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Abstract
The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

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Foreword

The report offers an analysis of the R&I system in Lithuania for 2015, including relevant policies and funding, with particular focus on topics critical for EU policies. The report identifies the main challenges of the Lithuanian research and innovation system and assesses the policy response. It 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 data is, whenever possible, comparable across all EU Member State reports. Unless specifically referenced all data used in this report are based on Eurostat statistics available in February 2016. The report contents are partly based on the RIO country report, 2014 (Paliokaite, 2015a).

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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 also provides up to date overview of Lithuania's R&I system for 2015, including relevant policies and funding, taking into account the priorities of the European Research Area and the Innovation Union.

Context

Lithuania is a small country with less than 0.6% of the total EU28 population (almost 3m inhabitants in 2015[1]), located on the eastern border of the EU. After being heavily hit by the recession of 2009, its economy was one of the fastest growing in the EU (6.1% GDP growth in 2011), however the rate of GDP growth decreased in recent years (1.6% in 2015 according to the Central Bank of the Republic of Lithuania).

As the 2008-09 economic crisis hit Lithuania very hard the country was under extreme pressure to pursue fiscal austerity measures. Those measures were implemented across the board, including R&D allocations. During the post-crisis fiscal consolidation in 2011-12 both GBAORD and government funded GERD stagnated nominally and as a share of total government expenditures, but decreased as a share of GDP. The post-crisis fiscal consolidation process had a negative impact on public support to the Lithuanian R&D expenditures but the evidence is not strong enough to conclude that it came at the expense of it. It was mainly due to the high share of EU funding that the country kept its R&D budget growing in the post-crisis years.

Lithuania ranks 25th in the Innovation Union Scoreboard (European Commission, 2015a) with no clear catching up with more advanced members of the EU. It can be considered a lower income country with specialisation in labour intensive traditional industries, facing the need for upgrading. The R&D effort is predominantly ensured by the public sector. At the same time there have been serious obstacles for public R&D commercialization and systemic collaboration (reflecting some path-dependencies): overdependence on basic science, outdated public R&D base and unattractive research careers, lack of social capital and network failures, weak innovation diffusion system, and low motivation to learn (Visionary Analytics, 2015). The private sector, in its current specialisation, does not perceive innovation as a critical factor to long-term competitiveness. This leads to limited capacities to absorb public R&D investments.

Changes in R&D spending were not significant in the previous years, however in 2014 GERD increased to 1.01% of GDP (from 0.95%), and the long-stagnating business funded R&D increased to 0.32% (from 0.26%). Despite this increase, achieved partly due to significant efforts to improve business R&D data collection, there is little chance that GERD and BERD targets set in Europe 2020 and national policy documents will be met.

There has been limited change in the structure of the national R&I system and its governance since 2012. The Ministry of Education and Science and the Ministry of Economy remain the two main bodies responsible for R&I policy, while several agencies distribute funding. The system as a whole is dominated by R&I funded and performed by public agents. The R&I policy remains fragmented. There is a main general strategic document, Lithuania 2030, which includes research and innovation. However, regarding the R&I policy specifically, the two above-mentioned ministries issued separate programmes which leads to some overlaps (e.g. both programmes cover R&D or education). The structure of funding flows remains rather similar to that of the previous years, and is dominated by the EU structural and investment funds (ESIF). Expectations for change are triggered by several recent initiatives:

[1] If not indicated otherwise, the source of the data is Eurostat [09-2015].

- The smart specialisation strategy development over 2013-2015 provided a cooperation framework for stakeholders from different institutions. Since both the Ministry of Education and Science and the Ministry of Economy will implement this strategy, a more collaborative approach is expected. Moreover, the monitoring and evaluation system was being developed in 2015 and involved both sides of the policymakers.
- Two initiatives of law making were started. The heavily revised Law on Higher Education and Science has been approved by the Government and is pending approval of the Parliament. The Ministry of Economy initiated a Law on Innovation Promotion. It was assessed externally in 2015, but further steps for its governmental approval were not taken.
- The years 2014-2015 have seen several evaluations and a benchmarking exercise, which is a positive sign. It indicates that there is more and more willingness to adopt evidence-based approach to policy making. One of the key evaluation initiatives in 2015 was the R&I system review carried out by the OECD, to be published in 2016.

Lithuania still has to make progress in aligning with some ERA policies. The country has made some progress in creating open labour market for researchers, but there is still considerable room for improvement. As a general rule, competition-based national research grants and research fellowships are open to non-residents from the EU and third countries but funding is not portable outside Lithuania. The level of transnational co-operation in joint activities with EU member states is rather low and the country is not very active in developing R&I cooperation with third countries. In general, the research system suffers from insufficient internationalisation.

The Lithuanian R&I policies have been focused in the recent years on technology upgrading and creation of public R&D infrastructure. Business access to venture capital markets have increased dramatically during 2011-2014. Although there were measures targeting innovative and young companies, this has not been enough to promote higher business involvement in R&D. Furthermore, the direct financial support for collaboration of science and business in joint R&D projects has been relatively low, compared to other policy instruments, but there are new policy measures in the pipeline (such as Joint initiatives) that aim to address this issue.

All in all, Lithuania‘s R&I system is behind the targets that were set for it both in terms of funding and in terms of framework conditions for R&I activities. The more specific structural challenges are the following:

- First, *building private R&D capacity.* The 2007-2014 innovation policy mix mainly focused on two routes: a) strengthening mature R&D performers and b) strengthening public sector research competencies, mainly through investments in R&D infrastructure. There is no evidence that any of it has been successful in leveraging business R&I capacities or restructuring the economy (Visionary Analytics, 2015). This means that 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’ (from basic to R&D based skills) largely differ within the target groups. A more balanced policy mix is needed, for example, focused on newcomers (start-ups, spin-offs, knowledge-based foreign investors) and encouraging previously non-innovative companies to transform their businesses towards higher value added activities.
- Second, *skills supply and demand mismatches* and availability of skilled human resources are pressing key obstacles for innovation. Companies lack specialists with skills important for innovating (Visionary Analytics, 2014). Despite a high numbers of graduates, Lithuania witnesses depreciation of higher education quality. A key challenge is to substantially improve education and training of skilled specialists, and to design smart talent attraction policies. The education system needs to integrate the critical, entrepreneurial, creativity thinking and social capital skills from an early age.
- Third, low *commercialisation of public research*. Most of Lithuania’s universities have limited capacities and motivation for commercialisation efforts. The innovation culture

and skills in universities and institutes need to be urgently developed. The collaboration between the business and the public research sector will not work unless the current researchers' career system and the 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 businesses. The existing public R&D services network (open access centres etc.) has to be better exploited.

- Fourth, *high policy fragmentation and limited policy capacities*, including lack of coordination at all levels, is an "old" problem**.** Absence of a systemic R&I policy approach has contributed to a fragmented mix of policies, policy instruments and implementation structures**.** Governance failures result in limited efficiency and missed opportunities. A number of systemic changes have been recommended over the years by experts and evaluators (Visionary Analytics, 2014, 2015; Technopolis Group and Ernst&Young, 2014, among others), for example to assign responsibility for developing and co-ordinating strategic intelligence on the basis of monitoring and ex-post evaluation to a single body and to align the mix of instruments, e.g. supply side with demand side policies, grants and reimbursable aid, national and transnational funding. Furthermore, such a body should not be dependent on other stakeholder institutions, such as ministries, but be established at a higher level.

The new policy mix for the financing period 2015-2020 aims to tackle some of these challenges. It is too early to tell how successful the designed measures will be. Furthermore, from mid-term perspective, the R&I system's dependence on EU ESIF poses a significant future challenge for Lithuania. It is likely that in the following programming period there will be a significant decrease of funds provided by the Commission. In this case, R&D expenditure will drop significantly and such a shock can prove detrimental to the whole R&I system. Therefore, in the following five years the Government should ensure that R&I funding sources become more diverse.

R&I Challenges

Challenge 1: Building private sector R&I capacity

All R&D and innovation performance indicators related to the business sector (e.g. BERD), as noted throughout the report, remain well below the EU-28 average. The private sector, in its current specialisation, does not perceive innovation as a critical factor for long-term competitiveness. This leads to limited capacities to absorb public R&D investments indicating the need for capacity building in the private sector. Export and competitiveness in Lithuania are highly dependent on relatively large (total share in value added and employment — up to 40% in 2013) traditional sectors such as transport and logistics, retail, agriculture, construction, manufacture of food products, beverages and tobacco products and manufacture of furniture. The number of existing research and innovation performers is rather limited. Therefore it is logical to focus on newcomers (start-ups, spin-offs, knowledge-based foreign investments) and to encourage previously non-innovative companies to transform their businesses towards higher value added activities.

The 2007-2014 innovation policy mix mainly focused on two routes: strengthening mature high-tech firms and public sector research competencies and commercialisation. There is no evidence that any of it has been very successful. For example, it is unlikely that ERDF policies had a significant effect on the development of high technology sectors in Lithuania (based on the results of MOSTA, 2015a; BGI Consulting, 2014; CSIL, Visionary Analytics, 2015). Direct support for business R&D over 2007-2015 reached merely 157 high/medium high technology firms (Visionary Analytics, 2015). It is also unlikely that direct support for business R&D had a significant effect on overall business R&D indicators, partly because of the high administrative load. Policy additionality has been achieved in about only 30-40% of the funded projects (Visionary Analytics, 2015). Finally, there is no evidence of significant economic impact of the clusterisation promotion or the investments in the innovation promotion infrastructures (Visionary Analytics, 2015). Innovation promotion intermediaries had limited effect on the collaborative behaviour of SMEs due to the focus

on investment in "hard" infrastructure. A warning sign is that as a direct response to the policy instruments there are now more than 40 clusters in a country as small as Lithuania. Thus the next period's challenge is to create incentives for merging the clusters working in similar sub-sectors and/or technology fields. A positive development is that public procurement for innovation and other demand-led policy instruments have started to be discussed and pre-commercial procurement was approved in 2015.

In Lithuania, the "low-hanging fruit" is starting to disappear. During the last decade, there has been a strong appreciation of the real effective exchange rate (35%, compared to 21% in the EU27) indicating a loss in cost and price competitiveness. Nominal unit labour costs have increased by 26% between 2000 and 2010, compared to an increase of 14% in the EU27 and 20% in the Euro area. While labour productivity per hour worked has gradually increased over the last decade, it is still about 45 percentage points below the EU27 average. This indicates the need to increase productivity further and to find new sources for competitiveness and growth. It's not anymore so easy to do business based on low cost and operating in the least profitable parts of the value chain. The labour costs are rising and competition is going up. The challenge is moving up the value chain - either by upgrading the position in the international value chain, or by starting to invest more in R&D and developing own products, becoming a brand owner and investing in marketing and sales. This requires not only technological, but also managerial skills.

The key challenge for Lithuania, thus, instead of focusing on the few existing R&D based innovators, is to promote the structural change of the economy by providing a transformation agenda for diversification of existing (incl. traditional) sectors and transition to new knowledge based activities. It would help upgrading the role of the Lithuanian industry in the global value chains. Importantly, 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 (mature, new and potential innovators). The country should take maximum advantage of its Smart specialisation strategy and use it as a basis to create a favourable environment for supporting entrepreneurship and fostering emerging technologies in export-oriented and high value added market segments where Lithuania has the capacity to attain a potential competitive advantage.

Challenge 2: Skills supply and demand mismatches

A key emerging bottleneck for the development of a knowledge intensive business sector (see challenge 1) is the availability of skilled human resources for innovation creation. High outward migration and low quality of education (from basic education to lifelong learning[2]) lead to mismatches in skills demand and supply as well as general shortage of skilled labour. This problem has a number of dimensions.

First, negative demographic tendencies with an increase by more than 67% since 1990 of the share of the population aged above 64 years and high economic migration steadily reduce the supply of labour. This puts future economic growth at risk. Second, since joining the EU, Lithuania has lost a substantial part of its labour force which has migrated to work in other EU Member States. According to Eurostat, the majority of Lithuanian economic migrants (73%) are 15–44 years old. If the current trends are not reversed, according to the European Commission's Ageing Report (2012), in 2030 Lithuania will have 384,000 less people of working age (15-64 years) compared to 2010, the labour force (in the 20-64 years group) will reduce to 1.376m, and the number of pensioners will increase to almost 1m.

Third, the current education system has a number of flaws. Despite a large number of higher education institutions in the country, none of the Lithuanian universities are in the top 500 world universities according to QS World University Rankings 2015/2016. Lifelong

[2] According to Eurostat, with respect to reading literacy performance of pupils Lithuania ranked only 20th out of 26 countries where data is available, in 2012. The country was also 21st in EU-28 with respect to lifelong learning.

learning is also comparatively low in Lithuania. In 2014, only 5% of persons aged 25 to 64 received education or training in the four weeks preceding the corresponding Eurostat survey. The EU28 average was 10.7% in the same year. These factors lead to lower level of skills compared to other EU countries (also see Martinaitis et al., 2014) and low acquiring of skills at later age.

Studies confirm the increasing mismatch between supply and demand of specialists in technology fields. For example, a survey of manufacturing companies (Visionary Analytics, 2014) revealed that one third of the surveyed firms lacked engineers, technology designers, technologists and technology project managers for pursuing their innovative 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, the Ministry of Education and Science increased funding of higher education in technology fields in 2014. 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 the total of €8.02m allocated per one study year), hoping to increase the attractiveness of technology education. However, this measure is clearly not sufficient to address the emerging challenge of ageing society and skills mismatches. It is important to ensure that there will be no shortage of skilled workers that are needed for carrying out R&D activities and other knowledge based activities, for initiating innovation ideas and creating innovative start-ups. A key challenge here is to substantially improve education and training of skilled specialists, and to design smart talent attraction policies. Based on Scandinavian examples, the education system needs to integrate the critical, entrepreneurial, creative thinking and social capital skills from early age.

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). This, at least at the policy document level, is addressed in Lithuania's smart specialisation strategy. In addition, public R&D and higher education systems need to open up more. This means they should adjust their staffing policies and dismantle language barriers to attract talent from abroad and ensure equal opportunities to foreign researchers not only in theory but in practice as well.

Challenge 3: Commercialisation of public research results

The majority of the overall modest R&D efforts in Lithuania are funded by the public sector, i.e. national budget and EU funds, and performed by public research institutions. Despite the huge potential, weak capacity to commercialise and exploit public research for economic benefits becomes more evident after heavier investments in research production (€400m invested in RIs alone[3]). The research output achieved is substantially weaker than in most EU Member States regardless of the heavy investments. For example, in terms of international co-publications, Lithuania is 24th in the EU (324 international co-publications per million, according to IUS 2015). In terms of scientific publications among the top 10% of the most cited publications worldwide as percentage of total scientific publications of the country, Lithuania was 22nd in the EU28 over 2000-2013. Moreover, in 2013 Lithuania had only 5.7 public-private co-publications per million of population compared to 29 for the EU-28. The number of EPO patent applications per million of inhabitants (6.09) was almost 18 times below the EU28 average (108.05) in 2012. Furthermore, according to WIPO, in 2013 Lithuania was 22nd in the EU28 by the PCT patent applications per million of inhabitants (46.1). Moreover, according to the innovation output indicator scores in 2010 and 2011, Lithuania has a second lowest score in EU-27 and is just above Bulgaria. It is unlikely that Lithuania will bridge this gap in the short or medium term. Thus, there remains a need for subsequent efforts to encourage research commercialisation. This

[3] It should be noted that two large infrastructure centres (National Centre of Physical and Technological Sciences and Joint Centre for Life Sciences) were only opened in the beginning of 2016 so returns cannot be expected yet.

could be achieved through spin-offs and knowledge transfer to the private sector through dedicated R&D services, and ensuring productive cross-sectoral (including science-industry) collaboration.

The starting point, however, is rather weak. Clusters could provide arenas for related cross-sector links internally (in the region) and externally. However, the cluster formation is in its early phase in Lithuania and few of the first results of the respective support programmes are encouraging. The way the clusters were initiated didn't support effectively enough the cross-sectoral approach and connections with the local knowledge sources (institutes and universities at the so-called 'valleys') and with the ones 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.

The policy makers are trying to address these issues in the new programming period. The OP for 2014-2020 plans to finance "joint initiatives", i.e. two or more complementary collaboration projects which involve R&D activities and have the aim of creating market-oriented commercially viable prototypes of technologies and products with high value added. In addition, the newly proposed Law on Higher Education and Research introduces the concept of "industrial doctorate" which would be another step forward in strengthening the ties between science and industry. The degree of success of these initiatives is to be seen in the next few years.

An increasing concern in Lithuania is how to deal with the issue of funding public research as an opportunity to strengthen 'demand steering', putting more focus on the industry capabilities and needs and the economic return on investments. So far, the policy results have been positive but weak (see Chapter 5.7). Universities and their research institutes are mainly dedicated to the roles of teaching. Applied research accounts only for approximately half of R&D performed in the higher education sector in 2013. Experimental development only made 12% of all R&D activities in this sector in the same year. In order to achieve better results of innovation performance, Lithuania needs to shift the focus of the national R&I system from basic science to innovation (Paliokaitė and Kubo, 2013). From this perspective there remain several issues.

First, the entrepreneurial culture in the Lithuanian universities needs to be urgently developed. It requires a change of the mind-set at the universities via incentive systems, e.g. modifications in the research funding rules (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 the collaboration of public sector researchers with companies are the researcher's career rules (overdependence on academic publications, and little attention to R&D results) and the lack of motivation at the institutional level.

Second, a related objective is to exploit the already created R&D infrastructures for commercialisation and technology transfer. There is extensive fragmentation of various innovation support institutions. The State should review the current existing innovation promotion structures. Attention should be placed 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. A virtual R&D infrastructure network could allow for developing innovation from idea to pilot manufacturing. In addition, all public research institutes and research centres with a mandate to engage with industry, and especially the open access centres in the 'valleys', should develop a distinctive industry-focused culture. They have to become better at marketing their research to the business sector.

Challenge 4: Reducing fragmentation and improving policy capacities

Fragmentation is a keyword to describe the current situation in R&I governance in Lithuania. 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. Governance failures result in lack of efficiency and missed opportunities. One example of limited synergies and high fragmentation is the failure to re-align the science "valleys", science and technology parks (STP) and industry clusters. As a result, Lithuania has 40+ clusters, 20+ 'open access centres', 9 science and technology parks, and several agencies with overlapping functions. Links between agents remain the weakest part of the innovation system, making it difficult to transform innovation inputs into outputs efficiently.

Policy fragmentation between the Ministry of Education and Science (covering higher education and public R&D policies) and the Ministry of Economy (responsible for private R&D and innovation policies) is often reinforced by discord between these two ministries. Although there is a background for cooperation in the process of implementation of smart specialisation, this remains a critical issue, considering the planned policy mixes of the two ministries. Collaboration across all the relevant funding and development agencies and funding sources has to be ensured to facilitate a streamlined implementation of RIS3 and to implement the holistic "whole of government" approach by integrating innovation policy into other policies.

At the strategic level, the lack of systematic (*ex post* and *ex ante*) evaluation hinders policy learning and does not allow improvements in the design and implementation of policies. The smart specialisation process has shown that policy-makers have limited understanding of how regions in principle diversify into new growth paths, and to what extent public policy may affect (or has affected) this process. Monitoring and evaluation of smart specialisation strategy by MOSTA and the Ministry of Economy should partially fill this gap. Nonetheless, it should be noted that access to business data may be difficult to get.

At the operational level, there is a relatively high administrative load (formal, technical and lengthy procedures, excessive bureaucracy, limited flexibility) for the applicant companies. For example, the "paper-based" application procedure provides an incentive for firms to hire consulting companies to draft grant applications that appeal to the reviewers but favour form over substance. In addition, the public support system has developed a culture of risk-aversion, biased against early-stage and high risk innovation ventures. Moreover, the staff of implementation agencies faces a set of constraints stemming from the overly legalistic approach to programme management. Emphasising on the EU's legal framework, the Lithuanian administrative law and procurement regulations often make civil servants 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. The new programming period has provided agencies with a window of opportunity to review their approaches. It remains to be seen if this opportunity will be exploited. The Ministry of Economy (and LVPA) intends to adopt a more flexible approach in applying the R&D concept by acknowledging the "D" (development) part when selecting the projects.

Looking further to the mid-term future, the post-2020 period will bring new governance challenges. This includes optimisation of the network of agencies and institutions that are currently focused on the administration of ESIF, more emphasis on policy impacts (hence – strategic intelligence, especially *ex post* evaluation) and even better coordination due to the need to exploit policy synergies for achieving more with less. Lithuanian policy makers have the responsibility to use the 2016-2020 period to prepare for these challenges and to develop the necessary capacities.

1. Overview of the R&I system

1.1 Introduction

Lithuania is a small country with less than 0.6% of the total EU28 population (almost 3 million inhabitants in 2015[4]), located on the eastern border of the EU. After the recession of 2009, its economy started to recover and was one of the fastest growing in the EU. However the rate of GDP growth recently decreased (from 6.1% in 2011 to 1.7% in 2015 with 2.6% GDP growth expected in 2016, according to the Central Bank of the Republic of Lithuania).

Despite high growth level, Lithuania is still lagging behind the EU average in terms of GDP per capita. In 2014 the difference was still more than twofold. The gap in absolute terms was diminishing very gradually over the last three years (the difference was €15.300 in 2012 and €15,000 in 2014). Although in 2012-2014 the rate of GDP growth was decreasing, over the whole period it was consistently positive and above the EU average. Thus, Lithuania was recovering from the economic crisis quicker than other EU Member States (MS) on average. Positive trends in the economy are also reflected by decreasing Lithuania's budget deficit. It shrank from -3.1% of GDP in 2012 to -0.7% of GDP in 2014. This may indicate both lower public spending and lower public borrowing. The EU average in 2014 was -3.0%, i.e. on average the deficit in EU MS was higher than in Lithuania. In terms of unemployment Lithuania also shows recovery from the crisis. While in 2012 unemployment rate was 13.4, by 2014 it diminished to 10.7%, and approached EU average (10.2% in 2014).

Concerning the structure of the economy, Lithuania's economy mostly relies on services, and the knowledge-intensive sector[5] accounts for 32.8% of total employment (2014). In 2012 gross value added from knowledge-intensive high-tech services amounted to 5.4% of total gross value added. Additional 7.5% added by knowledge-intensive market services excluding high-tech and financial intermediation. High-tech and medium-high-technology manufacturing accounted for 1.9% of total gross value added. Data for low tech manufacturing is confidential and, thus, not available. The agriculture sector's importance for the economy is diminishing. In 2012 agriculture still accounted for 4.4% of total gross value added, but in 2014 the figure fell to 3.5%. The gross value added of agriculture in terms of absolute numbers is also diminishing, even though employment in the sector increased in 2014.

Nominal GERD increased from €298.4m in 2012 to €369.83m in 2014. Compared to the country's GDP, the indicator is quite low – 1.02% of GDP in 2014. In EU28, GERD as percentage of GDP was 2.03%. Growth in GERD per capita (from €99.3 in 2012 to €125.6 in 2014) reflects both increase in total volume of GERD and diminishing population of the country. In terms of GERD per capita Lithuania is about 4.4 times below the EU average (€558.4 in 2014), and ranks only 21st in EU28. Thus, in terms of R&D expenditure Lithuania is significantly behind the EU average and current trends do not show possibility of rapid convergence. National targets for GERD and BERD as percentage of GDP were set for 2020. For GERD the figure is 1.9% (set in the Europe 2020 Strategy), for BERD – 0.9% (set in the National Development Strategy 2014-2020). Without radical changes in current R&D expenditure trends, these targets will not be reached, especially considering that the majority of government R&D expenditures come from EU ESIF. BERD remained approximately constant in 2011-2013, around 0.24% of GDP. GERD increased from 0.9% in 2012 to 0.95% in 2013 and to 1.02% in 2014. In 2014 BERD increased to 0.3% of GDP, but a major breakthrough in stimulating BERD is required to approach the due targets by 2020.

[4] If not indicated otherwise, the source of the data is Eurostat [12-2015].

[5] For economic activity sectors that are defined as knowledge-intensive services refer to Eurostat (n.d.).

Turnover from innovation is only half of the EU average. In 2012 it accounted for 5.5% of total turnover, whereas in the same year in Europe the figure was 11.9%. The turnover from innovation reached a peak in 2006 (12.4%) and since then was decreasing (6.6% in 2010). Due to low data availability it is impossible to assess change in the last two years. However judging by trends in GERD, it is doubtful that the situation could have improved significantly, unless the initial decrease was caused by the economic crisis. This would mean that recovery might have led to increase in turnover from innovation, but lack of data does not show it yet.

