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Agnė Paliokaitė

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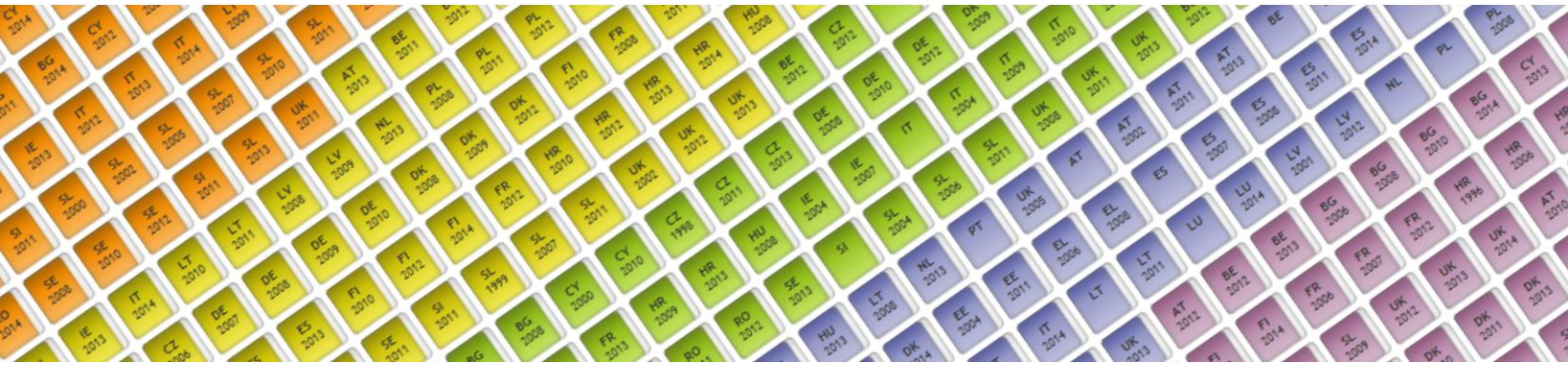

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Abstract

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

Acknowledgments

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Executive summary

This report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites, etc. The quantitative and qualitative data is, whenever possible, comparable across all EU Member State reports. The report provides an up to date overview of the country's research and innovation (R&I) system (including funding), examining developments towards topics central to two EU policies – the European Research Area and Innovation Union.

Lithuania with a population of approximately 3m is the seventh smallest country in the EU. The Lithuanian economy continues to recover after the peak of the crisis in 2009 recording stable growth of 2.9-3.8% in 2012-2014. The economic recovery, however, is not sufficiently large to spur job creation and the level of unemployment has not reached the pre-crisis level. Strategic objectives and funding for the Lithuanian R&I policies have gained weight over 2009-2014. The R&I policy mix has improved significantly in the context of the National Strategic Reference Framework (NSRF) 2007-2013, the Lithuanian Innovation development programme 2014-2020 and the public research and education system reform that took place in 2009-2012. The availability of high quality research infrastructure has been addressed by the policy actions focusing on the development of five science 'valleys'. The quality of human resources in research has been addressed by funding research mobility and research grants. R&D grants and tax incentives for R&D are available for business. Several actors, such as the Agency for Science, Innovation and Technology (MITA), the Lithuanian Research Council (LMT), the European Social Fund Agency (ESFA), the Lithuanian Business Support Agency (LVPA) and the Central Project Management Agency (CPVA), provide R&D funding. The Strategic Council for R&D and Innovation was set up in 2013 to coordinate R&I policies at strategic level.

The economic crisis has not had a major impact on public R&I funding in Lithuania, although there was a slight decrease in GERD during 2009-2010. The majority of R&I funding comes from the EU structural funds based on multiannual planning. The authorities have set a national R&D target of 1.9% of the national GDP/R&D intensity in 2020, of which 0.9% should be contributed by business investments. The stable low-medium technology dominated structure of private knowledge demand, low numbers of newly created knowledge-intensive companies and a low rate of entrepreneurship have so far made it difficult to reach the national commitment to the R&D target, especially on the private side. The main knowledge producers in the Lithuanian R&I system are the universities along with a few government research institutes. R&I funding indicators demonstrated positive trends during the last four years - total GERD in Lithuania increased by more than €100m, the Business enterprise R&D expenditure (BERD) as a percentage of total GDP increased to 0.26% in 2013 (an increase of €30m euros in absolute figures). However, the rate of change is too slow to bridge the gap. The contrast in terms of the EU average is sharp: Lithuania's BERD per capita is only 8%, GERD per capita – only 20% of the EU28 average. The investments undertaken in enhancing R&D capabilities thus have not led so far to a significant change in how companies compete in international markets. According to the Innovation Union Scoreboard (IUS) 2014, Lithuania scores low in almost all R&I performance indicators, except for the R&D expenditure in the public sector, the numbers of tertiary graduates, and non-R&D innovation expenditure.

In summary, the main structural challenges facing Lithuania largely remain as discussed by Paliokaitė (2014a):

1. *Private sector R&I capacity building: up the 'competence ladder'.* The key mid- to long-term challenge for Lithuania, instead of focusing on few existing innovators, is to promote the structural change of economy by providing transformation agenda for diversification of existing (also traditional) sectors and transition to new knowledge based activities. A more tailor-made approach to the R&I capacity building is needed taking into account that the current capacity levels and the potential to move up in the 'competence ladder') largely differ within the target groups.
2. *Commercialisation of public sector research results: entrepreneurial culture and technology transfer.* Most of Lithuania's universities have limited experiences with, capacities and motivation for patenting, licensing, start-up companies and other commercialisation efforts. The limited purchase of R&D results from universities is an indication for this weakness. The science 'valleys' were expected to strengthen the links between universities, PROs and businesses, however most of funds are invested in buildings and laboratories, while the scale of support for professional innovation services, IPR rights and joint research projects is low. An innovation culture and skills in universities and institutes need to be urgently developed. The existing R&D services network has to be better exploited.
3. *Mainstreaming internationalisation.* The public R&I system can be characterised as rather closed with limited institutional incentives and targets for internationalisation. It is unfortunate given the current quality of Lithuanian R&D and few niches of international science excellence, as well as the lack of qualified human resources at both public and private sectors. To benefit more from transnational R&I collaboration today's general declaration of importance of international collaboration should be replaced by more strategic R&I internationalisation policy, including respective positioning, target setting and incentives at the national level. In line with that all national R&I measures should include relevant international dimension, stimulate partnerships, open up for international partners and clusters, and design smart talent attraction policies.
4. *Reduce R&I policy and governance fragmentation and improve policy capacities*. Key remaining weaknesses are (i) fragmentation of strategies and institutions, failure to leverage different funds and create synergies between measures, lack of systemic coordination and strategic policy intelligence capacities, and (ii) process-oriented 'administration of funds' *vs* partnership-based programme management and project pipeline building. This challenge is critical when considering the implementation of the smart specialisation policies. To tap the potential of smart specialisation, public authorities and implementation agencies will need to behave more like accelerators, brokering new connections in the economy, and moving beyond the circle of 'usual suspects', both in terms of stakeholders involved and R&I activities concerned.

In 2014, the process of preparation for the 2015-2020 period has gained acceleration and many of the new and continued policy routes are framed by the Operational Programme for 2014-2020 approved in September 2014 (as previously, the EU structural funds will

remain the key funding source for R&I policy). The process of defining the national R&I priorities for smart specialisation was finalised in Spring 2014. The six broader priority areas, each with their 2-4 specialisations - thematic priorities were approved by the Government. In April 2014 the Lithuanian Government also approved the Programme on the Implementation of the R&I Priority Areas and Their Priorities. This Programme sets out the Lithuanian smart specialisation priority areas and their priorities and discusses some elements of the implementation and monitoring instruments. The Operational Programme provides that the 2007-2013 policy mix will be largely continued, with some new measures, e.g. innovative and pre-commercial public procurement, support for product validation and integration into the European infrastructures. Continuity ensures stability of R&I policies. On the other hand, by the end of 2014 it was not entirely clear how the weaknesses of the previous period will be solved, e.g. how the 'joint initiatives' provided in the Programme on the Implementation of the R&I Priority Areas and Their Priorities will be designed and realigned with clusters policies, if/how it is intended to invest into the entrepreneurial discovery processes, how the public-private or business-to-business collaboration platforms will be facilitated, etc. Moreover, it is a huge challenge ahead for Lithuania to adjust its governance to fit with the new challenges for the successful implementation of smart specialisation.

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1. Overview of the R&I system

1.1 Lithuania in the European RDI landscape

Lithuania is a small country with less than 0.6% of the total EU28 population (almost 3m inhabitants in 2013[1]). The country's economy experienced the European Union's second-worst recession in 2009, when real GDP per capita fell by 14% compared to 2008 and stood almost 70% below the EU28 average (€6,900 per inhabitant). During 2010-2013 the Lithuania's economy was one of the fastest growing in the EU: the real GDP on average grew by 3.5% (3.3% in 2013, 2.9% in 2014).

Since joining the EU, R&I policy has rapidly grown in importance. According to the 'National Development Programme 2014-2020' issued in 2012, Lithuanian authorities have set a national R&D target: R&D intensity in Lithuania should account for 1.9% of the national GDP in 2020, of which 0.9% should be contributed by private (business) investment. The Lithuanian Progress Strategy 2030 foresees that Lithuania should be 15th in the EU27 according to BERD/GDP figures by 2020, and 10th – by 2030. The stable low-medium tech dominated structure of private knowledge demand and low absorptive capacities of indigenous companies have so far made it difficult to reach the national commitment to the target, especially on the private side. The turnover from innovation reached a peak in 2006 (12.4%) and since then was decreasing (6.6% in 2010). Lithuania's GERD per capita fluctuated within 14-21% of EU28 average during 2009-2013. R&I funding indicators demonstrated positive trends during the last four years, but the rate of change is too slow to bridge the gap. Total GERD in Lithuania increased by more than €100m over 2009 - 2013. The Business enterprise R&D expenditure (BERD) as a percentage of total GDP increased from 0.20% in 2009 to 0.24% in 2013 (an increase of €30m euros in absolute figures). The total intramural Government R&D expenditure (GOVERD) fell from 0.44% in 2009 to 0.33% of the total GDP in 2013 (government funds for R&D decreased by €2.9m in absolute terms).

1.2 Main features of the R&I system

The Lithuanian R&I system is mainly funded by the public sector as the majority of R&I funding comes from the EU structural funds. The public sector funds 56% of all R&D performed (government - 53%, high education 3%). Business enterprise sector funds only 31% of all R&D performed. The rest of R&D is funded from abroad (13%) or the private non-profit sector (0.3%).

The 14 State universities form the backbone of the Lithuanian research system (remaining 9 private universities are not focused on R&D). The majority of governmental research institutes merged with the State universities in 2009-2011. The higher education sector is the main R&D performer: HERD accounted for 54.74% of GERD in 2013. The government sector in 2012 performed roughly 19.84% of all R&D. The share of R&D performed by the Business sector in 2013 constituted 25.42% of all R&D in the country. In terms of economic specialisation, Lithuania remains a country of predominantly traditional economic sectors (transport and logistics, food and beverages, textile, wood and furniture),

[1] If not indicated otherwise, the source is Eurostat [12-2014].

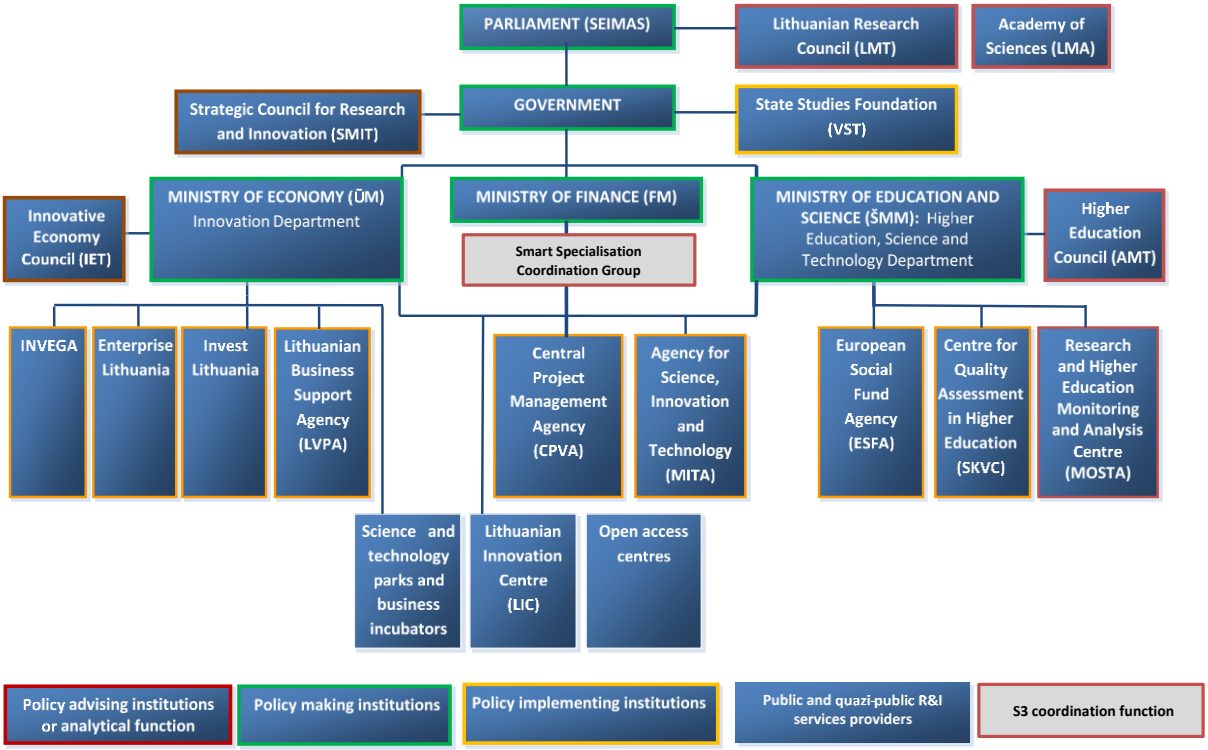
that so far have not exhibited high investments in R&D. Medium and high-tech industry and knowledge intensive services are the principal R&D investment sectors. The biggest share of private R&D investments in Lithuania in 2012 was made by the scientific research and development sector (33% of total business R&D investments), manufacture of fabricated metal, computer, electronic and optical products (13%), manufacture of chemicals and chemical products (12%), human health and social work activities (8%), computer programming, consultancy and related activities (8%). The private sector research community is dominated by small and medium sized high tech indigenous firms. Although the majority of FDI is attracted into the domestically oriented services and infrastructure sectors and export oriented cost-effective manufacturing functions, there are also several encouraging success stories in how to exploit FDI to generate new knowledge-based growth areas, notably in the pharmaceuticals and biotechnology sectors. Investments of ThermoFisher Scientific, Teva, MOOG Medical and Valeant over 2006-2013 have made Lithuania an emerging hotspot for the life sciences in Central and Eastern Europe.

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

The two *principal governing bodies,* shaping R&D and innovation policy in Lithuania, are the Ministry of Economy (ŪM), which is responsible for innovation policy, and the Ministry of Education and Science (ŠMM), responsible for higher education and (mainly public) R&D policy. For a small country as Lithuania the institutional system for the implementation of research and innovation policy is rather fragmented. The five main agencies (MITA, LVPA, ESFA, LMT, CPVA; see Figure 1 below) are responsible for funding of research and innovation. The Lithuanian Research Council (LMT) serves as an advisory body to the Seimas (the Parliament) and the Government. Changes to the legal base in 2008 gave the LMT the status of a permanently functioning agency responsible for the competitive funding of research programmes. The Research and Higher Education Monitoring and Analysis Centre (MOSTA) is an analytical and advisory body to the Ministry of Education and Science.

Since mid-2009, there have been considerable changes in the innovation governance system, especially the institutional set-up and strategic policy documents. The priority of establishing the creative and knowledge-based economy was placed high on the political agenda, which resulted in a number of strategies and planning documents. The Lithuanian Innovation Strategy was adopted in 2010, extending the definition of innovation by including social, customer-oriented, non-technological, demand-oriented, and public innovation. The Strategy was updated in December 2013 into the Lithuanian Innovation Promotion Programme 2014-2020. A large number of other strategic documents were adopted during 2012-2013 (see table below). However, ambitions to expand or re-align the innovation policy mix or to strengthen the institutional capacity to implement and formulate policy (starting with newly established MITA) remained constrained due to the financial crisis (limited ability to introduce new measures) and dependence on the SF Operational Programmes 2007-2013 approved before 2009.

Figure 1 Overview of Lithuania's research and innovation system governance structure



Source: developed by author based on Paliokaitė (2014a)

The weak effectiveness (see e.g. Ministry of Education and Science, 2011) gave impetus for the extensive public R&D and higher education sector reform with a re-focus on R&D and quality of studies. The reform gained acceleration in 2009-2010 with the approval of a new Law on Research and Studies: student vouchers[2], performance based research funding and peer review based external evaluation of research institutes were introduced; network of research institutes optimised; HEIs gained full autonomy, and the governance of HEIs was under reform. One of the key goals of the current Government that took office after the October 2012 elections is to abolish the system of 'student vouchers' by updating the existing Law on Research and Studies (planned in 2015).

In April 2010, the Government established the Agency for Science, Innovation and Technology (MITA) on the basis of the previously existing Agency for International Science and Technology Development Programmes. The Board of MITA is comprised of both ministries responsible for R&I and the Ministry of Finance. It was expected that corporate R&D and innovation support related measures will be gradually transferred to MITA from other agencies (e.g. Lithuanian Business Support Agency - LVPA) before 2015, but this did not happen.

The years 2013-2014 saw preparation for the new 2014-2020 period with continued dependence on the EU structural assistance.

[2] According to the voucher based funding system, student' decisions to choose particular HEIs and programme determine the amount of funding the HEI receives from the Government.

