Background Report on R&I policies in 2016: Lithuania

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Executive summary

Context

Lithuania is a small country with less than 0.6% of the total EU28 population (almost 3 million inhabitants in 2016), 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 gross domestic product (GDP) growth recently decreased from 6% in 2011 to 1.8% in 2015, with 2.0% GDP growth expected in 2016, according to the European Commission forecast (DG ECFIN). Lithuania has also experienced high growth in labour productivity in recent years, but remains below the EU average.

Environment in Lithuania is business-friendly, and the country ranked 20th in environment for establishing and running a business in 2016 according to the Doing Business Rank (World Bank Group, 2016). Recent changes (2014-2016) enabled entrepreneurs to start a business online, establish limited liability companies without minimum capital, etc. However, some barriers remain, such as resolving insolvency. The key venture capital funds available for business in Lithuania are dependent on EU investments, but privately owned funds are also emerging.

According to the 2016 Digital Economy and Society Index (DESI) report, Lithuania scores above EU average in connectivity, use of Internet, integration of digital technology and digital public services (European Commission, 2016c). However, the country is below EU average with respect to availability of e-services, organisational and managerial innovations, and internal services innovations. Nonetheless, Lithuania is among the nations with the biggest upward shift in providing public services through the use of information and communication technologies (ICT) (United Nations, n.d.). Citizen participation and collaboration receive less attention in Government policies if compared to transparency.

Lithuania ranks 24th in the European Innovation Scoreboard among EU28 (European Commission, 2016a) with no clear catching up with more advanced members of the EU. The country still needs a restructuring of the economy towards innovation-based growth rather than growth driven by low labour costs. Most of the research and development (R&D) activities are funded and performed by the public sector. However, the public sector suffers from low commercialisation of R&D results and unattractive working conditions for researchers. Currently, the private sector is rather traditional and does not perceive innovation as a critical factor to long-term competitiveness. This leads to limited capacities to absorb public R&D investments without simultaneously dealing with capacity building. Although there is some increase in gross domestic expenditure on R&D (GERD) and business expenditures on R&D (BERD) over the recent years, changes are too incremental to expect that targets set in Europe 2020 (1.9% of GDP for GERD) and national policy documents (0.9% for BERD) will be reached.

R&I Actors - summary

Lithuania's research and innovation (R&I) landscape is dominated by the public sector when it comes to both, performance and funding (if the EU funds are included). The private sector still plays a relatively minor role, contrary to tendencies in strong innovating countries.

Government funds approximately one third of all R&D, mostly performed by the higher education sector. The government also distributes EC funds, which accounts for another third of total R&D funds, making it the most important actor in terms of R&D funding. Despite this, the government performs only 17.4% of R&D (in 2014). R&I governance in Lithuania is also marked by fragmentation at both, programme and agency levels, which leads to overlaps and gaps.

Academia does not play a significant role in R&D funding, but is a major performer (55.9% of GERD in 2015). 46.7% of funds to academia come from the government, while domestic non-government sources play little role in funding research in higher education institutions (HEIs). About a third of funds come from the EU. Similarly to government, academia in Lithuania is highly fragmented leading to duplications of R&I activities and lowering its efficiency.

Private sector R&I is dominated by business, as the private non-profit sector plays a miniscule role. With respect to BERD Lithuania ranked 23rd among EU28 in 2014.

There remain serious obstacles for public R&D commercialisation and systemic collaboration, which reflect some path-dependencies: overdependence on basic science, lack of social capital and network failures, and weak innovation diffusion system (Paliokaitė & Antanavičius, 2015). In 2012-2014 only 4.1% of innovative companies cooperated with the government or public research institutes (Statistics Lithuania, 2016). A low level of intersectoral cooperation can also be seen by looking at joint research outputs in terms of co-publications, which are significantly lower than the EU28 average. Despite the high number of clusters (over 50), the country ranks only 87th with respect to their development (World Economic Forum, 2015). Increasingly, public policies are focused on encouraging intersectoral cooperation between businesses and academia, as institutional funding partly depends on it, and new measures such as joint business-science projects and innovation vouchers are introduced.

R&I Challenges

The four main R&I challenges faced by Lithuania remain largely unchanged since 2015:

1. Improving the coordination of innovation policies. The absence of a systemic R&I policy approach has contributed to a fragmented mix of policies and implementation structures, resulting in limited efficiency and missed opportunities (OECD, 2016b; Paliokaitė, 2015). Some coordination is emerging (e.g. during the Smart specialisation process) but no systematic steps have been taken. The Guidelines proposed by the President calls for political will to address this issue and appoints a Strategic Council for Research, Development and Innovation chaired by the Prime minister responsible for general coordination of science, research and innovation policy.

More focus is needed to encourage previously non-innovative 'traditional' companies to transform their businesses towards higher value added activities.