Table 1 Main R&I indicators 2012-2014

Indicator	**2012**	**2013**	**2014**	**EU average**
GDP per capita	11,200	11,800	12,400	2014: 27,400 2013: 26,700 2012: 26,500
GDP growth rate	3.8	3.5	3.0	2014: 1.4 2013: 0.2 2012: -0.5
Budget deficit as % of GDP	-3.1	-2.6	-0.7	2014: -3.0 2013: -3.3 2012: -4.3
Government debt as % of GDP	39.8	38.8	40.7	2014: 86.8 2013: 85.5 2012: 83.8
Unemployment rate as percentage of the labour force	13.4	11.8	10.7	2014: 10.2 2013: 10.9 2012: 10.5
GERD in €m	298.37	332.43	369.83 (p)	2013: 9,806 2012: 9,649
GERD as % of the GDP	0.9	0.95	1.02 (p)	2014: 2.03 (p) 2013: 2.03 2012: 2.01
GERD (EUR per capita)	99.3	111.9	125.6 (p)	2014: 558.4 (p) 2013: 54 2012: 534.4
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	1.8	1.8	1.9	2014: 5.7 2013: 5.6 2012: 5.6
Employment in knowledge-intensive service sectors as share of total employment	33.6	33.1	32.8	2014: 39.8 2013: 39.4 2012: 39.3
Turnover from innovation as % of total turnover	5.5	NA	NA	2012: 11.9
Value added of manufacturing as share of total value added	23.7	22.9	NA	2012: 26.2
Value added of high tech manufacturing as share of total value added	0.8	0.9	NA	2012: 2.5

Source: EUROSTAT

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

1.2.1 Main features of the R&I system

R&I system in Lithuania is centralized and regional governance plays little role in public policy of this area, since R&I policy decisions are made at the national level. Comparing funding sources, the Lithuanian R&I system is mainly funded from the EU ESIF and the national budget. In 2014, total funding from abroad was 34.24% of GERD. Public sector funded 33.84% of GERD (government – 33.68%, higher education – 0.2%). The business enterprise sector funds only 31.69% of all R&D performed and the private non-profit sector – 0.2%.

The 14 State universities form the backbone of the Lithuanian research system (the remaining 8 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 53.11% of GERD in 2014. The government sector in 2014 performed roughly 17.36% of all R&D. The share of R&D performed by the Business sector in 2014 constituted approximately 29.54% of total GERD. Private companies which carry out R&D are mostly high-tech SMEs of local origin.

1.2.2 Governance

Lithuania has a stable centre-of-government R&I structure, which provides predictable policy and budgetary framework. Approved legislative documents define how R&I funding will be distributed, so there is less uncertainty about budgetary procedures. Policy orientation is broadly defined, although it tends to change (e.g. joint research programmes which accompanied the creation of scientific valleys were abandoned), but even if revised, broad direction of policy is always indicated. The Smart Specialisation Strategy provides broad direction for Lithuanian R&I policy development in the coming years until 2020.

Creation of Smart Specialisation Strategy and identification of priority areas serves as a good example of involvement of relevant stakeholders. All priorities were identified with the help from governmental, research and business sectors. Representatives of each group participated in discussions and consultations to help shape Lithuanian Smart Specialisation Strategy, including drafting policy roadmaps that were used as basis for the Action Plans for the implementation of priorities.[6]

For a small country such as Lithuania the institutional system for the formation and implementation of research and innovation policy is rather fragmented. The two principal governing bodies, shaping R&D and innovation policy in Lithuania, are the Ministry of Economy, which is responsible for innovation policy, and the Ministry of Education and Science, responsible for higher education and (mainly public) R&D policy. The role of R&I Council is played by the Strategic Council for Research, Experimental Development and Innovation (SMIT). The five main agencies (MITA, LVPA, ESFA, LMT, CPVA) are responsible for funding of research and innovation.

Advisory bodies that help policymakers to shape R&I policy were established. The Lithuanian Research Council (LMT) formally 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 functioning agency responsible for the competitive funding of research programmes. Therefore, it now serves a dual role both as an advisory and a funding institution, with the latter dominating the former (European Science Foundation, 2014). The Research and Higher Education Monitoring and Analysis Centre (MOSTA) is an analytical and advisory body to the Ministry of Education and Science. Although there were

[6] For more information refer to MOSTA (n.d.).

discussions about establishing a similar advisory body under the Ministry of Economy, no such centre was established in 2015.

The R&I policy evaluation system is in development. In December 2009 MOSTA began implementing MOSTAF project. Its purpose was to create and test a research and higher education monitoring and analysis system, which to some extent was achieved. The project ended in October 2015. During the time various studies of the Lithuanian R&I system were carried out. This includes evaluation of return on public investment in R&D, international benchmarking of research institutions, foresight analysis, annual reviews of the state of Lithuanian research, etc. Some of the developed tools are already used systematically, some were only introduced and have not been used regularly so far. Formally, outputs of these activities were not necessarily used as grounds for policy change, but served as an idea and advice pool for policymakers. For example, based on evaluation of strengths of industry and science in Lithuania, smart specialisation priority areas and concrete priorities were identified. From 2015 on, monitoring and evaluation of smart specialisation implementation in Lithuania has started. As of the second half of 2015, a specific system has been developed by MOSTA and the Ministry of Economy. It should cover output indicators, interim evaluation, impact analysis, foresight exercise, etc. This monitoring and evaluation system will be used for an interim review of the Lithuanian smart specialisation strategy implementation and to plan R&I policy after 2020. Therefore, the role of monitoring and evaluation of R&I programmes will increase in the nearest future, and systemic annual updates will be provided to policymakers. By 2015 Lithuania did not have an accepted macroeconomic model that would assess R&I impact on economic growth specifically, although macroeconomic models are used to monitor and forecast the development of the country's economy.

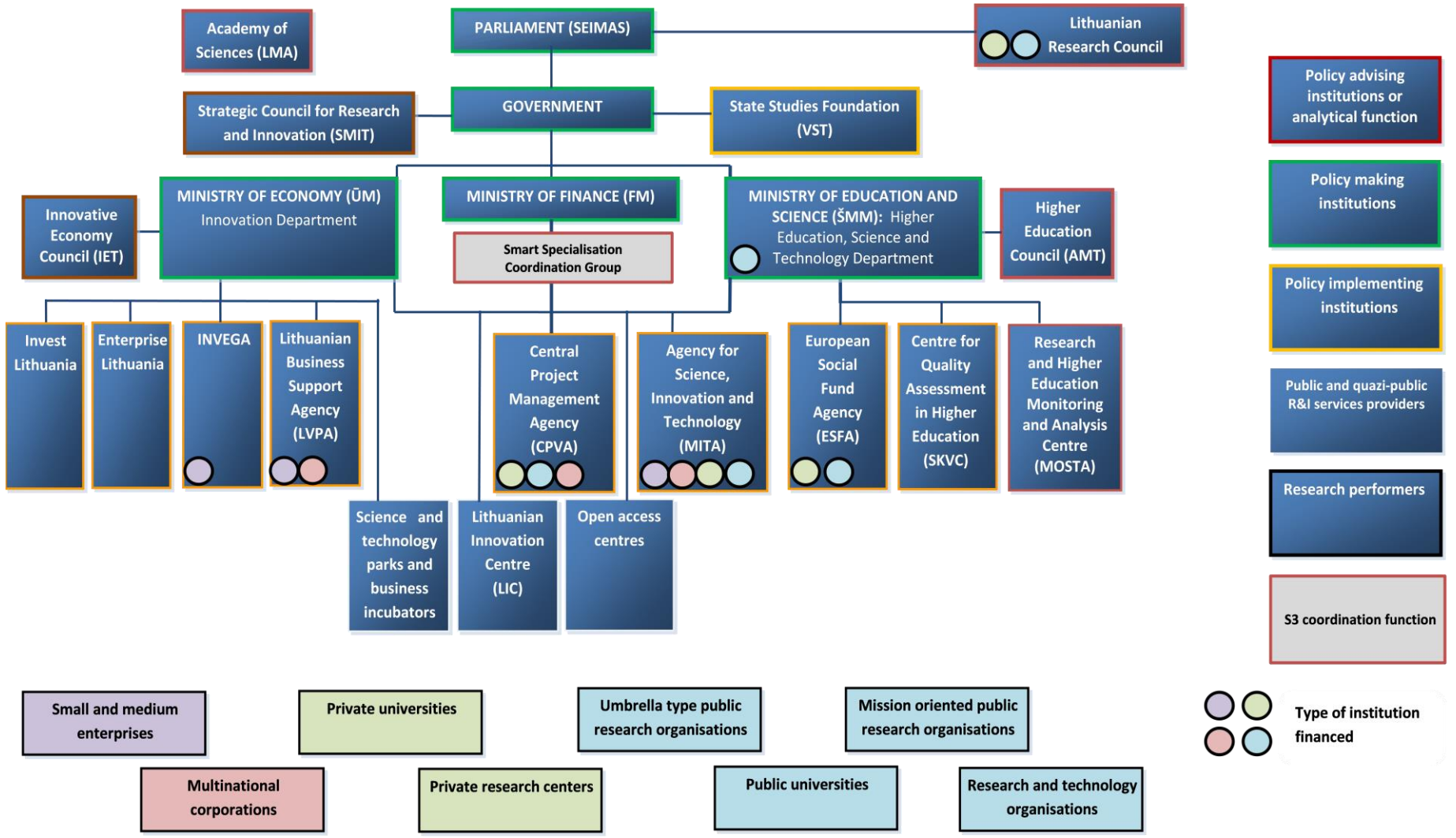
1.2.3 Research performers

HEIs[7] and public research organisations perform the majority of research activities in the country. In addition to research HEIs provide post-secondary teaching services. Although there are lower level post-secondary education institutions, HEIs remain the most popular choice for continuing education (MOSTA, 2014a). The activities of research and teaching are not always separated which leads to a major issue with researchers working full-time or part-time at HEIs. They often must both teach and carry out research. Therefore, teaching-related activities consume significant share of the researcher's timeand research-related activities suffer or must be done after working hours (MOSTA, 2015b and related reports). The same applies to third mission activities.

Data on research-oriented private sector structure is difficult to come by, due to confidentiality issues. However, it can be stated that 40.7% of companies introduced innovations in 2012-2014, a noticeable increase compared to 30% in 2010-2012 (Statistics Lithuania, 2016). The sector that was the most innovative was ICT (63.3% of enterprises). Lowest innovativeness was found in construction (30.3% of enterprises). Although nearly all sectors saw increase in the share of innovative enterprises, this indicator fell by 8.8 p.p. in the finance and insurance sector. The highest increase in innovative companies was observed in mining and quarrying (30.9 p.p.). Medium and high-tech industry and knowledge intensive services are the principal R&D investment sectors. The private sector research community is dominated by small and medium sized high-tech indigenous firms (Visionary Analytics, 2015).

[7] Mainly universities and research institutes, as colleges perform research only at a small scale.

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



Source: Developed by the authors, based on Paliokaite (2015a)

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

Concerning R&I policy, there is no single specific strategic document. However, the National Progress Strategy 'Lithuania 2030' which broadly defines the direction of the country's development also covers R&I even if in general terms. Overall, six key long-term and midterm policy documents were introduced or revised since 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, the updated Concept of the Establishment and Development of Integrated Science, Studies and Business Centres (Valleys), the Lithuanian Innovation Development Programme for 2014-2020 and the Programme on the Implementation of the R&D&I Priority Areas and Their Priorities which comes together with separate Action Plans for each priority. This Programme sets out the Lithuanian smart specialisation priority areas and their priorities and discusses some elements of the implementation and monitoring instruments. Its development incorporated foresight analysis, review of Lithuanian market developments and strengths in research. The priorities will be reviewed in 2017-2018. The principles of coordination and monitoring provide that a Coordination Group formed by key stakeholders will be established to monitor and coordinate the implementation of the priorities.

The Ministry of Economy launched an update of the broad Lithuanian Innovation Strategy for 2010-2020 and replaced it by a new strategic document in the form of Lithuanian Innovation Development Programme for 2014-2020 which was approved by the Government in December 2013. 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.

Overall, there remains large fragmentation of policy institutions and policy documents, despite there being an overarching strategy 'Lithuania 2030' and a smart specialisation strategy which provide a common direction for R&D&I. 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). The Ministry of Economy and the Ministry of Education and Science cooperated in the development of the Programme on the Implementation of the R&I Priority Areas and their Priorities. Still, differences in approaches of the two ministries are clear. This, for example was shown during establishing of the monitoring and evaluation mechanism for the smart specialisation programme.

Proposals for new laws or their revisions were made in 2015. The Ministry of Education and Science drafted a new Research and Studies Law which was approved by the Government and was considered in the Parliament but not yet adopted in 2015. The planned Law on Innovation Promotion (led by the Ministry of Economy) seems to be put aside.

The main changes over the last three years were: a) increased attention to strategic planning (a number of new planning documents were approved); b) development of Lithuania's Smart Specialisation Strategy in 2013-2015 coordinated by the Coordination group, established by the two ministries and MOSTA; c) proposed revisions to the Law on Research and Studies in 2015 (still to be approved by the Parliament as of January

2016). Regarding the latter, main revisions affect higher education, i.e. contracts with higher education institutions, studying fees, etc. However, the revised law also introduces the concept of *industrial doctorate*. Other less significant developments in the R&I area are discussed in the various chapters throughout this report.

The adopted strategies shape the actually implemented policies to some extent. This is especially the case with the Lithuanian Smart Specialisation Strategy. R&D&I measures for 2014-2020 EU ESIF financing period were based on this strategy. This also shows that policy is shaped in line with EU priorities since significant amount of R&D&I funds come from the European Commission, and Europe 2020 targets are referred to in policy documents. However, lesser attention is paid to leveraging private investment from public spending. International cooperation is mentioned among priorities in strategy documents, especially stressing the importance of joining international innovation and research infrastructure networks.

2.2 R&I policy initiatives

As discussed in section 2.1, there is still large fragmentation of policy initiatives, as is the case with policy documents. Some of them cover research, innovation and education in an integrated manner, while others treat them separately. Sometimes the objectives of documents overlap. Since just a general national strategy document exists but two ministries are responsible for these policy areas, it is not surprising that there is a lack of coordination among policies covering research, innovation and education.

Policy initiatives deal not only with 'soft' R&I activities, but also cover research infrastructure (RI). The OP for 2014-2020, under the Investment priority 1 'Enhancing research and development and innovation (R&D&I) infrastructure and capacities to develop R&D&I excellence and promoting centres of competence, in particular those of European interest' and its specific objective 'Enhancing R&D&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. In April 2014 the government updated the Concept of the Establishment and Development of Integrated Science, Studies and Business Centres (Valleys) which specifically covers RI development in five centres, and the possibility to establish new similar 'valleys', although no specific investment was planned. The concept was updated to show the potential synergies between 'valleys' and smart specialisation. In August 2015 the Ministry of Education and Science approved its General Action Plan of the Programme on the Implementation of the R&I Priority Areas and Their Priorities which also includes research infrastructure. It aims at finishing the development of the RI system, empowering RI, encouraging international cooperation, and integrating RIs into international networks. However, investment was still on hold at the beginning of 2016 because some of the proposed infrastructure was not thematically in the RIS3. In the same year, it also drafted a new Law on Higher Education and Research which was approved by the government in July 2015, however it was not yet approved by the Parliament in 2015. The planned Law on Innovation Promotion (initiative led by the Ministry of Economy) seems to have been put aside and was not reconsidered in 2015.

Despite welcome initiatives in R&I policy, there is no coherent and integrated framework for fostering innovation, and strengthening the knowledge base and fundamental research. Furthermore, since R&I policy is in the domain of two separate ministries, it sometimes leads to institutional collisions. These collisions might be strengthened by coalition politics if the Ministers are appointed by different parties. Nevertheless, since two ministries are responsible for the implementation of the Smart Specialisation Strategy, it is possible that the amount of cooperation will increase, and policy will become more integrated, leading to the creation of a more coherent framework.

Evaluations, consultations, foresight exercises

During 2014-2015 several evaluations and consultations were carried out. The process of identifying national R&I priorities and drafting the Smart Specialisation Strategy for 2014-2020 is the key analytical consultation initiative launched in 2013. It continued throughout 2014 and into 2015. As a result, a list of 6 R&I policy priority areas, with 20 specific priorities were identified within them. Groups involving stakeholders prepared implementation roadmaps. 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 became the basis for thematic R&I priority development programmes. The priorities Action Plans were approved 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 was achieved in the course of expert panels and other activities. It 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.

In 2014, the High Technologies Development Feasibility study was launched by the Ministry of Economy. Key conclusions of this Study (Visionary Analytics, 2014) stated that: a) in the new 2015-2020 period the policy spotlight has to move from 'hard' infrastructure development to capacity strengthening and acceleration of new ideas; b) 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; c) the key emerging problem is availability of skilled human resources for innovation, particularly – engineers, technologists and technology designers; d) R&D policy is dominated by basic research; e) business and public research sectors collaboration will not work unless the researchers' career system and public R&D institutional funding mechanism are modified; f) lack of coordination has led to huge fragmentation of instruments, programmes, institutions and infrastructures. In addition to this study, 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. The impact of the proposed Law on Innovation Promotion was also assessed *ex-ante* by an external organization. It indicated that the law should be oriented towards greater coherence with the Law of Research and Higher Education and the Law of Small and Medium Enterprises (Baltic Legal Solutions Lithuania, 2015).

A 4-year long project aimed at the monitoring and analysis of the integrated science, studies and business 'valleys' ended in March 2015. 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.

In 2014 MOSTA contracted two separate research studies to develop methodologies for calculating the return on State's investment in R&D and higher education. The methodology on estimating the return on public investments in R&D should also serve as the impact assessment methodology for smart specialisation. The pilot study on the return on State's investments into R&D was finished by June 2015 and covered High Technology Development Programme (for years 2011-2013) as well as Intellect LT measure. The study combined surveys, case studies and counterfactual analysis, and laid ground to a monitoring and evaluation system. The main indicative findings of the study were that the second call of Intellect LT had positive impact on employment. Evaluation of High Technology Development Programme (for years 2011-2013) suggested that it had small positive impact on employment, contributed to increased private R&D expenditures, and increased organisations' capacities to perform R&D and innovation (MOSTA, 2015a).

Furthermore, MOSTA conducted a Research Assessment Exercise in Lithuania, which took place from April 2014 to April 2015. MOSTA coordinated the exercise in consultation with the LMT according to a methodology prepared by Technopolis Group. The key element of the exercise was international peer review of research in universities and research institutes. The exercise was based on broad disciplinary panels composed of international top-level experts. The results were published in the first half of 2015, and were widely discussed with the stakeholders (Ministry of Education and Science, LMT, universities and research institutes. Results position different research units in the international context. The results indicate that despite good infrastructure and niches of excellence there is also high fragmentation with overlaps and thematic duplication in different research units, low management skills, lacking internationalisation and incentives for performing research. (MOSTA, 2015b).

Meanwhile LMT finished its triennial assessment of institutional research output in November, 2015. Its results will be used for allocation of institutional research funding by the Ministry of Education and Science. A review of the methodology of institutional assessment is proposed, but no results were available by the end of 2015.

In 2015, the Ministry of Economy and Knowledge Economy Forum prepared an initial assessment of the Lithuanian innovation policy in relation to Lithuania preparing to join OECD. The OECD should also publish its Review of Innovation Policy: Lithuania in 2016.

2.3 European Semester 2014 and 2015

In May 2015, the Commission has published country-specific recommendations for each Member State and issued Research and Innovation related recommendations for some of the countries, among which Lithuania was not included.

Lithuania's National Reform Programme (NRP) 2015 includes several measures related to R&I. These are (Government of the Republic of Lithuania, 2015):

- Commercialisation and application of science in business, mainly through scientific valleys and open access centres, but also through innovation vouchers and other means;
- Accrediting laboratories;
- Protecting intellectual property;
- Promoting clusterisation;
- Renewing the concept of science and technology parks.

This list somewhat updates measures discussed in NRP 2014, although they share some similar goals (such as measures to strengthen business-science cooperation). Most measures listed in NRP are related to R&I challenges identified in the 2015 European Semester Country Report. The main challenge is the lack of business involvement in R&I activities. Another important issue is the lack of coherent strategy for knowledge transfer. Valleys and parks can be important drivers of business-science cooperation, however, a lot still needs to be done in empowering these centres. Protection of intellectual property (IP) can contribute to knowledge transfer and the support measure to promote protection of IP rights have already started to show the results (European Patent Organisation reported that the number of patent applications by Lithuanian representatives increased by 60% in 2015 and reached the number of 39). However these measures have not achieved so far their most important aim – increasing business investment in R&D. Furthermore, significant part of new funding is on hold due to lag in launching new instruments. The National Reform Programmes 2014 and 2015 mention one target with R&I relevance – the gross domestic expenditure on R&D (GERD) should reach 1.9% of GDP by 2020. Lithuania's composite innovation index is increasing (European Commission, 2015b) and R&I funding indicators demonstrated positive trends over the last three years. However this target will not be met if the rate of progress remains the same (the increase of GERD as % of GDP was from 0.9% in 2012 to 0.95% in 2013 and 1.02% in 2014).

2.4 National and Regional R&I Strategies on Smart Specialisation

The Lithuanian Government approved the Programme on the Implementation of the R&D&I Priority Areas and Their Priorities in April 2014, and Action Plans for Priorities during the first half of 2015. By August 2015 a General Action Plan for this Programme as relates to measures coordinated by the Ministry of Education and Science was also approved. The six priority areas and the twenty priorities are listed in Table 2[8].

Table 2 R&D&I priorities identified in Lithuania's smart specialisation strategy

LT smart specialisation priority areas	LT smart specialisation priorities
Health technologies and biotechnologies	• Molecular technologies for medicine and biopharmaceutics • Advanced applied technologies for individual and public health Advanced medical engineering for early diagnostics and treatment
Agro-innovation and food technologies	• Sustainable agro-biological resources and safer food Functional food • Innovative development, improvement and processing of biological raw materials (biorefinery)
Energy and sustainable environment	• Smart systems for energy efficiency, diagnostic, monitoring, metering and management of generators, grids and customers Energy and fuel production using biomass/waste and waste treatment, storage and disposal Solar energy equipment and technologies for its use for the production of electricity, heat and cooling Technology for the development and use of smart low-energy buildings – digital construction
Transport, logistics and information and communication technologies	• Smart transport systems and information and communication technologies Models/technologies for the management of the international transport corridors and integration of modes of transport • Advanced electronic contents, content development technologies and information interoperability Information and communications technology infrastructure, cloud computing solutions and services
Inclusive and creative society	• Modern self-development technologies and processes • Technologies and processes for the development and implementation of breakthrough innovations
New processes, materials and technologies	• Photonic and laser technologies • Functional materials and coatings • Structural and composite materials • Flexible technological systems for product creation and production

Source: Ministry of Economy, 2016

Specific financial requirements, including those for structural co-funding, are to be described in detail when specific instruments are approved. It is already established that some instruments will require projects to be co-financed and sums of expected private sector investments are calculated. For example, the new 'Intellect LT. Joint science-business projects' expects over €126.6m of participant contribution. The aim to stimulate private investment is also present, and Priority Action Plans list co-financing as the means to achieve this. However, in 2015, the strategy and the action plans were approved but policy instruments of the first priority of the OP were only partially approved and first calls for R&D&I funding opened only in October-December 2015. Therefore, the strategy is not yet being implemented and it is impossible to assess how it will shape policy initiatives.

[8] Agnė Paliokaitė was member of the International Independent Experts Group (2012-2014) responsible for identifying Lithuanian smart specialisation (R&D and innovation) priorities and their implementation roadmaps. She was also the Project Director of the project "Services of the Preparation of Research and Innovation priorities for Smart Specialisation Strategy Development in Lithuania" (07/ 2013 – 04/2014) contracted by MOSTA. The services of the latter project involved methodological supervision of the Lithuanian smart specialisation (R&D and innovation) priorities' identification process.

Two institutions will be responsible for monitoring and evaluation of the implementation of the Programme on the Implementation of the R&I Priority Areas and Their Priorities – MOSTA (delegated by the Ministry of Education and Science) and the Ministry of Economy. This reflects the sharing of responsibility for Lithuania's smart specialisation implementation between the two ministries. It is planned that the monitoring and evaluation system will include mixed methods. The approach is expected to follow the study on returns on public investment in R&D, carried out by MOSTA (2015a). It should cover resource allocation, project and instrument implementation, developed products, knowledge transfer, results of instruments/projects funded in the context of smart specialisation and impact of such instruments/projects. In addition to this, counterfactual analysis is also included in the mechanism and it will be used to assess the impact of several instruments used in the programme after its end. There are plans to carry out a foresight exercise in order to find out whether priority areas and priorities remain relevant by 2017-2018. The Programme itself includes the possibility to modify priorities based on acquired evidence. Overall, the planned monitoring and evaluation mechanism is balanced and the included measures cover the main aspects of RIS3. A lot will depend on how successfully the two institutions responsible for monitoring and evaluation will manage to cooperate and whether there will be enough political will to modify policy based on evidence.

Lithuania's smart specialisation strategy also includes R&I infrastructures through both competitive and planned funding. The priorities' Action Plans include instruments for developing R&I and studies infrastructure. Some instruments are general (e.g. 'Intellect LT. Joint science-business projects', which supports developing R&I infrastructure as well as R&D activities of businesses), while others are aimed at specific infrastructures (e.g. Centre of Applied Chemistry and Biopharmacy at Kaunas University of Technology (KTU)).