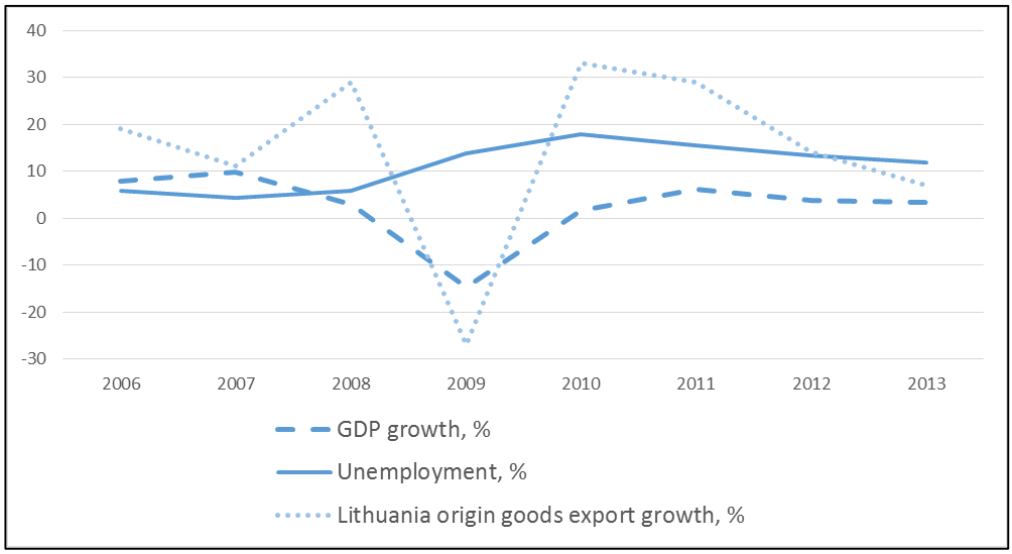
Main Changes in 2009
Establishment of the Innovation and Knowledge Society Department in the Ministry of Economy, and the Technology and Innovations Division in the Ministry of Education and Science. *New Law on Research and Studies.*
Main Changes in 2010
MITA created *Lithuanian Innovation Strategy 2010-2020.* *Implementation of the higher education reform (student voucher, autonomy of HEIs, merging of the research institutes etc.)*
Main changes in 2011
-
Main changes in 2012
Concept of the Establishment and Development of Integrated Science, Studies and Business Centres (Valleys) updated. *National Development Strategy "Lithuania 2030" approved.* *National Development Strategy 2014-2020 approved.*
Main Changes in 2013
Strategic Council for R&D and Innovation established. *Approval of the smart specialisation priority areas and their specific priorities.* *Lithuanian Innovation Strategy 2010-2020 updated into the Lithuanian Innovation Promotion Programme 2014-2020.*
Main changes in 2014
Approval of the Operational Programme for 2014-2020. *Approval of the R&D and Innovation priority areas and their priorities implementation Programme.*

2. Recent Developments in Research and Innovation Policy and systems

2.1 National economic and political context

The Lithuanian economy continues to recover after the peak of the crisis in 2009 recording stable growth of 3.8% in 2012, 3.3% in 2013, and 2.9% in 2014. The economic recovery, however, is not sufficiently large to spur job creation and the level of unemployment remained 11.4% at mid-2014. The crisis clearly slowed Lithuania's structural change towards technology-driven industries while favouring capital and labour intensive industries. Due to capital shortage industry was reluctant in investing. The decline in investment in 2012 shows that only a few companies raised their production by upgrading their technologies or implementing innovations, despite the inflow of EU funds for technology upgrading (Paliokaitė and Kubo, 2013).

Figure 2 Key indicators of Lithuania's economy development, 2006-2013



Source: Eurostat, 2014.

The significant growth of domestic demand in 2014 was stimulated by the recovering labour market and increasing wages, which are growing much more than prices. The positive effect of domestic demand was felt by almost all economic activities: construction is particularly intensifying, real estate activities were expanding, manufacturing and trade were growing. However, risks to sustainable economic development have noticeably increased during 2014. Economic development will be negatively affected by trade restrictions with Russia. The restrictions, enforced in August 2014, are applied to nearly a fifth of Lithuania's exports (including re-exported goods) to Russia. The annual exports of products, which are currently subject to the restrictions on trade, to Russia amount to more than €0.9b, or around 4% of Lithuania's total exports of goods. According to the Lithuanian Central Bank, the expectations of economic agents significantly deteriorated even before the trade restrictions with Russia came into force. This negatively affects economic development: households are encouraged to limit expenditure, while enterprises — to postpone investment projects and hiring decisions. Direct negative effect will be felt in agriculture, food industry and transport sector. Other negative factors relate to the

stagnating key Lithuanian export markets in the EU. Lithuania's Central Bank lowered its GDP growth projection for 2015 is 3.3% (Lietuvos bankas, 2014).

Lithuania adopted the single euro currency as of January 1, 2015.

2.2 National R&I strategies and policies

The two principal governing bodies, shaping R&D and innovation policy in Lithuania, are the Ministry of Economy (ŪM), which is responsible for innovation policy, and the Ministry of Education and Science (ŠMM), responsible for higher education and (mainly public) R&D policy. For a small country as Lithuania the institutional system for the implementation of research and innovation policy is rather fragmented. The five main agencies (MITA, LVPA, ESFA, LMT, CPVA) are responsible for funding of research and innovation, and several other institutions are responsible for regulating the field and/or providing specific services. The two responsible ministries have long been criticized for not coordinating their R&I related activities (World Bank, 2003; Paliokaitė et al, 2011; Paliokaitė, 2009, among others).

The Concept of the Establishment and Development of Integrated Science, Studies and Business Centres (Valleys) approved in late 2012 was a basis for the establishment of a new R&I policy coordinating body – the Strategic Council for Research, Development and Innovation (the Council). The Council was approved in May 2013 by the Prime Minister of Lithuania. Its main purpose lies in considering and providing the Government and governmental agencies with conclusions and recommendations for the R&I policy development and implementation in all economic sectors. Currently, the Council's centre of attention is warranting and guaranteeing smooth implementation of the Valleys concept in practice. This Council consists of 25 members - the high(est) positions being held by representatives of the main stakeholders. Representatives are from the ministries and agencies, higher education and research institutions, associated business structures and independent experts. The Council is chaired by the Prime Minister of Lithuania. So far much progress in coordinating the R&I policy in Lithuania has not been reached.

Lithuania does not have a single R&I strategy, rather there are several strategies and programmes in the field of R&I. The Ministry of Economy launched an update of the broad-based Lithuanian Innovation Strategy for 2010-2020. The new strategic document in the form of Lithuanian Innovation Development Programme for 2014-2020 was approved by the Government in December 2013. The new Programme was not preceded by an extensive analysis of strengths and weaknesses, or a participatory process of stakeholder engagement, but the formal requirements for strategic planning documents were met. The strategic aim of the Programme is to promote Lithuania's global competitiveness by establishing an effective innovation system. Also the Programme sets four specific objectives: 1) to educate innovative society by developing new knowledge and its application. The main goal is to properly use the intellectual potential and to promote researchers; 2) to increase business innovation potential by promoting business R&D investment; 3) to promote science-business collaboration, clusters development and global cooperation; 4) to establish an effective innovation policy and to foster public sector innovations.

The four key long-term and midterm policy documents were introduced or revised in 2012: the National Progress Strategy 'Lithuania 2030', the National Progress Programme for Lithuania for the period 2014-2020 (NPP), the Programme for Development of Studies and

R&D for 2013-2020, and the updated Concept of the Establishment and Development of Integrated Science, Studies and Business Centres (Valleys). In April 2014 the Lithuanian Government also approved the Programme on the Implementation of the R&I Priority Areas and Their Priorities. This Programme sets out the Lithuanian smart specialisation priority areas and their priorities and discusses some elements of the implementation and monitoring instruments. For example, the Programme provides that the priorities can be reviewed in 2017-2020, sets out the principles of coordination and monitoring, for example, provides that a Coordinating Group formed of key stakeholders will be established to monitor and coordinate the implementation of the priorities. More on Lithuanian smart specialisation is discussed in sub-chapter 2.6.

Overall, there remains large fragmentation of policy institutions and policy documents. Some of these documents (for example, the Innovation Development Programme 2014-2020) encompass research, innovation and education aspects, and some treat them separately (for example, the Programme for Development of Studies and R&D for 2013-2020 relates to public R&D and higher education, which also addresses frontier science, i.e. basic research). There is also an ongoing discussion on the update of the Research and Studies Law (led by the Ministry of Education and Science), and the creation of the new Law on Innovation Development (led by the Ministry of Economy).

The Operational Programme for 2014-2020, approved in September 2014, sets out the financial instruments and, along other investments, indicates investments into R&I infrastructures. It is expected that the new financial instruments and the 20 smart specialisation priorities will be implemented starting from 2015, while the year 2014 generally saw continuation of the 2007-2013 policy mix, which is also reported below. The main policy measures (R&I programmes) are listed in Table 6, sub-chapter 2.5.3. There have not been new measures since 2012. The new policy mix 2015-2020 will be reported in the R&I Report for 2015.

As noted, Lithuania has approved 20 smart specialisation (R&I) priorities, which will be implemented starting from 2015. They are well aligned with the societal challenges identified in the Horizon 2020.

Clearly defined thematic funding comprises less than 10% of the total R&I funding in the 2007-2013 policy mix. Although there are no official or publicly available calculations on the ratio between generic and thematic R&I funding, this ratio could be 50/50 if the EU SF support granted for the development of research infrastructures in thematic fields (science 'valleys') and the 12 national complex programmes is considered. The four R&D fields that received the highest amount of funding between 2002 and 2012 (in order of priority): Biotechnologies, bio pharmacy and medicine; Nano, laser, electrical and optical technologies; Food and agriculture; ICT. By 2014 Lithuania approved six new priority areas and 20 'specific priorities' within the selected broader priority areas (see Table above). These priorities will guide the Structural funds investments into R&I over 2014-2020.

Table 1: Lithuania's smart specialisation priorities and societal challenges addressed by Horizon 2020

Horizon 2020 priorities	LT smart specialisation priorities
Health, demographic change and wellbeing	Priority area 'Health technologies and biotechnology': • Molecular technologies for medicine and biopharmacy. • Intelligent applied technologies for personal and public health. • Advanced medical engineering for early diagnostics and treatment.
Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy	Priority area 'Agroinnovation and food technologies': • Safer food. • Functional food. • Innovative development, improvement and processing of bioresources (biorefinery).
Secure, clean and efficient energy	Priority area 'Energy and sustainable environment': • Smart systems for generators, grids and users energy efficiency, diagnosis, monitoring, accounting and management. • Energy and fuel production from biomass or waste, storage and disposal of waste. • Solar energy equipment and their use for power, heat and cool production.
Smart, green and integrated transport	Priority area 'Transport, logistics and ICT': • Intelligent transport systems and ICT. • Models/technologies for management of the international transport corridors and integration of different types of transport.
Climate action, environment, resource efficiency and raw materials	Priority area 'Energy and sustainable environment': • Smart low energy buildings development and maintenance technology – digital construction.
Europe in a changing world - inclusive, innovative and reflective societies	Priority area 'Inclusive and creative society': • Modern learning technologies and processes. • Technologies and processes for breakthrough innovations.
Secure societies - protecting freedom and security of Europe and its citizens	-
	Priority area 'New processes, materials and technologies for industry': • Photonic and laser technologies. • Functional materials and coatings. • Construction and composite materials. • Flexible technological systems for product design and manufacturing. Priority area 'Transport, logistics and ICT': • Technologies for developing advanced e-content and information interoperability. • Solutions and services for ICT infrastructure and cloud computing.

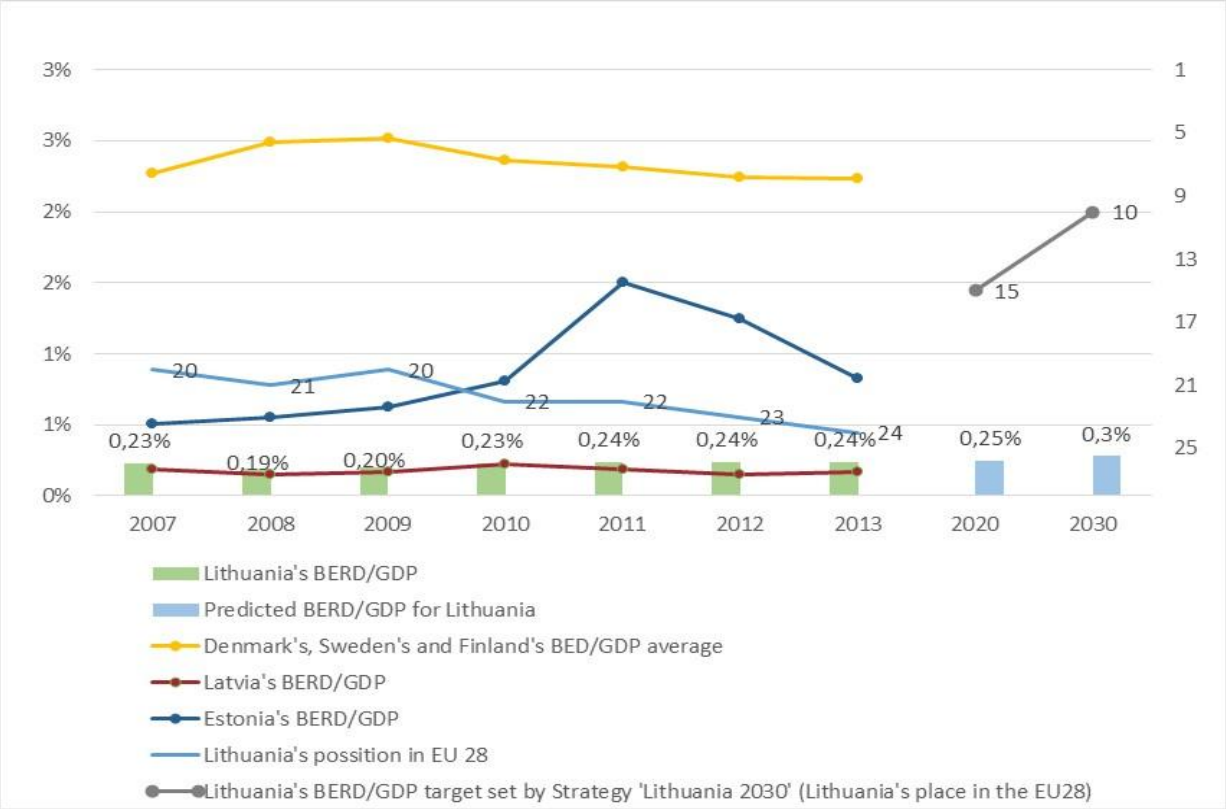
Source: compiled by the author

2.3 National Reform Programmes 2013 and 2014

The National Reform Programmes 2013 and 2014 set out one target with R&I relevance - the Gross domestic expenditure on R&D (GERD) should reach 1.9% of GDP by 2020, and BERD should at least reach 0.9% of GDP. Although the R&I funding indicators demonstrated positive trends during the last three years, these targets will not be met if the rate of progress remains the same. The key issue is stagnating business R&D expenditure (BERD) as a percentage of total GDP, which increased from 0.20% in 2009 to

0.24% in 2013 (no change since 2011). Lithuania lags substantially behind the leaders in innovation (e.g. the Scandinavian countries), and some of the neighbours (see Figure below).

Figure 3 Business expenditure on R&D as % of GDP at 2007-2013, and projections for 2020, 2030



Source: Eurostat, 2014; own projections. 2020 and 2030 forecast calculated, assuming that the rate of change will remain the same as during 2007-2013.

2.4 Policy developments related to Council Country Specific Recommendations

Not applicable.

2.5 Funding trends

2.5.1 Funding flows

The NSRF 2014 has set the national R&D target of 1.9% of GDP by 2020, and a target of 1.25% by 2015. 0.9% should be contributed by private (business) investment. The Lithuanian Progress Strategy 2030 foresees that Lithuania should be 15th in the EU27 according to BERD/GDP figures by 2020, and 10th – by 2030 (Lithuania was 24th in 2013, according to provisional Eurostat data; the BERD/GDP ratio was lower only in three EU27 countries: Romania, Latvia and Cyprus).

R&I funding indicators demonstrated positive trends during the last four years. The intensity of R&D funding in Lithuania measured as the GERD percentage of GDP in 2013 increased by 5.6% (from 0.9% in 2012 to 0.95% in 2013). According to Eurostat data, total GERD in Lithuania increased by more than €100m over 2010 - 2013. The Business enterprise R&D expenditure (BERD) as a percentage of total GDP decreased from 0.26% in 2009 to 0.24% in 2013 (an increase of almost 30 m euro in absolute figures). - R&D expenditure in all sectors funded by government sector fell from 0.44% in 2009 to 0.33% of GDP in 2013 (a decrease of 2.9 m euro in absolute value).

In 2012, R&D expenditure funded by government sector as a percentage of GDP in Lithuania (0.36% or €118.455 m in total) was below the EU28 average (0.66% in 2012). Moreover, in terms of this expenditure per capita, Lithuania with €39.4 in 2012 was sharply below the EU28 average (the Eurostat's estimate is €174.6 per inhabitant in 2012[3]). The contrast in terms of BERD was much sharper: Lithuania's BERD (0.24% of total GDP) as a percentage of total GDP in 2013 was only 19% of the EU28 average (1.29% of the total GDP) in 2013). The per capita figure for BERD was even more pronounced: €28.4 per inhabitant in Lithuania compared to €343.8 per inhabitant on average in the EU28 in 2013. In terms of GERD per capita, in 2013 Lithuania (with €111.8 per inhabitant) is only above Cyprus (€99.4), Poland (€89.2), Croatia (€83.2), Latvia (€68.9), Bulgaria (€36.6) and Romania (€27.9) and differs significantly from the EU28 average (€539.2). In summary, if the current trend continues the BERD/GDP targets for 2020 or 2030 will not be met as depicted by Figure 2 above.

Overall, the 2009-2011 economic crisis has had a slight impact on public R&I funding in Lithuania (there was a decrease of GERD: €258m in 2008, €223m in 2009, € 220m in 2010, €283m in 2011), but the key funding sources and plans generally remained unchanged. The majority of R&I funding comes from the EU structural funds based on multiannual planning. Hence, the research and innovation budgets were 'secured' in 2010–2014.

As noted, the current R&I policy mix in Lithuania is mainly funded by the European Regional Development Fund (ERDF)/ European Social Fund (ESF). This funding stream constitutes up to 80-90% of the total public R&D funding (about €150-200m per year, see Table 6). Only few programmes are funded solely from the national budget, e.g. the national research programmes (total annual budget is €1.9m). Trans-national/trans-regional funding is applied to a relatively limited extent. For example the Eurostars and other programmes promoting transnational cooperation, five bilateral/multilateral research programmes (Lithuania-Latvia-China (Taiwan), Lithuania-Belarus, Lithuania-France programme 'Gilibert', Lithuania-Ukraine, and Lithuania - Switzerland programmes) are implemented (the annual budget of the five programmes is about €1m).

[3] There is no EU28 data for 2013.

Table 2: Basic indicators for R&D investments

	2009	2010	2011	2012	2013	EU28 (2013)
GDP growth rate	-14.8	1.6	6.1	3.8	3.3	0.1
GERD (% of GDP)	0.83	0.78	0.9	0.9	0.95 (provisional)	2.02 (estimate)
GERD (euro per capita)	70.2	69.9	92.6	99.3	111.8 (provisional)	539.2 (estimate
GBAORD - Total R&D appropriations (€ million)	139.22	118.049	126.216	119.613	125.639 (provisional)	90,505.611
R&D funded by Business Enterprise Sector (% of GDP)	0.26	0.25	0.26	0.24	0.26 (provisional)	N/A
R&D funded by Private non-profit	0.637	0.406	0.434	0.463	2.491 (provisional)	N/A
R&D funded from abroad (% of GDP)	0.11	0.16	0.26	0.3	0.35 (provisional)	N/A
R&D related FDI	N/A	N/A	N/A	N/A	N/A	N/A
R&D performed by HEIs (% of GERD)	52.2	53.06	54.21	53.49)	54.74 (provisional)	N/A
R&D performed by Government Sector (% of GERD)	23.41	17.54	19.58	19.58)	19.84 (provisional)	N/A
R&D performed by Business Enterprise Sector (% of GERD)	24.39	29.40	26.22	26.93	25.42 (provisional)	N/A
Share of project vs. / institutional public funding for R&D	N/A	N/A	N/A	N/A	24% /76%	N/A
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	2.1	1.8	1.7	1.8	1.8	5.6
Employment in knowledge-intensive service sectors as share of total employment	32.8	34.2	34	33.6	33.1	39.2
Turnover from Innovation as % of total turnover	N/A	6.6	N/A	N/A	N/A	N/A

2.5.2 Project vs. institutional allocation of public funding

Institutional funding

The Government decision (adopted in 2009 and subsequently amended in 2010 and 2012) on the method for allocation of budgetary appropriations for R&D for public higher education and research institutions stipulated that higher share of institutional funding should be linked to research performance. The Decision established that 40% in 2010 and 50% in 2011 and subsequent years of institutional funding will be allocated to public HEIs and research institutions on the basis of results of assessment of R&D activities. The remaining 50% as of 2011 are allocated on the basis of "normative number of staff" that is approved for each institution by the decree of Minister of Education and Research.