2. Addressing human resources shortages in R&I. Due to unattractive research careers, insufficient quality of higher education and demographic as well as emigration factors, the lack of human resources for R&I has become a bottleneck for the achievement of most R&I policy objectives (OECD, 2016b; Paliokaitė & Antanavičius, 2015). The new policy mix includes some measures for development of human resources in research, mainly in the public sector.

More focus is needed to provide instruments attractive to young researchers and talents from abroad. Other changes, such as improving working conditions, increasing attractiveness of research careers are also relevant.

3. Encouraging private investments in R&I. A more balanced policy mix is introduced, open for newcomers (start-ups, spin-offs, R&D-based foreign investors), and consisting of venture capital, business R&D grants, vouchers, pre-commercial procurement etc.

4. Exploiting opportunities for commercialisation of public R&D results. An innovation culture and skills in universities and institutes need to be urgently developed. The existing public R&D services network (open access centres etc.) has to be better exploited. The new policy mix puts more focus on public R&D commercialisation, measures encouraging spin-offs and public-private collaboration are introduced. Still, currently approved measures give too much focus for further upgrading and development of R&D infrastructure.

Main insights (based on conclusions)

Overall, the new period's policy mix is much more comprehensive and balanced than the one from 2007-2013, even though research infrastructure is still allocated a substantial share of funds, the policy focus has become more diverse. Nonetheless, despite positive improvements there remain several bottlenecks which will have impact on the success of the policy instruments. Such is, for example, the insufficient availability of human resources in R&I, which became a bottleneck for the functioning of the whole Lithuanian R&I system (OECD,

2016b; Paliokaitė & Antanavičius, 2015). This challenge requires support given not only to experienced researchers but also increasing Lithuania's attractiveness to young researchers and talents from abroad, and implementing supporting regulatory and institutional changes (related to attractiveness of research careers) (OECD, 2016b; Paliokaitė et al. 2015). The focus of the new policy mix also shifts toward higher incentives for commercialisation of public R&D results. However, the success of foreseen instruments will depend on how the technology transfer, IPR and other policies will be developed, and whether supporting regulatory and institutional changes (related to research careers) will take place. Furthermore, urgent changes to the fragmented network of higher education institutions and incentives for improving quality of the study and research programmes are needed, as indicated in the Guidelines by the President of Lithuania.

The success of the policy mix will also depend on how well its implementation will be governed. This includes both coordination of the implementation of the smart specialisation strategy and strengthened evidence-based policy capacities, especially through developed use of impact evaluations.

1. Innovation ecosystem

The Summary Innovation Index (European Commission, 2016a) indicates that innovation system in Lithuania is still developing and increases its performance over time slowly. There remain a few structural challenges such as improving the coordination of innovation policies, addressing human resources shortages in R&I, encouraging private investments in R&I, and exploiting opportunities for commercialisation of public R&D results (see chapter 3). Several aspects are important and broadly cover the whole system: a) the general structure of country's economy; b) business environment; c) public sector innovation; d) civil society innovation and e) supply of human resources. Identifying potential factors behind low innovativeness of the country may shed light on both the main challenges that Lithuania faces and ways to overcome the challenges. These issues are discussed in the following sub-chapters.

Table 1: Main economic indicators

	2010	2014	2015 (when available)
GDP per capita	9,000	12,400	12,800
GDP growth rate	1.6	3.5	1.8
Budget deficit as % of GDP	-6.9	-0.7	-0.2
Government debt as % of GDP	36.2	40.5	42.7
Unemployment rate as percentage of the labour force	17.8	10.7	9.1
Value added of services as share of the total value added	67.61	65.79	66.52
Value added of manufacturing as share of total value added	18.77	19.2	19.34
Value added of knowledge-intensive services as share of total value	27.57	24.62	24.76
Value added of high and medium tech manufacturing as share of total value added	4.09	3.84	NA
Employment in knowledge-intensive service sectors as share of total employment	33.43	32.11	32.29
Employment in High and Medium High Tech manufacturing sectors as share of total e	1.83	1.91	NA
Employment in manufacturing as share of total employment	15.37	15.06	15.18
Employment in services as share of total employment	66.62	66.14	65.89
Share of Foreign controlled enterprises in the total number of enterprises	2.39	2.19 (2013)	NA
Business Structure of the economy: Share of enterprises by size class (0-9)	89.02	92.07	NA
Business Structure of the economy: Share of enterprises by size class (10-19)	5.59	4.05	NA