2.5 Main policy changes in the last five years

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 OP for 2014-2020. Approval of the concept of clusters development in Lithuania. Approval of the R&D and Innovation priority areas and their priorities implementation Programme.
Main Changes in 2015
Approval of Action Plans for smart specialisation priorities and inclusion of STEM education into the Smart Specialisation Strategy. Approval of monitoring and evaluation mechanism for Smart Specialisation Strategy. Approval of description for the development of Joint Studies, Research an Experimental (socio-cultural) development and Innovation initiatives. Government approved an updated concept for the development of science and technology parks. Government's approval of amended Law on Research and Higher Education (still to be approved by the Parliament). Governmental approval of Pre-Commercial Procurement Schedule of Procedures.

3. Public and private funding of R&I and expenditure

3.1 Introduction

R&I funding indicators demonstrated positive trends during the last several years. The intensity of R&D funding in Lithuania measured as the GERD percentage of GDP in 2013 increased by 6.3% (from 0.95% in 2013 to 1.01% in 2014). According to Eurostat data, total GERD in Lithuania increased by around €87m over 2011-2014. GERD funded by the business enterprise sector as a percentage of total GDP did not fluctuate much. It was 0.26% in 2011, then 0.24% in 2012 and again 0.26% in 2013, but increased to 0.32% in 2014. R&D expenditure in all sectors funded by government sector fell from 0.38% in 2011 to 0.33% of GDP in 2013, and increased to 0.34% in 2014.

In 2014, R&D expenditure funded by the government sector as a percentage of GDP in Lithuania (0.34% or €124.61m in total) was below the EU28 average (0.68% in 2013, n.d. for 2014). Moreover, in terms of this expenditure per capita, Lithuania with €38.6 in 2013 was sharply below the EU28 average (the Eurostat's estimate is €177 per inhabitant in 2013). The contrast in terms of GERD funded by the business enterprise sector was much sharper: in Lithuania it made 0.32% of total GDP in 2014, which was significantly below the EU28 average (1.28% of the total GDP in 2013, n.d. for 2014). The per capita figure for this indicator was even more pronounced: €30.7 per inhabitant in Lithuania in 2013 compared to estimated €298.2 per inhabitant on average in the EU28 in 2013. In terms of GERD per capita, in 2013 Lithuania (with €111.9 per inhabitant) is only above Cyprus (€99.4), Poland (€90.3), Croatia (€83.2), Latvia (€69.1), Bulgaria (€36.6) and Romania (€27.9) and falls far behind the EU28 average (€536). In summary, if a similar trend continues the R&D expenditure targets for 2020 will not be met.

Since the OP of 2007-2013 ended but most measures included in the OP 2014-2020 were not launched in 2015, there was a significant time gap in funding of projects. Although some of the projects were still being implemented no new projects funded from EU ESIF could be started. This caused dissatisfaction in both business and public research sectors because ESIF comprise the majority of project-based funding.

The 2009-2011 economic crisis has had a slight impact on public R&I funding in Lithuania (there was 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 ESIF based on multiannual planning. Hence, the research and innovation budgets were 'secured' in 2010–2014. In total, for the last OP (2007-2013) Lithuania was allocated from EU ESIF:

- €115.98m for strengthening of capacities of researchers and scientists in human resources development programme. Additional €9.29m were to be allocated from other sources, including national budget.
- €512.09m through direct and indirect assistance to R&D and innovations and investment promotion in OP Economic Growth. Additional €60.51m were to be allocated from other sources, including national budget.
- €570.97m were allocated to activities which do not necessarily constitute R&D from priority 'increasing business productivity and improving business environment' in OP Economic Growth. Additional €38.2m were allocated from other sources, including national budget.

The total budget from EU sources for Lithuanian participants for FP6 was €26.03m, for FP7 – €53.67m.

Table 3 Basic indicators for R&D investments

Indicator	2011	2012	2013	2014	2015	EU average (2014)
GERD (as % of GDP)	0.9	0.9	0.95	1.02	NA	2.03
GERD (Euro per capita)	92.6	99.3	111.9	125.6	NA	558.4
GBAORD (€m)	126.216	119.613	125.639	125.985	NA	92,828.15
R&D funded by BES (% of GDP)	0.26	0.24	0.26	0.32	NA	1.12 (2013)
R&D funded by PNP (% of GDP)	0	0	0.01	0	NA	0.03 (2013)
R&D funded by GOV (% of GDP)	0.38	0.36	0.33	0.34	NA	0.66 (2013)
R&D funded by HES (% of GDP)	0.01	0	0	0	NA	0.02 (2013)
R&D funded from abroad	0.26	0.3	0.35	0.35	NA	0.2 (2013)
R&D performed by HEIs (% of GERD)	54.21	53.49	54.71	53.12	NA	23.5
R&D performed by government sector (% of GERD)	19.58	19.58	19.83	17.32	NA	12.5
R&D performed by business sector (% of GERD)	26.22	26.93	25.46	29.56	NA	64

Source: Eurostat

3.2 Smart fiscal consolidation[9]

3.2.1 Economic growth, fiscal context and public R&D

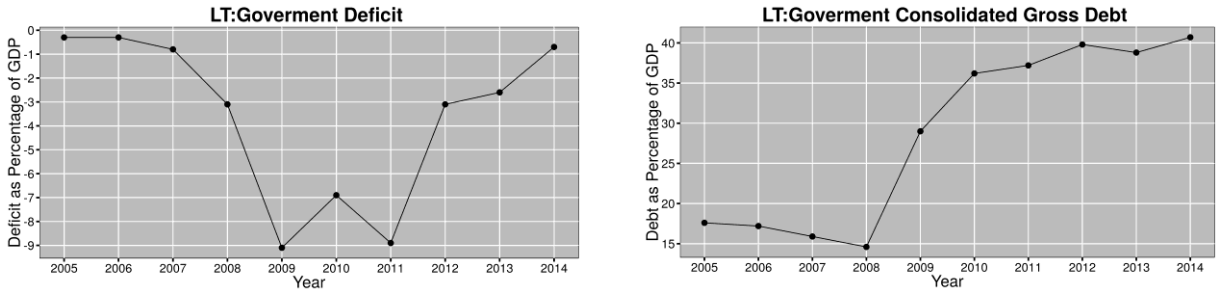
Lithuania has been extremely strongly hit by the crisis, facing a 14.8% drop of its real GDP in 2009. However, the country demonstrated a remarkable adjustment capacity and its regained competitiveness contributed to strong growth (3.4% p.a. on average in 2012-14). The export-led growth has gradually changed into a domestic demand driven one amid rising wages and disposable income, falling unemployment and low inflation. Real growth is estimated to fall to 1.7% in 2015 due to a significant drop in exports to Russia and to pick up during 2016-17 (2.9-3.4%) driven by strong household consumption (supported by robust real wage growth), investment and increasing exports.

Public finances in Lithuania were strong before the crisis. The headline deficit was below 1% and the steadily decreasing public debt (2008: 14.6% of GDP) was one of the lowest in the EU (Figure 2). In spite of the fiscal contraction the deficit increased to 8.9% of GDP in 2009 due to the even steeper fall in the GDP. Subsequent fiscal consolidation efforts based on severe expenditure cuts during 2011-2014 have successfully decreased the deficit to 0.7% of GDP in 2014. The Commission expects a halt in the fiscal improvement in 2015 (deficit: 0.9%) and 2016 (deficit: 1.2%) due mainly to higher defence expenditures compensated only partially by revenue measures. An improvement in 2017 (deficit down to 0.4%) is foreseen thanks to robust economic growth and limited increase of the expenditures. The structural deficit is expected to fall gradually to 1.0% of GDP by 2017. Public debt doubled during the crisis due to fiscal stimuli needed to re-launch the economic recovery. It slowly increased further reaching 40.7% of GDP in 2014. The Commission forecast sets public debt at 40-42% of GDP in 2016-17. Long-term fiscal sustainability is challenged by the impact of population ageing, as the country

[9] Smart fiscal consolidation is defined as public budget cost-cutting programmes aimed at establishing a foundation for long-term growth. This public policy strategy is based on a trade-off between the need to safeguard growth enhancing elements (including R&D) from budgetary cuts and the need to reduce public spending in a context of economic crisis. For reference see Kolev and Matthes (2013) and Veugelers (2014). The conclusions in our analysis focus only on the R&I aspect of Smart Fiscal Consolidation.

has not so far taken decisive legislative measures needed for a comprehensive reform of the pension system.

Figure 2 Government deficit and public debt



Data source: Eurostat

Total GERD in Lithuania was 332.4 MEUR in 2013. There are three main sources of R&D funding: the business sector (91.3MEUR), the government (114.8 MEUR), and foreign funding (123.4 MEUR). Direct funding from the government goes to business enterprises (2.4 MEUR), the government (29.3 MEUR) and the higher education sector (83.2 MEUR).

Table 4 Key Lithuanian R&D Indicators

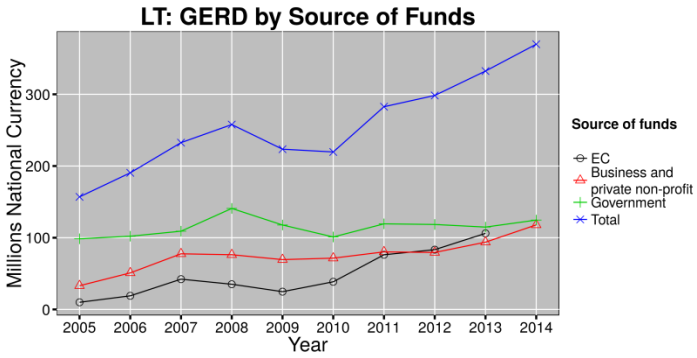
	2007	2009	2013
GBAORD, % of gov. exp.	1.42	1.16	1.05
GERD, % of GDP	0.80	0.83	0.95
out of which GERD to public, % of GDP	0.58	0.62	0.71
Funding from GOV to, % of GDP			
Business	0.01	0.01	0.01
Public (GOV+HES)	0.37	0.43	0.32
Total	0.38	0.44	0.33
EU funding, % of GDP	0.15	0.09	0.30

Source: Eurostat

3.2.2 Direct funding of R&D activities

The sources of R&D funding according to the Frascati manual are: Government sector (GOV), Higher education sector (HES), Business enterprise sector (BES), Private non-profit sector (PNP) and Abroad (including EC). In this analysis the public sector as source of funds is given by the GOV part of GERD, whereas the public sector as a sector of performance is the aggregation of GOV and HES. Figure 3 below shows the historical evolution of GERD financing in current prices in Lithuania.

Figure 3 Development of government funding of the total GERD



Data source: Eurostat

Total GERD in Lithuania has been on an ascending path throughout 2005-14. Although the government has been the most important contributor to GERD funding in this period,

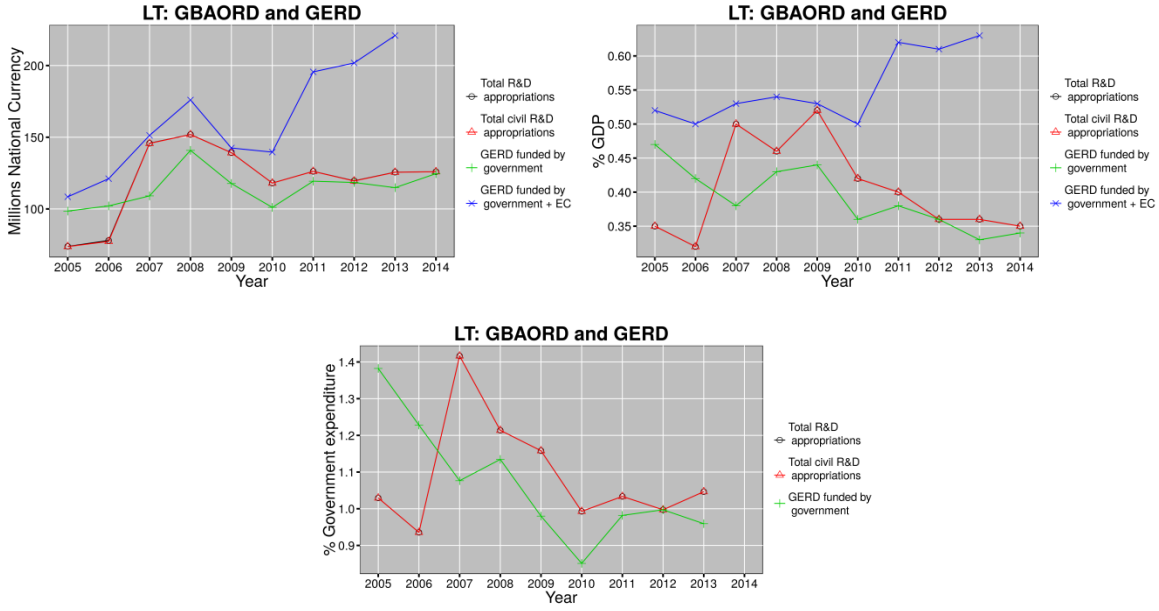
private sources gradually acquired more importance, especially in the 2010-14 post-crisis period when they registered a cumulated growth of more than 30%. Government direct support is practically stagnating at its 2011 level (i.e. a decrease in real terms).

During 2008-10, direct public financing of R&D from government dropped by about €40m (i.e. by ca. 30%). EU funding played an important role in this period, especially in 2010, when it was the main funding source thanks to which the country succeeded to avoid further declines in GERD. Further to this, its 2011 doubling contributed the most to the recovery of GERD to its pre-crisis levels.

3.2.2.1 Direct public funding from the government

Figure 4 shows that military R&D appropriations were practically absent during 2005-2014. This is not surprising for a country without extensive military base.

Figure 4 R&D appropriations and government funded GERD in millions of national currency, as % of GDP and as % of government expenditure



Data source: Eurostat

Both government appropriations for R&D (GBAORD) and government funded GERD increased significantly in the pre-crisis period in nominal terms (Figure 4, upper left). This was not the case when considering them as a share of GDP (Figure 4, upper right) due to the strong GDP growth of the same period. As already mentioned, the crisis hit Lithuania very hard. Public R&D appropriations and spending were cut significantly (Figure 4, down).

Fiscal consolidation in Lithuania started to bear fruit in 2011-12 when the deficit started to decline both nominally and in structural terms (Figure 6). Since then both GERD funded by government and GBAORD have practically stagnated both nominally and as a share of total government expenditures (Figure 4). However, as a share of GDP they seem to follow a decreasing path due to the rapid GDP growth.

3.2.2.2 Direct public funding from abroad

Based on Table 5, below, EU funding has been the major external source of financing throughout the last decade. Since 2007 the share of other external funding sources (business sector, international organizations, etc.) is only 10-15%. The vital importance of EU funding is further emphasized by its gradually increasing proportion compared to total government funded GERD, reaching 70% in 2012, representing one third of total GERD. As Bruegel policy contribution (Veugelers, 2014) highlights, in countries such as Lithuania (and for that matter for most Central and Eastern European states) 'Structural

Funds for research and innovation are of the same magnitude as national R&I budgets, meaning that Structural Funds (almost) double the volume of government R&I funding included in GBAORD data for the country'. This observation is also relevant for the other two Baltic States – Estonia and especially Latvia.

Table 5 Public Funding from Abroad to Lithuanian R&D (in millions of national currency)

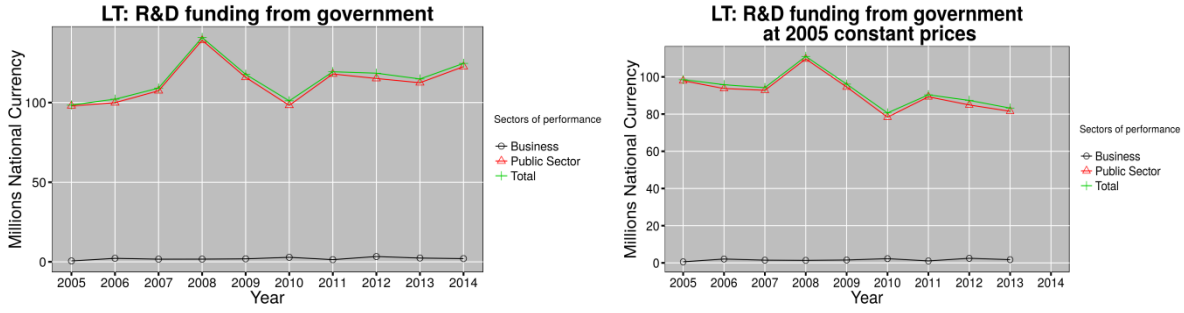
Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	16.51	27.31	45.56	39.97	29.08	43.76	80.28	98.99	123.35	126.68
BES	4.32	5.30	1.77	2.58	2.61	2.61	1.71	8.83	14.45	
EC	9.96	18.97	42.20	35.13	24.76	38.55	76.23	83.35	106.09	
GOV	0.26	0.26	0.06	0.12	0.32	0.90	0.70			
HES	0.06	0.17	0.12	0.26	0.12	0.29	0.12			
International Organizations	1.80	2.32	1.07	1.30	1.13	0.75	1.42	2.17	1.62	
Total as % GERD	10.52	14.34	19.59	15.50	13.01	19.93	28.40	33.18	37.11	34.25
EC as % GOVERD	10.11	18.58	38.68	24.94	21.03	38.14	63.87	70.37	92.38	

Based on data from European Commission DG REGIO, the total Structural Funds for the period 2007-2013 for Lithuania amounts to 6.8 billion Euros of which 0.5 billion is dedicated to 'Core' R&D activities[10]. As a share of the total Structural Funds for the country Lithuania is the 21st among the EU28.

Distribution of public funding

Figure 5, below shows how the distribution of public funding to sectors of performance over time.

Figure 5 Government intramural expenditure by sectors of performance



Data source: Eurostat

The public sector is clearly the main beneficiary of public funding and the share that goes to businesses is practically insignificant. Although with some fluctuations, public funding is relatively stable nominally. However, in constant 2005 prices it has an almost steady downward sloping trend with a ca. 20% total decrease throughout 2005-13.

[10] The definition of 'Core' R&D activities is provided in European Commission (2011).

3.2.3 Indirect funding – tax incentives and foregone tax revenues

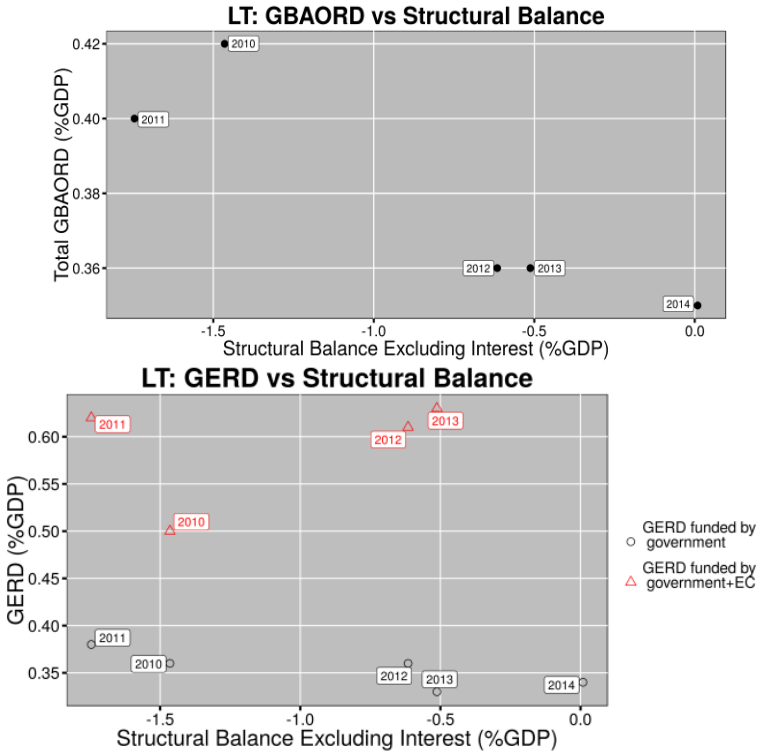
The Corporate Tax Law of Lithuania allows for a 300% super deduction of the costs of scientific research and experimental development (except for depreciation or amortisation of fixed assets) when calculating the corporate income tax base for entities where scientific research and/or experimental development works carried out are related to the usual or intended activities of the entity which generate or will generate income or economic benefit (Tax Guide Lithuania, n.d.). This arrangement exists since 2008. The second available fiscal instrument incentivising R&D spending in Lithuania is the accelerated depreciation scheme. Existing since 2008, the scheme allows for R&D capital assets to be written off over a very short period (2 years or less) (European Commission, 2014).

However, only a very small proportion of companies in the high and medium high technology sector and knowledge intensive services have used these incentives (2012: 0.79%). In 2013, only about 3 companies per thousand registered in Lithuania used the R&D tax incentive. Therefore, it can be concluded that tax incentives are underutilised and do not play a major part in the overall policy mix. According to the Lithuanian reply to the ERAC Survey 2013 the amounts of forgone tax revenues provided in 2011-12 were altogether ca. €3m, which is a marginal amount. The European Commission DG TAXUD estimated that public expenditure on R&D tax incentives as percentage of GDP is 0.01%.

3.2.4 Fiscal consolidation and R&D

Figure 6, below shows the scatterplot of the structural balance and GBAORD as % GDP, first panel as well as GERD as % GDP, second panel[11]:

Figure 6 Fiscal consolidation and R&D



Data source: AMECO, Eurostat

[11] Structural balance data comes from the AMECO database the other indicators were taken from Eurostat.

Lithuanian fiscal consolidation started to yield results in 2011-12 when the deficit started to decline monotonously both nominally (see Section 3.2.1) and in structural terms (Figure 6). As we have seen on Figure 4, although in nominal terms both R&D appropriations (GBAORD) and government funded GERD were relatively stable during 2011-2014, both of them decreased in relative terms by ca. 0.05% of GDP (Figure 6). Therefore, it can be argued that post-crisis fiscal consolidation had a small negative impact on direct public support to R&D. Indirect funding through R&D tax incentives in Lithuania are of a very low level. Adding them to direct support does not change the overall trend. Based on the right panel of Figure 6, EU funding is extremely important for the public funding of the Lithuanian R&D expenditures. In the period 2011-2014 it was so high that it compensated for the losses in the government funded GERD and stabilised the total public support to R&D.

In conclusion, the post-crisis fiscal consolidation process had a small negative impact on public support to the Lithuanian R&D expenditures, but the evidence is not strong enough to conclude that it came at the expense of it. It was due to the high share of EU funding that the country kept its R&D budget growing in the post-crisis years.

3.3 Funding flows

3.3.1 Research funders

The Ministry of Education and Science directly allocates funding to public HEIs and research institutes for R&D activities. Additionally, there are five main institutions which are responsible for funding of research and innovation. Overall funding situation is as follows:

- Ministry of Education and Science directly funds public HEIs and research institutes. In 2014 it allocated €61.8m[12] (Ministry of Education and Science, 2014);
- MITA provides both funding from the national budget and EU ESIF. In 2014 it spent €8.6m (MITA, 2015);
- LMT provides competitive funding for research from the national budget, EU ESIF and also international programmes (e.g. with Switzerland). In 2014 it allocated €29.9m (LMT, 2015);
- LVPA administers project-based funding from EU ESIF to business R&D performers. In 2014 it administered €30.1m (LVPA, 2015);
- ESFA administers project-based funding from EU ESIF for strengthening capabilities of researchers. In 2014 it administered €24.6m (Ministry of Finance, 2015);
- CPVA administers project-based funding from EU ESIF for large R&D infrastructure projects. In 2014 it administered €62.9m (Ministry of Finance, 2015).

Private non-for-profit funding of R&D constituted only 0.01% of GDP in 2013 (€2.33m), which is 11th result in the EU28. This sector does not play important role in R&I, which makes it difficult to identify the main funders.

3.3.2 Funding sources and funding flows

Funding from EU ESIF still accounts for the most significant part of public R&D expenditures. With respect to EU FP7 funding Lithuania is 26th in the EU according to budget share (European Commission, 2015c). Transnational programmes were implemented (e.g. through LMT or MITA) but only form a negligible part of total R&D expenditure. In 2013, funds from abroad accounted for 37.1% of GERD, but the majority of it (86%) came from the EC. R&D funds from foreign business amounted to 4.4% of GERD, and non-EC and non-business funds from abroad made less than 1% of GERD.

[12] However, it should be noted that some of these funds might go not directly to R&D activities, but also to cover related expenses.