The "competitive" half of institutional funding from 2012 onwards is reallocated every three years taking into consideration the results of assessment of R&D activities. The ministerial decree adopted in November 2012 stipulates that assessment of R&D activities is based on four criteria: a) funding received from participation in international research projects; b) funding received from R&D contracts with business companies; c) public funding from participation in joint R&D projects with business companies (funding of business subcontracts); d) results of evaluation of research production. The latter focuses on publications and patents and is annually carried out by LMT in accordance with the principles of international peer review. These criteria are given unequal weights for assessment of R&D activities in different fields of science. For example, results of evaluation of research production are given the highest weight in social sciences and humanities (80%) as well as physical and biomedical sciences (55%), as indicated by Table 4. Assessment of R&D activities in other fields of science mostly depends on institutions' capacities to attract funding from privately and internationally funded R&D projects. It was expected that linking public institutional funding with the capacity to attract additional funding should create incentives for institutions to increase the relevance of their research programmes.

Table 3: Institutional funding formula per field of science

	Humanities	Social sciences	Natural sciences	Biomedical sciences	Agricultural sciences	Technology sciences
Share of total institutional funding, of which:	14%	11%	25%	19%	6%	21%
a. Share according to funding received from participation in international research projects	5%	10%	15%	15%	15%	20%
b. Share according to funding received from R&D contracts with business companies	10%	5%	25%	25%	35%	30%
c. Public funding for business subcontracts / joint R&D projects with business companies	5%	5%	5%	5%	10%	15%
d. Share according to the results of evaluation of research production	80%	80%	55%	55%	40%	35%

Source: Government's Regulation No. 597 of 17-06-2009 on the Procedures for allocating State budget funds for research and (social, cultural) development and artistic activities of public education and research institutions. Latest amended version valid as of June 2014.

NB: 4% of total institutional funding is allocated for art activities (public institutional art funding).

The implementation of the institutional funding mechanisms has been amended several times in the last 5 years, therefore it is too early to discuss the consistency and efficiency of implementation.

Project R&D funding

After the heavy public research and education funding and the governance reforms carried out in 2008-2011 (see Erawatch country reports for 2010-2012), the share of project funding of research has increased. The share of SF funding has increased in 2013-2014 (see Tables 2 and 3), therefore the share of project funding has increased as well.

The Law on Higher Education and Research (adopted in 2009) and accompanying bylaws led to considerable increase in the share of funds that are allocated through competitive procedures. As of 2009 LMT acquired the functions of a funding agency. It provides grants to research projects through competitive calls for proposals that are subject to peer review. The funding is allocated through a number of programmes, "Promotion of High-Level International Scientific Research" is one of the latest measures approved in 2012. The main programmes for the allocation of project funding for public sector researchers are listed in Table 5.

Table 4: Public R&D project funding programmes (amount paid per year, €m)

Measure code	Agency	Name of the measure	2009	2010	2011	2012	2013
VP1-3.1-ŠMM-01-V	LMT	Support of scientists and researchers mobility and students scientific work	0,86	1,63	6,23	7,51	9,22
VP1-3.1-ŠMM-02-V	ESFA	Improvement of the Qualifications and Competencies of Scientists and Researchers (scientific databases, e-documents)	1,74	5,51	2,34	2,50	5,09
VP1-3.1-ŠMM-07-K	LMT	Support to the scientific work of scientists and other researchers (Global Grant)	-	-	2,32	4,53	10,72
VP1-3.1-ŠMM-08-K	LMT	R&D programmes (national complex programmes)	-	-	-	2,18	3,42
VP1-3.1-ŠMM-10-V	LMT	International level research	-	-	-	0,09	6,78
VP2-1.1-ŠMM-06-V	LMT	National research programmes and other high level research	-	-	-	0,11	2,64

Source: www.esparama.lt

The peer-review process in allocating competitive research funds is mainly organized and managed by Research Council of Lithuania (LMT). It is based on the scientific projects project funding methodology (LMT, 2010). The peer review is applied systematically in the following areas:

a) Competitive calls for proposals for national and international research grants;

b) Evaluation of research production. The results of evaluation have an impact on institutional funding of research carried out in public HEIs and research institutions. The first evaluation was completed in 2010. Feedback from stakeholders led to modifications in assessment methodology and the most recent evaluation (focusing on research production of 2010) was completed in 2012;

c) Long term R&D programmes of public HEIs and research institutions.

The experts' selection to conduct the peer-review in LMT is based on internal LMT decisions. Experts are chosen by the LMT committees from the confidential LMT experts' database and/or other suggested experts. Explicit LMT rules for experts' selection are expected to be finalised in 2014 (e.g. it will indicate the requirement on the number of published articles in international scientific journals). In principle, the participation of international peers is not limited as experts can be any qualified researchers and specialists, Lithuanian and foreign citizens working in Lithuania or abroad. However, in practice the LMT chooses experts according to the financial value of calls. The Global Grant programme is systematically assessed by international experts (in Natural and Technical sciences international peer review covers 100 per cent of calls, while in Humanities and Social Sciences – 2/3 of calls) as it is designed to support world-class scientists and researchers' projects (Paliokaitė, 2014b). Other project experts' evaluation is organised according to calls funding amount: if a call assigns less than €29 thousand, than usually it is reviewed by local experts. In other cases LMT hires Lithuanian experts working abroad or

international experts. A majority of grant proposals are submitted in Lithuanian language (with a short summary in English), which poses linguistic barriers to participation of international reviewers. When a project grant (e.g. Global Grant programme) is considered significant, LMT asks for submission of both Lithuanian and English versions of the proposal, which facilitates the international peer-review. Another obstacle is experts' availability. Local experts usually nominate themselves to LMT, while foreign experts are approached by LMT.

In summary, the Lithuanian public bodies responsible for allocating competitive research funds apply the core principles of international peer review to a large extent, i.e. research excellence criteria are applied and the funding agencies are rigorous in their peer review procedures (Paliokaitė, 2014b). However, international experts are used on systematic basis for evaluating large research projects only by LMT and for institutional assessment of HEIs, but not by other agencies that provide project funding for research and innovation. Currently, the cost of hiring international peer reviewers is considered too high. Also, using Lithuanian language in the forms and applications in most cases preclude using international peer reviewers for evaluating projects (Paliokaitė, 2014b).

Institutional versus project funding for public R&D

In 2013, the institutional funding for public HEI and research centres amounted[4] to approx. €60m so that €38m (62%) were allocated to R&D activities and €22m (38%) to administrative activities. Another €19m (or 24% of total budgetary appropriation for research activities) were allocated on project basis by the agencies LMT and MITA. This figure is similar to 2012, when €20m were allocated to project R&D funding. Only the national budget sources, excluding the EU structural funds, are included in these calculations.

With the EU structural funds, the project funding for public R&D constituted about €112m (65% of the total public R&D funding, excluding the public funding for business R&D), which includes State planning based funding for public R&D infrastructures (see Table 6). State planning is a funding method which falls in between institutional and competitive/project based R&D funding. The State pre-selects important infrastructure projects. In theory, best R&D infrastructures are funded, however in Lithuania it cannot be assumed that the selection of 'best' infrastructures followed the international standards of project funding (international peer review, rigorous procedures, clear selection criteria, etc.).

Other allocation mechanisms

In Lithuania, tax incentives and venture capital funds are also available (see sub-chapter 2.5.3 below).

Assessment

There remain two key challenges that are relevant for the efficient and effective functioning of the funding allocation system. First, although the availability of project funding increased in 2012-2013, the availability of R&D funding for human resources is too low compared to institutional funding and project funding for large scale R&I

[4] The data was provided by the Ministry of Education and Science.

infrastructures. In some cases universities lack human R&D resources to work with the newly purchased R&I infrastructures. Therefore, the new infrastructure cannot be fully exploited. Second, the existing institutional funding system is not effective in fostering the commercialization and entrepreneurship based culture in the universities and public research institutes. Studies reveal that the universities, research institutes and their researchers still lack motivation to commercialize research and work with industry. One negative factor is a huge teaching workload of the researchers, so they do not have time for R&D. The career system of university researchers also does not support knowledge transfer to industry – this system rather supports indicators such as teaching hours, academic papers etc. (see Chapter 4.4).

2.5.3 R&I funding

When assessing the balance between research funding and innovation funding, this Report, based on Paliokaitė (2014a) takes a stance that there are three groups of measures:

a) Those indirectly contributing to innovation (e.g. access to finance for business development, facilitation of organisational innovations in business);

b) Direct funding for R&D and innovation (further on – R&I) with the specific aim to facilitate development of innovative products and services to be later introduced into the market;

c) Direct funding for research activities not necessarily aimed for commercialization, including mostly basic research activities of the public sector organisations (universities and research institutes).

Table 6 below presents an overview of the budgets that are related to research and innovation (in a broad sense), based on the latest data available. This picture more or less represents overall balance of budgets dedicated to specific innovation and growth related policy aims. Only a small part of budgets are annually dedicated directly for business R&I activities. Moreover, these measures over 2007-2013 period mainly focused on the "research" part of the R&D activities in business and did not cover the full innovation development cycle, for example, support for development and validation of prototypes was not available. Lessons were learnt and the measures for SME innovation designed for the 2014-2020 period are covering the full innovation cycle from idea to the market (including prototype development, pilot lines, demonstration, validation, etc.).

A substantial part of funds (36.32% in 2011) over 2007-2013 were annually dedicated for (basic/fundamental) research activities and related infrastructure upgrade mainly in the public sector.

In Lithuania, tax incentives are available for companies performing R&D:

- The corporate profit tax incentive for R&D provides that expenses incurred by companies carrying out R&D projects can be deducted from taxable income three times. Long-term assets used in the R&D activities can be depreciated within two years. All investments into R&D disregarding the type of company or the amount of the investment qualify.
- Corporate profit tax incentive for investments into new technologies provides that companies carrying out investments into new technologies can reduce their taxable

profit by up to 50%. Investment expenses exceeding this sum can be postponed to later, consecutive tax periods (up to five years).

However, only a very small proportion of companies have used these incentives (0.79% of companies in the high-medium high technology sector and knowledge intensive services in 2012). Therefore, tax incentives do not play a major part in the overall policy mix, compared to subsidies or venture capital.

Micro-crediting and State guarantees funds were mainly available during the economic crisis (2009-2010). The 'Controlling fund' aims to improve SME access to external funding sources (micro crediting up to €25 000; venture capital fund investments; guarantees for SME financial obligations), while 'Partial compensation of SME credit interests' (budget of both is €274m) aims to ease the burden of financial obligations by partially compensating investment credit interests for SMEs and to support the development of enterprises. In 2010 the risk capital fund "Business Angels Fund I" was founded by the European Investment Fund for investments into innovative and export oriented companies in Lithuania. The establishment Agreement of the Business Angels Fund is signed under the project "JEREMIE the controlling fund". As of early 2013, Lithuania introduced new venture capital measures aiming to boost investments in early stage innovative companies in Lithuania. The European Investment Fund (EIF) together with Estonia, Latvia and Lithuania launched the Baltic Innovation Fund (BIF) - a "fund of funds" that will invest €100m into the private equity and venture capital funds operating in the Baltic countries. It is expected to encourage risk capital investments in SMEs. EIF and Practica Capital established an initial stage venture capital fund (Practica Seed Capital Fund, €6m) and Practical Venture Capital Fund (€15.7m) that will invest in Lithuanian SMEs (see sub-chapter 4.6). The Ministry of Economy in partnership with INVEGA planned to launch two new seed and pre-seed capital measures for innovative SMEs in 2013, however there were legal obstacles (the chosen approach was not approved by the Public Procurement Office).

Table 5: Funds transferred to the beneficiaries, 2013

Classification	**Measures**	**€m**	**% of total funds**
R&I FUNDING Target group – business companies. Managing agencies: LVPA, MITA			
Innovation-friendly environment	• Innovation support services and investments into institutional/absorptive capacity (Inogeb LT group of measures), • Assistant-2 (construction of technology and art incubators)	14.08	7.32%
Technology and knowledge transfer and cluster cooperation	• Inocluster LT/ LT+, R&D thematic networks and associations • Innovation vouchers	5.92	3.08%
R&D in firms	• Idea LT, Intellect LT, LT+	15.21	7.91%
INDIRECT INNOVATION FUNDING Target group – business companies. Managing agencies: LVPA, INVEGA			
Creation and growth of enterprises (SMEs competitiveness,	• Leader LT (production technology acquisition/upgrade in firms);	54.70	28.44%

Classification	Measures	€m	% of total funds
Economy Development OP, Priority 2) NB: this group of measures is **not** specifically designed to support R&I	• Process LT (organisational innovations); • Invest LT; Invest LT+, Invest LT-2, Assistant-3 (FDI attraction measures and development of industrial parks); • Controlling fund, Compensation of SMEs' credit interests, and Guarantees fund (general access to finance for business, financial engineering instruments)		
Demand-side interventions	• E-business LT (facilitation of e-commerce)	1.87	0.97%
RESEARCH FUNDING Target group – mainly HEIs and PROs and their researchers. Managing agencies: LMT, CPVA, ESFA, MITA			
R&D Infrastructure	• Economy Growth OP, Priority 1, investments into the development and upgrade of research infrastructures in the science, studies and business 'valleys'	50.63	26.33%
National and international programmes for (mainly) basic research	• Six National Research Programmes, • Programme of Industrial Biotechnology Development in Lithuania for 2011-2013, • High Technology Development Programme for 2007-2013, • bilateral and multilateral research programmes	7.52 (2011)	3.91%
Human Resources for research	• 'Global grant', research mobility and other measures under the HR Development OP, Priority 3, including the funding for R&D governance and policy analysis, thematic networks etc.	42.40	22.05%
Total		~€192.33	100%

Source: based on Paliokaite A. (2014a), www.esparama.lt

The data suggest that the balance between direct funding for research activities and innovation activities (including R&D for innovative products development) is not productive in terms of focus on innovative output, commercialization and growth. First, the current set of enterprise policies reinforces a general systemic tendency to favour technology absorption through capital investment over innovation. Second, policies targeting specifically R&I favour investments into public research infrastructure and centres of competence versus commercialization of public research (e.g. through spin-offs), science-business collaboration and professional technology transfer services, or even direct funding for business R&I activities. This has tended to reinforce the existing trend of low investment in R&D and innovation by business sector and 'passive' adoption of technologies developed elsewhere. Limited funds for business R&I activities can also be explained by small absorptive capacity.

As was already discussed in the previous Erawatch reports (2012-2013), the 2007-2013 policy mix tended to follow the 'linear model of innovation' perspective. It was assumed that investment in science and the 'transfer' of scientific knowledge to companies would be the key to ensure an innovation based competitive approach. This perspective lacked a clear view about the systemic nature of the innovation process and the importance of non-technological dimensions. The terminology reflected in the policy documents, measures, projects and monitoring systems focused on the supply side of knowledge and particularly on basic research. As a result, the critical parts of the innovation process related to the experimental and technological development as well as the incremental development of products and processes, and the systemic nature of innovation in general, was not captured, and key support elements for innovation development were missing. To achieve better results of innovation performance, Lithuania needs to shift the national R&I system from the current system traditionally focused on the basic science to one more inclusive of innovation (Paliokaitė and Kubo, 2013).

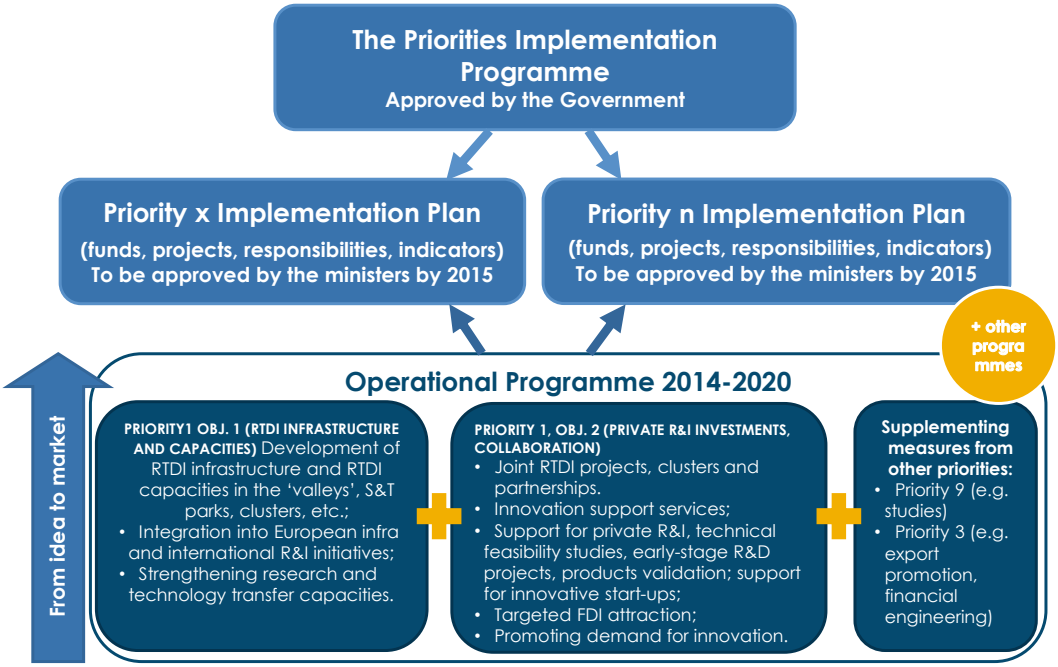
2.6 Smart Specialisation (RIS3)

The process for identifying the national R&I priorities and drafting the Smart Specialisation Strategy for 2014-2020[5] was the key analytical – consultation initiative in 2013-2014. The smart specialisation broader priority areas and their priorities approved by the Lithuanian Government in December 2013 are listed in Table 2. These priorities will be used as a background for practical implementation of national R&I and industrial policies. The approach adopted in Lithuania seeks to (1) foster interactions between sectors by (2) linking priorities with emerging opportunities and challenges and (3) focusing on measurable outcomes. Accordingly *priority area* is understood as a field of concerted actions of government, research and business community with the highest potential in responding to key emerging drivers and challenges that could have a significant effect on Lithuanian R&D and innovation system and competitiveness of the economy. *Priority* refers to the development of new output – technology or process – that has high potential to transform Lithuanian economy (Visionary Analytics et al, 2013).