Business Structure of the economy: Share of enterprises by size class (20-49)	3.38	2.43	NA
Business Structure of the economy: Share of enterprises by size class (50-249)	1.77	1.25	NA
Business Structure of the economy: Share of enterprises by size class (250 persons employed or more)	0.21	0.19	NA
Entrepreneurship performance indicator: Firms births rate	21.55	23.64 (2013)	
Entrepreneurship performance indicator: Firms death rate	16.73	18.16 (2012)	
Entrepreneurship performance indicator: Firms survival rate (3 years threshold)	22.83	40.17 (2013)	
Labour productivity	100.0	114.7	113.6
Innovation output indicator	28 (2011)	28	NA
Summary Innovation Index (score)	0.25	0.29	0.28
Summary Innovation Index (rank)	31	31	30

Source: ESTAT 2016

1.1 Structure of the economy

Lithuania is a small country with less than 0.6% of the total EU28 population (almost 3 million inhabitants in 2016), 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 1.8% in 2015 with 2.0% GDP growth expected in 2016, according to the DG ECFIN).

Real GDP grew around 2% in the first three quarters of 2016, somewhat below estimations. According to the European Commission's autumn 2016 European Economic Forecast (9 November), despite continued strong private consumption growth, domestic demand was dampened by weak investment, which suffered severely from an interruption in EU funds flow. In 2017, recovering investment is set to increase GDP growth to 2.7%. However, higher inflation is forecast to dampen private consumption which will increasingly weigh on growth in 2017 and 2018.

In 2015, the general government's deficit declined to 0.2% of GDP from 0.7% in 2014, yet the expected value for 2016 is 0.6%. In 2015, debt was 42.7% of GDP in 2015 and is forecast to fall to 40.8%. The unemployment rate went from 10.7% in 2014 to 9.1% in 2015 and is forecast to decline further in 2016 (7.6%) and 2017 (7.4%). Tightening labour market conditions and accelerating wage growth are expected to drive inflation in 2016, while external price pressures remain weak.

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 in terms of real GDP per capita. The gap in absolute terms was not diminishing for at least several years (the difference was €15.400 in 2010 and €15,300 in 2014, but increased to €15,900 in 2015). Although in 2012-2015 the rate of GDP growth was decreasing, over the whole period it was consistently positive

and mostly above the EU average (except 2015). Thus, Lithuania was on average recovering from the economic crisis quicker than other EU Member States (MS). Positive trends in the economy are also reflected by the decreasing Lithuania's budget deficit. It shrank from -3.1% of GDP in 2012 to -0.2% of GDP in 2015. This may indicate both lower public spending and lower public borrowing. The EU average in 2015 was -2.4%, and therefore, 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 2015 it diminished to 9.1%, and was lower than the EU average in 2015 (9.4%).

After the crisis of 2009, which hit Lithuania's economy hard, it rapidly recovered, and in 2015 the country joined the Euro zone. Nonetheless, the (innovation-driven) growth might be hindered by several factors in the coming future (Office of the Government of Lithuania, 2014):

- Decreasing size of the labour force, mainly due to emigration (OECD, 2016b). This not only diminishes the capabilities of the economy, but also puts additional stress on the welfare system, as fewer people contribute with taxes to the country's budget.
- Skills demand/supply mismatches and insufficient human capital contribution to the total factor productivity (OECD, 2016a; Reymen et al., 2015). Given the decrease in the labour force, higher productivity might not be enough to support economic growth.
- Low private investment, which is at a lower level than the historical average and did not manage to recover since the crisis.
- Together, low level of investment and lack of highly skilled human capital form a bottleneck for creation of higher value added. Transformation of the economy is needed to ensure that growth is sustained.

These issues pose a threat to convergence with more advanced economies and leads to 'middle-income trap'. The transition to higher value added activities could be achieved through improving research and innovation system (cf. Staehr, 2015).

1.1.1 Sectoral structure

Concerning the structure of the economy, Lithuania's economy mostly relies on services and the traditional sectors (low and medium technology manufacturing industry) which form the backbone of the economy. The knowledge-intensive sector accounts for 33.8% of total employment (2015). In 2015 value added from knowledge-intensive services amounted to 24.76% of total value added. High-tech and medium-high-technology manufacturing accounted for 3.84% of total value added in 2014.

According to Eurostat data, the agriculture sector's importance for the economy is diminishing. By 2014 gross value added in agriculture, forestry and fishing was only 3.6% of total value added. In general the largest share of value added is created in services (66.5% of total value added in 2015), and manufacturing (19.3% in 2015). These sectors also account for 65.9% and 15.2% of employment respectively. In general the largest share of value added is created in the wholesale and retail trade; repair of motor vehicles and motorcycles sector (25.1% of all value added in 2013), and manufacturing (23.0% in 2013). These sectors also account for 28.3% and 22.8% of employment respectively.