During the implementation of the OP for 2007-2013, research was mainly supported through the priorities 'strengthening of capacities of researchers and scientists' and 'research and development for economy's competitiveness and economic growth'. For the former, €115.98m were allocated from EU ESIF, and as of 19 January 2016, €120.57m were allocated to projects, out of which €115.9m were already paid.[13] For the latter priority, €512.09m were allocated from EU ESIF. As of 19 January 2016, €496.92m were allocated to projects and €480.55m were paid.[14] Therefore, within these priorities absorption rates of ESIF are 99.9% and 93.8% respectively. Within separate measures absorption rate varies significantly. As of March 2015, it was between 51% (Inogeb LT-3) and 97% (Inogeb LT-1) for measures that specifically target R&D in business. Average absorption rate of these measures was 69% (Visionary Analytics, 2015). Among the reasons for the rather low absorption rate already well into 2015, one can distinguish a) long and restrictive public procurement procedures; b) late calls for funding; c) long periods of time required for implementing R&D activities. By the end of 2015 absorption rate should be higher. However, other factors, such as lengthy public procurement procedures also have negative effect on absorption of ESIF.

Comparing actual R&I expenditure from the national budget and EU ESIF in 2014, the latter plays a major role. €130.43m were provided for R&I measures, out of which €118.44m came from EU ESIF and the rest €11.99m from other government sources.[15] Meanwhile, the Ministry of Education and Science distributed €36.98m to public HEIs and research institutes for R&D activities as well as €24.85m for administrative activities. Additional non-ESIF €17.84m were distributed through LMT and €3.54m through MITA. Thus, government sources contributed €95.2m to R&D activities which is lower than the total funding from the EU ESIF. Additional €0.1m came from the Lithuania-Switzerland cooperation programme (allocated through LMT). Table 6 presents the main R&I related funds that were distributed to beneficiaries in 2014 based on their objectives.

The share of R&D funded by business has been mostly constant and fluctuated in the bounds of 0.24%-0.26% of GDP in 2011-2013. However, in 2014 it increased to 0.32%. R&D performed by business enterprise also increased from 0.24% to 0.3% in 2014. This is however still significantly below the EU28 average and indicates the problem with private financing of R&D. Private sector innovation heavily depends on public funds. Co-financing in projects funded by EU ESIF is required in some policy instruments (e.g. Intellect LT), national budget programmes also aimed at attracting business R&D investment through co-financed projects (e.g. High Technology Development Programme). It remains to be seen whether new similar programmes will take their place. Some data is available for private co-funding in measures of the OP 2007-2013. As of April 2015 private investment amounted to €112.1m in the projects funded through the Ministry of Economy in the priority 'Direct and Indirect Assistance to R&D and Innovations and Investment Promotion' in the OP Economic Growth (Visionary Analytics, 2015).[16]

[13] In total, including domestic co-funding, €135.27m were allocated to projects in this priority, out of which €135.22m were already paid by 19 January 2016.

[14] In total, with domestic co-funding €552.56m were allocated to projects in this priority, out of which €534.75 were already paid by 19 January 2016.

[15] This includes priority 'Strengthening of capacities of researchers and scientists' from OP 'Human Resources Development' and priority 'Research and development for economy's competitiveness and economic growth' from OP 'Economic Growth'.

[16] Only those measures, where private co-funding is one of the monitoring indicators are included (i.e. Idea LT, Intellect LT, Intellect LT+, Inocluster LT+, Ino-vouchers LT).

Table 6 Main R&I related funds transferred to the beneficiaries, 2014

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) • R&D Quality and Training of Experts	11.24	7.58%
Technology and knowledge transfer and cluster cooperation	• Inocluster LT/ LT+, R&D thematic networks and associations • Innovation vouchers	7.56	5.10%
R&D in firms	• Idea LT, Intellect LT, LT+	16.61	11.20%
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'	62.94	42.43%
National and international programmes for (mainly) basic research	• National Research Programmes, • Bilateral and multilateral research programmes, • Researchers groups projects, • Mobility funding, • Institutional funding due to unused funds	15.66	10.56%
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.	34.33	23.14%
	Total	~€148.34	100%

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

Additionally, many instruments from OP Economic Growth measure 'Increasing business productivity and improving business environment' were aimed at creation and growth of enterprises. Although not directly targeting R&I, they are related to increasing business innovation activities. In 2014, €47.78m were transferred through such instruments. Furthermore, controlling and guarantees funds were functioning, and an instrument for compensation of SME's credit interests was implemented.

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding

In 2015 competitive institutional funding for public HEIs and research centres amounted to approximately €41.59m for R&D and €27.10m for administrative activities (Ministry of Education and Science, 2014). Concerning project based funding (from both domestic

and ESIF sources), around €29.9m were allocated through LMT and €8.6m through MITA.

With the EU ESIF, in OP 2007-2013, the project funding for public R&D constituted about €112.4m (68% 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 between block and competitive project-based R&D funding. The state pre-selects important infrastructure projects and funds them from both domestic and ESIF sources. In theory, best R&D infrastructures are funded, however in Lithuania it cannot be verified that the selection followed the international standards of project funding (international peer review, rigorous procedures, clear selection criteria, etc.). Some of the EU ESIF will be allocated in a similar pre-selective manner during the 2014-2020 programming period. However, in this case ex-ante conditions for funds' allocation had to be followed, and the assessment is pending. The Ministry of Education and Science already provided a list of selected infrastructures in its General Action plan approved in August 2015.

Concerning the institutional and project funding during 2012-2015, the money allocated to projects financed from EU ESIF diminished by 2014, since the financing period for 2007-2013 was already ending. Thus project-based funding decreased. This resulted in dissatisfaction of researchers who experienced a financing gap due to the belated launch of measures included in the OP 2014-2020 (first calls were opened only by the end of 2015). Meanwhile, institutional funding in years 2013-2015 constantly increased from €36.77m in 2013 to €41.59m in 2015 allocated to institutions for R&D activities and from €21.57m to €27.1m allocated for administrative activities (Ministry of Education and Science, 2014). Yet, even though the share of institutional funding increased, the funding is dominated by project-based allocation. Concerning competitively and non-competitively allocated institutional funding, the majority of the funds are distributed competitively. In fact, most funding that conforms to the definition of block funding is allocated through projects (e.g. 'valley' projects were financed from EU ESIF, but funding decisions were not based on some competition between projects).

3.4.2 Institutional funding

The Government decision (adopted in 2009 and subsequently amended in 2010, 2012 and 2014) 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 carried out by LMT every three years to assess annual performance 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%). 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.

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. LMT should finish evaluation of R&D in public HEIs and research institutes by November 2015. The evaluation should also be used to allocate institutional funding to these institutions.

3.4.3 Project 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 ESIF funding has increased in 2013-2014, and the share of project funding has therefore increased as well.

The Law on Higher Education and Research (adopted in 2009) and the 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, e.g. 'Promotion of High-Level International Scientific Research' approved in 2012, Projects of Scientists' Groups, National Research Programmes and others.

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

- Competitive calls for proposals for national and international research grants;
- 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 was completed in 2015;
- 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 were finalised in May 2014. 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% 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 the funding amount of calls: if a call assigns less than €29,000, then 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. However, some instruments, such as National Research Programmes, require that proposals are submitted both in Lithuanian and in English. That is, when a project grant (e.g. Global Grant programme) is considered significant, LMT asks for submission of both language 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. Another institution providing institutional funding, MITA, also hires experts from both Lithuania and abroad. Yet, the requirements for researchers imposed by MITA are somewhat lower than those of LMT

(e.g. minimum number of articles in case of LMT is 15 (or 10 if published in Web of Science) and in case of MITA the number is only 5 (or 3 if published in WoS)). This might be due to the more specific focus of MITA on technological development, thus evaluation criteria differ.

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). Using Lithuanian language in the forms and applications in most cases precludes using international peer reviewers for evaluating projects (Paliokaitė, 2014b), but both LMT and MITA hire international experts to evaluate projects, especially if they are large.

The success rate of proposals varies from programme to programme and even between calls of the same programme (e.g. the first call of the High Technology Development Programme saw success rate of 57.7%, while the second call of the same programme saw success rate of only 13.9%) (MOSTA, 2015a). While it is difficult to compare programmes due to different focus and target groups, or even differences between calls, the various success rates might indicate that information about financing opportunities spreads sometime after the initial launch of a programme or an instrument. Generally, success rate is around 50%, although there is variation (e.g. Intellect LT (success rate of 50.88%), Intellect LT+ (42.31%), public grant to researchers (30.37%), etc.). It is important to stress that in some cases projects are not financed because proposals are technically inadequate or lack R&D activities (e.g. in Intellect LT instrument 12.8% of non-financed proposals were rejected due to administrative issues, 83.3% due to ineligibility (e.g. lack of R&D activities in the project) (see MOSTA, 2015a)). Therefore only a small number of projects get rejected during project benefit-quality assessment, and there might be little competition among proposals with respect to the quality of their content.

In 2007-2013 individual grants were usually not awarded directly. Instead, resources were allocated through project-funding to institutions which then provided grants for individual researchers, e.g. as in the measure 'Support of scientists and researchers mobility and students scientific work'. Eleven projects were run by institutions which then distributed funds to individual researchers. The exception is the instrument 'Support to the scientific work of scientists and other researchers (Global Grant)', where scientists and other researchers could apply for funding directly, if they worked at HEIs or research institutions. €33.2m were allocated in this way, 106 out of 349 proposals were approved. LMT funded post-docs through the measure 'Support of scientists and researchers mobility and students scientific work' funded from EU ESIF and national budget. €2.4m were allocated to post-doc training in 2014.

3.4.4 Other allocation mechanisms

Although most R&D funding is either institutional or project-based, new allocation mechanisms are being introduced. In summer 2015 LMT introduced 'Purposive research orders'. Its aim is to finance applied research based on topics put forward by state institutions, which want to address societal issues. Institutions provide specific research question for researchers who then propose solutions. The best proposal is chosen from several candidates based on proposals. Therefore, while this measure is innovative, it has many similarities with project based funding with the exception that it is demand-led. For 2015-2016 9 projects were financed and were allocated €0.49m in total. Meanwhile, the Ministry of Economy introduced pre-commercial procurement procedure which is another demand-led policy measure (see more in section 3.6).

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

Funding of private R&I activities mostly comes from EU ESIF through instruments administered by the Ministry of Economy. During the 2007-2013 financing period different instruments were used for separate steps of the innovation process (e.g. Idea LT for developing initial ideas for R&D activities, Intellect LT+ for acquiring infrastructure needed for planned R&D activities, Intellect LT for carrying out 'soft' R&D activities). Only a small part of total budgets were annually dedicated directly for business R&I activities. In total 270 SMEs were supported, out of which 157 were from the high / medium high technology sector (Visionary Analytics, 2015)[17]. However, a variety of funding instruments were available for SMEs in Lithuania, including clusters promotion and innovation vouchers, as well as co-financing of business R&D investments (Idea LT, Intellect LT) and acquisition of R&D equipment (Intellect LT+). These measures over the 2007-2013 period mainly focused on the research part of the R&D activities in business. They 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. Separate steps of innovation creation were merged in the renewed Intellect LT instrument. Action Plans for the 'R&D&I priority areas and their priorities' implementation programme include measures aimed at encouraging prototype development and product commercialisation. However, the success of these measures will only be seen well into the next financing period.

There is not much initiative at the institutional (university) level. Universities 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).

Some instruments set specific amount of funds to be contributed by businesses. For example 55-75% of the whole project budget, depending on the size of a firm, had to be contributed in Intellect LT. Although under specified conditions it could have been as low as 30% for very small and small enterprises; Inocluster LT could provide 50% of the whole budget of a project, etc.). Some measures also required or stimulated public-private cooperation (e.g. the Innovation Vouchers instrument stimulated it by requiring funded companies to carry out R&D activities in HEIs). All in all, measures from the first priority of OP Economic Growth attracted €112.1m of private investment. Other measures related to SMEs but not targeting R&D directly attracted €646.7m, with attracted private investment totalling €758.8m (Visionary Analytics, 2015).

Project evaluation involves peer review, and in some measures many projects are rejected based on technical or conceptual inadequacy (i.e. proposal lacks R&D activities), rather than on the perceived benefits and quality of the idea. For the latter evaluation of proposals clear guidelines are provided in the description of project funding conditions. Priorities are also identified. 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. 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. The long evaluation procedures and the difficult process of making changes to the project plan

[17] This number covers policy instruments that are more selective. That is, those instruments which have more elaborate criteria for applications (e.g. activity sector, cooperation with public research organisations, etc.). These instruments include Idea LT, Intellect LT and Intellect LT+. If less specific instruments were included (Leader LT, E-business Lt, Process LT, New opportunities, Compensation of SMEs' credit interests), the number of funded SMEs would be 6600 (Visionary Analytics, 2015).

also add to the 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). A similar tendency was noted in evaluation of the impact of the High Technology Development Programme (2011-2013) (MOSTA, 2015). 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). Similar two-step approach is now also used by LMT in Purposive Research Projects.

There are measures which take into account the needs of companies (e.g. lower requirements might be set for SMEs, larger part of the project budget might be publicly funded, etc.). Some (e.g. Technostart LT) also promote establishing new enterprises (start-ups) that carry out R&I activities. Creation of spin-offs is also one of the indicators of implementation included in R&I priorities' Action Plans.

Several additional issues with measures run through OP for Economic Growth were apparent. Firstly, many of them were launched at the same time. Since companies had to provide their own funds in many of these measures, they had to choose, where to participate and where not. This might have hindered their opportunities to implement projects in a step-by-step manner. Secondly, the implementation of some measures (e.g. Inocluster LT) was delayed due to their complexity. This led to low demand for such support (Visionary Analytics, 2015).

Funding schemes are evaluated at least once per implementation period. Although it is not a standard, MOSTA carried out an evaluation of socio-economic impact of the measure Intellect LT (see more in section 2.2.1). However, benchmarking against comparable schemes in other countries is not done.

During the preparation for implementation of RIS3 in 2014-2020 international meetings between representatives of governments and agencies from member states took place. For example, concerning the monitoring and evaluation, some networks were established.

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 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 has relied mainly on innovation supply side instruments. Since 2012, however, policy debate shifted towards demand-side oriented measures and the Ministry of Economy in cooperation with MITA has drafted the description of pre-commercial procurement which was approved by the government in July 2015. More information on the implementation of the innovative public procurement and the pre-commercial procurement instruments can be found in Section 3.6.

There were no lead market initiatives in Lithuania as of 2015.

3.5.2 Indirect financial support for private R&I

During 2007-2013 both direct and indirect support to private R&I was provided. The former was provided through measures discussed in 3.5.1 and other direct means. The latter was provided through corporate profit tax R&D incentive and corporate profit tax incentive for investments into new technologies. While direct support to business R&I was used for a reasonable time already, the R&D tax incentive was introduced only in 2008. It allows companies to subtract three times the value of R&D expenditure for a given financial period from its taxable income. The tax incentive for investment into new technologies can reduce taxable profit by up to 50%.

However, tax incentives did not reach the expected level of use. For the period 2014-2020 both direct and indirect support measures will again be combined, as the plans for new instruments indicate. 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. This might be due to a low number of companies which have R&D investment and low gains from tax relief due to small scale of activities. In 2013, only about 3 companies per thousand registered in Lithuania used the R&D tax incentive. Since the number of companies using R&D tax incentives is low, the foregone tax revenues should also be low. According to the State Tax Inspectorate, revenue deductions due to tax incentives were €78.6m in 2009, while by 2013 it fell to €36.3m (State Tax Inspectorate, 2014). Data on the specific amount of foregone tax revenues is unavailable.

3.5.3 Public procurement of innovative solutions

Legal Public Procurement framework

Public procurement in Lithuania is regulated by a number of laws and decrees transposing the relevant European legislation. The Law on Public Procurement of the Republic of Lithuania (adopted in 1996, last amendments in 2015) sets the general framework for the public procurement regime.

The main legal acts regulating issues on procurement of R&D services are (Soloveičik, 2015):

- Decree No 709 of the Government of the Republic of Lithuania of 1 July 2015 on the Approval of the Procedures for Pre-commercial Procurement (hereinafter – the Approval of the Procedures for Pre-commercial Procurement).
- Resolution No VII-85 of the Research Council of Lithuania of 21 November 2011 on the Approval of the Procedures for the Evaluation of the Technical Part of the R&D Supplies, and the Selection of the R&D Services and the Suppliers of such Services.
- Decree No 772 of the Government of the Republic of Lithuania of 22 April 2011 on the Approval of the Procedures for Procurement of R&D Services other than those where the Benefits Accrue Exclusively to the Contracting Authority for its Use in the Conduct of its own Affairs, on Condition that the Services Provided are Wholly Remunerated by the Contracting Authority.

The Ministry of Economy has prepared in 2015 and submitted to the Government for consideration a **new draft of the Law on Public Procurement**. New EU Procurement directives and consequently the new draft of the Law on Public Procurement of Lithuania establish a new Innovation Partnership procurement procedure to help contracting authorities to use public procurement for new product development and its subsequent acquisition. After the approval by the Government in 2015, the updated Law will be submitted to the Parliament for consideration. The new Law on Public Procurement of Lithuania is expected to come into force in the spring of 2016.

The PCP/PPI landscape in Lithuania

The Lithuanian innovation system has relied mainly on innovation supply side instruments and has neglected possibilities to link innovation demand with knowledge producing capacities. However, 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 OP for 2014-2020 as well as the Lithuanian Innovation Development Programme 2014-2020 contains measures aimed at fostering markets for innovation (firstly, pre-commercial procurement is foreseen, purposive research projects might play a similar role). The strategy for the Development and Improvement of the Lithuanian Public Procurement System for 2009-2013 and the

Lithuanian Innovation Development Programme 2014-2020 set a target for the share of innovation procurement to account for **5%** of all public procurement in Lithuania.

The Ministry of Economy has led the debate on how to increase the implementation of the innovative public procurement and the pre-commercial procurement instruments. The Ministry of Economy in cooperation with the Lithuanian Agency for Science and Technology (MITA) has drafted the description of pre-commercial procurement and it come into force in 2015. It 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. In July 2015, the Government approved the procedure of pre-commercial procurement, which allows three types of such process – when only a trial run of the product is ordered, when prototype creation is also ordered, and when in addition to the two mentioned stages, developing of the concept is also ordered by the buying organisation. The document also presumes that MITA (contracting authority) is entrusted with organising and implementing pre-commercial procurement. It should co-finance pre-commercial procurement, consult potential beneficiaries, and disseminate the information about this instrument.

PCP/PPI initiatives in Lithuania

MITA as a coordinating authority will provide co-financing for Lithuanian procurers to start pre-commercial procurements, but so far no resources were allocated to them. It is expected that 'Pre-commercial Procurement LT' will enable the implementation of pre-commercial procurement. Projects are currently under preparation but not yet launched in 6 key areas (Soloveičik, 2015):

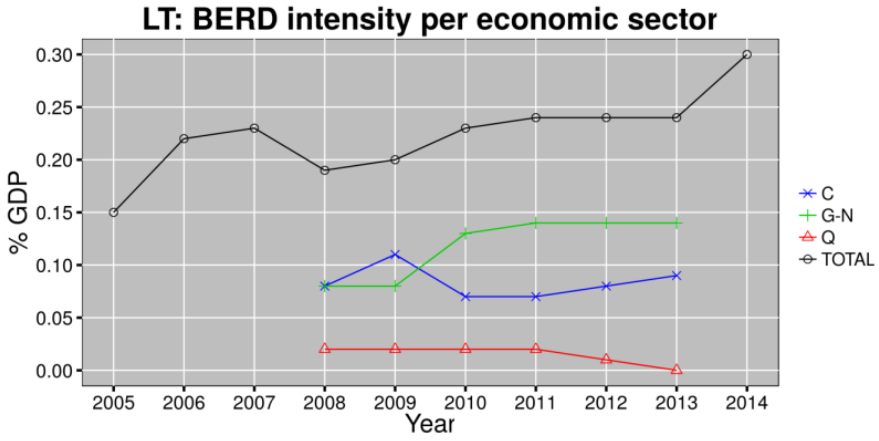
- Development and production of drones;
- Health care;
- Agricultural sector;
- National defence;
- Waste management;
- Energy consumption.

3.6 Business R&D

3.6.1 The development in business R&D intensity

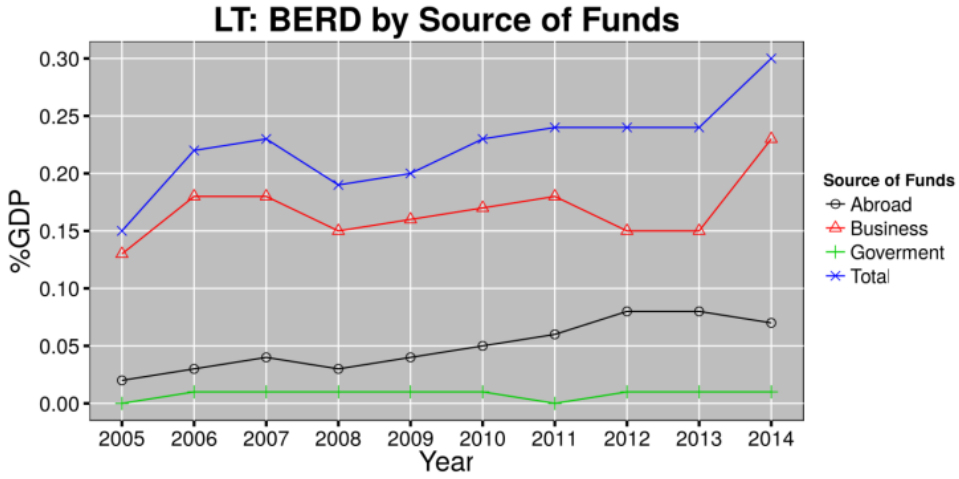
As one can see from Figure 7, BERD intensity doubled between 2005 and 2014. However, the actual value (2014) of 0.3% of GDP is still one of the lowest in the EU. The highest BERD spenders were the manufacturing, business services and the healthcare industry. In 2010 manufacturing BERD intensity dropped and business services became the most important sector in this respect. When turning to Figures 9 and 10 we can observe that BERD in ICT (mostly telecommunications and computer programming) and Professional, scientific and technical activities (mostly scientific research and development) (J61, J62, M72 sectors) increased significantly, but none of the manufacturing top sectors (in terms of BERD) are responsible for the drop in manufacturing BERD. This drop is instead due to a decrease in R&D spending in the sectors of paper products, fabricated metal products (except machinery and equipment) and in repair and installation of machinery and equipment. Also, BERD in healthcare has practically ceased by 2013.

Figure 7 BERD intensity broken down by most important macro sectors (C= manufacture, G_N=services, Q=Human health and social work activities)



The private sector is the main funder of the Lithuanian BERD and up until 2011 it was the main driver of its changes (Figure 8). However, in 2012-13 a slight drop of funding from domestic private resources has been compensated by external resources, notably EU funding (based on Eurostat data) that has gradually gained importance since 2008, when a number of SF-funded measures targeting the business sector were introduced. Funding from government sources was of marginal importance throughout the whole period under scrutiny.

Figure 8 BERD by source of funds



3.6.2 The development in business R&D intensity by sector

Based on Figure 9, below, the highest BERD spenders in manufacturing are medium high (chemicals) and high-technology sectors (computer, electronic & optical products, as well as pharmaceuticals). None of them seem to be negatively affected by the crisis in terms of R&D expenditure.

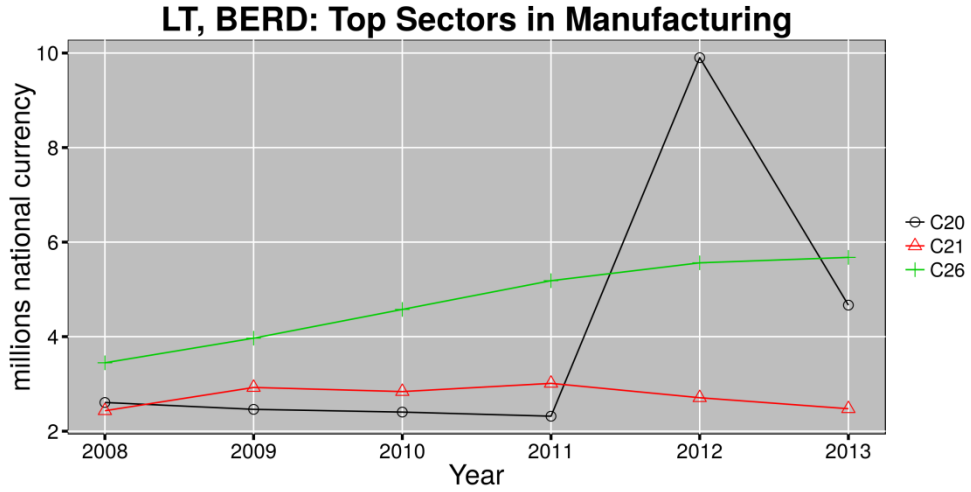
One of the most profitable Lithuanian industries has been the chemical industry which mainly produces nitrogen and phosphate fertilizers. Among the key players in the chemical industry in Lithuania are Achema, which is the largest fertilizer producer in the Baltic states and Lifosa, a phosphate industry company. The chemical industry in Lithuania exports about 80% of its products and is among the main manufacturing export sectors (Pekarskienė and Susnienė, 2013).