Lithuania does not have a separate national level strategy for the implementation of smart specialisation – RIS3 is designed on the basis of already existing documents. Figure 3 pictures the Lithuanian RIS3 implementation structure and the key funding instruments, including ones aimed at leveraging private R&I investments.

[5] More on smart specialisation process in Lithuania available at: http://www.mosta.lt/en/smart-specialisation

Figure 4 RIS3 implementation structure: key documents and funding sources



Source: Paliokaitė (2014a).

In April 2014 the Lithuanian Government approved the Programme on the Implementation of the R&I Priority Areas and Their Priorities. Lithuania is a small country, hence it is considered as one region in this Programme and links between regional and national levels are not discussed. The Programme provides the basic principles for implementing the smart specialisation priorities, such as the rules for selecting and approving the new priorities, monitoring and review procedures, key implementing bodies and their responsibilities. The Priorities Implementation Programme also provides for the establishment of the coordinating structures, for example, a working group consisting of the key policy forming and implementing institutions. This Programme provides that specific implementation plans (specific thematic programmes) will be designed for each of the 20 smart specialisation priorities. While the Programme itself does not include a detailed consideration on financial requirements, including for structural co-funding, the priority implementation plans will design the funds allocated per each priority. These plans will discuss the topics of R&D and innovation, objectives and targets to be achieved by implementing each specific priority, as well as specific policy mixes for the implementation of the priorities. The priority implementation plans were being drafted throughout the second half of 2014. It is expected that these plans will be approved in 2015.

Funding of RIS3 implementation in Lithuania is primarily linked to the 2014-2020 Operational Programme, approved in September 2014, and its Priority 1 concerning R&I. The preliminary structure and planned group of measures of the Priority 1 of OP for 2014-2020 is depicted by Figure 3 and consists of both infrastructure and capacity building measures, innovation supply and demand side measures (e.g. pre-commercial procurement, public procurement of innovation, which will be launched in 2016-2017, according to preliminary estimates). There are plans to use the cohesion funding for 2014-2020 for integration into the European RIs, especially the ESFRI roadmap. The Operational Programme foresees financial support for the 'integration of Lithuanian R&D infrastructure

into European infrastructures, especially ESFRI, according to the Roadmap of Lithuanian research infrastructures'. More efforts could be put to the transnational cooperation within Baltic Sea Area. Collaboration with the world innovation leaders in Nordic countries could facilitate R&I policy learning, enable to achieve critical mass and wider visibility, and provide bigger test market for innovative products and services to mention just some of the possible untapped benefits. There is scope for more intensive and better coordinated transnational collaboration in developing the R&I infrastructures, especially within the Baltic Sea Region. Baltic research cooperation programmes, especially in line with the Baltic Sea Region Strategy, can be promoted.

The design effort of RIS3 implies it does not come to an end when the strategy moves on to the implementation phase. A strategy for smart specialisation should evolve and adjust to changes in economic and framework conditions, as well as to emergence of new evidence during implementation (Foray et al. 2012). It implies that, first, multiannual research and innovation agendas and priorities' review procedures should be put in place. Implementation of the priorities will unavoidably face many risks, therefore there is a need for timely and effective monitoring information on the success of the implementation progress. Some 'priorities' can fail, and new prospective fields can emerge, hence intelligence and review procedures should allow for flexibility. A process for regular review of the priority areas must be put in place, with the possibility to renew the priorities based on specific reported outcomes. Reviewing the priorities should be organised so that the support will not be discontinued too soon, nor continued so long that subsidies are wasted on non-viable priorities (Paliokaite and Kubo, 2013). The International Independent Experts Group which coordinated the smart specialisation process proposed that the implementation of S3 priorities should follow a 'stage-gate' approach where the priorities can be reviewed and funds reallocated if the priority is not viable (does not achieve the targets at some stage in the implementation process). The responsible coordinating institution should assess the risks related to priorities viability and for proposing shutting down the priorities and/or allocating the funds to other more viable or new (emerging) priorities.

The monitoring and evaluation framework of smart specialisation is provided in both the Programme on the Implementation of the R&I Priority Areas and Their Priorities (provides basic principles for monitoring and review) and the specific priorities implementation plans (will provide specific qualitative and quantitative monitoring indicators per each priority) altogether will define the smart specialisation monitoring framework. These basic principles are provided in the Programme on the Implementation of the R&I Priority Areas and Their Priorities:

- The interim evaluation (in 2017-2018) should allow for review of priorities or their implementation system.
- The ex post evaluation should be carried out (after 2020).

The continuous monitoring of the priorities should be implemented, and assigned institution (or committee, working group, etc.) should coordinate the actions and instruments implemented by numerous policy agencies. The Coordinating Group for the implementation of smart specialisation was approved in June 2014 by two ministers (of Economy and Education and Science) and consists of 15 members of various interested parties, including the viceministers of two key ministries. Two institutions (MOSTA and the Ministry of Economy) were assigned for the monitoring (i.e. data collection, analysis and

supplying the above-mentioned Coordination Group with strategic intelligence) of implementing smart specialisation.

2.7 Evaluations, consultations, foresight exercises

Various analyses and evaluation reports (Paliokaitė, 2009; Paliokaitė et al, 2011; Paliokaitė and Kubo, 2013; Technopolis Group & Ernst and Young, 2014; Visionary Analytics, 2014; Whitelegg et al., 2008, among others) in the last several years have pinpointed the lack of an effective research policy monitoring and review system, international benchmarking and ex-post evaluation tools in Lithuania. In summary, all the mentioned reports recommended to strengthen the strategic intelligence functions and R&I policy learning. The recent five year period demonstrated a shift in governmental attitude towards policy accountability and policy learning. The establishment of MOSTA under the Ministry of Education and Science in 2007 has been one of the responses to the experts' recommendations. However, the strategic intelligence on R&I in business is still limited and thus it remains a "black box". At national level, the improved Strategic Planning Methodology (2009) introduced an official requirement to evaluate all public programmes funded by the national budget at the *ex ante*, interim and *ex post* levels. However, the usage of *ex post* evaluation and international benchmarking can be further improved. Lithuanian authorities have not yet upgraded the impact evaluation mechanisms used in the innovation system from monitoring inputs and outputs to assessing outcomes. Without a methodologically rigorous evaluation system, it is difficult to say with at least some degree of confidence what has worked in the innovation system and what has not. At present, the design of the R&I policies itself poses obstacles to meaningful evaluation, as programme objectives often make it impossible to establish baselines. Moreover, while some evaluations have been conducted, most of them have not met the standards of methodological precision or included control groups, which means that they were unable to assess the actual additionality of funds spent. The wide scope and limited resources dedicated to the ex post evaluation studies do not allow application of sophisticated methods (counterfactual or theory led evaluations) or deeper insights on the impact/alternatives of each specific measure. Specific programmes are rarely evaluated separately. Often the scope of evaluations is too broad and the time resources too short to be able to apply rigorous methodologies. Most importantly, even the conclusions of otherwise useful evaluation studies have not received sufficient attention from policy makers, making the whole exercise largely futile (Paliokaite and Kubo, 2013).

The existing practices of R&I policy evaluations are mostly used for policy accountability purposes, as opposed to policy learning.

The process for identifying the national R&I priorities and drafting the Smart Specialisation Strategy for 2014-2020[6] is the key analytical consultation initiative launched in 2013 and was ongoing throughout 2014. As a result, a list of 6 broad priority areas, 20 specific priorities within those areas and their implementation roadmaps were prepared. The list of R&I priorities will be used as a background for practical implementation of national R&I and industrial policies. The 'policy roadmaps' developed for each specific priority describe targets (technologies to be developed), policy measures, technology development stages, etc. These roadmaps will become the basis for thematic R&I priority development

[6] More on smart specialisation process in Lithuania available at: http://www.mosta.lt/en/smart-specialisation

programmes. The priorities implementation plans are in progress (to be completed by early 2015). Furthermore, it is expected that the consensus-building discussions should contribute to the development of innovative partnerships between businesses and S&T and education communities. The consensus on the R&I priorities development achieved in the course of expert panels and other activities should create a platform for further concerted actions and policies that are consistent not just with national strategies but could be shared by all parties involved in their implementation.

The High Technologies Development Feasibility study was launched by the Ministry of Economy in 2014. Key conclusions of this Study (Visionary Analytics, 2014):

- In the new 2015-2020 period the policy spotlight has to move from "hard" infrastructure development to capacity strengthening and acceleration of new ideas through the innovation support services, seeking to encourage more "potential" and "new" innovators to invest into the development of new business fields, business models and products.
- The already created public (including the clusters) R&D infrastructure has to be smartly exploited by connecting all infrastructures into one professionally managed virtual R&D and innovation services network. Attention should be placed not on building more (overlapping) infrastructures, but on solving "soft" issues such as exploitation of the open access centres, science and technology parks, clusters and their infrastructures, and creation of related capacities and human resources.
- The key emerging problem is availability of skilled human resources for innovation, particularly – engineers, technologists and technology designers. Hence, a key challenge is to substantially improve education and training of skilled specialists, and to design smart talent attraction policies.
- R&D policy is dominated by basic research. The current legislation is dominated by a narrow definition of R&D activities, which reflects on the related policy measures and institutional as well as competitive R&D funding. The dominating approach portrays R&D as basic science, hence companies do not think that what they do is actually R&D (especially the D part), which means that a large proportion of R&D in business and researchers in business is not captured by the statistics because companies simply do not report it. An indication for that is the fact that for example in 2013, only about 200 companies in Lithuania applied for R&D tax incentive, and the numbers are declining year by year. One of the reasons is the strict definition of what can be considered as R&D applied by the tax authorities In order to solve this problem, it is necessary to change the approach and revise the definition of R&D in the official legislation and to fill a gap in the innovation policy implementation measures. Accordingly, it is necessary to adjust the statistics on R&D activities in business and researchers in business. The ministry of economy and MITA launched a special project on innovation statistics in 2015 to examine and improve the situation with business R&D/innovation statistics.
- Business and public research sectors collaboration will not work unless the current researchers' career system and public R&D institutional funding mechanism are changed. The current system does not encourage public sector researchers to focus on commercialising R&D results or providing R&D services for business.

- Lack of coordination has led to huge fragmentation of instruments, programmes, institutions and infrastructures. It is therefore necessary to reduce fragmentation and purify functions (for example, by merging the R&I related functions of MITA, LVPA and CPVA) and ensure better coordination (for example, by fostering exchange/internships between the institutions and strengthening the functions and secretariat of the Strategic R&D and Innovation Council).

A 4-year long project aimed at the monitoring and analysis of the integrated science, studies and business "valleys" ended in 2014. The project, coordinated by MOSTA and implemented by Technopolis Group and Ernst&Young, provided a series of recommendations on the monitoring of the „valleys", their R&D infrastructure projects and the joint research programmes, knowledge transfer programmes etc.[7]

Lithuania does not have an accepted macroeconomic model to assess R&I impact on economic growth. In 2014 MOSTA contracted two separate research studies to develop methodologies for calculating return on State's investment into R&D and higher education. The methodology on return on State's investments into R&D should also serve as the impact assessment methodology for smart specialisation. Research Assessment Exercise in Lithuania, which took place from April 2014 until April 2015 was run by MOSTA in consultation with the Research Council of Lithuania and following the methodology prepared by Technopolis Group. The key element of the exercise is international peer review that is based on broad disciplinary panels. The results are expected in 2015.

[7] More information, detailed conclusions and recommendations (in English) at: http://www.mosta.lt/en/projects/valleys-and-jrp

3. National progress towards realisation of ERA[8]

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

The developments since 2010 have paved the way for closer integration of the Lithuanian research system into ERA. However, some challenges were left to be addressed in the near future: (1) national policy efforts have not actively supported transnational cooperation and search for synergies with Framework Programmes/Horizon 2020 (2) limited incentives and targets for internationalisation; (3) limited involvement in joint research agendas; and (4) Lithuania is one of the weakest Member States in terms of the number of signed contracts (24th out of 27) and of budget share of EC contribution (26th).

The current situation analysis suggests that Lithuania has been involved unevenly into ERA-NETs. Even though there have been fragmented actions to implement joint research agendas (for example, the education and science ministers of Lithuania, Latvia and Estonia have held a meeting in 2013 discussing potential collaboration in R&D, without concrete outcomes), financial commitments to joint research agendas are rather limited and national research programmes are only implicitly aligned with research priorities pursued at ERA. The Lithuanian Ministry of Economy actively seeks participation in the international innovation programmes which support international innovation networks, especially in the Baltic Sea Region. For instance, starting with 2012, it has been acting as an administrating institution of the Green Industry Innovation Programme, conducted in cooperation with Norway.

Evaluations of research projects carried out within the framework of ERA, bilateral and trilateral programmes are performed according to the excellence and eligibility criteria in Lithuania.

There is no specific development in removing legal and other barriers to the cross-border interoperability of national programmes. The national authorities together with Latvian and Estonian authorities started discussion on coordinating their research capacities, but no visible results have been achieved. Therefore, the mainstreaming of transnational collaboration is needed. For instance, specific support mechanisms can be established to encourage Lithuanian research teams to engage further in collaboration with their European /global peers. In 2012 the Minister of Education and Science set up the guidelines that shape the procedures that regulate Lithuanian research institutions' involvement in the international RIs.

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

3.2.1 Introduction

There were 18083 researchers (8557 FTE) in Lithuania in 2013 (about 0.98% of active population). The EU28 average in 2011 was 1.05% of active population. The number of researchers increased significantly by 2.8 thousand from 2009 to 2012. Majority of

[8] This chapter benefited significantly from Paliokaitė (2014b)

researchers (88.5%) in Lithuania work in the public sector, 11.5% of researchers belong to business enterprise sector. On the other hand, some studies (e.g. Visionary Analytics, 2014) discuss that the statistics on researchers in business might be inaccurate due to the narrow definition of „researcher“ and limited incentives for business to report this data. Hence, in reality the number of researchers in business could be larger. On the positive side, Lithuania enjoys the trend of researchers getting younger (MOSTA, 2014), hence ageing of researchers is not a serious problem.

A key emerging problem for high technologies development and apparently the key bottleneck of the future is the availability of skilled human resources for innovation, particularly – engineers, technologists and technology designers. Next to high economic migration and low higher education quality, the demographic trends create a scenario where the economy increasingly lacks skilled labour force, and there is a mismatch of skills supply and demand (current and future needs of companies). Hence, a key challenge is to substantially improve education and training of skilled specialists, especially in the technology and engineering professions, and to design smart talent attraction policies (Visionary Analytics, 2014).

Historically, Lithuania had a centrally regulated system of higher education (HE). Lithuania has made some progress in creating open labour market for researchers, but there is also considerable scope for improvement. In 2009 Lithuania witnessed a major HE reform. In terms of Clark's (1983) "triangle of HE governance", the reform represents a move from a mixture of bureaucratic-academic oligarchy models towards the (quasi) market. With the view of fostering competition among higher education institutions (HEIs) reform focused on few key areas. Firstly, reform sought to introduce a quasi-market for HE by introducing a voucher-based system as a primary mean for funding HEIs. Secondly, as a result of the reform, an increasing proportion of research funding is allocated through competitive schemes. Thirdly, management structures of public universities have changed: the right to elect Rectors and make strategic decisions has shifted from Senates, comprised of members of academic community, to Councils, composed of external stakeholders and academic community. All public universities and colleges organise their work according to their Statute and guidelines set in the Law on Higher Education and Research. They are granted freedom in decision-making, the right to own property and to manage property entrusted to them by the State. With passing of the new Law on Higher Education and Research in 2009, the main decision-making body became the Council, with half of members put forward by the ministry. Private universities can be organised as public or private entities and their operations are defined by university constituent acts. Lastly, the reform aimed at reducing the scope and depth of regulation governing personnel policy, financial management, admissions and fees, introduction of new study programmes and other areas. Hence, in terms of Verhoest, Verschuere & Bouckaert (2007), the reform sought to "make managers manage" by strengthening competition and a system of incentives and "allow managers manage" by increasing managerial autonomy.

Yet, University Autonomy in Europe Scorecard (Estermann, Nokkala & Steinel, 2011) ranked the level of autonomy of Lithuanian HEIs as "medium low" in financial and academic spheres, "medium high" in organisational autonomy and "high" in staffing autonomy. In comparison to other European countries Lithuanian HEIs have particularly low autonomy in the following criteria: term of office of executive head (part of organisational autonomy), ability to keep surplus and own buildings (financial autonomy), introduction of programmes at Bachelor and Master levels and selection of quality assurance mechanisms and providers (Martinaitis et al, 2014).

The Ministry of Education and Science is currently revising the Law on Research and Studies so that some changes might take place in 2015. For instance, it is considered to change the legal status of all public universities and research centres to organise them as public entities. The amendments are aimed to narrow the gap between research and business.

3.2.2 Open, transparent and merit-based recruitment of researchers

The Law on Higher Education and Research establishes necessary conditions for open, transparent and merit based recruitment of researchers. Public universities have freedom to decide on their academic structures and conduct recruitment of their academic staff. In 2012 LMT adopted the specification of the Description of the minimum qualification requirements for positions of research staff at public higher education and research institutions (for instance, the number of articles needed to be published in international science publications). Universities are autonomous to stipulate salaries for their academic and scientific staff. However, the managerial positions (rectors) recruitment in public HEI is stated by law. Rectors must hold a doctoral degree, demonstrated managerial competencies and experience in pedagogy. Moreover, external members in governing bodies are appointed not only by university, but also by the Ministry of Education.

Public HEIs and public research institutes are legally obliged to: publish information on vacancies on relevant national online platforms, publish job vacancies on relevant Europe-wide online platforms (e.g. EURAXESS), establish selection panels, publish selection criteria, provide adequate time period (three months) between vacancy publication and submission of applications, offer the right of appeal, etc. A recruitment commission which evaluates candidates for the position of teaching staff members and research staff members shall be set up in accordance with the procedure laid down by higher education and research institutions. Not less than one-third of the members of the recruitment commission must be persons who do not work in this higher education and research institution. In addition, vacancy positions of Heads of public Research Institutes should be published in English. When making arrangements for a competition to fill the position of the chief research staff member or professor, at least one international expert must be in the recruitment commission. 73.9% of researchers were employed on fixed-term contracts in 2012 (European Commission, 2013).

Private HEIs have their own recruitment procedures that should be consistent with the Lithuanian Labour Law. For instance, the vacancy notice is valid until suitable candidates are found, without establishing time period between vacancy publication and submission of applications.

In 2009, a Government Decree was introduced to reduce differences between researchers' salaries. Public universities are autonomous to stipulate salaries for their academic and scientific staff. Project funding schemes offer top-performing researchers the possibility of improving their salaries. On average, researchers' salaries have increased in the last years. Minimum salaries (as for other professions) are regulated by law in Lithuania. Private universities are free to decide on researchers' remuneration as far as it is consistent with the Lithuanian Labour Law. As a general rule, they offer a competitive salary (for Lithuanian standards of living) that is subject to employee-employer bargain.