1.1.2 Firm organisation and entrepreneurship performance

According to the 2015 Small Business Act Fact Sheet for Lithuania (European Commission, 2016d), there were 145,085 SMEs and 280 large enterprises in Lithuania. Considering innovative activities of Lithuanian companies, according to Statistics Lithuania (2016) in the period of 2012-2014, 85.8% of large enterprises were innovative, 58% of enterprises which employed 50-249 staff were innovative and 35% of enterprises which employed 10-49 employees were innovative. Thus, there appears to be correlation between the size of an enterprise and its innovativeness. Nonetheless, given the higher number of SMEs, as compared to the quite small number of large companies, it is safe to assume that a significant share of total innovations come from the SME sector as well. Still, Lithuania scores below the EU average with respect to introducing innovations, innovating in-house, and

collaboration of innovative SMEs and sales of innovations (European Commission, 2016d). Data on innovation activities by multinational enterprises is not available.

The Global Entrepreneurship Monitor (GEM) [1] indicates that Lithuania has a high share of intrapreneurs (i.e. entrepreneurs within a firm). Furthermore, the findings show that entrepreneurship driven by necessity is being replaced by entrepreneurship driven by opportunity. In 2013, the birth rate of enterprises, 23.64, was the highest among the EU Member States for which the data is available. However, their survival rate was 40.17 – among the lowest in the EU. According to World Bank data,[2] in 2014, 14% of men and 10.2% of women were self-employed, with slow but steady increase in the share of self-employed persons. According to Eurostat self-employed persons made 12.1% of total employment in 2014.

1.1.3 Integration in global value chains

There is little research done on the Lithuania's integration into global value chains (GVCs). However, based on De Backer & Miroudot (2014) it seems that integration into GVCs in the agricultural sector is medium and approximately half of the chain is domestic-based. Regarding food industry, Lithuania is downstream of the GVC, as is the case with motor vehicles, and down- to midstream in electronics and other business services, and have short value chains. There is lack of research on most economic sectors, but it is likely that in many cases, Lithuanian enterprises lack involvement in GVCs, or enter them at labour-driven segments, which hinders their capabilities to move towards activities that create more value added.

1.1.4 Productivity

In terms of productivity, according to Eurostat, Lithuania's rate of growth in labour productivity over 2010-2015 was one of the largest in terms of per hour growth in EU28, only falling behind Ireland, Romania and Latvia. However, in terms of total labour productivity, Lithuania still significantly lags behind both EU-28 and OECD average. According to Eurostat data, compared to 2010, by 2015 labour productivity increased by 13.6%.

Lithuania's labour productivity (in per hour terms) has been consistently increasing for the major part since the country's accession to the EU with the exception of 2009 and 2015. According to Eurostat data, GDP per hour worked increased by 14.7% over 2010-2014. A minor decline was registered in 2015, leading to €15 (in current prices) per hour worked. In terms of real labour productivity per person employed no decline was registered, even if the growth slowed, according to the Eurostat data. The nominal labour productivity per person employed in Lithuania was 73.2% of the EU average (up from 65.1% in 2008), 22nd among the Member States. According to OECD (2016a), higher supply of skilled workers and increased business innovation activities could help further improve Lithuania's productivity.

1.2 Business environment

Regarding environment for establishing and running a business, Lithuania ranked quite high (20th place of out 189 according to the 2016 Doing Business report). This indicates that, overall, the environment is business-friendly. Nonetheless, there is increasingly a lack of breakthrough in private sector research, development and innovation (RDI) activities, which is reflected by the low share of innovative enterprises. Therefore, it is important to determine where the main weaknesses in the ecosystem lie.

[1] http://www.gemconsortium.org/country-profile/82
[2] Data for self-employed persons in Lithuania is not available in Eurostat database.

Table 2: Main business environment indicators

	2010	2014	2015
Country position in Doing Business WB	NA	21	20
Product market regulation (OECD) (score)	NA	1.52 (2013)	NA
Product market regulation (OECD) (rank)	NA	17 (2013)	NA
Ease of access to loans (WB GII) (Ease of getting credit, value)	NA	70	70
Ease of access to loans (WB GII) (Ease of getting credit, rank)	NA	22	27
Survey on the Access to Finance of Enterprises (SAFE) Share of companies which identified access to finance as one of their most important	14% (2015)		
Venture capital indicators (EVCA)	*NA*	*NA*	*NA*
Total venture investment (thousands €, no bank leverage included)	*NA*	*9,297*	*NA*
Private equity investment by amount (thousands €)	*NA*	*38,845*	*NA*
Innovative enterprises as a share of total number of enterprises CIS data 2012	*32.9% (2012)*		
EC Digital Economy & Society Index rank (DESI)	NA	8	11

Sources: ESTAT 2016, OECD, World Bank, EVCA

1.2.1 Ease of doing business / barriers to entrepreneurship

Overall, it is quite easy to start a business in Lithuania. Since 2015 it became possible to establish a business faster due to quicker registration with the State Tax Inspectorate, and the requirement for a business seal was repealed. Recent (2014-2016) changes enabled entrepreneurs to start a business online, established limited liability companies without minimum capital, etc.