In the pharmaceutical sector there are some successful examples of exploiting FDI (e.g. by Teva and Valeant) to generate new knowledge-based growth over 2006-2013. For example, 'SICOR Biotech', a local manufacturer of biotechnological pharmaceuticals joined the Teva Group, one of the world's largest producers of generic pharmaceuticals.

Computer & electronics BERD shows a stable growth with a compound average growth rate (CAGR) of 10.5% between 2008 and 2013. Lithuania has over 50% of the world market for high-energy picosecond lasers and is a leader in global production of ultra-fast parametric light generators[18]. Lithuanian lasers companies were among the first ones in the world to transfer fundamental research into manufacture. The country exports laser technologies and devices to Europe, USA, Japan and Israel, mostly for universities and corporate laboratories for scientific research purposes (International Business Publications, 2015). An example for a company active in laser manufacturing (part of the electronic and optical products sector - C26) is EKSPLA.

The other two sectors were practically stagnating with small fluctuations throughout the period except for a very strong one-off increase in chemicals BERD in 2012 most likely due to investments in more environmentally friendly production processes (e.g. greenhouse gas emission mitigation in the nitric acid manufacturing process).[19] This increase has been maintained somewhat one year later and in 2013 the chemical industry together with the computer, electronics and optics are the most R&D intensive sectors in Lithuania. Manufacturing of furniture (C31, not depicted) also comes close. This sector has grown in double digit numbers in the recent years. The biggest companies in this field cooperate with IKEA, which owns one of the biggest wood processing companies in Lithuania (International Business Publications, 2015). Lithuania is the fourth biggest supplier for IKEA after Poland, Italy and Germany.[20]

Figure 9 BERD, top sectors in manufacturing (C20=chemicals and chemical products; C21=basic pharmaceutical products and pharmaceutical preparations; C26=computer, electronic and optical products).



[18] For more extensive overview see: https://ec.europa.eu/digital-agenda/en/news/lithuania-leading-light-laser-technology

[19] In 2012, Achema won the 'Green Company of the Year' award among Lithuanian businesses and in 2013 it was the winner of 'Environmental Protection Achievements 2012' nomination 'Most Environment Friendly Process' for greenhouse gas emission mitigation in the nitric acid manufacturing process.

[20] As reported in the media, cf. http://en.delfi.lt/lithuania/economy/lithuanian-furniture-makers-among-ikeas-biggest-suppliers.d?id=69498850

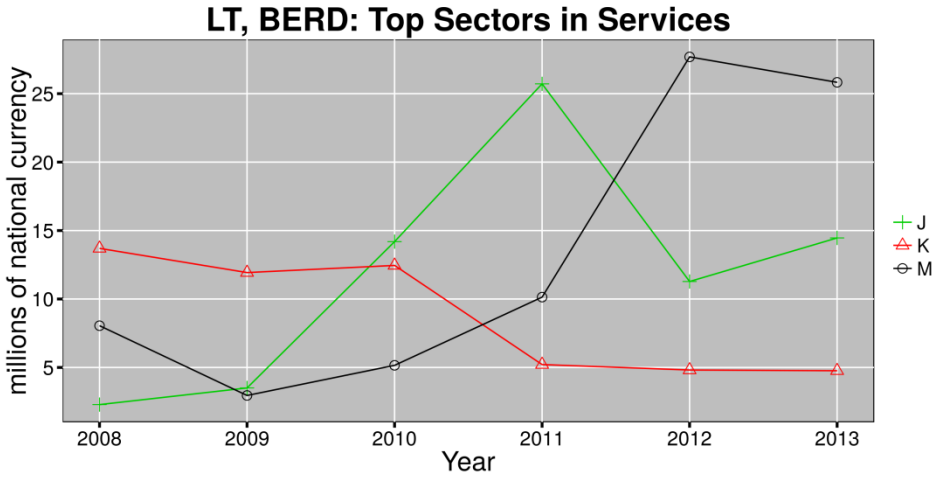
In the business services sector professional, scientific and technical activities, ICT, as well as the financial and insurance activities sector are the top BERD spenders (Figure 10).

One of the fastest internet speeds in the world, well-educated workforce and one of the most developed information technology infrastructures in Central and Eastern Europe have helped Lithuania turn into an IT business attraction centre in the region. Lithuania is gaining a position as a regional centre of excellence for smaller software and games start-ups, but also for larger ICT operations.[21] Foreign investment in the ICT sector has grown by 10.5% between 2010 and 2013, but fell in 2014 (Statistics Lithuania, 2015). Companies such as Google and Nasdaq are investing in Lithuania but there is also a surge in the number of local IT start-ups.[22]

As far as the professional, scientific and technical activities sector is concerned, in the recent years Lithuania's life sciences industry has developed in a quick pace and is now regarded as one of the most advanced in Central and Eastern Europe. Annual growth within the biotechnology and pharmaceutical research and production sector is 22%, and it has 80% of its output exported[23]. With a scientific heritage that dates back to the Soviet times, Lithuania's biotechnology industry is outpacing developments in many larger Central and Eastern European countries due to the country's highly skilled talent pool and especially due to FDI from companies such as Moog, Sicor/Teva group, Biotechfarma and Thermo Fisher. In addition, one of the 'valleys' provides an extensive support network for life sciences.

While both professional and scientific activities (in particular scientific research and development, mostly in biotech and renewable energy) as well as the ICT sector (and in particular the telecommunications and computer programming subsectors) BERD faced impressive growth between 2009 and 2013 due to inflows of FDI in these sectors and due to well-developed IT infrastructures and centres of excellence, financial sector BERD is on a declining path since 2008. This may be explained by the contraction of the activity (loan portfolios) of banks and other financial institutions active in Lithuania after the severe financial crisis of 2008-9.

Figure 10 top service sectors (J=information and communication, K= financial and insurance activities, M=professional, scientific and technical activities).



[21] https://www.lietuva.lt/en/business/investment_and_trade_profile/attractive_sectors

[22] A non-exhaustive list of innovative companies in the ICT sector in Lithuania can be found here: http://www.inovacijos.lt/gate2inno/lt/inst_paieska/type/ent13/

[23] https://www.lietuva.lt/en/business/investment_and_trade_profile/attractive_sectors

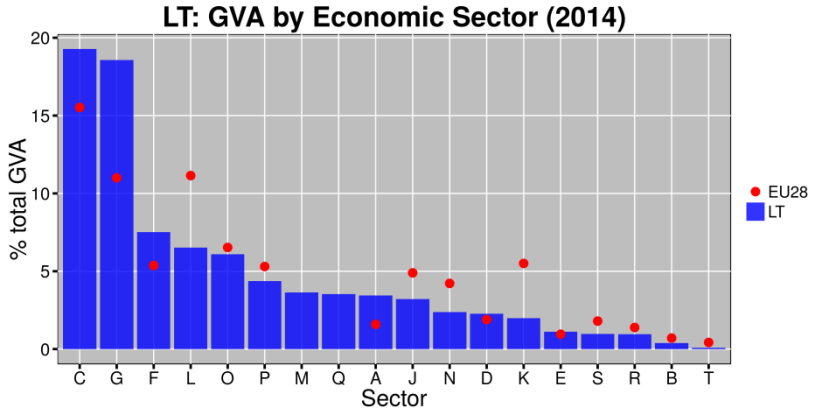
3.6.3 The development in business R&D intensity and value added

When looking at the contribution of the various sectors to the total gross value added (GVA), we notice that wholesale and retail trade, manufacturing as well as construction were the top three sectors providing the highest GVA to the Lithuanian economy in 2014 (Figure 11, below). The first two are the largest economic sectors with a share between 15-20% in the GVA. They are followed by construction, real estate and the public administration sector with a share of ca. 5-7% in total GVA each. Other sectors are below 5%. The levels of Lithuanian manufacturing, wholesale and retail trade and construction GVA are well above the EU-28 levels.

Comparing Figures 9, 10 and 11 one observes that manufacturing is both a top contributor to GVA and a top receiver of BERD. However, large BERD spender business services sectors like ICT or professional and scientific activities fail to be among the top GVA contributors. Real estate, wholesale & retail and construction, which are not extremely important for the Lithuanian BERD expenditure, are nevertheless among the top sectors in terms of GVA.

Figure 11 economic sectors as percentage of the total GVA.

Top 6 sectors in decreasing order: 1) manufacture; 2) wholesale and retail trade and repair of vehicles and motorcycles; 3) Construction; 4) Real estate activities ; 5) Public administration and defence; compulsory social security; 6) Education.



The manufacture of food, beverages and tobacco appears to be the leading manufacturing sector in terms of GVA accounting for ca. 4.5% of total GVA in 2013 (Figure 12). The food processing sector is also among the leading ones in Lithuanian exports - Lithuanian dairy products are well known in the neighbouring countries (International Business Publications, 2015).. Although the food sector's contribution in BERD as a share of GVA is comparatively low, it is still an important R&D performer in the Lithuanian economy.[24]

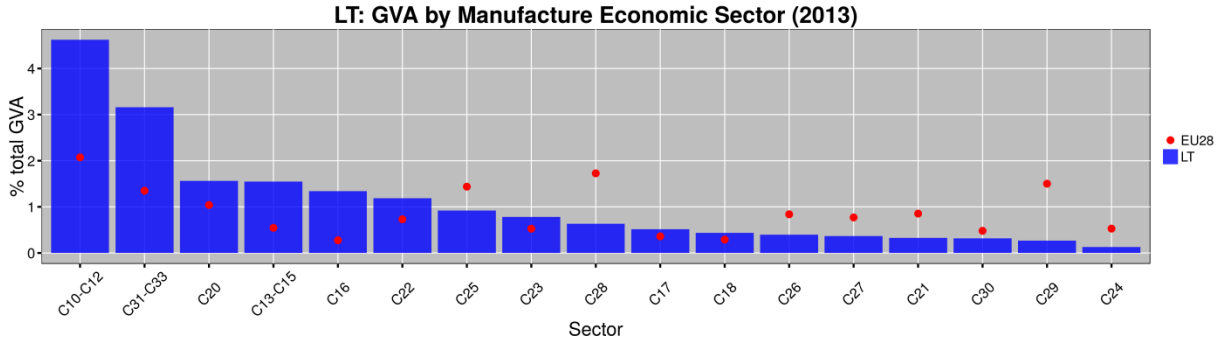
The food and beverage sector is followed by the furniture and the chemical sectors, both of which have been traditionally profitable sectors for Lithuania with high shares of exports. While furniture sector continues to increase exports, the chemical sector seems to fluctuate more.[25]. Consistently with its importance in manufacturing in terms of BERD, the chemicals sector appears to be important also in the GVA. On the contrary, the pharmaceutical and the computer & electronics sectors fail to be among the top GVA contributors. In terms of technological intensity in the top 6 sectors contributing to GVA we find both low as well as medium high sectors. One observes some medium to high tech sectors among the top ones, but with a clear dominance of the low-tech sectors with a cumulated share of 6.2% of total GVA vs. the 3.4% of the medium high and high-tech sectors (in 2012). This is in line with the structure of the national economy.

[24] In 2013 the total amount of BERD by the food sector (€2.6m) was above the amount of BERD contributed by pharmaceuticals (€2.4m).
[25] Versli Lietuva (2015).

The relatively high – compared to other industrial sectors – value added of low-tech sectors and, simultaneously, the relatively lower importance of many of the R&D-intensive sectors in Lithuania can partially explain the low intensity of the Lithuanian business R&D. Other structural issues potentially explaining the low levels of BERD in the country include the scarcity of large manufacturing FDI serving developed markets and the lack of critical mass - indigenous companies are very small and unavailable to pull resources for high impact innovations in a relatively small market.

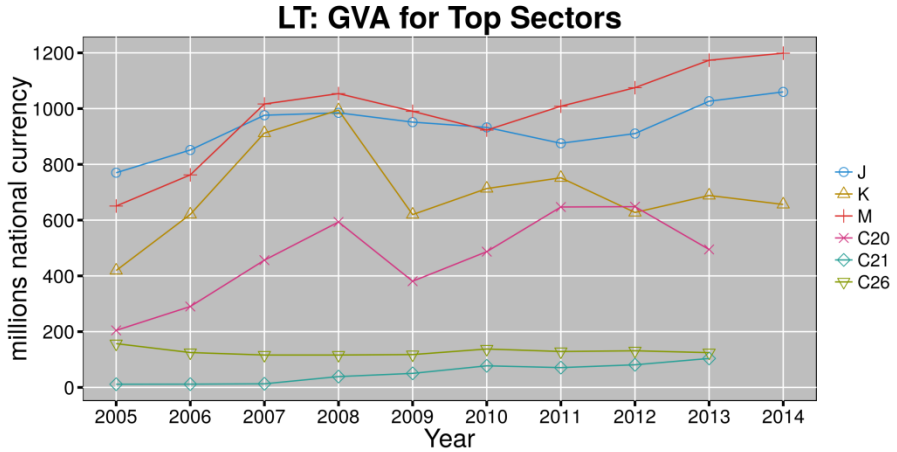
Figure 12 GVA in manufacturing.

Top 6 manufacturing sectors: 1) food products; beverages and tobacco products; 2) manufacture of furniture; other manufacturing; 3) chemicals and chemical products; 4) textiles, wearing apparel, leather and related products; 5) Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; 6) Manufacture of rubber and plastic products.



In line with the above discussion, professional, scientific and technical activities, ICT, financial and insurance activities as well as manufacturing of chemicals are the top sectors in terms of VA at factor cost (Figure 13). Their VA showed a similar behaviour throughout the analysed period: ascending up until the crisis, although to various extents, but generally hit and decreasing during the crisis and being on a recovering path afterwards. Unsurprisingly, financial and insurance activities (K) were hit the hardest during the crisis. Contrary to these sectors, pharmaceuticals and computer, electronics & optical products, i.e. two high-tech sectors, had a rather stable VA at factor costs indicating that companies in these sectors managed to maintain their sales during and after the crisis thanks to their innovativeness (for example, laser technology).

Figure 13 value added at factor cost for the leading manufacture and service sectors in Figures 9 and 10



Finally, employment in the most innovative manufacturing sectors has slightly decreased between 2008 and 2013 but the employment in the most innovative service sectors (ICT and Scientific research and development) has been on the rise in line with the quick development of IT (software and games) and biotech in Lithuania in the recent years (based on Eurostat).

3.7 Assessment

One of the main issues in Lithuania's R&I system is its dependence on EU ESIF. With time this source of funding will significantly diminish (most likely by 2020 with the new programming period) and the already low level of R&I activities may either stagnate or recede. Therefore, the Government must use the five coming years to solve this problem.

Institutional funding combines block funding and competitive funding which allows both targeting specific issues and providing incentives for organisations in the R&I system to compete for support. The criteria for institutional block funding are based on both R&D performance and size of an organisation, which provides a good basis for funding distribution.

The funding system itself aims to incentivise certain behaviours. For example, in the case of institutional competitive funding of public HEIs and research institutes, the government incentivises publishing. Although high quality publications earn more points, several low quality publications might outweigh the benefit gained from top-quality ones. Such wording also incentivises establishing new local peer-review journals that could publish papers from local institutions. Thus, the quantity of articles and scientific outlets become inflated, although the quality might be low. However, additional measures are introduced, such as lists of journals with high level of self-citation which are not counted. Patenting is also encouraged, although it does not seem to work. In areas of agricultural, biomedical and technology sciences points awarded for patent registered at the European Patent Office, United States Patent and Trademark Office or Japan Patent Office equal the number of points awarded for two quires in a scientific monograph published by an internationally renowned publisher. Therefore, incentives could be better structured and relying more on high quality outputs.

Overall, the system of incentives is perverse to some extent. For example, businesses are discouraged from high-risk projects, since the state is rather risk averse and unwilling to invest in riskier R&I activities. As learned from researchers during evaluation of returns on investment in R&D, project managers are also incentivised to achieve the aims of a project no matter what, or at least to prolong a project for as long as possible. In such way funding is continued for a prolonged period of time, instead of abandoning a failing project immediately and thus saving resources. Funding agencies should provide incentives to terminate a project as soon as research shows that expected results are impossible to achieve due to scientific reasons. In addition, some of the requirements (e.g. for publications) do not set the quality bar high enough which leads to high quantity of output, but low quality. However, too detailed regulations imposed by funding organisations may lead beneficiaries to aim at conforming to formal requirements rather than increasing the quality of the output. While there are initiatives to change the allocation mechanism so that it would favour quality over quantity (e.g. the February 2015 amendment to the evaluation of public HEIs and research institutes procedure might impact institutional funding and incentivise researchers to produce higher quality output), it remains to be seen if changes will be profound enough.

Although co-funding requirements are in place and supported enterprises must contribute their own resources to publicly funded R&I activities, some evaluation studies report substitution effect (i.e. crowding out) and claim, for example, that policy additionality has been achieved in about only 30-40% of the funded projects (Visionary Analytics, 2015). Therefore, measures of direct public support to business R&I are not very effective in augmenting businesses expenditure in this area. Indirect support, such as tax incentives for R&D activities also show decrease both in the number of businesses

applying for tax deduction and in the amount of R&D expenses that are qualified as deducible. This might partly be due to a restrictive definition of R&D that is used by policymakers. Therefore, not all activities related to R&D guarantee tax reduction.

2012-2014 did not see any significant changes in funding allocation mixes. However, starting in 2015, new policy instruments will be launched and might include differences in funding allocation mechanisms. It is still too early to tell what the exact changes will be and what the outcome of newly introduced or modified measures will be.

4. Quality of science base and priorities of the European Research Area

4.1 Quality of the science base

Table 7 Main science output indicators

Indicator	Year	EU
Number of publications per thousand of population Full counting – 0.92 Fractional counting – 0.71	2013	Full counting – 1.43 Fractional counting – 1.22
Share of international co-publications Full counting – 36.2%	2013	Full counting – 36.4%
Number of international publications per thousand of population Full counting – 0.33	2013	Full counting – 0.52
Percentage of publications in the top 10% most cited publications Full counting – 6.8% Fractional counting – 4.94%	2000-2013	Full counting – 11.29% Fractional counting – 10.55%
Share of public-private co-publications (based on SciVal, 2011-2013) 0.7%	2011-2013	1.8%

Source: JRC IPTS RIO elaboration on Scopus data collected by Sciencemetrix in a study for the European Commission DG RTD (Campbell, 2013). The share of public-private co-publications is derived from the Scival platform and is also based on Scopus data (September 2015). SciVal ® is a registered trademark of Elsevier Properties S.A., used under license. The data on public-private co-publications is not fully compatible with the data included in the IUS, due to differences in the methodology and the publication database adopted.

Total scientific output of Lithuania in terms of publications per thousand of population is significantly below the EU28 average (64.3% of EU28) and is above only several countries. This indicates that generally there is a lack of scientific knowledge produced in the country. Moreover, Lithuania is also lagging behind in terms of quality of publications (22nd in the EU with respect to percentage of publications in the top 10% most cited publications). Thus, both the quantity and the quality of publications are lower than the EU average. International collaboration in publishing and international publication in general is lower than the EU28 average as well (24th in the EU in both cases). This means that either publication, especially in top quality journals, is not incentivized, or there are serious issues with the quality of human resources, as a consequence of limited funding, lack of internationalisation policies etc. (see section 3.8).

Low share of public-private co-publications (26th in the EU) reflects the generally bad situation with public-private cooperation with relation to R&I activities. This indicator could improve if collaboration of science and business could be enhanced in general. As long as measures do not bring satisfying results, it is naïve to expect sudden surge in public-private co-publications. Therefore, while co-publications should be encouraged through measures that support joint projects, the main attention should be given to establishing and developing ties between business and science more generally.

If analysed over time, there is a trend of increase of the share of publications in top 10% of the most cited publications. However, the gap between Lithuania and most of the other EU countries remains. Meanwhile, Estonia outperforms Lithuania with respect to all of the discussed indicators, while Latvia is mostly behind with the exception of the share of private-public co-publications. Neighbouring but much larger Poland produces more publications per capita, but the share of top 10% most cited publications is lower than that of Lithuania. The share of public-private co-publications is higher in Poland than in Lithuania. All in all, it seems that this lack of successful cooperation between public and

private sectors is one of the main issues with the Lithuanian R&I system even when compared to neighbouring countries.

Low patenting (6.1 patent applications for EPO per million inhabitants in 2012 (MOSTA, 2015c))also indicates a challenge that must be overcome, as it shows that successful commercialisation of research results meets obstacles. Even though specific measures were introduced in 2007-2013, e.g. through MITA, they did not lead to significant initial increase neither in number of patents nor in patent applications. However, in 2015 the number of EPO patent applications increased by 60% compared to 2014. In 2016-2020 a special instrument Inopatent LT will be launched specifically to support international patenting in identified R&I priorities. €3.04m will be allocated (amount dedicated to each priority may differ).

All in all, it is evident that Lithuania does not unlock its research potential and does not manage to significantly improve the quality of its science base, as indicators on research outputs and their commercialisation indicate. Without improvement in this area it is difficult to expect that other research outputs will improve.

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

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. The Ministry of Education and Science is also active in cooperating with foreign institutions. It signed agreements with the majority of EU Member States, as well as Asian, South and North American countries, 40 in total (MOSTA, 2015).

Joint programming process was launched in 2008, and in 2010 Lithuania joined two of the joint programming initiatives (JPIs), namely 'Cultural Heritage: A Challenge for Europe' and 'Healthy and Productive Seas and Oceans'. In the initiative on cultural heritage LMT joined ERA-NET plus project 'Heritage Plus' in 2013. In the same year pilot call for projects was run. Lithuania provided €0.1m to the budget of the project (total budget – €3m). Seven of the proposals included partners from Lithuania, one of them was funded. In the JPI on Productive Seas and Oceans in December 2014 call for proposals on microplactics was launched but Lithuania did not contribute to the budget.

LMT is also involved in Science Europe, and Lithuania has a representative in European Science Foundation in the programme European Network for Gastrointestinal Health Research. In 2014, Lithuania and the European Space Agency (ESA) signed an agreement which allows Lithuanian researchers to participate in ESA programmes. One of the new national research programmes, namely 'Towards Future Technologies' is also aimed at strengthening Lithuanian research, development and innovation capacities needed for greater cooperation with ESA.

There are intentions to take into account R&I policy trends in neighbouring, EU28 and third countries and modify policy based on the findings of smart specialisation monitoring and evaluation system This would allow coordinating national smart specialisation strategy according to R&I and market trends in both neighbouring countries and globally. In 2015 separate evaluations of joint transnational R&I cooperation were not carried out. So far, in the Baltic Sea region the BONUS programme covers R&D area (for the period 2010-2017). In Lithuania LMT and MITA are responsible for its implementation. A BONUS programme call 'Sustainable ecosystem services' was

opened in 2014. Out of 16 projects involving partners from Lithuania, 2 were allocated financing.

All in all, the level of transnational co-operation in joint activities with EU MS is rather low. Lithuania joined only two JPIs and contributed to one call so far. In addition, there is lack of policy coordination with neighbouring countries and possible synergies are not pursued. With the OP of 2014-2020, more transnational coordination could take place and new routes of cooperation might open.

4.2.2 RI roadmaps and ESFRI

The original national RI roadmap prepared in 2011 provided detailed information on RI in humanities and social sciences (e-resources of the Lithuanian language, databases, heritage and historical research), biomedical science (computer, structural and system biology, human biology resources, databases and standardisation, metobolomic ecology, experimental animals, aerobiology), as well as physical and technology sciences (lasers, semiconductors, spectrometric characterisation, ultrasound experiments and diagnostics, astronomical observatory, Lithuanian GRID and calculation network). The RI roadmap also identified international infrastructure, where Lithuanian RI could be integrated (e.g. CESSDA, BBMRI, ESS, etc.). In 2015, the process of Lithuania joining CERN also began. The roadmap itself does not define funds required by listed projects.

In 2014 and 2015, LMT updated this RI roadmap and provided a new list of infrastructure projects, which should be prioritized with the aim of connecting to European RIs according to the ESFRI roadmap and other international RIs that are important to Lithuania. In addition to new RI projects in the already existing science fields, RI for agricultural science was added (plant genetics and biotechnology). Humanities and social sciences RI was supplemented with European social survey; biomedical sciences RI with Biobank LT; physical and technology sciences RI with innovative chemistry, mechatronics, micro- and nanotechnology, applied chemistry and biopharmacy. LMT also provided €0.2m to international RIs through competitive funding in 2014 (LMT, 2015).

In 2007-2013 huge investments were made in developing RIs, by creating specialised scientific valleys, which replaced the outdated RI. The largest Lithuanian RI centres are five valleys: Santara and Saulėtekis in Vilnius (biotechnologies, medicine, biopharmacy, ecosystems, sustainability, ICT, lasers and light, materials, nanotechnologies, semiconductors, civil engineering), Nemunas and Santaka in Kaunas (agro biotechnologies, bioenergy, forestry, food, safety and wellness, chemistry and pharmacy, mechatronics, energy and ICT), and Maritime Valley in Klaipėda (maritime technologies and environment) (MITA, 2014). The two largest RI centres will only start operating in March 2016. Since the creation of valleys was funded from public sources, they guarantee open access to external agents, including foreign research institutions and foreign private sector organisations.