However, in practice, the implementation of transparent recruitment in public institutions remains problematic. There is no reliable statistics, but anecdotal evidence has it that the

number of applications for a vacancy rarely exceeds one. This could be due to poor carrier prospects (wage, working conditions, etc.) and willingness of institutions to employ their own PhD graduates / extend contracts with current staff. Low level of competition could be also related to rather widespread beliefs that actual recruitment decisions are taken before formal recruitment procedure. Inconsistencies in the recruitment process could also hinder openness and transparency. For instance some institutions provide only 15 days for submission of applications after publication of vacancy. Hence, while legal requirements seek to ensure openness and transparency of the recruitment process, there is in practice considerable room for improvement.

Resources from mainly international sources (e.g. Erasmus, EU structural funds) are increasingly available for mobility of Lithuanian researchers. However, inward mobility of foreign researchers is hampered by obstacles in accessing national grants and lack of transparency in institutional recruitment of outsiders (including a dysfunctional EURAXESS centre). Higher standards for new PhD programmes introduced in 2010 have led to increased national and international cooperation in the provision of doctoral training.

According to MOSTA (2014), there is a mismatch between inward and outward brain circulation in Lithuania. For example, the ratio of Lithuanians seeking PhD degree abroad and foreigners seeking PhD degree in Lithuania is 10 versus 1. It is one of the indicators showing the limited international attractiveness of the Lithuanian research and education system. 24% of Lithuanian PhD researchers go for short term mobility visits abroad (EU-28 average is 18%).

Lithuania has not yet implemented the Scientific Visa package. At the national level there is little tailoring of Article 17 of regulation 1408/71 for researchers through bilateral agreements. No tax incentives exist to facilitate the participation in supplementary pension schemes. After the European Council Directive No. 2005/71/EB was issued, the Lithuanian Parliament issued an amendment in 2008 to the Law on the Legal Status of Foreigners that provided regulation on the issuing of residence permits for foreign researchers having a contract with a Lithuanian research institution. According to the Law, a temporary residence permit is issued for one year and it is not necessary to apply for a work permit.

3.2.3 Access to and portability of grants

As a general rule, competition-based national research grants and research fellowships which are provided by the Lithuanian Research Council are open to non-residents from the EU and third countries. However, funding is not portable outside Lithuania. The Lithuanian Government has not put in place any specific measures supporting the portability of grants.

In principle researchers from EU and non-EU countries can apply for grants administered by LMT. Non-resident researchers affiliated in foreign institutions can also apply, but these researchers should then come back to LT and do their research in one of the national institutions. Enhancement of transnational mobility is an objective of the 'Researchers Career Programme' (RCP) under Operational Programme for Human Resources Development for 2007–2013 (also valid in 2014 and 2015) that foresees funding for these measures: grants for international level researchers (including non-nationals); support for reintegration of researchers that used to work abroad; post-doctoral fellowships and internships; promotion of scientific work of PhDs (support for research, funding scientific internships, PhD scholarships). However, the number of participating

foreign researchers remains limited. There is a legal requirement that beneficiaries of grants have to be employed in a Lithuanian institution. Therefore, even though national grants are awarded to a specific managing institution, they are portable inside Lithuania (if institutions agree, a researcher can change managing institution inside Lithuania). However, a researcher cannot transfer a grant to other institutions abroad. It is impossible as the R&D funding programmes aim at increasing interest in Lithuanian research areas and stimulating progress and competitiveness of Lithuanian research activities. Moreover, it can be the case that currently Lithuanian institutions are uncompetitive on the international arena, so that considerable amount of R&D funding may leave the country if international grant portability is introduced.

Under the Global Grant measure, foreign researchers – project managers - can lead the team in Lithuania remotely. It encourages world-class foreign researchers to collaborate with Lithuanian institutions without leaving the home institution.

There have been no specific developments in this area over 2011-2014.

3.2.4 EURAXESS

In 2011, LMT took over from the Centre of Quality Assessment in Higher Education the functions of the coordinator of the Lithuanian national EURAXESS centre Local EURAXESS contact points are located in five main Lithuanian universities. The EURAXESS portal (http://www.euraxess.lt) provides accurate and relevant background information on Lithuanian higher education and research landscape, social insurance, work permits, etc. However, the number of researchers posts advertised through the EURAXESS jobs portal is quite limited (only two research positions for incoming research were posted in the English version of the EURAXESS jobs portal in December 2014). Moreover, posted research positions for incoming research differ in the English and Lithuanian versions of the EURAXESS jobs portal (the Lithuanian version provides links to more job positions), making the opportunities for national and foreign researchers unequal.

3.2.5 Doctoral training

The Regulation on Doctoral Training (the Law on Research and Studies of 2009) established the way for a new approach to PhD training in Lithuania. The right to provide doctoral training is granted by the Minister of Education and Science. Universities and research institutes have a joint right to train PhDs. Coordination between universities and research institutes increases the quality of doctoral training, and fosters openness and transparency in the research system. The Lithuanian Research Council supervises doctoral training and evaluates research activities. Hence, the universities are not completely autonomous in developing their PhD programmes – their draft programmes are evaluated by the Lithuanian Research Council and only then a university gains the right to launch a specific PhD programme. As a general rule, researchers are encouraged to spend time abroad during their PhD.

The Decree of the Minister of Education and Science on procedures for establishing the right to offer PhD studies adopted in 2011 by the Minister of Education and Science stipulates that institutions willing to register new PhD programmes have to comply with considerably more stringent requirements in terms of excellence of research, relevance of proposed research programmes, human and physical resources, etc. As a result, an

increasing number of Lithuanian institutions establish joint PhD programmes, with the view of pooling intellectual resources and research infrastructure. Furthermore, several universities have started Joint international PhD programmes (some of them funded by Erasmus Mundus).

On the agency level, currently LMT is implementing programmes to support activities related to doctoral training: the promotional scholarships for doctoral candidates (doctoral scholarship and support for (doctoral) academic visits), competition based doctoral training, funding of research visits, the project funding of short-term researcher visits (including participation in doctoral degree process, holding seminars or cycles of seminars in Lithuanian science and education institutions, performing of scientific research, participation in international science events), funding of scientific events, financial support for the publication of research results, and support for students' research activities (including support for PhD students' internships). The programme calls are popular, resulting in high amount of applicants.

The industrial doctoral training was not introduced before 2014 because it was considered that Lithuanian companies, in general, do not have sufficient internal resources to develop their own doctoral placement. In 2014, the Ministry of Education and Science was preparing to launch a new industrial doctorate measure funded by the SF Operational Programme 2014-2020 (to be launched in 2015-2016).

3.2.6 HR strategy for researchers incorporating the Charter and Code

The implementation of the 'European Charter for Researchers' as well as the 'Code of Conduct for the Recruitment of Researchers' is not actively promoted as a government programme and are not formally transposed into relevant laws.. However, both the Rectors' Conference and the Conference of Rectors of Research Institutions have signed the Charter.

There have been no specific initiatives in this field in 2011-2014. In the 2015-2020 programming period a number of research programmes will be dedicated to researchers, also in order to increase their mobility, integration, social aspects (e.g. additional grants to cover researchers' family expenses during visits abroad) etc. The specific measures have not been launched and details were not announced by the time when this Report was prepared.

Low salaries and poor access to academic databases, libraries and world class equipment have been the principal obstacles to the attractiveness of a research career in Lithuania. While access to world class equipment is being addressed, the low attractiveness of salaries is still a big problem, especially for young researchers. Lithuanian universities pay very low salaries to early career researchers (including PhD stipends), sometimes paying less than 20 per cent of the respective best paying country. Only 30% of researchers are satisfied with their salaries (Idea Consult, 2013). There is a significant gap between remuneration levels in the public and the private business sector, as remuneration of researchers working in the higher education sector was 43% lower than that of those working in the business sector. The principal factor behind the low salary levels of researchers in Lithuania was the old higher education (HE) funding system, which included legal obstacles for a university to determine the salaries of its staff. Recent reforms in the HE sector, which increased the levels of autonomy of universities and the capacity of research institutes to determine the salaries, along with more competitive education and

research institutions funding might have a positive effect on the levels of remuneration to research and academic staff in Lithuania. There are no recent studies on progress in restructuring research careers (including salaries level).

3.2.7 Education and training systems

A number of financial (SF-funded) measures as well as higher education sector reforms (discussed at the beginning of this chapter) were implemented over 2007-2014 to promote excellence in education and ensure a sufficient supply of (post)graduates in science, technology, engineering and mathematics and an appropriate mix of skills among the population (including through strong vocational and education and training systems) in the medium-to-longer term. For example, Lithuanian higher education institutions were able to use the SF support for updating their study programmes, optimising their internal structure, putting in place quality management systems; lecturers were enhancing their qualifications; a number of scientific, methodological guidelines were published; cross-border cooperation in the studies areas as well as the mobility possibilities for lecturers and for students have been expanded.

However, based on the analysis performed by the Lithuanian Operational Programme 2014-2020[9], there still remain problematic issues. Challenges for 2015-2020 are related to the quality of studies that does not match the needs of the labour market and the society (in terms of content, structure and delivery). The fragmented involvement of social partners into the development of the content of studies, the lack of practical skills, process- rather than result-oriented studies and the poorly developed career services lead to a lower level of employment and a mismatch between supply and demand of skills. Increasingly more people choose studies abroad (the number of Lithuanian students studying in EU Member States and candidates as well as in European Economic Area countries increased in 2004-2011 from 4,400 to 9,400) (MOSTA, 2014b). In the 2015-2020 programming period, the focus is on higher quality of studies by: involving social partners in the improvement of the content of studies; providing methodological guidance to higher education institutions; developing result-oriented study programmes and modules. Access to studies is limited by the lack of remote or flexible forms of studies and the underdeveloped system of financial incentives, therefore the availability of studies will be improved by social and financial incentives (scholarships, allowances, preferential loans to finance tuition fees, etc.) to students from underrepresented social groups.

Studies confirm the increasing mismatch between supply and demand of specialists in technology fields. For example, survey of manufacturing companies (Visionary Analytics, 2014) revealed that one third of surveyed companies lacked engineers, technology designers, technologists and technology project managers for pursuing their innovation ideas. This bottleneck was perceived as more critical than the lack of technology development related innovation services provided by public R&D infrastructures. To address this issue, in 2014 the Ministry of Education and Science increased funding of higher education in technology fields – more than one third of total funding allocated for university and college education for first year students is channelled to technology fields (€2.78m of total €8,02m allocated per one study year), hoping to increase the attractiveness of technology education.

[9] Source: The Lithuanian Operational Programme 2014-2020 and Partnership Agreement, available at: http://www.esparama.lt/strateginiai-dokumentai1 (in Lithuanian)

Education and training curricula in Lithuania insufficiently focus on equipping people with the capacity to learn and to develop transversal competences such as critical thinking, problem solving, creativity, teamwork, and intercultural and communication skills. Increasingly, attention is paid to address innovation skills gaps. Nevertheless, entrepreneurship education and training is not yet widely available or included in curricula. Partnerships between formal education and other sectors are not sufficiently promoted to that end. However, several ongoing initiatives address this issue. The State Education Strategy 2013-2022 was approved in 2013. One of its objectives is to strengthen the "non-formal" education at schools, especially focused on leadership, creativity, entrepreneurship. In 2014, a working group formed by representatives from the Ministry of Economy, Ministry of Education and Science, Vilnius University and Junior Achievement Lithuania prepared recommendations on strengthening the entrepreneurship programmes in secondary schools as well as in universities. The outcome of this work was unknown at the time when this Report was prepared.

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

3.3.1 e-Infrastructures and researchers electronic identity

There is no national policy in respect to e-infrastructure. However, as a general rule publicly funded e-infrastructures are accessible to researchers from public and private sectors without major restrictions. In 2014 MITA was developing a portal "E-Science Gate"[10] that could provide e-services to public research institutions and private enterprises. The overall objective of the initiative is to facilitate commercialisation of ideas generated in research institutions and foster cooperation between public and private sectors.

"Lithuanian virtual university programme 2007-2012" has been running since 2007. It provides Lithuanian HE and research institutions with access to academic e-library and distance learning platforms. A new programme for 2013-2016 was approved in 2012.

There are no national strategies or policies related to electronic identity that would facilitate researchers' access to transnational digital research services.

3.3.2 Open Access to publications and data

According to Archambault et al. (2014), Green open access is least used in Lithuania (4.5%), similar as in Malta (5.0%), Croatia (5.2%), and Romania (5.3%), while publishing in Gold journals is much more frequently encountered (12.8%). One hypothesis is that researchers in these countries may use Gold journals because they more frequently allow publishing in languages other than English.

The Law on Higher Education and Research (adopted in 2009) stipulates that "the results of all research works carried out in State higher education and research institutions must be announced publicly (in the Internet or any other way) <...> The results of research conducted in non-State higher education and research institutions with funds of the State

[10] More information: http://www.mita.lt/en/general-information/projects/e-science-gate/

budget shall be announced publicly (in the Internet or any other way) <...>". However, implementation of these principles remains problematic due to several reasons. First, institutions and researchers do not have sufficient incentives to ensure open access to research results, since formal evaluation of R&D activities focuses on monographs, ISI journals, patents and other products subject to intellectual property rights. As a result, less than half of institutions encourage researchers to provide open access to publications and data and less than 20 % have internal procedures relating to open access and preservation of scientific information (data) (Tautkevičienė, 2011).

Secondly, there are at least four public databases: database on students' thesis and dissertations (http://etd.library.lt), academic electronic database (http://www.elaba.lt/), Lituanistika database on research in social sciences and humanities (http://www.minfolit.lt/), Lithuanian humanities and social science data archive (LiDA) (http://www.lidata.eu/). However, none of them has reached critical mass - they include just a fraction of research outputs (publications and data) and generally do not provide access to full-text sources contained elsewhere. In 2011 €4.3m were allocated to Vilnius University for implementation of the project "National open access archive of research information (MIDAS)"[11], which seeks to provide infrastructure for preservation and open access to research data. It is planned to integrate it with other databases.

With the view of addressing these challenges the Minister of Education and Science in 2012 approved the Programme for Development of Lithuanian Research and Studies Informational Infrastructure for 2013-2016 (total budget €18m). It seeks better integration of previously developed databases and increased accessibility of research outputs (publications, etc.) and data. The target is that 40% of publications and at least 10% of collected data should be publicly available free of charge by 2016.

On the agency level, LMT has applied a rule ensuring that since a research project is finalised in 3 years' time period, empirical projects data should be provided to a managing research institution and scientific society. However, as LMT started to provide grants only in 2009, the rule has not been applied yet. Moreover, LMT makes publicly available all project summaries and reports (green access initiative[12]). No other initiatives are planned for the near future. In 2013, the Ministry of Education and Science appointed LMT to be responsible for open access development in Lithuania. LMT studies alternatives to make all publications that receive funding publicly available through a local database[13].

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[11] Source: http://www.esparama.lt/paraiska?id=32177&pgsz=10 (in Lithuanian)

[12] There are 4 types of Open Access:

(i) 'Gold' open access (open access publishing): payment of publication costs is shifted from readers (via subscriptions) to authors. These costs are usually borne by the university or research institute to which the researcher is affiliated, or by the funding agency supporting the research.

(ii) 'Green' open access (self-archiving): the published article or the final peer-reviewed manuscript is archived by the researcher in an online repository before, after or alongside its publication. Access to this article is often delayed ('embargo period') at the request of the publisher so that subscribers retain an added benefit. The green access model allows for certain variations: the length of the embargo period and the version that may be archived at different moments in time vary, e.g. depending on the agreements between publishers and authors.

(iii) Hybrid open access refers to a publishing model in which subscription-based journals allow authors to make individual articles open access on payment of an article publication fee.

(iv) Please pay particular attention to whether the further variant called ID/OA mandate (i.e. Immediate deposit/Optional Access), also called the "Liege Model" has been introduced in your country (cf., for instance http://openaccess.eprints.org/index.php?/archives/71-guid.html)

[13] Interview with senior official at LMT (Paliokaitė, 2014b).

Since 2012 LMT supports the publication of research results. The support is intended for Lithuanian researchers to publish their scientific articles in high level scientific journals as well as independent scientific books. In order to get the support researchers are not asked to provide open access to their scientific works. As a general rule, the support does not cover costs associated with ensuring open access to scientific works if access to databases is available in Lithuanian institutions. In addition, since 2009 LMT has been developing the international scientific database "Lituanistika" accumulating and disseminating verified information on the most current Lithuanian studies. MITA has been managing Science and Research Open Access (MITAP) project (€0.7m for 2012-2014) that addresses 3 main challenges: public access to the R&D activities results; centralised promotion of open access centres' activity; technology transfer organisation and implementation through open access centres.

The Operational Programme for 2014-2020, under the Investment priority 1 'Enhancing research and innovation (R&I) infrastructure and capacities to develop R&I excellence and promoting centres of competence, in particular those of European interest' and its specific objective 'Enhancing R&I infrastructure and capacities to develop excellence of research', foresees financial support for „Investments into the information, communication and other non-technological infrastructure in the research infrastructures, for example support is planned for the development of publications databases, ICT infrastructure and licences acquisition, and organisational and management innovations and capacities that are expected to improve the capacity to market and commercialise the research results.

The described measures are expected to contribute to the objectives of this ERA Action.

4. Innovation Union

4.1 Framework conditions

In terms of legislative or regulatory actions such as laws, framework laws addressing research and innovation with the (articulated or indirect) objective to improve the environment for innovation, the Law on Research and Higher Education (2009) defines the terms R&D, science and technology parks, integrated science, studies and business centres („valleys"), R&D institutes, and regulates funding and governance of R&D. Recently, the Ministry of Economy started a debate that this Law and the subsequent implementing bylaws, decrees and regulations apply a narrow and inaccurate definition of R&D activities (equated with "research" only), which impacts on the related policy measures and institutional as well as competitive R&D funding. As a consequence, often the experimental development (especially at the 6-9 technology readiness levels (TRL), i.e. prototype testing and pilot manufacturing) is the missing link. Studies (Visionary Analytics, 2014) note that companies lack the financial and technological services related to TRL 6-9, and that the inaccurate definition of R&D may have led to ignoring the important parts of R&D process in businesses, therefore leading to inaccurate statistics of business R&D expenditure and researchers in business. One proxy proving drawbacks of the narrow, basic research dominated definition of R&D could be the decreasing number of companies using the R&D tax incentives (from 226 companies in 2009 to 181 companies in 2013). In 2013, about 3 companies per one thousand registered in Lithuania have used the R&D tax incentive.

Drawing on the argument that basic science dominates innovation regulation and that the promotion system is responsible for the extremely limited innovation results (see chapter 5), the Ministry of Economy initiated the Innovation Promotion Law which should tackle the above-mentioned problems. The working group under the Lithuanian Government, consisting of the representatives of key ministries and interested parties, was formed in January 2015 to discuss the need for this new Law and the reform of the national innovation system. The *ex ante* impact assessment of this Law was contracted by the Ministry of Economy, with results expected in mid-2015.

In terms of the overall business environment, over the past few years it has become much more favourable for starting and accelerating business in Lithuania. For example, in 2013-2014 Lithuania made starting a business easier by eliminating the need to have a company seal and speeding up the value added tax registration at the State Tax Inspectorate. It also made dealing with construction permits easier by reducing the time required for processing building permit applications. In addition, Lithuania made enforcing contracts easier by introducing an electronic filing system for court users. As a consequence, Lithuania ranks 24th (10th in the EU-28) in the World Bank's Doing Business Rank 2015.