However, some barriers remain, as in 2016 Lithuania ranked only 70th with respect to resolving insolvency (no changes since 2013) and 54th with respect to getting electricity out of 189 countries. Paying taxes and protecting minority investors could also be further improved.

Regarding small businesses Lithuania scores high, often higher than the EU average, including for the entrepreneurship indicator. However, there are exceptions in the areas of skills and innovation, where Lithuania's performance is problematic for businesses (European Commission, 2016d; World Economic Forum, 2015). Low innovativeness of businesses is among the main challenges for Lithuania with respect to R&I.

1.2.2 Access to finance

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

In 2012, the 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 development of Lithuanian SMEs. 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. A 'business accelerator' under the name of Startup.lt actively supports the funding process of new companies throughout their early life cycle from their launch to incorporation, thereby filling the gap start-ups experience in Lithuania. LitCapital is another growth capital fund, established in cooperation with the European Investment Fund in 2010 under the JEREMIE initiative. 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, by 31st December 2014, the INVEGA fund attracted €180.6m of private investment (support was provided to 2,874 SMEs). INVEGA aims at promoting growth and competitiveness of Lithuanian SMEs through loans, guarantees, partial compensation of interest, and support for first job[3]. 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. Similar instrument is planned for 2014-2020, see below.

In 2016, €179.6m has been secured for loans, guarantees and venture capital in the new 'fund of funds'. The new Business Financing Fund, managed by INVEGA and funded from the European structural and investment funds (ESIF), consists of three instruments to be implemented during 2016-2022:

- 'Technoinvest' (€17.6m) will provide VC for innovative firms including start-ups, spin-offs, early stage innovating firms.
- 'Entrepreneurship fund' (€103.28m) will provide loans, guarantees, VC and interest rate compensation for any new businesses.
- 'Investment fund' (€58.72m) will focus on loans, guarantees, VC and interest rate compensation for industry investments in the regions (local and international).

In addition to the above mentioned achievements of venture capital funds, mentoring, advice, contacts and other help provided via these funds benefited 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 for early stage investment (seed capital fund) as the maximum amount of investment at this stage is only €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

[3] For more specific information, see Paliokaitė & Antanavičius, (2015), p.29.

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 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).

The Lithuanian Parliament has adopted the Law on Crowd Funding on November 2016. It sets up the conditions for crowd funding, crowd funding platform operator, the terms and conditions for mandatory disclosure of information provided in crowd funding platform, as well as crowd funding platform operator's maintenance procedures.

1.2.3 Digital infrastructure and services

Digital infrastructure and services in Lithuania are well developed. In 2016 DESI was above the EU average (0.55 vs 0.52), and Lithuania ranked 13th among the 28 EU countries. According to the 2016 DESI report, Lithuania scores above the EU average on connectivity, use of Internet, integration of digital technology and digital public services. Additionally, as in the data discussed above, DESI 2016 report shows that human capital in this area is problematic in Lithuania, as the country ranks only 19th. This is especially driven by low number of employed ICT specialists, and the number of regular Internet users is also low (European Commission 2016c).

1.3. Public sector innovation

According to the Public Sector Innovation Scoreboard (European Commission, 2013), Lithuania is below EU average with respect to more than 10 PSI indicators, such as: availability of e-services (71.7 vs 84.3 in the EU), organisational and managerial innovations (58 vs 75.5 in the EU), and internal services innovations (42 vs 63.5). Over the recent decade, Lithuania has put the main focus on the availability of e-services and data transparency – the country is among the six nations with the biggest upward shifts in providing public services through the use of ICT in the period of 2003-2012, according to the E-government development index (United Nations, n.d.).

Table 3: Public sector innovation indicators

Researchers and technicians working in government as share of total R&D personnel	61.72% (2013)
Online availability of public services – for citizens and businesses (Estat)	44% (2015)
E-Government Development Index (UN)4 rank	23 (2016)
Government procurement of advanced technology products (WEF)	100 (2015)
Enterprises with procurement contract for domestic and/or foreign public sector (CIS 2012)	29 (2012)

Sources: ESTAT 2016, OECD, World Bank, EVCA

1.3.1 Public sector modernisation agenda

Lithuania has made substantial progress over 2009-2016 in adopting various initiatives leading to better availability of e-services and higher transparency of policy decisions and making public sector data openly available. The most important initiatives are:

