures for knowledge accumulation across public and private knowledge poles. • Reinforcing the development of knowledge intensive business sector through the support of university spin-offs and new technology-based firm creation.	• Institutional rigidity reinforcing the separation of public R&D, Higher Education, and Business sectors. • Weak R&D demands and low absorptive business capacity, possibly failing to establish productive R&D links.

6.3 System and policy dynamics from the perspective of the ERA

Opportunities of Lithuanian R&D sector participation in ERA at the current development stage have been restricted by limited research capacities and quality, as well as by outdated research infrastructures and by the lack of highly qualified R&D personnel. Relative isolation of R&D sector in national and international terms has restricted international knowledge flows within the Lithuanian Science sector, and again, has limited its ERA integration.

Current policy actions have been exclusively oriented towards the support of Lithuanian participation in ERA, first of all, with the development of research excellence structures, and also by integrated infrastructures for science and business partnerships in R&D. Development of new technology-based business sectors has been among the policy targets; it has also aimed at ensuring the development of sophisticated R&D demand and at applying research results for national competitiveness. Still, it has been fully recognised that Lithuanian R&D system is neither self-sustaining, nor competitive, if taken out of international networks. A small size of the R&D system, its weak links to the national economy, the specifics of R&D funding, at the national level, limited to public sources, drive Lithuanian R&D activities towards the international dimension. Current policy actions aimed at the establishment of research excellence centres and integrated knowledge poles will further support ERA integration, where new technology-based businesses will complement the missing link. Given the current situation, Lithuanian science system faces more risks being apart from the national economy than from the European research area, as the current linking mechanisms and ties to the national economy are weaker than those relating to international networks.

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List of Abbreviations

ERA	European Research Area
FP	Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HEI	Higher Education Institutions
HERD	Higher Education Expenditure on R&D
IG	Integrated Guidelines
NTBF	New technology based firm
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
PRO	Public Research Organisations
SME	Small and Medium Sized Enterprise
NIS	National Innovation System

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Abstract

The main objective of ERAWATCH country reports 2008 is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports are produced for each EU Member State to support the mutual learning process and the monitoring of Member States' efforts by DG Research in the context of the Lisbon Strategy and the European Research Area. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The reports are based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.
This report encompasses an analysis of the research system and policies in Lithuania.

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