In terms of the supply and demand-side policies and instruments, innovation policies are dominated by supply side instruments (see sections 4.4-4.6). However the Ministry of Economy is currently preparing a set of innovation demand side instruments aimed to bridge this gap (see section 4.7).

The joint formulation, coordinated implementation and systemic evaluation of innovation policies is however still an issue. Strengthening one individual factor does not bring direct benefits if the whole innovation system or its existing relationships and interactions are not effective. Not only the institutional structure or the incentive structure has an effect on the

productivity of the innovation system productivity, but also its' actors (business, education sector, consumers, the public sector), their skills and cultural features - trust, cooperation, openness level, the so-called "social capital" (Visionary Analytics, 2014). Especially the implementation of smart specialisation requires a systematic approach and a policy mix stepping outside the boundaries of a single public policy. This implication leads to the need of good inter-institutional co-ordination and effective governance. Policy co-ordination has been discussed and analysed many times over the past few years (for example, by Paliokaitė, 2009; Paliokaitė et al, 2011; Paliokaitė and Kubo, 2013; Technopolis Group & Ernst and Young, 2014; Visionary Analytics, 2014; Whitelegg et al., 2008, among others). Despite the establishment of formal coordinating institutions such as the Strategic R&D and Innovation Council, the situation has not improved since 2008 (NB: the previous Science, Technology and Innovation Council under the Government has not been effective as well and was therefore dismissed in 2008).

As concluded by Visionary Analytics (2014), lack of coordination leads to huge fragmentation of instruments, programmes, institutions and infrastructures. As a result, the various institutions play (or at least should play according to the definition of their functions) a similar role - for example, science and technology parks, technology transfer centres, open access centres, MITA, Lithuanian Innovation Centre and so on. All these institutions compete for scarce funding, making it impossible to provide professional services or to attract qualified professionals. There is a similar fragmentation of functions at the national agencies' level (LVPA, CPVA, MITA, LMT, ESFA). The instruments and programmes, implemented over 2007-2013, were in general not coordinated, despite continued efforts to do so. Therefore their complementarity was relatively limited. There was lack of effective and systematic programme management mechanisms. For example, the "valleys" development essentially took place in an uncoordinated manner and depended on the universities' interests and abilities. Failure to create programme management capacities for the implementation of smart specialisation (i.e. a team/teams in one of the implementing bodies responsible for supervising the implementation of individual priorities, encouraging cooperation, monitoring, project pipeline development and so on) is likely to lead to the same problems in the new 2015-2020 period.

In 2014, the joint programming processes were initiated in order to prepare the smart specialisation priorities' implementation plans which should define specific policy mixes per each priority. It is too early to say if the joint programming goal has been achieved. For example, the Programme on the Implementation of the R&I Priority Areas and Their Priorities provides for the programming of 'joint initiatives' (programming a pipeline of several related R&D, education, infrastructure projects funded by several sources) in implementing the priorities. The 'joint initiatives' were proposed by the Ministry of Education and Science, but the idea was not supported by the Ministry of Economy. The outcome was not known at the time this Report was prepared.

4.2 Science-based entrepreneurship

10 Science and Technology parks operate in Lithuania, some of which include technology incubators. Some of the science and technology parks are very active in start-ups promotion, regularly organize business plans competitions etc. (for example, the North Town STP), but are not exclusively focused on science-based entrepreneurship. The STPs are an integral part of the science, studies and business centres (valleys).

As discussed in the section 2.5.3 (Table 6), direct funding for R&I and science based entrepreneurship, has been relatively low in Lithuania, compared to technology upgrading and creation of public R&D infrastructure (including buildings). Generally, the SF-funded measures Inogeb LT1-3 provide assistance to entrepreneurs and young innovative companies. These measures aim to:

- Support the creation and development of new business incubators, and so to improve the conditions for start-up creation and development. They are mainly focused on investment into infrastructure.
- Support public business support service providers (STPs, incubators and MITA) in improvement of the services and information quality and ensuring its relevance to business, and improve business conditions for SME's and natural persons willing to start a business.

Since 2012, MITA has become active in promoting science-based and/or high tech innovative start-ups. The first MITA' initiative on the commercialization of R&D results was launched under the High Technology Development Programme in 2012. The main goal of this initiative was to encourage scientists, researchers and students to establish start-up or spin-off companies. After applying the two-steps selection process, 13 new enterprises were established and received public funding (up to €20,273) from MITA in mid-2012. The projects are carried out in high-tech areas: information technology (4), nanotechnology (3), biotechnology (2), mechatronics (2) and lasers technology (2).

After the success of the above mentioned initiative, two Inogeb-LT3 funded projects followed: 'Innovative business promotion (INOVEKS)', €2.8m, and 'Incubation of new technology companies (Technostart)', €1.35m. Both projects are implemented by MITA and target innovative companies creation and innovative ideas pipeline building.

The task of the INOVEKS project is to create opportunities for students and young researchers to establish new companies. The project is implemented by MITA in partnership with several universities and STPs, which will (a) run a selection process of the best ideas from undergraduate, post-graduate and PhD students and young scientists and based on their ideas teams will establish SME enterprises, and (b) help to clarify and test existing business ideas, provide advice on prototypes and/or models creation, as well as opportunities to get additional funding or R&D services for the development of the products, help to develop high-quality investment proposals needed to support the young enterprises.

The Technostart project aims at generating a pipeline of innovative ideas coming from students or researchers, which will be evaluated by expert teams, and acceleration support will be provided to the best ideas. Most promising ideas will be commercialised, acceleration and mentoring services will be provided at the initial stages of the innovative companies' creation. Then the best companies will be channelled to other support and funding providers - Startup.lt or venture capital funds (see section 4.6). The project seeks to select 100 technology ideas suitable for commercialisation, to establish 45 new technology companies, to provide expert consultations to 45 SMEs. It is also expected that at least 10 start-ups will attract venture capital investments (beyond this project).

Both projects will finish in late 2015. Apart from these centralised and project-based initiatives, there is no movement at the institutional (university) level. As is discussed below, universities and their research institutes generally lack clear spin-off creation and/or IPR protection strategies and policies. A key problem is a lack of motivation at the institutional and researchers' level to commercialise R&D. Another substantial factor limiting public sector researchers' collaboration with companies are the researcher's career rules (overdependence on academic publications and teaching, and little or no attention to the economic R&D results).

4.3 Knowledge markets

Basic regulatory framework for intellectual property is in place, but its implementation at the institutional level (the universities and research institutes) is lagging. Pursuant to the Law on Research and Higher Education (2009), researchers were guaranteed with the copyright to their intellectual work products. It was unclear however whether the IP rights to design and patent could be the property of a researcher when the research is carried out within the HEI or PRO. Previous legislation did not grant IP rights of designs and patents to the researchers, thus IP rights could be regarded as the property of the said institutions. The new Law has provided for a different set of rules. Generally the Law establishes that all rights stemming from the intellectual work products belong to the natural persons who have created them, while the HEIs might be granted economic IP rights under the agreements with creators of intellectual work products (Inteligentsia, 2009). In December 2009, the Minister of Education and Science approved a set of Intellectual Property Management Recommendations (guidelines) for the HEIs and PROs. In these Recommendations, the organisations are advised to organise IP management strategies in a way that creates more incentives for knowledge commercialisation, for example:

- HEI or PRO must include the IP management principles in its long-term strategy and foresee its implementation framework and monitoring strategy, exploitation and dissemination strategy;
- An institution is advised to delegate the functions of IP management to a specific employee or establish a separate entity – a technology transfer centre;
- Contracts between the institution and its employees and students should include issues related to IP rights when intellectual work products are created during working/leisure time, using institution property, etc;
- HEI or PRO should ensure that the framework for creation of research results is clear; the exploitation of new knowledge is simple; the results of intellectual work created are publicly announced without violating the IP rights;
- If a spin-off company is created as a result of an R&D partnership agreement, it is recommended that the HEI/PRO seeks to acquire part of its shares;
- A HEI/PRO should establish a methodology for distributing the profit acquired as a result of commercialising intellectual work products, between the HEI structural department and its employee/student/group. .

Still, few universities (Kaunas Technology University being the one leading progress in this area) have clear spin-off development strategies and internal intellectual property policies, clearly outlined, for example specified in the annex to the researcher's employment

contract. Lack of IPR policies at institutional levels lead to lack of motivation to commercialise public R&D as well as lack of trust between the universities and their researchers. As of 2015, MITA intends to fund R&D commercialisation feasibility studies and awareness raising activities by the universities and research institutes, including specialised trainings on technology transfer and patenting. The universities and research institutes had to submit their applications by October 2014. No feasibility studies or specialised trainings have been funded by the time when this Report was submitted[14].

Financial support from national sources (provided by the Ministry of Economy) is ensured for legal entities who aim to protect intellectual property rights. Eligible institutions (private companies and/or research and education institutions) can apply for a grant covering from 50% (for companies) to 95% (for research and education institutions) of patenting expenses (up to €14,481). Applications are submitted via calls for proposals procedure with fixed deadlines. Applications are evaluated by the workgroup launched by the Agency for Science, Innovation and Technology (MITA). In 2008 the Ministry of Economy introduced new instruments to support the acquisition of patents – prepayment and payment on accounts. After the introduction of prepayment and payment on accounts procedures, the numbers increased dramatically. The knowledge markets for patents and licencing, according to our best knowledge, are not coordinated transnationally.

4.4 Knowledge transfer and open innovation

The majority of the text below is based on Paliokaitė (2014b) as there has been no significant change since 2013 (the new policy mix for 2015-2020 is neither designed nor launched).

Measures to support R&D co-operation projects between public/academic/not-for-profit sector research institutions and enterprises. The direct financial support for collaboration of science and business in joint R&D projects and cluster development projects is relatively low, compared to other policy instruments. The group of measures in this route comprises the investments in innovative clusters development (Inocluster LT, Inocluster LT+, and Inogeb LT-3), the R&D projects funded by the High technology development programme (2011–2013), the Industrial biotechnology development programme (2011–2013), and the so called 'joint research projects' that started in 2012. In the latter case, LVPA funds the business part of the project (the measure Intellect LT); MITA finances the part of the project where universities and research institutes are involved so that they can get support up to €0.9m from the measure 'Promotion of high level international research'.

The pilot innovation vouchers scheme was launched in 2010 and after the confirmed success was upgraded to the Ino-vouchers LT scheme in 2012 (the annual budget is €1.65m). The value of one innovation voucher is €2,896 (*de minimis* support of 100%) or €5,792 (*de minimis* support of 75%). The voucher enables an SME to buy R&D expertise or knowledge from a research or higher education institution. Supported activities: industrial or applied research; technological development (experimental or development, design and technological works); technical feasibility studies. 1026 ino-vouchers (€4m) were funded over 2010-2014.

Measures for supporting cooperation and knowledge transfer between public and private sector. Over the past few years there is substantial political focus on circulation of

[14] More at (in Lithuanian): http://www.mita.lt/lt/inovacijos/komercinimo-centrai/

knowledge particularly in the context of fostering cooperation between public research and private enterprises. "Integrated science, studies and business centres – valleys" constitute the most important instrument (worth around €400m) for fostering open innovation and transfer of knowledge between public research and private enterprises. 21 open access centres (R&D laboratories, which should provide R&D services for business and other interested applicants for a particular price) have been constructed in the 'valleys'. However, to date the involvement of enterprises in these projects has been limited and overall the investments resulted in the modernisation of public research infrastructures rather than research-enterprise collaboration. Two Technology Transfer Offices started operation recently in the Kaunas Technology University and Vilnius Gediminas Technical University. The new Operational Programme plans to finance operation of new technology transfer offices in other universities as well. In 2013, public research organisations submitted 31 patent applications to the State's Patent Office, of which 23 applications were submitted by universities.

The State has also implemented an SF-funded measure which finances researchers' placements in SMEs. 17 researchers and four companies benefited from the academia-industry research placement/exchange contracts funded by this measure. 17 start-ups (mostly initiated by university students) were launched by MITA in a SF-funded project aimed at fostering commercialization of public research results or initiating innovative start-ups.

There have been a number of initiatives aimed at fostering access to and preservation of scientific information via open-access databases. These initiatives, however, remain fragmented and none of them has reached critical mass to become dominant source of information on research production in Lithuanian research system. There was no significant progress in fostering access to and transfer of scientific knowledge via digital ERA.

So far, the impact of the current policy mix on the collaboration between the science and business sectors is estimated to be below average (Paliokaitė et al. 2011) because of the lack of a proper legal base for the successful commercialisation of scientific projects, information asymmetry, low quality of scientific research, and – especially - the insufficient in-house capabilities and the passive and bureaucratic stance adopted by universities as well as a lack of a collaboration projects pipeline. Despite the establishment of intermediary organisations (formal and non-functional 'valleys' associations, S&T parks, open access centres etc.), cooperation between industry and research organisations remains at a rather low level and success stories on the technology transfer or commercialisation of public R&D are rare. Evaluation results have demonstrated that business-science collaboration is often more formal (in order to meet the eligibility criteria for funding) than real, i.e. leading to joint research. The involvement of business partners in the valleys development process and especially in the valleys governance system has been rather limited. The existing legal framework does not allow private enterprises to become stakeholders in the newly constructed "open access" research infrastructures.

Despite a large number of strategic documents and different measures, there is a lack of consensus on the overall logic of intervention for fostering open innovation and knowledge transfer. Instead, different strategies (and their institutional "owners") focus on separate elements, which imply a risk of fragmentation. Evidence on the success of implemented measures is lacking and the results of available evaluation reports point to the still existing systemic barriers in the field of open innovation and knowledge transfer. One problem is that the 'clusters' approach fostered by the Ministry of Economy has not been coordinated

with the 'valleys' approach encouraged by the Ministry of Education and Science. As a result, (a) there is a huge fragmentation - 45 business clusters in a country as small as Lithuania (most comprised by less than 10 companies), and (b) science valleys are mainly university projects. Formally, the coordination of policies implemented by ŪM and ŠMM and implemented mainly under the umbrella of smart specialisation will be ensured by the Coordination group, comprised of ŪM and ŠMM viceministers, department directors, as well as representatives of Ministry of Finance and policy implementing agencies. Specific policy mix schemes are represented in the action plan of each specific RIS3 priority. How well policies are coordinated in the new 2015-2020 period, remains to be seen.

Framework conditions to incentivise and reward academics engaged in cooperation with industry/users. The knowledge transfer between science and industry is also strengthened by the non-financial measures introduced by the Ministry of Education and Science, e.g. the results-based university funding model (more value is attributed to R&D contracts with industry) and the Recommendations on the intellectual property management in universities. However, studies (Technopolis Group and Ernst & Young, 2014; Paliokaitė et al, 2011; Paliokaitė, 2009, among others) reveal that the current measures are not effective enough and universities, research institutes and their researchers still lack motivation to commercialize research and work with industry. One negative factor is a huge teaching workload of the researchers, so they do not have time for R&D. The career system of university researchers also does not support knowledge transfer to industry – this system rather supports indicators such as teaching hours, academic papers and similar.

Measures for supporting open innovation and the optimal circulation of knowledge between both academia and the private sector and within the private sector. Open innovation within private sector is fostered by the dedicated cluster programmes, including creation of the jointly used R&D infrastructure ("Inocluster LT", "Inocluster LT+"). There are positive examples of open innovation, when several companies establish an R&D cluster based around one export-oriented product. For example, the Photovoltaic Technology Cluster in Lithuania aims at developing solar energy products, based on elements produced by different companies. The companies in this cluster also jointly use the R&D infrastructure and train their employees[15].

As already noted above, general rule publicly funded e-infrastructures are accessible to researchers from public and private sectors without major restrictions. Successful implementation of the "E-Science Gate" services should contribute to the knowledge flows between academia and private sector.

4.5 Innovation framework for SMEs

The European Commission has set out a series of common principles for national insolvency procedures for businesses in financial difficulties. The objective is to shift the focus away from liquidation towards encouraging viable businesses to restructure at an early stage so as to prevent insolvency[16]. These recommendations are not yet accepted in Lithuania. According to World Bank's Doing Business 2015 Report, Lithuania is ranked 67

[15] More on this case at Gaušas, Paliokaitė (2012): http://eurofound.europa.eu/observatories/emcc/case-studies/the-greening-of-industries-in-the-eu/lithuania-baltic-solar-energy
[16] More at: http://europa.eu/rapid/press-release_IP-14-254_en.htm

out of 188 countries in terms of resolving insolvency (for example, Latvia is ranked 40, Estonia – 37). This indicates that current insolvency regulations could be an obstacle to entrepreneurs.

Overall, a variety of funding instruments are available for SMEs in Lithuania, including clusters promotion and innovation vouchers (see description in the 4.4 sub-chapter above), as well as co-financing of business R&D investments (Idea LT, Intellect LT) and acquisition of R&D equipment (Intellect LT+). While the current mix of instruments does not fund prototype testing or pilot manufacturing, funding for these R&D stages will become available as of 2015.

The funding schemes are evaluated at least once per implementation period. However, anecdotal evidence as well as previously carried out evaluation reports (e.g. Paliokaite et al, 2011, Paliokaite and Kubo, 2013) note that suboptimal selection procedures tend to discriminate against riskier innovation projects. Policy funding agencies in Lithuania are somewhat reluctant to use public resources to finance high-risk innovation projects as it cannot be warranted that the R&D sponsored by the state will translate into commercially viable products. Therefore, there is a marked tendency in the system to finance low-risk technology projects, with tangible and guaranteed outcomes. The culture of risk aversion is typical to all Member States that are using SF funds and have to report to the European Commission on the 'products' and 'results' created. Risk aversion is an issue of great concern, especially at the early stages of the innovation process.

Although the support schemes are relatively well targeted to the needs of SMEs (BGI Consulting, 2014), the efficacy of public support is also reduced by the formal, technical and 'desk-top' selection procedure. Due to alleged concerns over potential corruption, officials from the implementation agencies (esp. LVPA) are banned from face-to-face interaction with applicants throughout the selection process, which cripples their ability to conduct proper due diligence and diminishes their capacity to choose the most promising projects. The 'paper-based' application procedure provides incentive for firms to hire consulting companies to draft grant applications that appeal to the reviewers but favour form over substance. In essence, this approach to candidate selection turns the decision-making process into a 'beauty contest' judging the consultants' writing skills rather than a professional appraisal of the applicants' capabilities and the proposed projects. The above-mentioned weaknesses create high administrative load for beneficiaries and reduce experimentation. Hence, public support may be replacing, rather than complementing, private expenditures on innovation and R&D. In the survey of beneficiaries, carried out in 2011, 69% of beneficiary firms that received support for R&I, concluded that they would have implemented the funded projects even without the public support (although to a smaller extent or in a longer timeframe) (Paliokaitė et al. 2011). The Ministry of Economy has taken some steps in addressing this issue, for example a staged approach of submitting applications may be introduced (i.e. first submission of the project idea, then the full application).