- Adoption of legal acts: Regulation concerning public availability of all government decisions (Government of the Republic of Lithuania, 2009b) and creation of TAIS – an informational system for all legal acts and their drafts, which was updated in 2015 and became more user friendly (e.g. registered users can comment on drafts); Regulation concerning public availability of all policy studies and evaluations (Government of the Republic of Lithuania, 2009a); adoption of new Law on Law-making (Parliament of the Republic of Lithuania, 2012), setting the rules for better quality of regulation; the adoption of Governance improvement Programme for 2012-2020 (Government of the Republic of Lithuania, 2012), which focused on better availability of public services, e-government, citizen participation, and improvement of the quality of services as well as competences of policy making and policy implementing institutions.
- Creation of a number of e-services portals, such as: 'My Government[5]' portal –gates to any activity of the Government and its institutions; 'E-citizen[6]' portal with centralised availability of public e-consultations; e-services portal (https://www.epaslaugos.lt/portal/).
- Creating standards for "good" services. The Ministry of Interior published guidelines on the standards of public services and related criteria for public sector institutions on the website There are also sectorial initiatives, related, for example, to e-health (e-recipe system and similar).
- Joining international organisations, such as: OECD (process ongoing since 2014) and Open Government Partnership (OGP, in 2011). Lithuania's process to join the OECD, has put the open government higher on the political agenda. Lithuania joined the OGP in 2011 and approved the four-year OGP action plan[7] in 2014, focused on four action lines: quality of public services, open data (the architectural design of Lithuanian public sector open data model was created in 2015), prevention of corruption (implementing of the 'Clean Hands' initiative[8], and citizen participation. Under the latter, the Government's Office is implementing a three year 'Open Government' project that intends to institutionalise citizen consultation procedures in the Lithuanian policy making cycle by 2020 (see the sub-chapter 1.3.2.).

Despite the above-discussed initiatives and several successful ICT-based projects (e.g. e-procurement initiatives in Lithuania have resulted in costs savings of at least €176 million, according to the pilot exercise of the European Public Sector Innovation Scoreboard (European Commission, 2013), substantial gaps remain. The implementation of the open data and e-services initiatives remains fragmented and their quality varies (OECD, 2016c). Both supply and demand of citizen participation initiatives are weak. For example, in 2016, Lithuania implemented in total three e-consultations (compared to 167 in Norway), which attracted on average 1.6 citizen proposals per one consultation (compared to 39.1 in Norway)[9]. Importantly, more substantial attempts to modernise the Lithuanian public service (e.g. to put more focus on results, reform the selection and activity of leaders, reform the salary system, implement smaller and 'lean' public service, etc.) have been rejected so far, including the Concept for Modernisation of Public Service[10] submitted by the Prime Minister's

[5] https://lrv.lt/
[6] https://epilietis.lrv.lt/
[7] Lietuvos Respublikos Vyriausybė (2014). Lietuvos dalyvavimo Tarptautinėje iniciatyvoje "Atviros Vyriausybės partnerystė" veiksmų planas 2014-2016 m.
[8] Lietuvos Respublikos Sveikatos apsaugos ministro įsakymas Dėl Šakinės korupcijos prevencijos sveikatos sistemoje 2014-2016 m. programos patvirtinimo. 2013-12-31, Nr. V-1262.
[9] Source: calculated according to data published on https://epilietis.lrv.lt/ and https://www.regjeringen.no/. Norway selected due to similar size of the country and public availability of data on consultations.
[10] Concept for Modernisation of the Public Service (2010) is available to download at (in Lithuanan): https://www.e-tar.lt/portal/lt/legalAct/TAR.51DDCC4E5793

Office to the Parliament in 2010. Instead, incremental changes were implemented, focused on updating of informational systems, providing trainings etc.

The OECD published its review of Lithuanian open government initiatives in 2015 and recommended, among other actions, to: develop a common vision of open government; elaborate a common methodology to foster citizens' participation; develop stronger monitoring, impact measurement and communication of digital government initiatives; expand the use of digital technologies to promote openness, transparency & accountability to fight corruption (OECD, 2015).

1.3.2. Public sector innovation culture

In Lithuania, citizen participation and collaboration receive less attention in Government policies than transparency. Introducing collaborative governance based on co-design and co-creation of innovative solutions together with citizens implies major challenges to countries marked with socialist past and economic transition. The starting point in Lithuania is rather weak. Participative approach to decision making is not supported by prevalent policy-making styles. Since the start of the EU accession negotiations, considerable efforts have been made to increase transparency in public funding decisions. As a result, the last decade witnessed the development of systems for allocation of public funds that rely on quantitative indicators and/or judgment of external independent experts (Paliokaitė et al., 2015). Involvement of wider society takes place in the form of public consultations with citizens. A typical process would include formal presentations to the society, and setting up working groups.

The recent participatory process of identifying the national R&I priorities and drafting the Smart Specialisation Strategy for 2014-2020 (2015) and the process of designing the Lithuania's Progress Strategy 'Lithuania 2030' (2012) are two exceptions that mark progress in this area.