There are plans to use cohesion funding for 2016-2020 for integration into the European RIs, especially those in the ESFRI roadmap. Lithuania's Smart Specialisation Strategy includes the measure 'R&D infrastructure development and integration into European infrastructures' with €188.0m allocated to it. However, specific financial support for this measure is not precise yet, as it is funded together with several other RI development projects. These are partly related to areas selected in the national RI roadmap. The ESFRI roadmap was approved in 2010 and in 2014 a process of revising it was started, and results were published in 2016. The national RI roadmap and the ESFRI roadmap are well aligned. Lithuania's RI roadmap lists international infrastructures from ESFRI that are important to Lithuania and ideally should be joined. As of 2014 Lithuanian RIs were members of the following international RIs from ESFRI: CLARIN ERIC, ESS ERIC. LIDA (archive for Lithuanian humanities and social sciences data) considers becoming full member of CESSDA, and HUMRE (RI for human wellbeing and development) was in the process of joining SHARE ERIC in 2015, although final decisions were not yet taken by the Ministry of Education and Science. In areas other than humanities and social

sciences there were no full members of ESFRI infrastructures, although either negotiations were underway or collaboration took place (LMT, 2014). The government will support joining other ESFRI infrastructures in 2016-2020. However, it is not clear which ones will be approved by the responsible Ministry, as available funds do not allow full integration into all ESFRI infrastructures listed in the national RI roadmap.

4.3 International cooperation with third countries

By 2015 there was no single national strategy that focused specifically on cooperation with third countries in the R&I area, but international cooperation is emphasized in programmes such as the National Progress Programme for Lithuania for the period 2014-2020 (NPP). At the same time, bilateral or multilateral agreements as well as programmes with third countries are in force, both in Europe and outside. Most policy documents apply similar measures towards R&I cooperation with EU and third countries. In addition, instruments such as Smartinvest LT will be used to attract foreign investment, while instruments targeting foreign researchers will include those from outside the EU as well.

MITA administers EUREKA and EUROSTARS programmes, which include many non-EU countries. In the case of BILAT projects, Lithuania took part in BILAT-UKR*AINA project which was successfully finished on 30 June 2015. Even though interinstitutional agreements were signed, Lithuania did not have funding programmes aimed at Ukrainian R&I agents. With respect to SFIC, Lithuania is also not active, although several cases of involvement exist (e.g. participation in Korean programmes). Additionally, Lithuania has intergovernmental cooperation programmes with Belarus, China (together with Latvia), Ukraine.

Although the major part of Lithuania's international cooperation takes place within the EU boundaries, there are initiatives with third countries as well. Perhaps the most well-known programme is the Lithuania-Swiss programme 'Research and development' which aims at promoting cooperation in R&D, deepen scientific knowledge, and improve social and economic development in Lithuania. In total around €9m were allocated to this programme by the Swiss government. Lithuania also participates in the Nordic and Baltic countries cooperation programme LILAN, coordinated by NordForsk. While this includes countries that belong to the EU, third countries, such as Norway, also participate. Lithuanian State scholarships are available to researchers from Ukraine, Georgia and other countries. Furthermore, there is an agreement for cooperation with the USA in the field of science and technology (to be revised), and an agreement with NASA on student internships.

All in all, on the policy level Lithuania is not active in developing R&I cooperation with third countries within the EU framework/activities. Even though there are research visits to and from third countries, the cooperation could be much stronger if Lithuania involved itself deeper into various programmes offered by the EU and non-EU states.

4.4 An open labour market for researchers

4.4.1 Introduction

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 space 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 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 less than half of the members proposed 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 and 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 and 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, Gaušas and Paliokaitė, 2014).

The Ministry of Education and Science initiated a revision of the Law on Research and Studies so that some changes might take place in 2016. In July of the same year Lithuanian Government approved the amendments and passed the law project to the Parliament), however, it is still too early to say whether changes with respect to institutional autonomy will be implemented.

In total there were 18083 researchers (8557 FTE) in Lithuania in 2013 (about 0.98% of active population). The EU28 average in 2013 was 1.12% of active population (0.72% if compared to FTE). The number of researchers increased significantly by 4,200 from 2009 to 2013. In 2014, the majority of researchers (76.9%) in Lithuania worked in the public sector, while only 23.1% of researchers belong to the 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. At the same time it should be mentioned that while the supply of researchers increased (by 4,200 in 2009-2013), the demand for researchers increases more slowly (FTE of researchers increased by 67 in 2009-2012). These different trends in supply and demand are also evident in annual data, which also allows analysing the impact of the crisis. Absolute number of researchers constantly increased at least since 2004 (first data point), and the average annual growth amounted to 5.2% in 2004-2013. The most significant change in the number of researchers took place in 2011, when the growth of the number of researchers in a year was by 23.5% (MOSTA, 2014c). This might partly reflect people's willingness to apply for PhD programmes during the crisis, since PhD studies guaranteed a stable source of income. At the same time, joining the field of research, especially in public institutions, even if part-time, could offer more safety in times of uncertainty in the market. Having in mind that significant part of R&D expenditure comes from EU ESIF, which is allocated on a multiannual basis, research in publicly funded projects becomes more attractive. Nonetheless, separate analysis is required to test whether this hypothesis is correct. Meanwhile, the number of FTE researchers has changed in the opposite direction. Average annual growth was 1.8% in 2004-2013. Most importantly, in the years 2010-2012 the number of FTE researchers decreased by 5.5% (MOSTA, 2014c). Therefore, it could be stated that during the crisis the supply of researchers increased, while the demand decreased and only in 2013 reached the level of 2009. This

may also reflect the limited amount of funding that is allocated for research. However, even though the overall number of FTE researchers decreased, this number should be taken with a grain of salt when interpreted with respect to demand of researchers due to several reasons: a) the number of FTE researchers decreased only in government and higher education sectors for two years, while the decrease in the business sector lasted only one year, was less drastic and the subsequent increase was much more rapid; b) in the private sector researchers are often called technologists, engineers, etc. and employers indicate that there is a lack of such employees (Visionary Analytics, 2014), thus there are indications that demand for researchers in the private sector is higher than their supply. Point b) also applies when discussing the total number of researchers with respect to supply. Some employees may be doing research, but have differently titled positions. On the positive note, Lithuania enjoys the trend of researchers getting younger (MOSTA, 2014c), hence ageing of researchers is not a serious problem.

4.4.2 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 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 HEIs is regulated 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 the 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 is 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 a 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. After several amendments a new Decree was approved and entered into force in 2014. Public universities are autonomous to stipulate salaries for their academic and scientific staff. Project funding schemes offer top-performing researchers the possibility of increasing their salaries. The Programme for Increasing Remuneration of Employees of Research and Higher Education Institutions 2009-2012 foresaw an increase in researchers' salaries, although the programme was criticized by trade unions for remaining unimplemented. 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 are 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 the willingness of institutions to employ their own PhD graduates / extend contracts with current staff. Low level of competition could be also related to the rather widespread belief 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.

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.

Resources from mainly international sources (e.g. Erasmus, EU ESIF) 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 (2014b), 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%).

The market is generally stable for the younger generation. Although during the crisis there was a decrease in the number of FTE researchers, in 2013 the market for researchers reached the level of 2009. Furthermore, the total number (supply) of researchers significantly increased. It is a common practice that a university in which a student enrols for PhD programme also contracts him/her whether it is teaching, research or project-based work. Therefore, entering a PhD programme quite often guarantees a part-time job which serves as a first career step.

Measures to attract foreign researchers are used (e.g. instrument 'Strengthening capacities of scientists and other researchers, promoting mobility and student research' included this as one of its aims). Nonetheless, the focus is often concentrated on local researchers. Therefore, the measures taken are not as successful as they could be. One of the reasons why it is difficult to attract more foreign researchers is the low salary if compared to EU15 or advanced countries outside the EU. The MORE2 cross-country report on researcher remuneration found that by 2013 Lithuanian first stage researchers (R1) earned only approximately 15.6% of what first stage researchers (R1) earned in Germany, when measured in 2011 PPP €. Similar differences are found across different groups of researchers as well. In Lithuania PhD stipends were approximately 44.8% of those in Germany but only 19.9% of those in Denmark (Idea Consult et al., 2013). However, since October 2015 the stipends were increased by 25%. There are plans to

make further increases in 2017. Even within Lithuania salary differences are high. Researchers in the high education sector earn 43% less than researchers in the private sector (Paliokaitė, 2015). It is also one of the reasons for emigration of young researchers. Language may also be a barrier for young researchers, especially in some science areas, such as humanities or social sciences. However, in general, English language is enough to communicate within the academic community. Among the measures which aim at attracting foreign researchers, Lithuania's Smart Specialisation Strategy includes separate instruments administered by LMT – 'Foreign Scientist Attraction and R&D Activities' and 'Brain Attraction and Reintegration' – which target foreign (or emigrant Lithuanian) researchers and aims at bringing them to Lithuania. €20.3m from EU ESIF are allocated to these instruments. Another instrument – 'Doctoral Studies Financing and Development (Attraction of Youth from Abroad)' – targets both Lithuanian and foreign PhD candidates, or youth willing to enter PhD studies. This instrument was supposed to be financed both from the EU ESIF (€23.2m) and the national budget (€62.2m). Both cover priority areas and priorities distinguished in Lithuania's smart specialisation strategy. However, current measures implementation plan does not include these measures. Several other measures have attraction of foreign researchers as one of their objectives.

Lithuanian EURAXESS is barely functional. For example, as of 7th September 2015, there were only five job offers placed for incoming researchers in English. Meanwhile, the LMT webpage provided 26 open job offers in the Lithuanian language. Therefore, there is a discrepancy between theoretic provision of equal opportunities to foreign researchers and its practical implementation, where language barrier makes it difficult to access job offers and enter the Lithuanian research market.

4.4.3 Access to and portability of grants

As a general rule, competition-based national research grants and research fellowships which are provided by LMT 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 Lithuania and do their research in one of the national institutions. Enhancement of transnational mobility is an objective of the 'Researchers Career Programme' (RCP) under OP for Human Resources Development for 2007–2013 (also valid in 2014 and 2015). It foresees funding for the following 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 in 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 their home institution. There have been no specific developments in this area over 2011-2014. Since details of instruments for the

OP for 2014-2020 are not yet clear, it is too early to tell whether portability of grants will be introduced.

4.4.4 Doctoral training

The Regulation on Doctoral Training (the Law on Higher Education and Research 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. LMT supervises doctoral training and evaluates research activities. PhD studies are evaluated every three years based on self-assessment by a group of experts who are appointed based on rules set by LMT. The group is coordinated by an employee of LMT. The European University Association's *University Autonomy Tool* evaluates the indicator 'Introduction of programmes at doctoral level' only at 40% due to the fact that not all academic units can open new doctoral programmes (European University Association, 2015). 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 studies 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 doctorates (some of them funded by Erasmus Mundus).

On the agency level, LMT implements 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. Additionally, the Education Exchanges Support Foundation (ŠMPF) organises competitions to distribute grants by foreign governments which are also provided to Lithuanian doctoral candidates for study and research visits abroad.

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 introduce the *industrial doctorate* concept, although it is not mentioned in the smart specialisation policy documents. It is included in the project of the revised Law on Higher Education and Research. The revised law would allow organisations other than HEIs or research institutes to implement doctoral studies together with HEIs or research institutes, if these organisations perform high-level R&D activities. How the level of R&D activities would be assessed is not clear yet. Industrial doctorate should help young researchers become more entrepreneurial and better understand what research is needed by industry. Researchers who receive industrial PhDs could become intermediaries between business and science by translating the needs of business to science and the possibilities of science to business.

4.4.5 Gender equality and gender mainstreaming in research

Women are relatively well-represented among researchers in Lithuania. In 2011, Lithuania and Latvia were the leading countries in women representation among researchers (20% above the EU average) (MOSTA, 2014b). However, two key problems remain significant in Lithuania: a) women are not proportionally represented in all fields of science; b) women are considerably under-represented in senior academic positions. Undertaken steps to fight gender inequality are insufficient to counter historically embedded barriers to gender equality in research. Already at the undergraduate level, female students are the exception in engineering, technology and physics fields. As the career progresses, their share approaches zero in these fields. In general, women participation is low in mathematical and technological fields (although the share (33%) is above the EU average (less than 30% for countries with available data) (MOSTA (2014b)). Moreover, the share of women is insufficient in better paid research leadership positions both in senior academic positions and managerial positions (here the numbers are lower than the EU average). This is well illustrated by the gap in the annual average salary between men and women as it increases with experience. A Strategy on Equal Opportunities was adopted in 2008. It provides legal foundations for the introduction of 'Gender equity and gender mainstreaming' as a horizontal principle in other strategies and programmes (e.g., the Researchers Career Programme).

In the R&I area horizontal gender equality and non-discrimination policy was applied in OP 2007-2013. However, the annual report of ESIF monitoring committee to European Commission for 2013 on the 'Human resource development' OP indicates that the impact of the priority 'Strengthening capabilities of researchers' on improving gender equality was felt only at project level (Ministry of Finance, 2014). For example, the Lithuanian Academy of Sciences (LMA) carried out a project 'Promoting gender equality in research', and €0.58m were allocated to it (LMA, n.d.). The project was coordinated by the LMA partners which included: LMT, the association BASNET Forum and the National Union of Student Representations of Lithuania. Gender equality in research committees, boards and governing bodies could be promoted better via establishment of systemic approach or legal regulations. Still, there are no legal restrictions on female academic and administrative careers. Generally, all EU funded projects from the Ministry of Education and Science are assessed with respect to ensuring non-discrimination. There were no additional requirements concerning gender for projects in 2007-2015.

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers electronic identity

By 2015 MITA developed a portal 'e-Science Gate' 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. The '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.

Although descriptions of R&I policy instruments related to e-infrastructures for 2016-2020 are not yet available, they are non-competitive and project implementers are already announced (e.g. public HEIs). An instrument for development of e-infrastructures – 'Development of Information Infrastructure for Research and Higher Education' is already being prepared. KTU will implement this project, which will be financed from EU ESIF (€4.3m). Another instrument which is related to development of digital research services is the subscription to databases that are needed for R&I activities (for this €30m come from EU ESIF).

It is a general rule that publicly funded infrastructure (including e-infrastructure) must be open access. That is, it can be accessed by external agents both from Lithuania and abroad. Access to infrastructure is also not limited to researchers from the public sector;

private sector is eligible to use it. There are no national strategies or policies related to electronic identity that would facilitate researchers' access to transnational digital research services. Even though there is no uniform e-identity, use of e-infrastructure is possible through e-Government gates. As of August 2015 there is no support for identity federation communities. There are also discussions concerning personal data security, privacy on the internet and similar issues, but they are rather sketchy and do not concentrate specifically on e-security issues in the research field.

4.5.2 Open Access to publications and data

The Law on Higher Education and Research (adopted in 2009, revision expected to be adopted in 2016) stipulates that results of all publicly funded research in both public and private research and higher education institutions must be publicly available unless they are limited by intellectual property or other requirements. 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. This is due to formal evaluation of R&D activities focusing 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 is an increasing number of public databases, for example: database on students' theses and dissertations (http://etd.library.lt), academic electronic database (http://www.elaba.lt/), Lituanistika database in research in social sciences and humanities (http://www.lituanistikadb.lt/en/home.html), Lithuanian humanities and social science data archive (LiDA) (http://www.lidata.eu/). There also are more specialised databases covering specific disciplines or publishers. However, these databases have not reached critical mass yet – 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)'. It seeks to provide infrastructure for preservation and open access to research data up to five petabytes, and there are plans to integrate it with other databases. The project is already launched (http://www.midas.lt), but by the end of 2015 only 22 studies were published there. Also, not all data is open access. Access is sometimes restricted to owners of research.

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 project data should be provided to a managing research institution and scholarly 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). 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. In 2014 LMT became a partner in the project PASTEUR4OA.

According to Archambault et al. (2014), green open access is least used in Lithuania (4.5%), similarly to in Malta (5.0%), Croatia (5.2%), and Romania (5.3%), while publishing in gold OA 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.

LMT supports the publication of research results since 2012. 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 this 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 (€1.16m for 2012-2015). It addressed 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.

5. Framework conditions for R&I and Science-Business cooperation

5.1 General policy environment for business

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 has high ranking in several of the World Bank's Doing Business Rank 2015 categories. It ranks 24th (10th in the EU28) with respect to ease of doing business. In starting a business Lithuania is 11th (2nd in the EU28), and in registering property – 9th (2nd in EU28) (World Bank Group, 2015).

However, with respect to resolving insolvency Lithuania ranks only 67th (27th in EU28). 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. These recommendations are not yet accepted in Lithuania. Although Lithuania's score on commencement of proceedings index is high (2.5 out of 3) and management of debtor's assets score is also rather high (4 out of 6), other areas are evaluated much less positively. Reorganisation proceedings scores only 0.5 out of 3 and creditor participation 1 out of 4. Concerning the extent to which entrepreneurs may begin anew after failing, the main obstacles are that: a) a debtor cannot obtain credit after insolvency proceedings have commenced; b) post-commencement credit is not prioritized (World Bank Group, 2015).

5.2 Young innovative companies and start-ups

The number of start-ups in Lithuania has been steadily increasing. An analysis of 42 IT and life sciences start-ups carried out by Enterprise Lithuania found that before 2011 only one or two were established per year. However, 2011 six were established, another 11 in 2012 and 20 in 2013 (Versli Lietuva, 2014). The same can be said about investment. In 2014 €46m were invested by venture capital, nearly three times as much as in 2013 (Startup Highway, 2015). This tendency follows the general trend of business in Lithuania. Over the past five years there has been a stable increase in the number of established enterprises in general as well (62,889 in 2012, 79,840 in 2016).

Direct funding for innovative 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 provided assistance to entrepreneurs and young innovative companies. These measures aim to:

- ✓ Support the creation and development of new business incubators, in order 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 their relevance to business, and improve business conditions for SME's and natural persons willing to start a business.

Since 2012, MITA has been active in promoting science-based and/or high tech innovative start-ups. The first MITA initiative on the 'Commercialisation of R&D results' was launched in 2012. The main goal of this initiative was to encourage scientists, researchers and students to establish start-up or spin-off companies. By the end of 2015 four calls were made in total. In 2014, 42 proposals were received. Out of them 18 were

funded. Participation of KTU was significant. It implemented 8 out of those 18 projects. Newly established enterprises created 19 new products and 9 services, created 35 jobs (MITA, 2015). With the fourth call 13 new projects were funded in 2015.

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

The task of the INOVEKS project was to create opportunities for students and young researchers to establish new companies. The project was implemented by MITA in partnership with several universities and STPs, which (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. Within INOVEKS 411 new technology ideas were selected and 71 companies were established in 2014 alone.

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. The most promising ideas will be commercialised, and 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. The project selected 100 technology ideas suitable for commercialisation, established 45 new technology companies, and provided expert consultations to 45 SMEs. Newly established enterprises introduced 15 new products/services to the market. 21 start-ups were established in Vilnius, 15 in Kaunas and 3 in Klaipėda.

Spin-off creation will be encouraged in 2016-2020 as well. Such indicator is included in the smart specialisation programme. However, it remains to be seen how the support will be actually implemented.

5.3 Entrepreneurship skills and STEM policy

A number of financial (funded from EU SF) measures as well as higher education sector reforms (discussed at the beginning of this chapter) were implemented over 2007-2014. They 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. However 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 addressing innovation skills gaps. To solve these issues the Ministry of Education and Science aims at promoting STEAM education both by providing required infrastructure (400 secondary education institutions were provided with equipment) and by encouraging STEAM teaching activities. The Ministry of Education and Science is preparing an action plan for STEAM education. In October 2015 it informed that there will be 10 STEAM education centres in Lithuania. The Smart Specialisation Strategy also includes a measure for establishing open access centres of research and development in STEAM areas which would be suitable for students at the secondary education level. The plan indicates allocation of €5.8m to this measure.

The Global Monitor of Entrepreneurship (GEM) asked national experts to evaluate the state of entrepreneurship education in various countries, including Lithuania. The GEM 2014 Global Report identified that on a 5-point Likert scale Lithuania got 2.37 with respect to basic school entrepreneurial education and training (17th out of 73 evaluated

countries) and 3.07 points with respect to post-school entrepreneurial education and training (22nd out of 73) (Singer, Amorós and Moska Arreola 2015). 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 addition, Junior Achievement Lithuania cooperates with the Ministry of Economy and the Ministry of Education in promoting entrepreneurial education. In 2014, pupils' visits to the Ministry of Economy and competition of entrepreneurial ideas of pupils were organized. A report on entrepreneurship among youth in Lithuania identified that Junior Achievement in Lithuania plays an important role in strengthening this type of training (OECD and European Commission, 2015).

In addition to teaching entrepreneurial skills in the education sector, the measure 'Human resource development in companies' was implemented in 2007-2013 by the Ministry of Social Security and Labour. In total, 240 projects were funded and €54m were allocated to them. This measure included teaching employees and employers, qualifications development, teaching in the workplace, creation and implementation of personnel management systems, new work organisation forms, assessments of the needs to develop qualifications.

5.4 Access to finance

Business access to venture capital markets has 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 Practica 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, start-up) 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. 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, the Practica Venture Capital Fund could potentially provide follow-up 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 the European Investment Fund in 2010 under the JEREMIE initiative. The fund size is €25m. It is aimed at investing in small - medium-size enterprises in Lithuania. The 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.

In addition, as of 31st December 2014, the INVEGA fund attracted €180.6m of private investment (support was provided to 2,874 SMEs). JEREMIE attracted €15.43m (support was provided to 77 SMEs) (Visionary Analytics, 2015). INVEGA aims at promoting growth and competitiveness of Lithuanian SMEs through loans, guarantees, partial compensation of interest, and support for first job[26]. INVEGA provides guarantees for credits aimed at investment, turnover funds and refinancing. Guarantees may cover up to 80% of the total project value. Since 2016 INVEGA guarantees can also be provided to large enterprises. EU funds are also used to finance SMEs' credits. In the financing period of 2007-2013, €16.22m were allocated to such activities. A similar instrument is planned for 2014-2020, with initial allocation of €4.34m.

According to the Lithuanian Private Equity and Venture Capital Association (LT VCA)[27], European Union funds under the JEREMIE initiative enabled Lithuanian venture capital funds to invest in 56 companies with a total investment size of €95.3m. According to Visionary Analytics (2015, p. 31), the business and economic performance indicators of JEREMIE holding fund's portfolio companies increased significantly[28]:

- Turnover of the portfolio companies increased by 66% from the beginning of investment to 2013, and reached €96.92 million in 2013.
- Export of the portfolio companies grew by 31% from the beginning of investment[29] to 2013 and was €44.5 million in 2013.
- Number of employees increased by 14% from the beginning of investment to 2013 and was 1,559 in 2013.
- The additional private investment attracted was 2.5 times higher than EU SF support until 2013.

In addition, qualitative evidence of JEREMIE Holding fund's indirect impact on the overall financial market ecosystem is observed:

- *Formation of venture capital ecosystem*. Until 2010 (when the JEREMIE venture capital funds started to operate) venture capital market was dominated by foreign investors and was not stable. Now there are 5 venture capital funds operating under JEREMIE roof and one private venture capital fund. In addition, the regulatory system of venture capital funds was also slightly improved (improvements were made in the legal and tax base – see the last paragraph of this section).
- *Private venture capital funds entered the market*. In 2013 the private venture capital fund 'Nextury Ventures' was established.
- *The network of private investors is developing*. Now there is a business angels network of approximately 100 angels (BGI Consulting, 2014), private pension funds (e.g. Swedbank, SEB pension funds) and foreign investors (e.g. Intel Capital, Accel Partners, Nokia Ventures) are investing into venture capital funds.

In addition to the above mentioned achievements of venture capital funds, mentoring, advice, contacts and other help provided via these funds created benefits for the supported SMEs. The main *challenge* faced by venture capital funds relate to the restrictions of the funds' investment opportunities. Firstly, each fund has a ceiling for investment per SME. In some cases, especially in the later investment stage, a larger investment is needed (e.g. for the acquisition of infrastructure). This is the problem also

[26] For more specific information, see Visionary Analytics (2015), p.29.

[27] LT VCA unites 8 full members and 13 associate members 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.

[28] This data has been collected via survey of beneficiaries, counterfactual evaluation was not performed.

[29] Here and below the beginning of investment refers to the launch of each fund. Practica Seed Capital Fund was launched in 2012; Practica Venture Capital Fund was launched in 2012; Lithuania SME Fund was launched in 2010; LitCapital I was lauched in 2010; Business Angels fund was launched in 2010.

for *early stage investment* (seed capital fund) as the maximum amount of investment at this stage is only EUR 0.2 million. As a result, the majority of investments are made in the ICT sector as this sector does not require capital-intensive investments in the early stages of business. Secondly, the funds can invest only in Lithuania's territory. This restriction makes it harder to attract private investors, as the risk of investing only in Lithuania is higher than investing in e.g. all three Baltic States. This is especially important for the seed capital funds as they are riskier than the later stage investment funds and it is more difficult to manage such funds. In addition, only one seed capital fund is available in the whole venture capital ecosystem (and it was launched at the very end of the programming period). On the other hand, according to the interviewees, there are not so many good ideas to be supported.