Such obstacles can be overcome in an efficient institutional environment, for instance by engaging professional programme managers. Importantly, experience from other countries suggests that early interactions between entrepreneurs and selection bodies often prove pivotal, as they allow entrepreneurs to acquire invaluable feedback on their business model, thus improving their future prospects for commercialisation or helping them abandon projects that may already be under implementation elsewhere. Face-to-face interaction, therefore, is more than justified in the broader context of entrepreneurial

mentoring and attempts to build real and lasting entrepreneurial capacity. This is especially relevant in the context of smart specialisation that is supposed to foster entrepreneurial discovery processes in firms in order to move to more promising (although risky) new fields of higher value added products and services and respective public-private partnerships (Paliokaite and Kubo, 2013)..

4.6 Venture capital markets

Business access to venture capital markets have increased dramatically during 2011-2014 in Lithuania. In 2010 the risk capital fund "Business Angels Fund I" was founded by the European Investment Fund for investments into innovative and export oriented companies in Lithuania. The Establishment Agreement of the Fund is signed under the project "JEREMIE the controlling fund". As of early 2013, Lithuania introduced new venture capital measures aiming to boost investments in early stage innovative companies in Lithuania. The European Investment Fund (EIF) together with Estonia, Latvia and Lithuania launched the Baltic Innovation Fund (BIF) - a "fund of funds" that will invest €100m into the private equity and venture capital funds operating in the Baltic countries. It is expected to encourage risk capital investments in SMEs.

EIF and Practica Capital established an initial stage venture capital fund (Practica Seed Capital Fund, €6m) and Practical Venture Capital Fund (€15.7m) that will invest in Lithuanian SMEs. The deal has been signed under the local JEREMIE initiative (Joint European Resources for Micro to Medium Enterprises). The main purpose of the Practica Seed Capital Fund is to develop new businesses by financing and incubating the prospective ideas and help them to develop at the pre-seed and seed stages. The funds invest in early-stage (seed, startup) development of high-potential business ideas and later-stage expansion of established businesses in Lithuania. Practica Capital funds invest in equity (minority or majority share capital) or quasi-equity instruments (convertible debt and similar) seeking return on invested capital. Investments vary from €3,000 to €2m per project[17]. A "business accelerator" under the name of Startup.lt actively supports the founding process of new companies throughout their early life cycle from their launch to incorporation, thereby filling the gap start-ups experience in Lithuania. The "business accelerator" provides vital services such as business advice, office space, networks and other services including bookkeeping, legal and intellectual property advice. In parallel, a Practica Venture Capital Fund could potentially provide follow-on investments for the ideas developed under the Seed Fund, but will also invest into existing high-growth companies. Both funds are managed by the Practica Capital team which consists of well reputed successful entrepreneurs and financial professionals brought together through this initiative.

LitCapital is another growth capital fund, established in cooperation with European Investment Fund in 2010 under JEREMIE initiative. The fund size is €25m. It is aimed at investing in small - medium-size enterprises in Lithuania. Fund is aimed at long term investments in the authorized capital of private enterprises seeking faster growth and expansion. The investment horizon is between 4 and 6 years.

[17] Source: Practica Capital, http://practica.lt/en/

According to the Lithuanian Private Equity and Venture Capital Association (LT VCA), European Union funds under JEREMIE initiative have already let Lithuanian venture capital funds invest in 56 companies with total investment size of €95.3m. The turnover of the companies that were in the portfolio of funds for at least a year increased by 66% and the number of employees - by 14%. LT VCA unites 13 active members covering different types of venture capital business activities: fund management companies, consulting firms, lawyers, public institutions etc., who support and advise investors and entrepreneurs in the structuring and management of their partnerships. LT VCA serves as a central platform for representation and promotion of the venture capital business to institutional investors, opinion leaders, and public policy makers.

Currently, key venture capital funds in Lithuania are dependent on the EU investments (e.g. JEREMIE umbrella). A positive sign is the emergence of 100% privately owned venture capital funds, such as Nextury Ventures, established in 2014. At the moment, in Lithuania there are no tax incentives aimed at private venture investors or business angels.

4.7 Innovative public procurement

Public procurement and other demand-led policy instruments have not been used so far in Lithuania. The overly restrictive interpretation of public procurement rules has been discriminating against demand-led innovation, especially among SMEs. Lithuania also lacks a developed administrative culture of organizing tenders around innovative ideas (for instance, technologies for the transformation of public administration buildings into zero emission establishments). The Lithuanian innovation system relies mainly on innovation supply side instruments and neglects possibilities to link innovation demand with knowledge producing capacities. It is especially important for (i) supporting those R&D fields and industry sectors that are new, on the rise and outside the scope of existing policies, as well as (ii) using the existing R&D potential for tackling main socio-economic challenges (e.g. in the field of energy transmission, generation and efficiency, which are the key national long-term challenges).

Since 2012, policy debate shifted towards the demand-side oriented measures. The National Progress Programme for Lithuania for the period 2014-2020 (approved in 2012) contains a set of demand-side innovation policy measures, e.g. innovative public and pre-commercial procurement, regulation, financial and tax incentives for innovation consumers. The Operational Programme for 2014-2020 as well as the Innovation Development Programme 2014-2020 contains measures aimed at fostering markets for innovation (firstly, pre-commercial procurement is foreseen).

Although no new measures were launched yet, the Ministry of Economy is leading the debate on how to increase the implementation of the innovative public procurement and the pre-commercial procurement instruments. The Ministry of Economy published the Guidelines on innovative public procurement. These guidelines describe how public procurers can buy goods, services or works of better quality, more adapted to their needs, services or goods that could enhance performance of public procurers and quality of their services, and increase demand for innovation on the market. The Ministry of Economy in cooperation with MITA has drafted the description of pre-commercial procurement and when it will come into force, intends to implement pilot actions of pre-commercial procurement and to conduct a survey of other ministries on the demand for the innovative

public procurement as well as for the pre-commercial procurement. It is planned that pre-commercial procurement would be funded by the OP for 2014-2020.

It has to be noted that demand-led innovation policies are relatively new even in the innovation leading countries, and evidence on effectiveness or impact of these measures is lacking. To apply sophisticated measures such as pre-commercial procurement, related capacity building of the ministries, agencies and other public authorities (the 'clients') would be needed to effectively use the new measures. Considering this, the Ministry of Economy plans resources for awareness raising and capacity building in the field of pre-commercial procurement.

5. Performance of the National Research and Innovation System

5.1 Performance of the National Research and Innovation system

According to the assessment of the Innovation Union Scoreboard (IUS) 2014, Lithuania's aggregate innovation index stands at 0.289 in 2013, considerably below the EU average (0.554). For the analysed eight-year period 2006-2013, Lithuania has improved its average annual rate of innovation performance of 2.6% and takes the second place after Portugal of 3.9% in the moderate innovators group. For comparison, for the same period overall EU annual average growth rate of innovation performance reached 1.7%. Lithuania managed to improve its group membership in 2012 from modest innovators to moderate innovators. Due to rapid rates of improvement from 2011 to 2013 Lithuania is currently performing at 52% of the average for the EU. However there was no leap in 2013-2014. The country is still the fifth least innovative in the group of 28 EU countries right after Bulgaria, Latvia, Romania and Poland.

Lithuania scores low in the majority of R&D performance indicators, except for the indicators in the categories of Human resources, Finance and support and Firm investment (see Table 7 for the main IUS indicators for Lithuania and EU28). Lithuania is above EU average only in human resources category and non-R&D innovation expenditure. High growth is observed for Community trademarks (28.4%), Most cited scientific publications (10.7%) and International scientific co-publications (8.9 %). However, in terms of open, excellent and attractive research systems, linkages & entrepreneurship, intellectual assets and economic effects Lithuania is far below EU average. The largest growth decline is in Non-EU doctorate students. Other large declines are observed for Innovative SMEs collaborating with others and Sales share of new innovations. Moreover, according to the new innovation output indicator scores in 2010 and 2011, Lithuania is one of the lowest performers[18] - it has a second lowest score in EU-27 and is just above Bulgaria. It is unlikely that Lithuania will bridge the innovation gap in the short or medium term.

In Lithuania the RDI effort is predominantly ensured by the public sector, a sign that conditions for business R&D investment are still insufficiently attractive, and that supporting specialisation with a view to establishing more knowledge-based business activities is proving difficult (IUC, 2013). Public RDI investments are close to the EU average (0.71% of GDP in 2013). The public sector is also the key knowledge producer. Business RDI investments remain sharply below EU average (BERD/GDP makes only 18.6% of the EU28 average) and there are no signs of convergence. Lithuania advanced from 'modest' to 'moderate' innovators group mainly due to increased spending on non-R&D based innovation (for example, improvement of design, brand creation or process optimization). Businesses in Lithuania still rely more heavily on the acquisition of machinery as one of the most important mechanisms for knowledge acquisition, which confirms that the Lithuanian economy is in between the efficiency based and knowledge based growth mode. Lithuanian firms spend more than 70% of their innovation expenditure on acquiring machinery, whereas this number in Denmark or Austria is less than 10%. The share of researchers employed in the private sector is also very low (below

[18] European Commission communication "Measuring innovation output in Europe: towards a new indicator"

20%), compared to the EU countries such as Denmark, Malta, Austria and Sweden with a high share of business researchers (over 60%).

Table 6: Assessment of the Performance of the National Research and Innovation System.

1. ENABLERS	Year	LT	EU
Human resources			
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	2011	0.90	1.70
Percentage population aged 30-34 having completed tertiary education	2012	48.70	35.80
Open, excellent and attractive research systems			
International scientific co-publications per million population	2012	304.30	343.15
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	2009	6.23	10.95
Finance and support			
R&D expenditure in the public sector as % of GDP	2012	0.66	0.75
Venture capital (early stage, expansion and replacement) as % of GDP	2012	N/A	0.08
2. FIRM ACTIVITIES			
R&D expenditure in the business sector as % of GDP	2012	0.24	1.31
Linkages and entrepreneurship			
Public-private co-publications per million population	2011	9.59	52.84
Intellectual assets			
PCT patent applications per billion GDP (in PPS€)	2010	0.39	3.92
PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	2010	0.13	0.85
3. OUTPUTS			
Economic effects			
Contribution of medium and high-tech product exports to trade balance	2012	-0.85	1.27
Knowledge-intensive services exports as % total service exports	2011	12.51	45.26
License and patent revenues from abroad as % of GDP	2012	0.01	0.59

Source: European Commission, IUS Database (2014).

On average in 2012, Lithuania produced 9.12 publications per 10,000 inhabitants, below the EU-28 average (13.8). Only 35.56% of publications are internationally co-published. In 2012, Lithuania had about 304 international scientific co-publications per million population (when Estonia, for example, had 864 and Ireland – 1193.6). In the period 2002-2012, 6.54% of the Lithuanian scientific publications were in the top 10% most cited publications worldwide in comparison with 11% of top scientific publications produced in the EU28 (Science Metrix, 2014)[19]. The share of public-private co-publications in Lithuania is 0.7% in the period 2008-2013 well below the 2.8% for the EU28[20].

State universities currently have the highest potential of research activity in Lithuania and they are the most productive (ca. 70% of all scientific publications, 45% of FP7 grants).

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

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

There are 23 universities (14 State and 9 private ones) as well as 13 State research institutes and 7 private research institutes in Lithuania. Still, despite high public R&D inputs, Lithuania suffers from low economic R&D-based outputs. The productivity in preparing the highest quality research is low. This could be interpreted as due to (a) lack of incentives or (b) poor quality of the major part of the research production. The research output achieved using the same human and financial resources (especially given the relatively high public investments in R&D) are substantially weaker than in other EU MS. According to IUS 2014, the number of international co-publications increased by 8.9% and most cited scientific publications increased by 10.7% compared to the previous year, but the proportion of publications among 10% of the most cited publications is twice below the EU27 average. Lithuanian universities in general do not fare well in international comparisons. None of the Lithuanian universities is listed in the top-500 of the Shanghai ranking. Among the World top universities by 2014/15 QS World University Rankings Vilnius University is ranked 551-600. Kaunas University of Technology, Vilnius Gediminas Technical University, Vytautas Magnus University are ranked 701+, which is the lowest place in the rankings. This indicates that universities fall short in international excellence and the fragmented science base does not allow for achieving critical mass. The number of EPO patent applications per million of inhabitants (6.09) was almost 18 times below the EU28 average (108.05) in 2012.

A well-performing national innovation system is an essential framework for any holistic attempts to build up knowledge based economies. The above gap between R&I input and output is an 'old' problem and it has been addressed by the dedicated policies. The R&I policy mix has improved significantly in the context of the National Strategic Reference Framework (NSRF) 2007-2013, the Lithuanian Development Programme for 2014-2020 and the public research and education system reform that took place in 2009-2012. The availability of high quality research infrastructure has been addressed in the policy actions focusing on the development of five 'valleys'. The quality of human resources in research has been addressed by funding research mobility and research grants. R&D grants and tax incentives for R&D were made available for business.

Despite the systemic approach to innovation that was introduced with the Lithuanian Innovation Strategy in 2010 and the Lithuanian Innovation Development Programme 2014-2020 that replaced it, the national innovation system is far from being 'ready'. The still "linear" and R&D centric policy approach is prevailing at cognitive, but also at policy measures level. As the innovation system in Lithuania is still evolving, improving its performance should be high on the policy agenda for 2015-2020. This includes building up effective organisations, filling the gaps, removing misbalances and facilitating connections between different stakeholders in Lithuania and beyond. But it also assumes moving beyond the current narrow understanding of innovation and circle of 'usual suspects', both in terms of stakeholders involved and activities concerned. There remain several structural challenges that are discussed in the sub-chapter 5.2. There were no systemic changes in the innovation policy mix or innovation governance in 2014, as the policy makers were preparing for the introduction of the 2015-2020 policy mix, including the design of smart specialisation. Hence, the structural challenges largely remain the same as discussed by the Erawatch Country Report 2013 (Paliokaitė, 2014a).

5.2 Structural challenges of the national R&I system

Private sector R&I capacity building: the 'competence ladder'

The most prominent sectors in the Lithuanian economy are the traditional ones (e.g. food, transport) accounting for the largest share in value added, employment and leading in the Lithuanian exports. However, to sustain the competitiveness also in the future they face the need of upgrading. At the same time, the R&I potential in the Lithuanian economy lies within emerging high tech sectors like biotechnology and pharmaceuticals, information technology (both manufacturing and services), and engineering industry (manufacturing of metals and machinery), which are still rather small with little to contribute to Lithuania's economy in terms of value added and employment (Paliokaitė and Kubo, 2013). Hence, the key mid- to long-term challenge for Lithuania is to promote the structural change of the economy by providing a transformation agenda for diversification of existing sectors and transition to new activities. Hence, the focus should move from existing mature innovators (experienced R&D based SMEs) to new and potential innovators.

For Lithuania capacity building is an important way to improve its R&I performance in terms of excellence although it is a rather long way to go considering the baseline situation at the point of departure. As the existing target group in Lithuania for the excellence-based competitive R&D measures is rather limited – consisting mainly of the limited number of top-tier research groups and few knowledge-based (spin-off) companies - raising the allocations for direct R&D measures without simultaneously dealing with the pipeline creation through capacity building might result in problems with absorption of available funding and stagnation in terms of participation in Horizon 2020.

The Lithuanian 2007-2013 R&I policy mix has been mainly targeting the limited number of existing R&I performers, thus leaving the vast bulk of existing economy players and possible newcomers in the form of start-ups with their development needs out of the scope. Building innovation capacities and project pipelines in the form of 'soft' measures constituted only a marginal share of total R&I investments, while the majority was invested into the research infrastructures and S&T parks. Given the above, the new period's policy needs should be to focus on extensively and effectively investing into firms' innovation capacities thus building and leveraging private sector investments into R&I. The R&I policy mix should focus on providing incentives to encourage companies, entrepreneurs and other organisations (universities, research institutes) to become involved in the discovery of possible specialisations and opportunities for diversification therein, such as: (i) open innovation and collaboration platforms keeping in mind the complexity of innovation process and the chain from basic research to product development, design, pre-production, and market placement; (ii) mechanisms (e.g. vouchers) to boost experiments and discoveries while encouraging connections among economic agents; (iii) prizes and bonus mechanisms for entrepreneurial discovery to reward those entrepreneurs who discover new domains and activities, also those who initiated or integrated into international value chain; (iv) industry, technology and market foresights, studies on long term future trends and likely development of technologies.

To build an effective stairway to excellence, 'soft' capacity building measures are required to deliver the expected change in R&I and knowledge based growth. Therefore, more sophisticated approach to the capacity building is needed taking into account that the current capacity levels and the potentials to move up in the 'stairway to excellence' largely differ within the target group. While today's R&D performers would need the boost to

expand their activities and engage into different collaborations (e.g. with other companies in the field, local SMEs, public research or international partners), those with the R&I potential, but only modest or no R&I activity at present, would mostly benefit from 'soft' capacity building measures like innovation and technology audits, vouchers, clusters, foresights, innovation brokering and matchmaking etc. Therefore, also in capacity building, one size doesn't fit for all and designing target group specific policy interventions could be the solution. In the new 2015-2020 period the policy spotlight has to move from "hard" infrastructure development to capacity strengthening and acceleration of new ideas pipeline through the innovation support services, seeking to encourage more "potential" and "new" innovators to invest into the development of new business fields, business models and products. The already created public (including the clusters, open access centres, STPs) R&D infrastructures have to be smartly exploited by connecting all infrastructures into one professionally managed virtual R&D and innovation services network (Visionary Analytics, 2014).

Moreover, lock-in should be avoided and policy kept open for newcomers. Spin-off policy is rather new in Lithuania and the focus is on universities and technology transfer through IP commercialisations therein. However, considering the development phase of Lithuanian economy and the international R&D commercialisation experience, other forms of knowledge transfer could be more or equally relevant to target like e.g. collaborative projects with industry, industry PhDs, joint study programmes with industry etc. In addition, spin-off policy should be extended also to encourage business spin-outs from mature innovators as a possible source for greater variety and knowledge spill-over. The role of FDI as one possible source of new activities and variety cannot be underestimated in the Lithuanian context, given the success story of the biopharmaceutical sector.

Commercialisation of public research results: entrepreneurial culture and technology transfer

The majority of the overall modest research and development (R&D) efforts in Lithuania are funded by the public sector and carried out by public research institutions. The R&D policies over 2007-2013 mainly invested into precompetitive (mainly basic) research and related infrastructure at public R&D institutions. The investments were necessary considering the worn out state of the research base. However, this approach has proven relatively weak in leveraging private sector investments into R&I and fostering public research commercialisation, and tended to reinforce the existing trend of low investment in R&D and innovation by business sector. Despite the huge potential, weak capacity to commercialise and exploit public research for economic benefits becomes more evident after heavier investments in research production. Thus, there remains a need for subsequent efforts to encourage research commercialisation, for example through spin-offs and technology knowledge transfer to public sector through dedicated R&D services, and ensuring productive cross-sectoral (including science-industry) collaboration.

The starting point is rather weak. Clusters could provide arenas for related variety/cross-sector links internally in the region and externally. However, the cluster formation is in early phase in Lithuania and few of the first results of the respective support programmes are encouraging. The way clusters or the 'valleys' were initiated didn't support effectively enough the cross-sectoral approach and connections with the local knowledge sources (institutes, universities at 'valleys') and to outside Lithuania. As a result clusters are rather sector based, inward looking, operating as 'private clubs' with 5-7 members and with

limited inter-regional connections. A warning sign that clusters policy has gone wrong is that there are now more than 40 clusters in Lithuania, a country with less than 3m people.