'Lithuania 2030' marks one of the first attempts to institutionalise participatory and collaborative governance in Lithuania. The Lithuanian society shares the responsibility for the implementation (hence, co-delivery) of the Strategy. A number of tools and instruments are designed to guide this process:

- The mandate to coordinate the implementation has been assigned to the State Progress Council, established in 2010. The State's Progress Council's Secretariat at the Office of Lithuanian Government serves as a management body driving the process of implementation.
- Open Progress Forum (OPF) – a series of national and regional discussion forums, organised twice a year around key issues and involving the society. Seven OPF were organised so far.
- A web-based 'Good practices' library, collecting success stories on co-implementing Lithuania 2030 (mainly society, NGOs, business initiatives).
- Annual Progress Report on the implementation of the Strategy and emerging issues.
- 'Quick wins' (Lithuanian Progress Strategy 2030, 2012) – a list of 'annual progress actions' submitted by the State Progress Council to the Government. The Government has to implement (or at least start to implement) these actions within a year.

The implementation of these tools is not without challenges. To further institutionalise citizen participation in the co-designing of policy, the Government's Office implements a three year project that will consult good foreign practices, develop and publish citizen consultation methodology, train public officials, and organise a number of pilot consultations by mid-2019.

Lithuanian public sector innovation culture is hindered by a number of barriers discussed by Visionary Analytics (2015), mainly lack of incentives, low motivation and competences of public officials and politicians, hierarchical systems and 'siloed' approach. Solving those challenges is a long term process, and much of the success depends on the modernisation of the public service which itself has so far proven challenging.

1.4. Civil society innovation

1.4.1. Citizen science initiatives

Although citizen science is gaining popularity globally, it is currently not the case in Lithuania. There are no country-wide platforms or participatory R&D impact assessments similar to Sciencewise[11] in the UK. However, the country, especially its capital Vilnius, is becoming a popular scene for start-up hubs, platforms and co-working spaces.

Until now policy measures to popularise science in the Lithuanian society were rather sporadic. However, in the new financing period, instruments in the smart specialisation strategy include two projects aiming at increasing society's awareness regarding science. The first one aims at creating infrastructure for science popularisation with focus on informing society about development of research and science. The project is likely to take form of a science museum in Kaunas. The second one is about establishing open access Science, Technology, Engineering, Art, Mathematics (STEAM) centres for secondary school students with focus on encouraging more young people to choose research careers.

Measures discussed above aim at popularising science and research, but they lack the active component of citizen science. That is, citizens themselves experience research results or research processes. However, most importantly, they do not actively contribute to research, as would be in the case of citizen science. A concentrated effort to increase the involvement of society in scientific activities does not exist yet.

1.4.2. Role of non-profit in supporting innovation

There is not much involvement of non-profit actors in supporting innovation. Mostly, they come in the form of scholarships from personal/individual funds. However, since 2005, the Lithuanian Innovation Centre together with the Lithuanian Confederation of Industrialists has awarded an annual Innovation Prize, currently given for the most innovative companies and products. Still, generally, private non-profit sector does not play a significant role in Lithuania's innovation ecosystem (see section 2.4).

1.4.3. Mediating structures

Although not too abundant, there are mediating structures in Lithuania's research ecosystem. Regarding fab labs, there are M-Lab established in Vilnius or FabLab Kaunas opened in Kaunas University of Technology. Both have been established very recently (2015-2016) and it is not yet possible to assess their performance.

There are also research hubs, which can be partly associated with 'valley' projects, and co-working spaces are opened by universities and by private enterprises (e.g. 'Western Union Start-up Space' in the Sunrise Valley technology park). Finally, there are also platforms for start-up cooperation, such as Startup Lithuania or 'bzn start'. The latter also gives annual start-ups awards. With regard to bottom-up policy initiatives, they haven't emerged yet.

In addition, the private or semi-private start-up hubs, platforms and co-working platforms scene is booming. Several start-up hubs and co-working spaces, both public and private, have been launched over the last five years. For example, one of the largest start-up and game development centres in the Baltic Countries - Vilnius Tech Park - was opened in autumn 2016, filling more than 9000 square metres with start-up offices, co-working spaces, cafeterias, hostel and recreational areas in a former 19th century hospital. Some successful Lithuanian start-ups (for example, Vinted) have already announced their moving to the park. Among the recent attracted tenants there is Eagle Genomics Ltd. from Cambridge UK, which is developing genome testing and launched their unit in Lithuania, announcing €1.8m investments in R&D.