In sum, currently the key venture capital funds in Lithuania are dependent on EU investments (e.g. the JEREMIE umbrella). However, a positive sign is the emergence of 100% privately owned venture capital funds, such as Nextury Ventures, established in 2014. Investment funds are not taxed in Lithuania, if they are established under Lithuanian law. There is no incremental tax for domestic investors, and no VAT on management fees at a fund level is introduced. However, companies are taxed both at firm and at employee levels. Domestic and foreign investment differs in that there is more transparency in the former than in the latter (EVCA, 2013).

5.5 R&D related FDI

The majority of FDI is attracted into the domestically oriented services and infrastructure sectors and export oriented cost-effective manufacturing functions. However 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.

However, no data was available on the volume of R&D intensive FDI investments. This lack of collected data might be related to the fact that in 2007-2013 no specific measures were devoted solely to attracting R&D intensive FDI. The indicator on which data is available is R&D funded by business enterprise sector from abroad. The amount of such funds increased from 0.01% of GDP in 2007 to 0.03% of GDP in 2012.

Lithuania's smart specialisation strategy includes several measures to attract R&D related FDI in the Action Plans of R&I priorities. These include Smartinvest LT (€5.8m) and Smartinvest LT+ (€28.96m with anticipated similar investment attracted from the private sector). Another measure, Smartpark LT will be used to attract FDI to industrial sites in all of the smart specialisation priorities . The Ministry of the Economy plans to allocate €13m through Smartpark LT.

5.6 Knowledge markets

The 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 are guaranteed with the copyright to their intellectual work products. The HEIs are granted a share of economic IP rights under the agreements with creators of intellectual work products. The extent to which 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 is not fully defined, but 1/3 of profit gained from exploitation of intellectual property belongs to authors, unless agreed differently in contract between HEI and researcher. 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.

The newly proposed revision to the Law on Higher Education and Research does not make any significant changes to treatment of intellectual property. It is still stipulated that intellectual property belongs to researchers although financial rights belong to the institution in which the intellectual product was created. The researcher is entitled to receive at least one third of the total revenue gained from the product (before this revision it was at least one third of profit). Otherwise, everything remains unchanged.

Some universities (KTU being the one leading progress in this area) already have clearly developed spin-off strategies and internal intellectual property policies, clearly outlined (e.g. specified in an annex to the researcher's employment contract). Lack of IPR policies at the institutional levels lead to lack of motivation to commercialise public R&D as well as lack of trust between the universities and their researchers. However the situation is improving, as more universities are starting to address these matters. To this end, MITA funds R&D commercialisation feasibility studies and awareness raising activities by 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. As of 2015 13 out of 14 proposals were funded for R&D commercialisation activities. Total funding was €0.35m.

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 MITA. In 2011-2014 MITA allocated €1.44m to 258 intellectual property projects. 190 projects covered patenting inventions, the rest 68 – registering design. Both the number of projects and allocated funds increased each year. 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.

The Action Plans of the priorities set out in Lithuania's Smart Specialisation Strategy include measures (InoPatent LT and Inocertification) which specifically aim at stimulating patenting and certification of new inventions, designs and products. The Ministry of Economy planned to allocate €8.7m to SMEs through Inocertification and €3m to all types of enterprises through InopatentLT. However, these measures have neither been launched, nor included in the plan of priority implementation in 2015 as separate measures.

5.7 Public-private cooperation and knowledge transfer

5.7.1 Indicators

Funding: BES-funded/publicly performed R&D

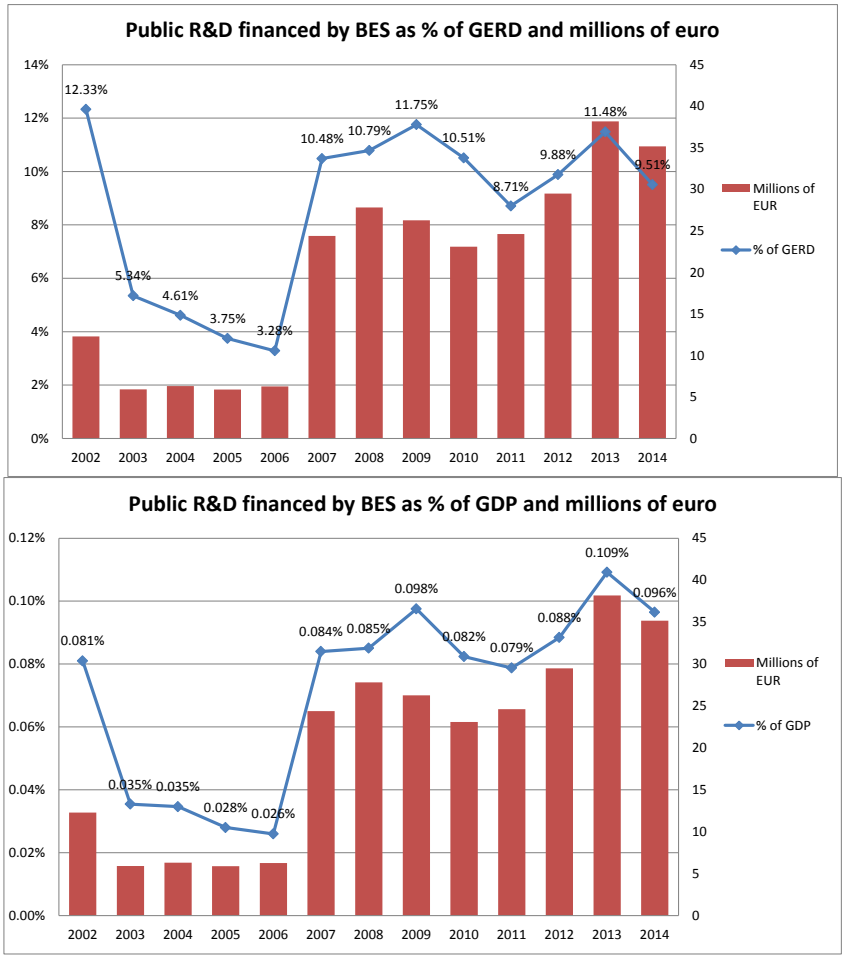


Figure 14 BES-funded public R&D in LITHUANIA as % of GERD (in €MLN) and % of GDP

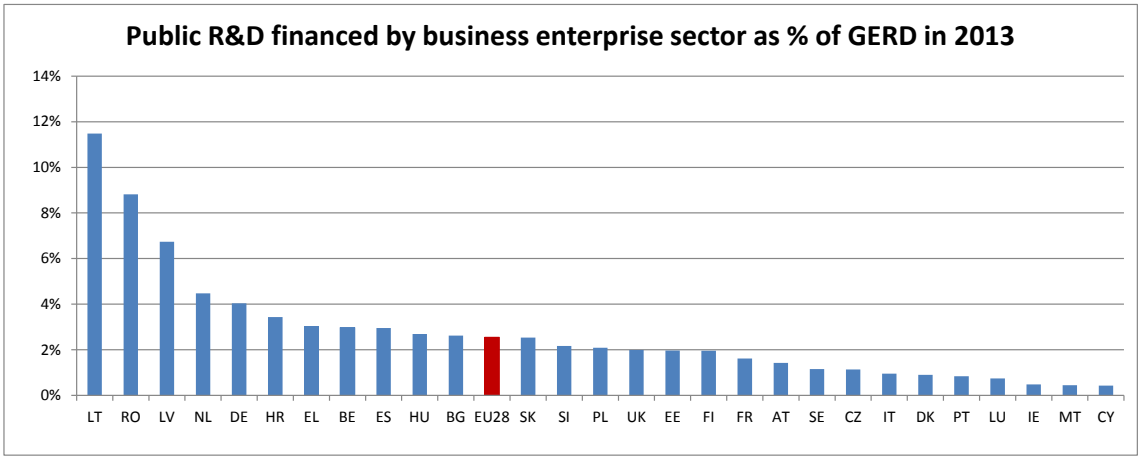
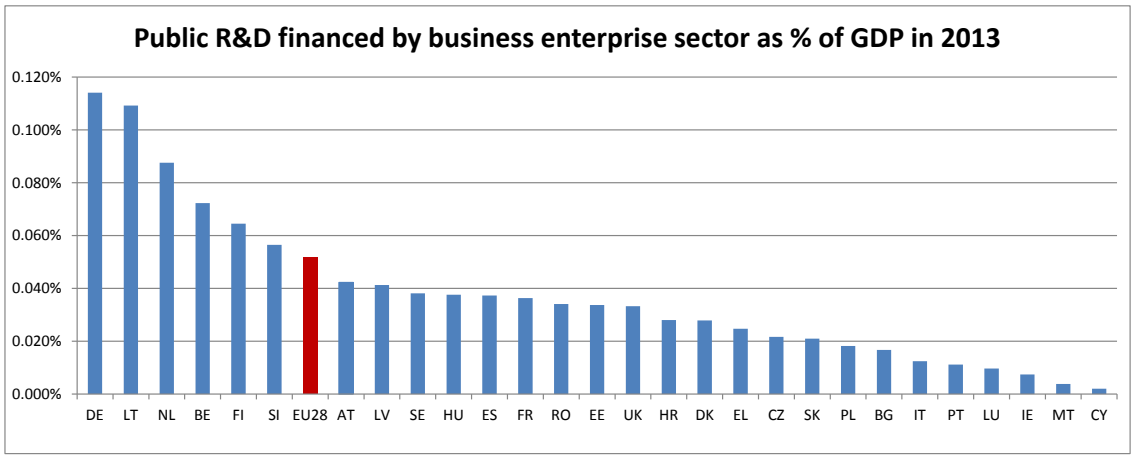


Figure 15 BES-funded public R&D as % of GERD and as % of GDP in 2013 in Member States[30]

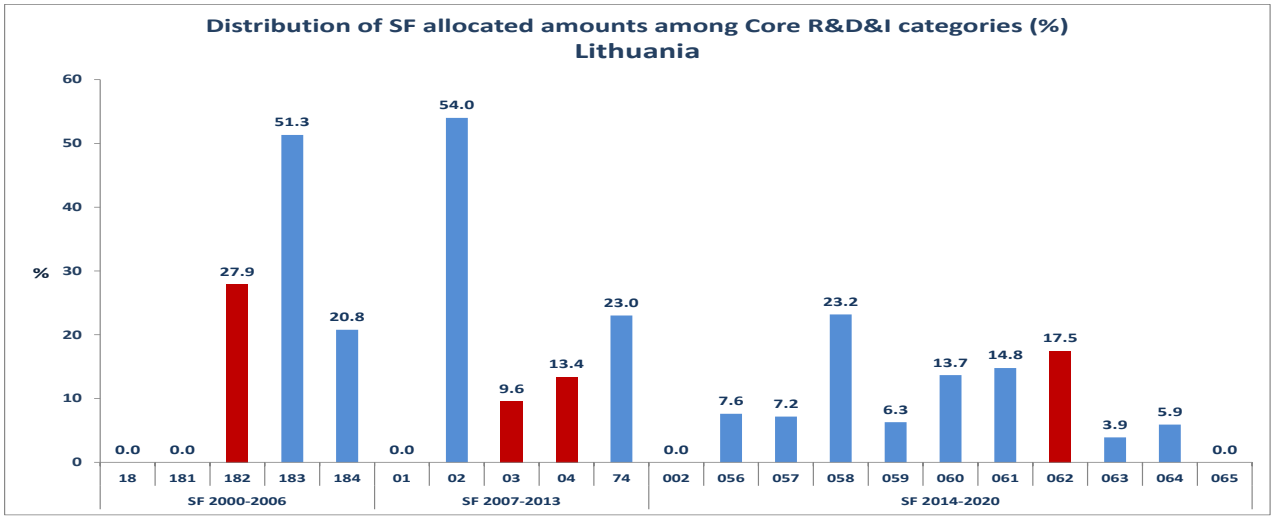


The high level of privately funded public R&D in Lithuania is difficult to explain based on the information available.

[30] 2013 was chosen as the latest data series providing a full comparison within EU-28.

Funding: Structural funds devoted to knowledge transfer

Figure 16 Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020[31]. We use the categories: 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.

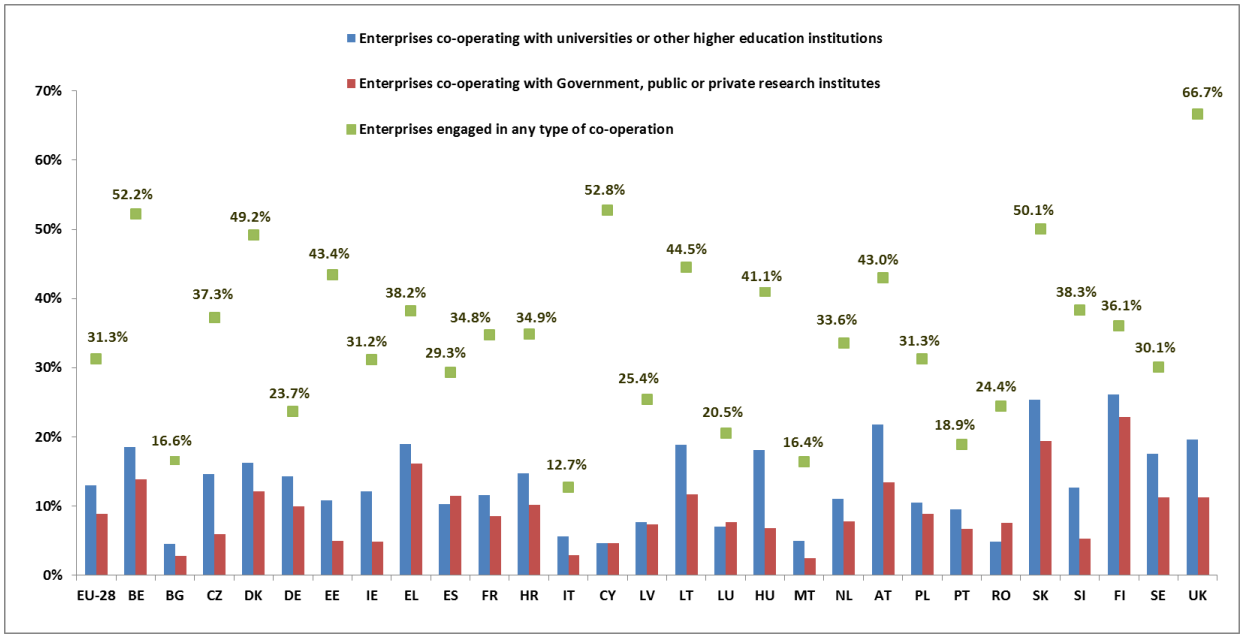


[31] Figure 16 provides the Structural Funds allocated to Lithuania for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State. The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.
The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.
The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.
The categories for 2014-2020 include: 002. Research and Innovation processes in large enterprises; 056. Investment in infrastructure, capacities and equipment in SMEs directly linked to Research and Innovation activities; 057. Investment in infrastructure, capacities and equipment in large companies directly linked to Research and Innovation activities; 058. Research and Innovation infrastructure (public); 059. Research and Innovation infrastructure (private, including science parks); 060. Research and Innovation activities in public research centres and centres of competence including networking; 061. Research and Innovation activities in private research centres including networking; 062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs; 063. Cluster support and business networks primarily benefiting SMEs; 064. Research and Innovation processes in SMEs (including voucher schemes, process, design, service and social innovation); 065. Research and Innovation infrastructure, processes, technology transfer and cooperation of enterprises focusing on the low carbon economy and on resilience to climate change.

Lithuania has allocated 17.5% of its structural funds for core R&D activities to 'Technology transfer and university-enterprise cooperation primarily benefiting SMEs' (compared to 27.9% for 2000-2006 and 23% in the 2007-2013 programming period). It is slightly higher than the EU average of 15.7% (the EU average was 26.1% for 2000-2006 and 30.1% for 2007-2013). Most of it was invested into infrastructure - the competence centres/open access centres of public universities (the so called 'valleys').

Cooperation: Share of innovative companies cooperating with academia

Figure 17 CIS survey 2012 – share of enterprises cooperating with academia



According to CIS 2012, in Lithuania 44.5% of companies engaged in any type of cooperation, which is higher than the EU average of 31.3%. Slightly less than half of those innovative companies (i.e. 18.9% of the total sample) cooperate with universities and higher education institutions compared to almost 7.7% in LV and 10.8% in EE. A bit less – 11.7% cooperate with government or public or private research institutes (compared to 7.4% in LV and 5% in EE). Still, looking at the impressive rate of cooperation in Finland - one of the innovation leaders (26% of innovative companies that work with higher education institutions and 23% with government or public or private research institutes), one can see the space for intensifying cooperation between innovative Lithuanian enterprises and academia.

Cooperation: Technology Transfer Offices (TTOs), incubators and technological parks

Lithuania, 25 Open Access Centres, 9 Science and Technology Parks. Technology transfer is also becoming more important for universities, so that they start establishing Technology Transfer Offices. 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. In addition, all these institutions compete for scarce funding, making it difficult to provide professional services or to attract qualified professionals.

The new Operational Programme 2014-2020 plans to finance operation of new technology transfer offices in universities as well. The 20+ Open Access centres (R&D laboratories, which should provide R&D services for business and other interested applicants for a particular price) have been established in the framework of the 'valleys'. 7 of the 9 science and technology parks are operating in the 'valleys' and some of them include technology incubators. Some of the science and technology parks are very active in start-ups promotion, regularly organise business plans competitions etc. (for example,

the North Town STP), but are not exclusively focused on science-based entrepreneurship.

Cooperation: Share of public-private co-publications

Figure 18 Co-publications by field 2003-2013 in Lithuania. Scopus database

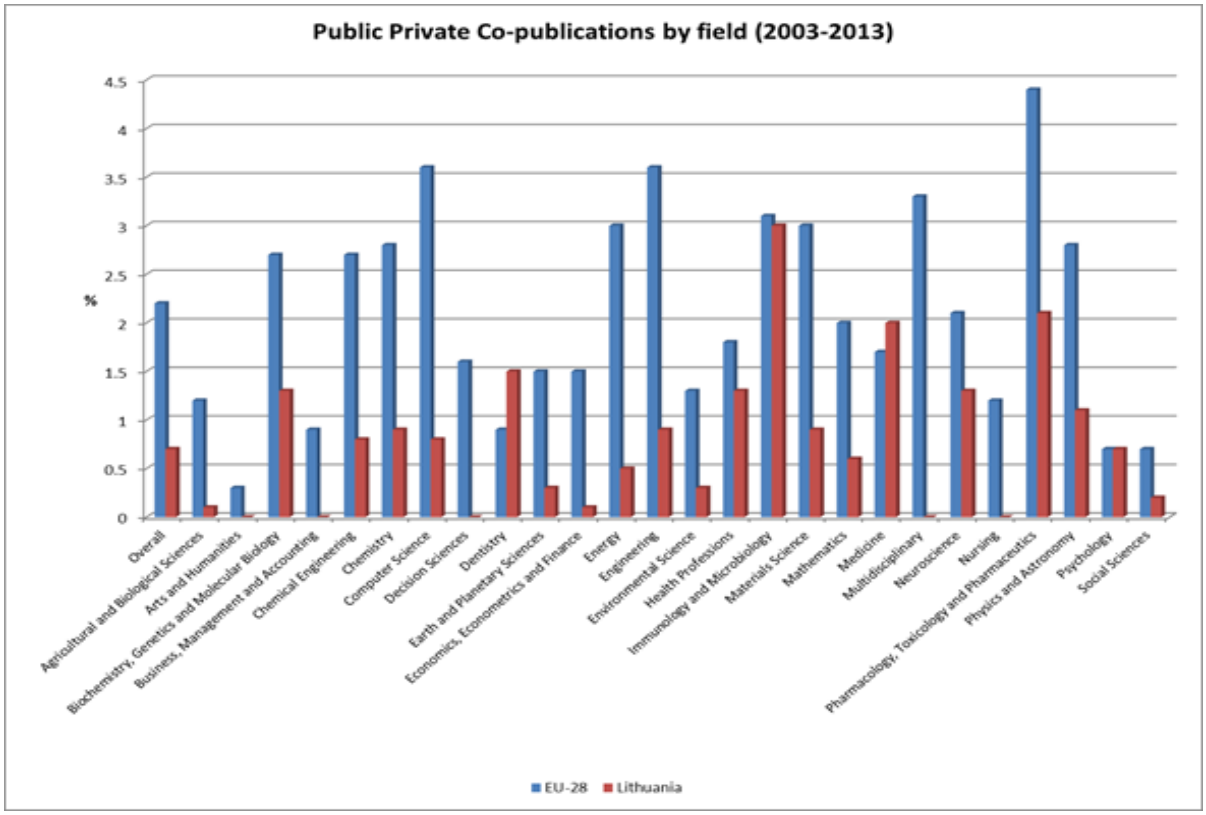


Figure 18 shows the 2003-2013 average percentages of academia-industry co-publications by field in Lithuania compared to the European average. Scopus data indicate that the percentage of co-publications has not changed much in the last eight years (2006-2013), with 0.6% of academia-business publications in 2013. Moreover, in 2013 Lithuania had only 5.7 public-private co-publications per million of population compared to 29 for the EU-28 (and 6.4 for LV, 28 for EE)[32]. The domains with highest percentage of co-publications (excluding multidisciplinary publications) are immunology and microbiology, pharmacology and medicine.

Cooperation: Patenting activity of public research organisations and universities together with licensing income

In 2013, public research organisations submitted 31 patent applications to the State's Patent Office, of which 23 applications were submitted by universities (about 26% of all patent applications in Lithuania in 2013).

No data could be found on licensing income from these patents, neither on co-patenting activity of academia and business sector.

Cooperation: Companies

Since 2012, the Agency for Science, Innovation and Technology (MITA) has been active in promoting science-based and/or high tech innovative start-ups. The first MITA initiative on the commercialisation of R&D results was launched in 2012. The main goal of this initiative was to encourage scientists, researchers and students to establish start-up or spin-off companies. Four calls were already made in 2012-2015. In 2014, 42

[32] RIO elaboration based on Scopus data.

proposals were received and out of those 18 were funded. Participation of Kaunas University of Technology was significant – it implemented 8 out of those 18 projects. The newly established enterprises created 19 new products, 9 services and 35 jobs. With the fourth call 13 new projects were funded in 2015.

After the success of this initiative, two Inogeb-LT3 funded projects followed: 'Innovative business promotion (INOVEKS)' and 'Incubation of new technology companies (Technostart)'. Within INOVEKS 411 new technology ideas were selected and 71 companies were established in 2014. The Technostart project selected 100 technology ideas suitable for commercialisation and established 45 new technology companies. Newly established enterprises introduced 15 new products/services to the market.

It should be stressed that creation of spin-offs has not been incentivized enough and neither HEIs nor research institutes had precise strategies for spin-off creation. This issue is partly addressed in Lithuania's Smart Specialisation Strategy covering the period of 2014-2020, where indicators covering spin-off creation are included there is aim to encourage it.

5.7.2 Policy Measures

There have been a number of measures strengthening the cooperation between science and industry introduced by Lithuania in the recent years.

One incentive for HEIs is the shift to a more result-based university funding model whereby more value is attributed to R&D contracts with industry. 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 stipulates that higher share of institutional funding (50% since 2011) should be linked to research performance. Two out of the four assessment criteria are directly related to knowledge transfer**:** funding received from R&D contracts with private establishments and public funding from participation in joint R&D projects with private establishments.

The direct financial support for collaboration of science and business in joint R&D projects and cluster development projects comprises a group of measures mostly financed by the EU structural funds: the 'Integrated science, studies and business centres – Valleys', the investments in innovative clusters development (Inocluster LT, Inocluster LT+, and Inogeb LT-3), and the Innovation vouchers scheme that was launched in 2010. Newly planned measures in the 2014-2020 programming period include 'Industrial doctorates' and 'Joint initiatives'.

'Integrated science, studies and business centres – Valleys' constituted the most important instrument (worth around €400m) for fostering open innovation and transfer of knowledge between public research and private enterprises. The goal of the concept is promoting rapid development of valleys, which would meet international standards, enabling training of world-class professionals, creating new internationally competitive high-added value knowledge and products, promoting high-tech businesses, advanced technologies and innovation in high-tech industries and traditional sectors of the economy, culture and social environment. On the 1 of April, 2014 the Government of the Republic of Lithuania approved the new edition of 'The concept of the establishment and development of integrated science, studies and business centres (valleys)'.According to the Lithuanian National Reform Program 2015, the implementation of 4 projects within the 'Valleys' programme was completed in 2014 and some use of research equipment obtained through financed valleys in business can already be observed: 25 open access centres have been established, businesses are created, contracts for the performance of research are signed with foreign companies. 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.