An increasing concern in Lithuania is how to deal with the difficulties in funding public research as an opportunity to strengthen 'demand steering', putting more focus on the industry capabilities and needs and economic return of investments, also through the transfer of knowledge from higher education institutions to industry which if successfully converted into commercially marketable products and services would lead to increased employment and export sales. So far, the policy results were weak (Paliokaitė et al. 2011) because of the lack of a proper legal base and/or pipeline for public-private partnerships, information asymmetry, low quality and narrow specialization of public R&D, and – especially - the insufficient in-house capabilities and the passive and bureaucratic stance adopted by universities. Despite the establishment of intermediary organisations (formal and non-functional 'valleys' associations, S&T parks, open access centres etc.), cooperation remains at a rather low level and success stories on the technology transfer or commercialisation of public R&D are rare. Universities and their research institutes are mainly dedicated to the roles of teaching and basic research. Lithuania, unlike other EU Member States, lacks a network of specialised application-oriented research institutes whose mission is to provide technological services to SMEs for industrial research and product development.

From this perspective there remain several issues. First, the entrepreneurial culture is not developed in Lithuanian universities and thus requires a change of the mind-set at the universities via incentive systems, e.g. modifications to the research funding (e.g. more focus on the outcomes of R&D) and researchers' career criteria, university IPR policies, development of the knowledge transfer offices, and entrepreneurial training. Substantial factors limiting public sector researchers' collaboration with companies are the researcher's career rules (overdependence on academic publications, and little attention to R&D results) and the apparent lack of motivation at the institutional level (for example there is only one Knowledge transfer office functioning at KTU).

As noted in section 2.5, to achieve better results of innovation performance, Lithuania needs to shift the national R&I system from the current system traditionally focused on basic science to one more inclusive of innovation (Paliokaitė and Kubo, 2013). R&D policy is too dominated by basic research and insufficient incentives are created for applied research and experimental development. The current legislation is dominated by narrow and inaccurate definition of R&D activities (often equated with "research" only), which reflects on the related policy measures and institutional as well as competitive R&D funding. This is one of the factors limiting the motivation to commercialise public R&D. In order to solve this problem, it is necessary to change the approach and revise the definition of R&D in the official legislation and to fill a gap in the innovation policy implementation measures (institutional and project funding).

Second, a related objective is to exploit already created R&D infrastructures for commercialisation and technology transfer. There is extensive fragmentation of various innovation support institutions. At the moment, the potential of R&D infrastructure is very fragmented, highly specialised and scattered between the universities, institutes, clusters, and science and technology parks. Companies do not have access to this infrastructure, they do not know what infrastructure and under what conditions is available to use. Complicated procedures applied by public infrastructures, bureaucracy, long execution periods, lack of flexibility and responsibility limit the collaboration attractiveness to

industry (Visionary Analytics, 2014). The already created public (including the clusters) R&D infrastructure has to be smartly exploited by connecting all infrastructures into one professionally managed virtual R&D and innovation services network. Attention should be placed not on building more (overlapping) infrastructures, but on solving "soft" issues such as exploitation of the open access centres, science and technology parks, clusters and their infrastructures, and creation of related capacities and human resources. The virtual R&D infrastructure network could allow developing innovation from idea to pilot manufacturing. All public research institutes and research centres with a mandate to engage with industry, and especially the open access centres in the 'valleys', must develop a distinctive industry-focused culture. They have to become better at marketing their research to the business sector.

Mainstreaming internationalisation

The public R&D system can be characterised as rather closed with limited institutional incentives and targets for internationalisation. Lithuania is one of the weakest Member States in terms of the number of signed FP7 contracts (24th out of 27) and budget share (25th). It is unfortunate given the current quality of Lithuanian research and few niches of international science excellence. There is scope and rationale for more targeted, intensive and better coordinated transnational collaboration. Additional support mechanisms could be needed for the research pools to encourage further collaboration with European peers. Equally, Horizon 2020 can offer more value for the emerging high-growth potential fields/companies to increase their international competitiveness. To benefit more from transnational R&I collaboration today's general declaration of importance of international collaboration should be replaced by more strategic R&I internationalisation policy, including respective positioning, target setting and incentives at the national level. In line with that all national R&I measures should include relevant international dimension, stimulate partnerships, open-up for international partners and clusters, etc. Moreover, none of the smart specialisation priority areas should involve purely national agendas.

For Lithuania it is justified to focus its transnational R&I cooperation efforts towards the Baltic Sea Region (BSR) to amplify the networks and projects already established and make better use of the reinforced framework of the EU's Strategy for the Baltic Sea Region by including respective arrangements into the Operational Programmes. This is particularly relevant concerning the further investments into R&D infrastructures. Moreover, synergies between Horizon 2020 and transnational collaboration under cohesion policy need to be improved, e.g. establishing more joint R&I programmes, cluster alliances etc. where BSR countries pool funds and launch common calls for proposals. This could help to initiate and support co-operation at its initial phase while building the capability for participation in Horizon 2020. Also as foreign students and researchers might be a considerable source for knowledge transfer from abroad and bring in diversity, the internationalisation policy of higher education and R&I should also be linked with the smart specialisation (Paliokaitė and Kubo, 2013). In addition, public R&D and higher education systems need to open up, adjusting their staffing policies to attract talent from abroad.

From a governance perspective, today's practice reflects that FP activities (NCPs), cohesion funded programmes, national programmes and transnational cooperation (under ETC and EUSBSR) activities are all rather separate streams of planning and actions. Therefore linkages between them, both at strategic and operational level and looking for complementarities, is needed. The strategy might not be enough; it also needs supportive

governance processes to be implemented. For example, structures should be set up to facilitate the strategic identification of priorities for the different instruments and to seek to avoid duplication of effort and identify areas where additional financial support is needed.

Reducing policy fragmentation and improving policy capacities

Fragmentation is a keyword to describe the current situation in R&I governance. There is fragmentation of policy priorities, programmes, funds and institutions, and insufficient leverage of different funds as well as few synergies between measures. Efforts to concentrate funds and create connections have so far been able to deliver only very limited effect. This is a critical issue, considering the policy mixes planned for the implementation of smart specialisation. The present governance mode in Lithuania is administrative and reactive rather than proactive and innovative. However to tap the potential of smart specialisation, public authorities and implementation agencies will need to behave less like traditional public bureaucracies and more like innovation promoters, brokering new connections and conversations in the economy. Therefore it is a huge challenge ahead of Lithuania to adjust its governance to fit with the new demanding role it is expected to play for the successful implementation of S3. Otherwise the entrepreneurial discovery and experimentation as the focal ideas of smart specialisation just remain on paper (Paliokaite and Kubo, 2013).

First, collaboration and co-operation across all the relevant funding and development agencies and funding sources has to be ensured to facilitate streamlined, joined-up implementation of the actions required to realise the priority areas. The smart specialisation priorities are expected to provide different public sector stakeholders with the common framework and focus to be able to mobilise priority-relevant resources across different funding instruments. In practice, it also means that there has to be a coordinating centre assigned with a responsibility to monitor synergies (and duplications) between the programmes and measures, to monitor calls for proposals (e.g. of ESFA, LVPA, LMT), and review how successful are the different priorities in moving from stage to stage in the implementation process.

Second, in order to create ownership of R&I policies and consequent stability, orchestration of policies affecting R&I performance would require informed policy processes. A critical issue is lack of strategic intelligence systems for policy learning and informing the decision making, including the weak involvement of various stakeholders in the process of designing R&I policy. Effective monitoring systems, evaluation and foresight are the main tools to be used to ensure policy learning and forward looking capabilities. Currently the respective capacities are relatively low and the functions are not embedded into the Lithuanian R&I policy-making cycle. This gap is tackled by both MOSTA and (increasingly) MITA, but so far the monitoring and analysis efforts are mainly focused on public research and education because the policy design process mostly lacks data on business R&I. As a result, policy-makers have very little understanding of how economies in principle diversify into new growth paths, and to what extent public policy may affect this process.

Third, the efficacy of public support is also reduced by the formal, technical and 'desk-top' procedures of 'policy administration' (see section 4.5). This is especially relevant in the context of smart specialisation that is expected to facilitate entrepreneurial discovery processes in firms in order to move to more promising (although risky) new fields or interactions. Simplifying the procedures would not suffice as the key problem is within the

management capacities of the implementing agencies and the limited focus on working on the innovative projects pipeline. The system does not sufficiently integrate cutting-edge industrial expertise and knowhow, and it has developed a culture of risk-aversion, biased against early-stage and high risk innovation ventures, particularly in high-technology sectors. The staff of implementation agencies does not possess sufficient knowledge of the industry, and therefore they will remain limited in their capacity to fashion effective, output-oriented programs maximizing the impact of the funding distributed unless industry expertise is integrated in the instrument design and the selection phases. Moreover, the staff faces another set of constraints stemming from the overly legalistic approach to programme management. Emphasis on the EU's legal framework, the Lithuanian administrative law and procurement regulations often makes them reluctant to allocate public resources to projects that may not immediately result in commercially viable products and services. In so doing, they are avoiding risk in an industry which by definition must be focused on stimulating risk-taking among innovative enterprises.

5.3 Meeting structural challenges

The following table provides the assessment on how appropriate the existing policy actions are for addressing the specific structural challenges.

Concerning the misbalances in the current policy mix, the 2015-2020 R&I policy focus should be moved to 'soft' capacity building and R&I human resource development measures vs. infrastructure investments. The latter could be only justified if clearly focussed on enhancing applied research, through reinforced cooperation with industry to leverage private R&I investments. Smart specialisation should create a favourable environment for underpinning entrepreneurship and innovation and fostering emerging technologies in export-oriented and high value added market segments where Lithuania has the capacity to attain a competitive advantage and develop greater diversity. Pillars of the smart specialisation policies should include both supply side instruments (direct support for R&I) and demand side instruments that provide indirect support to innovations by boosting demand and creating favourable framework conditions for their take up by the market. But it also assumes moving beyond the current narrow understanding of innovation and circle of 'usual suspects', both in terms of stakeholders involved and activities concerned.

Table 7: Assessment of the Lithuanian R&I policy mix

Challenges	Policy addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
1. Private sector R&I capacity building: the 'competence ladder'.	Restructuring the economy towards higher value added creating sectors is the overarching R&I policy objective. Grants to business R&D (Idea LT, Intellect LT/LT+) Inogeb LT1/LT2/LT3 Tax incentives for R&D intensive companies.	The 2007-2014 policy mix was mainly designed for the existing R&I performers. Investments into innovative capacities and project pipeline building constituted a marginal share of R&I investments. Such innovation support system lacked critical mass of „soft" measures aimed at strengthening of companies' innovation capabilities and motivation to start new innovation activities. Public procurement and other demand-led policy instruments have not been used so far. The overly restrictive interpretation of public procurement rules has been discriminating against demand-led innovation, especially among SMEs. The lack of qualified specialists/skills lead to low capacity to switch to new business models and new product development. The policy spotlight has to move from "hard" infrastructure development to capacity strengthening and acceleration of new ideas pipeline through the innovation support services, seeking to encourage more "potential" and "new" innovators to invest into the development of new business fields, business models and products. ➢ Significantly increase the funding for innovation support services (innovation brokerage, facilitation of links between business and science, evaluation of innovation potential in specific companies, innovation ideas evaluation and facilitation, technology transfer facilitation etc.). ➢ Implement business researchers' international training and apprenticeships measures. Encourage foreign researchers and high-level specialist recruitment at the Lithuanian companies, clusters and R&D institutions. Encourage postgraduate student placements in enterprises. Implement Industrial Doctorates programmes. Review the study programmes in the engineering and technology fields.. ➢ New business acceleration systems, based on seed / start capital, mentorship and good practice systems need to be implemented similarly to the above. ➢ Implement smart demand-side policies and ensure capacity building (awareness raising, training and pilot-testing).

2. Commercialisation of public sector research results: entrepreneurial culture and technology transfer	Main policy focus on strengthening of research infrastructures in the context of building the 'valleys'. • Technology transfer centres, technology incubators and S&T parks. • Support for protecting intellectual property. • Innovation vouchers • Support for clusters • Valleys (open access centres, S&T parks etc) • Joint research projects	The key weakness is that the limited effectiveness of the attempts to create synergies between the different measures. The entrepreneurial culture is not developed in Lithuanian universities and thus requires more effective incentive systems, e.g. modifications to the research funding and researchers career criteria, university IPR policies, development of the knowledge transfer offices, and entrepreneurial training. ➢ The new R&D infrastructure investments should be limited strictly with the requirement for the actual and strategic R&I collaboration between research and business community, incl. demonstration of strong industry commitment. ➢ Development of the 'valleys' infrastructure should be more clearly linked to the clusters projects and soft measures for networks, R&I collaboration and capacity building. In order to achieve economies of scale by using funding of various state institutions, it is advisable to focus on larger rather than small-scale projects. ➢ Connect the current public R&D infrastructure into a single virtual R&D services network, ensuring synergies between thematically related public infrastructure (in the open access centres, clusters, etc.), so that they allow developing innovation from idea to the market, and provide not only technological, but also related training and ideas commercialization acceleration services. Institutions should substantially strengthen their human resources. The proactive approach needs to be employed. Clusters' R&D infrastructure should become available to all interested parties. ➢ Researchers' contracts should specify the allocation of time between teaching and R&D as well as remuneration options in case of successful applied R&D or R&D commercialisation. The researcher should be able to choose between two career directions: teaching and performing R&D. The researchers' career rules and performance requirements should be revised accordingly. A similar change should occur throughout the institutional level, i.e. institutional funding criteria should be updated. It is necessary to change the basic-science/science push dominated approach and revise the definition of R&D in the official legislation.

3. Mainstreaming internationalisation	Support for international projects (FP7, Eureka) Fragmented involvement into ERA-NETs National large infrastructure roadmap (2010) The LT, LV and EE authorities started discussion on coordinating their research capacities, but there were no visible results.	Transnational cooperation and looking for opportunities for synergies with Framework Programmes has rather stayed outside of the national policy efforts in Lithuania than considered as an integral part it. Limited incentives and targets for internationalisation. Limited involvement in joint research agendas. Public R&D and HE systems rather closed for talent attraction from abroad. To benefit more from transnational R&I collaboration today's general declaration of importance of international collaboration should be replaced by more strategic R&I internationalisation policy: ➢ In line with that all national R&I measures should include relevant international dimension, stimulate partnerships, open-up for international partners and clusters, etc. Moreover, none of the smart specialisation priority areas should involve purely national agendas. ➢ Opening up public R&D and HE systems and staffing policies at the institutional levels to attract talent (researchers, lecturers, PhD students) from abroad. At the same time, given the demographic challenges and the limited supply of high quality labour force, Lithuania should start designing smart immigration policies, e.g. attracting specialists and business from abroad. ➢ For Lithuania it is justified to focus its transnational R&I cooperation efforts towards the Baltic Sea Region. E.g. establishing more joint R&I programmes, cluster alliances etc. where BSR countries pool funds and launch common calls for proposals could have a role to initiate and support the co-operation at its initial phase whereas build the capability for participation in Horizon 2020.

4. Reduce fragmentation and improve policy capacities	National Progress Programme 2014-2020. Strategic Research and Innovation Council (SMIT) and Innovative Economy Council (IET). Smart Specialisation process 2013-2014. The Strategic Planning Methodology. Analyses and Evaluations and studies performed by MOSTA and MITA.	Key remaining weaknesses: ➢ Fragmentation and failure to leverage different funds and create synergies between measures; lack of systemic coordination and policy monitoring and strategic intelligence capacity. ➢ The present governance mode, mirrored by process-oriented policy implementation vs partnership-based programme management. Introduction of SMIT or a list of strategies does not automatically solve the policy coordination problems. The structure of the mid-term policy documents, policy measures and agencies remains very fragmented. A systemic and consistent initiative has to be taken to address this challenge. Sound and inclusive governance set-up should allow for orchestrated implementation of a 2014-2020 smart specialisation policy framework: ➢ Collaboration and co-operation across all the relevant funding and development agencies and funding sources has to be ensured to facilitate streamlined, joined-up implementation of the actions required to realise the priority areas. The smart specialisation priorities are expected to provide different public sector stakeholders with the common framework and focus to be able to mobilise priority-relevant resources across different funding instruments. However, the strategy might not be enough; it also needs supportive governance processes to be implemented. In practice, it also means that there has to be one coordinating centre assigned with a responsibility to monitor synergies (and duplications) and review how successful are the different priorities in moving from stage to stage in the implementation process. ➢ Orchestration of policies affecting R&I performance in the priority areas would require both strengthened policy coordination and informed policy design processes. R&I monitoring and analysis of innovation performance (esp. on the business side), ex ante and ex post policy evaluation capacity, foresight capacity need to be increased substantially and assisted by consultations with the main stakeholders and actors in the innovation system. The smart specialisation monitoring framework should feed into rigorous impact evaluation system. ➢ Sufficient attention and adequate resources should be granted to effective programme management, with a focus on simplification, reducing administrative load, abandoning the risk-averse and process-oriented approach, strengthening the implementation capacity in the agencies, and overall making programmes closer to the needs of companies and researchers. It is important to create strong programme management skills - teams responsible for the implementation of the smart specialisation priorities and supervision of project pipeline initiation.

Source: Paliokaitė and Kubo (2013); Paliokaitė et al (2011, 2014a), Visionary Analytics (2014).

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Annex 2 - Abbreviations

BERD	Business Expenditures for Research and Development
ERA	European Research Area
EPO	European Patent Office
ERA-NET	European Research Area Network
ERDF	European Recovery Programme Fund
ESFRI	European Strategy Forum on Research Infrastructures
ESF	European Social Fund
EU	European Union
EU-27	European Union including 27 Member States
FDI	Foreign Direct Investments
FP	Framework Programme
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
ICT	Information and Communication Technologies
IP	Intellectual Property
IPR	Intellectual Property Rights
IUS	Innovation Union Scoreboard
IRP	Integrated research programme
KTO	Knowledge Transfer Offices
LVPA	Lithuanian Business Support Agency
LIC	Lithuanian Innovation Centre
LIS	Lithuanian Innovation Strategy for 2010-2020
LMA	Academy of Sciences
LMT	Lithuanian Research Council
MITA	Agency for Innovation, Technology and Science
MOSTA	Research and higher education monitoring and analysis centre
NIP	National integrated programme
NIS	National innovation system
NSRF	National Strategic Reference Framework
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
PCT	Patent Cooperation Treaty
PPS	Purchasing Power Parity
PRO	Public Research Organisations
RCP	Researchers Career Programme
R&D	Research and development
RI	Research Infrastructures
R&I	Research and innovation
RTDI	Research Technological Development and Innovation
SF	Structural Funds
SKVC	Lithuanian Centre for Quality Assessment in Higher Education
SME	Small and Medium Sized Enterprise
S&T	Science and technology
ŠMM	Ministry of Education and Science

ŪM	Ministry of Economy
VST	State Studies Foundation

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