Innovative clusters development comprises a set of measures: Inocluster LT and LT+ and Inogeb LT-3. The Inocluster set of measures started in 2010 with the aim to support cluster infrastructure development activities in order to promote open innovation and ensure knowledge and technology transfer. The cluster is defined as the agglomeration of at least five private legal entities, connected in the value chain and sharing common economic interests. Investments were earmarked for the support of activities related to the formation of clusters in identified technological 'breakthrough' areas. Among the foreseen support areas are investment into the cluster's training and research infrastructure, the cluster's joint (open source) R&D infrastructure (laboratories, testing labs), marketing of the cluster in order to attract new members (Paliokaite, 2014a). Positive examples of open innovation, when several companies establish an R&D cluster based around one export-oriented product is the Photovoltaic Technology Cluster which aims at developing solar energy products based on elements produced by different companies.

The Inogeb LT group of measures aimed at improvong the environment for knowledge and technology transfer and to facilitate science and business R&D cooperation. Inogeb LT-1 provided support services for SMEs, Inogeb LT-2 – support for science and technology park infrastructure, and Inogeb LT-3 promoted innovative business creation and entrepreneurship (INOVEKS,Technostart). The measure is administered by the Lithuanian Business Support Agency (LVPA) and runs until 2015 (Paliokaite, 2014a).

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 up to €5,792 (*de minimis* support of 80%). The voucher enables an SME to buy R&D expertise or knowledge from a research or higher education institution. Supported activities include industrial or applied research, technological development (experimental or development, design and technological works), technical feasibility studies. 989 inno-vouchers (€3.6m) were funded in the period 2010-2014.

The State also implemented a SF-funded measure which finances researchers' placements in SMEs through 'High qualification employee employment in enterprises'. 17 researchers and four companies benefited from the academia-industry research placement/exchange contracts funded by this measure. Start-ups (mostly initiated by university students) were launched by MITA in an ESIF-funded project 'Commercialisation of R&D results' aimed at fostering commercialisation of public research results or initiating innovative start-ups.

As regards newly planned measures, 'Industrial doctorates' to stimulate intersectoral mobility is introduced in the revised Law on Higher Education and Research which is pending approval in the Parliament. The Ministry of Economy is planning to launch a measure aimed at compensation of the PhD process cost for private companies (e.g. in the cases when an SME provides a supervisor), and the Ministry of Education tested in 2015 the revised Competitive Doctorate programme, whereby PhDs can be prepared in cooperation between a university and a company. Also, the Operational Programme for 2014-2020 (1st priority – 'R&D and innovation promotion') plans to finance 'Joint initiatives', i.e. two or more complementary collaboration projects which involve R&D activities and have the aim of creating market-oriented commercially viable prototypes of technologies and products with high value added. The Ministry of Education and Science has the instrument 'Joint research-business projects' to support projects eligible for joint initiatives (allocated €35.92m), while the Ministry of Economy adds to joint initiatives through the 'Intellect LT. Joint science-business projects' instrument (planned funding €139m), which saw its first call launched in December 2015. However, it should be noted that projects will be implemented in two separate stages which increases the risk of lack of complementarities between activities carried out by research institutions and businesses.

Assessment

Lack of a proper legal base for commercialisation of scientific projects, information asymmetry, low research quality, and especially the insufficient in-house capabilities and the passive and bureaucratic stance adopted by universities combined with a lack of a collaboration projects pipeline led to below average cooperation between science and business (Paliokaitė et al., 2011). Despite the establishment of intermediary organisations, cooperation between industry and research organisations remains at a rather low level and success stories of technology transfer or commercialisation of public R&D are rare. Evaluation results (e.g. Paliokaitė et al, 2011; Visionary Analytics, 2014) have demonstrated that business-science collaboration is often more formal (in order to meet the eligibility criteria for funding) than real. 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, even though they can use them for R&D activities.

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. One problem is that the 'clusters' approach fostered by the Ministry of Economy was not 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.

Studies (Technopolis Group and Ernst & Young, 2014; Paliokaitė et al, 2011, 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 activities. 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, which does not provide incentives for researchers to build relationships with the industry.

Successful implementation of the E-Science Gate services should contribute to the knowledge flows between the academia and the private sector. Concerning intersectoral mobility, one important indicator showing the lack thereof is the share of researchers working in the public sector (76.9% of the total number of researchers in 2014) (MOSTA, 2015c). This disproportion alone shows that the mobility of researchers from the public to the private sector and vice versa cannot be high. Yet, due to the definition of researcher, actual number of employees carrying out R&D activities in the private sector might be higher (see also section 4.4.2). However, with the planned introduction of industrial doctoral studies the things might change for the better and stimulate intersectoral mobility.

5.8 Regulation and innovation

Local level government is not responsible for R&I policy and therefore does not analyse the impact of regulation on innovation. Meanwhile, the central government more often assesses impacts of specific funding programmes than the impact of regulation. Although certain laws require ex-ante assessment of their effects (e.g. the new Law on Higher Education and Research), the process of assessment is not always transparent. On the other hand, the proposed Law on Innovation Promotion had ex-ante assessment carried out by Baltic Legal Solutions Lithuania, which indicated the need for an overarching regulation of R&D&I. There are no specific requirements to assess the regulation on innovation impacts ex-post, and usually only EU funded measures are evaluated. MOSTA consults the Ministry of Education and Science concerning the impact of regulations on research, but so far this is not highly systematic. Suggestions on how innovation policy

can be improved are suggested (as, for example, in the case of the development of the smart specialisation strategy), and at times these proposals are implemented.

5.9 Assessment of the framework conditions for business R&I

The Law on Research and Higher Education 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. The Ministry of Economy started a debate that this Law and the subsequent implementing acts apply a narrow and inaccurate definition of R&D activities (equated with 'research' only). It impacts on the related policy measures and institutional as well as competitive R&D funding. As a consequence, the experimental development (especially at the 6-9 technology readiness levels (TRL), i.e. prototype testing and pilot manufacturing) is often missing. Studies (Visionary Analytics, 2014) note that companies lack the financial and technological services related to TRL 6-9.Also, inaccurate definition of R&D may have led to ignoring important parts of the 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) and the decreasing sums which are considered deductible. In 2013, about 3 companies per one thousand registered in Lithuania have used the R&D tax incentive.

The Ministry of Economy took the argument that the promotion system is responsible for the extremely limited innovation results. It initiated the Innovation Promotion Law which was aimed at tackling the 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, but actions concerning governmental and parliamentary approval of the Innovation Promotion Law were not taken.

In terms of the overall business environment, over the past few years it has become much more favourable for starting and accelerating a 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. As a consequence of this and other measures, Lithuania ranks 24th (10th in the EU-28) in the World Bank's Doing Business Rank 2015 and 11th with respect to starting a business (2nd in the EU-28).

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, 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. The Smart specialisation coordinating group has made steps in a good direction, as it provided a platform where stakeholders had to decide on the new policy mix. However, so far it is not clear how successful such discussions were, since interinstitutional quarrels played a role in drafting the policy. Nonetheless, this coordination group will continue to work throughout the whole period of 2015-2020 which might help advance co-ordination of R&I policy between different institutions. The Strategic Council for Research, Experimental Development and Innovation (SMIT), which also serves as an important high-level inter-institutional platform, may also aid in increasing cooperation.

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 (at least according to their official 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, and 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, even though the renewal of research infrastructure was a prerequisite for greater industry-academia cooperation, 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, and 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 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. In February 2015, the joint initiatives' implementation procedure was approved (amended in August 2015). This allows launching instruments that are based on joint initiatives logic, where a partnership between HEI/research institute and private sector/public body is a requirement.

6. Conclusions

6.1 Emerging structural challenges of the national R&I system

Most of the structural challenges of the Lithuanian R&I system remain unchanged since 2014. However, new critical challenges are emphasized in this report – the need to diversify R&D funding sources, and skills mismatches (also due to the ageing society) that are becoming a threat to the innovative economy and long term sustainability. Concerning the future outlook in medium-long term, one particular challenge seems to be emerging. In recent years, the increase in R&D expenditures was very small, and targets set in Europe 2020 will most likely not be met unless significant changes take place. It was projected that GERD should reach at least 1.9% of GDP by 2020. However, with the current rate of growth in R&D expenditure, it is not likely that Lithuanian GERD will meet the target in the said year. The target for BERD (0.9%) set in national policy documents will most likely not be met either by 2020. Overall, this is an issue for concern not only because the aim will not be achieved, but because business investment in R&D is stagnating at around 0.25% - 0.3% of GDP. Without increasing business investment it is doubtable that outputs of R&I activities will increase both in quality and in quantity. Furthermore, the main burden of financing R&I will lie on the national government, which is prone to budgetary constraints especially during economic shocks. A key driver of the problem for Lithuania in this area is its dependence on EU funds. As shown in chapter 3, this source of funds plays a very important role with respect to total R&D expenditures in the country. Over-reliance on EU ESIF and/or resources from the national budget can lead to stagnation of the R&I system in the long-run. Lithuania's GDP per capita is approaching 75% of the EU average. 2020 may mark a possible tipping point after which, due to decreased funds from the Commission, R&I activities might not only stagnate but diminish. Therefore, it is important that the policy mix for 2015-2020 actually manages to increase R&D funding from sources other than EU ESIF, be it business, private non-profit sector or international funds other than ESIF.

For example, funds from abroad (other than ESIF) can give significant push both to intensifying R&I activities and finding new areas for research. However, the public R&D system can be characterised as rather closed with limited institutional incentives and targets for internationalisation. 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. This future challenge is closely related to more pressing challenges that are discussed in the executive summary section of the report. If solutions to them are found, it is likely that by 2020 the lack of funds for research will not be as severe as it could be if these current challenges are not solved.

6.2 Meeting structural challenges

As discussed above, there is an emerging future challenge of significant decrease in R&I funding by 2020, and measures should be taken to prevent this. R&I policy should aim at stimulating R&D investments from the non-governmental sectors, especially the funds coming from local and foreign business and international sources other than ESIF. Such diversification requires separate measures targeting separate types of economic agents. Local business should be encouraged to spend more on R&D, private R&D activities should complement rather than displace private investment. However, successfully meeting the more pressing challenges would also help reduce this future challenge. The following table provides the assessment on the remaining gaps in the current policy mix.

Table 8 Assessment of the Lithuanian R&I policy mix

Challenges	Policy addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness, with focus on remaining gaps and policy recommendations
1. Private sector R&I capacity building	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. JEREMIE co-funded VCs	Although some of the measures in the new policy mix aim at achieving (some of) these goals, there is not much difference from the policy mix of 2007-2013. One key novelty is planned implementation of demand side innovation policies. Recommendations: • Establish a more balanced policy mix by increasing the focus on extending the number of R&D and innovation performers among companies - focus on newcomers (start-ups, spin-offs, knowledge-based foreign investments), and encouraging previously non-innovative companies to transform their businesses towards higher value added activities. • Different types of policy interventions at different pace ('two-tier' process). While the potential innovators (e.g. companies in traditional industries looking for new business models) would benefit from 'soft' innovation support and smaller experimentation projects, mature innovators (larger R&D based SMEs, e.g. biotech or laser tech companies) could immediately start with larger and more long term innovation projects combining various funding sources. • This means that in the new period the policy spotlight has to move from 'hard' infrastructure development to 'soft' capacity strengthening. 'Soft' innovation promotion services, innovation brokering/scouting, platforms for rapid experimentation (demonstrations, piloting, etc), mentoring and pipeline facilitation via technical assistance and support are necessary preconditions for higher absorptive capacities of potential innovators. • To speed up the development of the high tech sector, innovation policies need to open for newcomers through start-ups, spin-offs acceleration, mentoring and start-up/seed funding as well as targeted FDI attraction. Start-up policies should be based on private funds with strong mentorship assistance. Preserving ineffective systems (e.g. science parks, incubators) is sometimes more costly than giving the funds for the market (e.g. in the form of vouchers). • Implement smart demand-side policies and ensure capacity building (awareness raising, training and pilot-testing). LMT has already started implementing demand-led Purposive Research Projects, and pre-commercial procurement is also planned in the period of 2015-2020. • Also, new innovation forms (not only hard technological, but also managerial service organisational innovations) need to be accepted and related innovation management skills need to be strengthened.
2. Skills supply and demand mismatches	Upgrade of study programmes Researchers placements Competence maps and forecasts	• Structural reform of the education and research system, e.g. systemic review of the study programmes (starting with basic education, also in line with STEAM policies), introduce incentives for optimizing the number of universities, opening up public R&D and HE systems and staffing policies at the institutional levels to attract talent (researchers, lecturers, PhD students) from abroad, and introducing serious incentives for life-long learning. The new policy mix for 2015-2020 involves attracting researchers, PhD students, academics from abroad,

Challenges	Policy addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness, with focus on remaining gaps and policy recommendations
	STEAM programme by the Ministry of Education and Science	and attracting R&D related FDI. • Liberalization of labour relations. • Implement business researchers' (incl. engineers, technologists) international training and apprenticeships measures. • Encourage postgraduate student placements in enterprises. Implement Industrial Doctorates programmes. New policy mix and proposed amendments to the Law on Higher Education and Research attempt to do this. Specific measures aim at attracting foreign researchers (albeit mostly to public HEIs and research institutes), and the concept of industrial PhD is pending parliamentary approval. • 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. Encourage foreign researchers and high-level specialist recruitment at the Lithuanian companies, clusters and R&D institutions.
3. Commercializing public sector research results	• 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 initiatives	• The State should review existing innovation support structures. For example, some clusters can become part of the existing science and technology parks (STPs). In some cases, science parks could lead the activities of clusters. The strongest organization can become a project leader of 'joint project' or 'joint initiative'. 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. • 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. The new policy mix includes several infrastructures that will get investment in a non-competitive way. For competitive funding of RI, both business and public RIs will be financed, however, it is not clear whether synergies will be sought with these measures or not. • Development of RIs or technology/competence centres 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. It is currently not clear if this will be implemented in the new policy mix. Although there are measures aiming at capacity development and joint business-science projects, it is not yet clear how successful will they be and whether they will differ in scope from those of the previous programming period. It is still not clear what specific role will be played by 'valleys'. • 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 (with possible division between scientific research and experimental development). The researchers' career rules and performance requirements should be revised accordingly. A similar change should occur

Challenges	Policy addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness, with focus on remaining gaps and policy recommendations
		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. No such changes are expected in the nearest future, and the problem of time division between teaching, research and administrative activities will further be a burden for researchers.
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	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: • Interinstitutional coordination of smart specialisation strategy should be used to strengthen ties and open collaboration between different institutions. This especially applies to the Ministry of Education and Science, and the Ministry of Economy which often have distinct positions towards R&I policy. RIS3 strategy might not be enough; it also needs supportive governance processes. In practice, it also means that there has to be one coordinating centre assigned with a responsibility to monitor synergies and review how successful are the different priorities in moving from stage to stage in the implementation process. Currently, a coordinating group manages the whole

Challenges	Policy addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness, with focus on remaining gaps and policy recommendations
	Methodology. Analyses and Evaluations and studies performed by MOSTA and MITA.	smart specialisation process. However, it does not manage instilling cooperation rather than simply serving as a forum for identification of consensus position. • 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. MOSTA and the Ministry of Economy, responsible for monitoring and evaluation of Lithuania's smart specialisation strategy implementation are still developing the methodology, but impact evaluation is one of its cornerstones. • Sufficient attention and adequate resources should be granted to effective programme management. The focus should be on simplification, reducing administrative load, abandoning the risk-averse and process-oriented approach, strengthening the implementation capacity in the agencies (strong programme management skills - teams responsible for the implementation of the smart specialisation priorities and supervision of project pipeline initiation). • Systemic review of the existing agencies and coordination model and related functions (especially taking into account the approaching challenges of post-2020 period). Decisions have to be made in order to optimize the network of agencies/institutions, to reduce fragmentation and to install strong strategic capacities such as effective coordination, strategic intelligence and systemic programme management.

Sources: Paliokaitė (2015a, 2015b), Visionary Analytics (2014, 2015).

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Abbreviations

BERD – Business Expenditures for Research and Development / Verslo sektoriaus išlaidos MTEP
BES – Business Enterprise Sector / Verslo sektorius
BIF – Baltic Innovation Fund / Baltijos investicijų fondas
BSR – Baltic Sea Region / Baltijos jūros regionas
CPVA – Central Project Management Agency / Centrinė projektų valdymo agentūra
EIF – European Investment Fund / Europos investicijų fondas
ERA – European Research Area / Europos tyrimų erdvė
ERA NET – European Research Area Network / Europos tyrimų erdvės tinklas
ESA – European Space Agency / Europos kosmoso agentūra
ESFA – European Social Fund Agency / Europos socialinio fondo agentūra
ESIF – European Structural and Investment Funds / Europos struktūriniai ir socialiniai fondai
ESFRI - European Strategy Forum on Research Infrastructures / Europos strateginis mokslinių tyrimų infrastruktūrų forumas
ETC – European Territorial Cooperation / Europos teritorinis bendradarbiavimas
EU – European Union / Europos Sąjunga
EU28 – European Union Including 28 Member States / Europos Sąjunga apimant 28 Valstybes Nares
EUSBSR – European Union Strategy for the Baltic Sea Region / Europos Sąjungos strategija Baltijos jūros regionui
FDI – Foreign Direct Investment / Tiesioginės užsienio investicijos
FP – Framework Programme / Bendroji programa
FP7 – 7th Framework Programme / Septintoji bendroji programa
FTE – Full-Time Equivalent / Visos dienos ekvivalentas
GBAORD – Government Budget Appropriations or Outlays on R&D / Valstybės biudžeto asignavimas ar išlaidos MTEP
GDP – Gross Domestic Product / Bendrasis vidaus produktas
GEM – Global Entrepreneurship Monitor / Pasaulinė verslumo stebėsena
GERD – Gross Domestic Expenditure on R&D / Visos išlaidos MTEP
GOV – Government sector / Valdžios sektorius
HEI – Higher Education Institution / Aukštojo mokslo institucija
HERD – Higher Education Expenditure on R&D / Aukštojo mokslo išlaidos MTEP
HES – Higher Education Sector / Aukštojo mokslo sektorius
ICT – Information and Communication Technologies / Informacinės ir ryšių technologijos
IP – Intellectual Property / Intelektinė nuosavybė
IPR – Intellectual Property Rights / Intelektinės nuosavybės teisės
IUS – Innovation Union Scoreboard / Inovacijų sąjungos švieslentė
JPI – Joint Programming Initiative / Jungtinio programavimo iniciatyva
KEF – Knowledge Economy Forum / Žinių ekonomikos forumas
KTU – Kaunas University of Technology / Kauno technologijos universitetas
LMA – Lithuanian Academy of Sciences / Lietuvos mokslų akademija
LMT – Research Council of Lithuania / Lietuvos mokslo taryba
LIC – Lithuanian Innovation Centre / Lietuvos inovacijų centras
LT VCA – Lithuanian Private Equity and Venture Capital Association / Lietuvos rizikos ir privataus kapitalo asociacija
LVPA – Lithuanian Business Support Agency / Lietuvos verslo paramos agentūra
MITA – Agency for Science, Innovation and Technology / Mokslo, inovacijų ir technologijų agentūra
MOSTA – Research and Higher Education Monitoring and Analysis Centre / Mokslo ir studjų stebėseno ir analizės cetnras
MS – European Union Member State / Europos Sąjungos valstybė narė
NCP – National Contact Points / Nacionaliniai kontaktai kreipimuisi
NPR – National Reform Programme / Nacionalinė reformų darbotvarkė
OP – Operational Programme / Veiksmų programa

PNP – Private Non-Profit Sector / Privatus pelno nesiekiantis sektorius
PRO – Public Research Organisation / Vieša mokslinių tyrimų organizacija
R&D – Research and Development / Moksliniai tyrimai ir eksperimentinė plėtra
R&I – Research and Innovation / Moksliniai tyrimai ir inovacijos
RI – Research Infrastructure / Moskslinių tyrimų infrastruktūra
RIS3 – Research and Innovation Strategies for Smart Specialisation / Mokslinių tyrimų ir inovacijų strategijos Sumaniai specializacijai
S&T – Science and Technology / Mokslas ir technologijos
SME – Small and Medium-Sized Enterprises / Mažos ir vidutinio dydžio įmonės
SMIT – Strategic Council for Research and Innovation / MTEP ir inovacijų strateginė taryba
STEAM – Science, Technology, Engineering, Arts and Mathematics / Matematika, gamtos mokslai, technologijos, inžinerija ir kūrybiškumas
STP – Science and Technology Park / Mokslo ir technologijų parkas
TRL – Technology Readiness Level / Technologijų parengtumo lygis

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Annex 1 – List of the main research performers

Main public R&D performers, based on publications

Rank	Institution	Number of publications[33]
1.	Vilnius University	8191
2.	Kaunas University of Technology	4957
3.	Vilnius Gediminas Technical University	3809
4.	Mykolas Romeris University	3360
5.	Vytautas Magnus University	2655
6.	Lithuanian University of Health Sciences	2633
7.	Šiauliai University	1647
8.	Klaipėda University	1408
9.	Aleksandras Stulginskis University	1336
10-11.	Centre for Physical Sciences and Technology	1145
10-11.	Lithuanian University of Educational Sciences	1145

Source: MOSTA (2014b)

[33] Number of publications is taken from MOSTA (2014b) and covers 2009-2013. Due to total publication count being aggregated from data on separate fields of science, some publications might be counted more than once.

Annex 2 – List of the main funding programmes

Name of the funding programme	Timeline	Budget	Target group
Technoinvest	2016-	€17.6m	Enterprises
Smartinvest LT	2016-	€5.8m	Enterprise Lithuania
Smartinvest LT+	2016-	€43.4m	Foreign enterprises, enterprises controlled by foreign business
Innovation vouchers	2016-	€10.1m	Private legal entities
Intellect LT. Joint science-business projects	2016-	€139.0m	Private legal entities (public legal entities in special cases)
Process LT	2016-	€8.7m	SMEs
R&D infrastructure development and integration into European infrastructures	2016-	€188.0m	Research and higher education institutions, three budgetary entities
R&D results' commercialisation and internationalization	2016-	€13.0m	Research and higher education institutions, private legal entities if research and higher institution is its stakeholder
Competence centre and innovation and technology transfer centre promotion	2016-	€26.1m	Research and higher education institutions
Development of competences centres	2016-	€8.7m	Research and higher education institutions
Purposive research in smart specialisation areas	2016-	€44.9m	Public legal entities acting in the field of research and higher education
Independent R&D projects	2016-	€35.9m	Research and higher education institutions, university hospitals
Strengthening of capabilities of scientists and other researchers' groups	2016-	€43.0m	LMT, KTU, MITA, LMA, MOSTA
Support for activities of scientists, other researchers, and students' research	2016-	€68.4m	Public legal entities acting in the field of research and higher education or education
Improving qualifications of scientists and other researchers in knowledge-intensive enterprises	2016-	€2.9m	SMEs
Intellect LT	2008-2015	€60.3 m	Individual enterprises
Promotion of High-Level International Scientific Research	2008-2015	€13.8m	Public research and higher education institutions
Support of scientists and researchers mobility and students scientific work	2008-2015	€36.7m	Public research and higher education institutions, Lithuanian Research Council
Improvement of the Qualifications and	2008-2015	€21.2m	Higher education institutions, Lithuanian

Name of the funding programme	Timeline	Budget	Target group
Competencies of Scientists and Researchers (scientific databases, e-documents)			Research Council and Lithuanian Research Library Consortium
Support to the scientific work of scientists and other researchers (Global Grant)	2008-2015	€33.2m	Researchers
National Research Programme 'The State and the Nation: Heritage and Identity'	2010-2014	€4.8m	Public research and higher education institutions
National Research Programme 'Social Challenges to National Security'	2010-2014	€2.8m	Public research and higher education institutions
National Research Programme 'Chronic non-infectious diseases'	2010-2014	€5.8m	Public research and higher education institutions
National Research Programme 'Future Energy'	2010-2014	€5.0m	Public research and higher education institutions
National Research Program 'Ecosystems in Lithuania: climate change and human impact'	2010-2014	€5.8m	Public research and higher education institutions
National Research Programme 'Healthy and safe food'	2011-2016	€4.6m	Public research and higher education institutions
National Lituanistics development programme for 2009-2015	2009-2015	€9.7m	Public research and higher education institutions
Idea LT	2008-2015	€4.3 m	SMEs
Intellect LT +	2008-2015	€69.8 m	Individual enterprises
Inocluster LT	2008-2015	€3.6 m	Individual enterprises
Inocluster LT+	2008-2015	€18.9 m	Individual enterprises
Inogeb LT-1	2008-2015	€6.4m	Technology parks
Inogeb LT-2	2008-2015	€35.2 m	Technology parks
Inogeb LT-3	2008-2015	€9.3m	Technology parks
Ino-vouchers LT	2012-2015	€3.5 m	SMEs and research institutions

Annex 3 – Evaluations, consultations, foresight exercises

1. The process for identifying the national R&I priorities and drafting the Smart Specialisation Strategy for 2014-2020. More at: http://www.mosta.lt/en/reports-and-analyses
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