[11] http://www.sciencewise-erc.org.uk/

1.5. Supply of human resources

The deficiency in human capital is one of the main issues hindering the growth of the Lithuanian economy. According to Reymen et al. (2015), employers in Lithuania increasingly can't find employees with the needed skills. Overall, there are several issues related to the access to adequate human capital, as discussed below.

Table 4: Supply of human resources

	2010	2014	2015
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	0.66	0.83	NA
New graduates in STEM per 1000 population	3.03	2.52	NA
Number of researchers per thousand of population	5.69 (2011)	6.58 (2013)	NA
Share of women researchers (2012)	50.25% (2014)		

Source: ESTAT 2016

First of all, there is a lack of skills in specific sectors, such as ICT, manufacturing, transport and logistics, health, as indicated by employers (Reymen et al., 2015). These sectors have the potential to generate high-value added. However, without access to adequate human capital, it is not possible to realise this potential.

Secondly, the labour force is shrinking due to both historical trends of natural birth rate and high emigration. In 2013 and 2014, 38,818 and 36,621 persons have emigrated respectively. Given the size of the total population of the country, and the fact that statistics may not account for all cases of emigration, the problems seem to be menacing. If such trends continue, the social welfare system will also be challenged, requiring a larger share of budget dedicated to social transfer payments, potentially diminishing the amount of funds available for research and innovation. Furthermore, a share of emigrants are educated specialists, therefore, the brain drain emerges.

Thirdly, employers perceive that employees lack soft skills, such as critical thinking, teamwork, decision making, etc. (MOSTA, 2014b; OECD, 2016a). Such skills have effect on productivity.[12] Therefore, without soft skills the productivity of labour cannot quickly catch-up with leading economies. Finally, although the administration of HEIs perceives improvements in the quality of studies, employers disagree and affirm that quality decreased over the previous 5 years (MOSTA, 2014b). Tertiary education seems not oriented towards quality, innovation and development of entrepreneurial skills (Paliokaitė et al., 2014). HEIs with questionable results attract significant share of funding, but no significant positive changes in the quality of education is seen.

The total number of researchers (full-time equivalent - FTE) was 8,124 in 2015 and has declined since 2014. The majority of researchers work in the higher education sector (4,830 or 59.5%), compared to business enterprise sector which employs 1,845 (22.7%), and the government sector, with 1,449 (17.8%).

Regarding the gender ratio, in 2015, 50.25% of researchers were women (head count). However, the share varied across sectors. In the business sector they represented 32.2% of all researchers, while in the higher education sector the share was larger (55.4%) in 2014. Although these indicators show that gender ratio is close to equal, at least on the whole, two

[12] For example see Haskel, Hawkes and Pereira (2003).

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.

An important issue is that Lithuania lacks capacity to attract and maintain young researchers. According to MOSTA (2016) there are two main deficiencies with governance of RDI human capital system in Lithuania: a) low salaries for researchers, including in the early stages of career; b) high workload divided among teaching and research, often in several institutions. The same issues burden attracting researchers from abroad, including PhD and post-doctoral students.

To increase interest in research careers, the Ministry of Education and Science aims at promoting STEAM education. In October 2015 it informed that there will be 10 STEAM education centres in Lithuania, and in August 2016 the first agreement on establishing such a centre was signed. By April 2016 a minister's decree on an open access STEAM centre was adopted. It is not clear if any special gender-based policies regarding STEAM education will be adopted. 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.

Some policy actions were taken to address remaining challenges in the wider education sector, such as vocational education and training programmes or increase in remuneration for doctoral students. However, the results remain to be seen. Furthermore, even with the new programmes, there remains mismatch between skills acquired in the education system and the skills demanded by the labour market. Life-long learning indicators also show that adult population is not learning, which could improve the supply of skills. Emigration is frequently discussed by both the government and the current opposition. However, despite declarations of the need to reduce emigration flows from the country, trends show that policies, such as Guidelines of Lithuania's Migration Policy approved in January 2014, are not achieving their aims and do not reverse trends. Lithuanian government also approved the plan for reduction of emigration in July 2016, but it is too early to assess its success.

2. R&D and innovation structure and actors

Lithuania ranks 24th in the EU28 Innovation Scoreboard (European Commission, 2016a) with slow catch up with the EU28 average. The gap between EU28 average and Lithuania remains significant although there is some convergence (in 2008 Lithuania's score was 48.3% of EU28 average, while in 2015 the number increased to 54.1%). The rate of increase in summary innovation index (average annual increase of 2.4%) was amongst the highest in EU28, although there was a decline in 2015. The country still needs restructuring the economy towards innovation-based growth rather than growth driven by low labour costs. Most of the research and development (R&D) activities are funded and performed by the public sector. However, the public sector suffers from low commercialisation of R&D results and unattractive working conditions for researchers (MOSTA, 2016; Paliokaitė et al., 2016).

Gross expenditure on R&D (GERD) increased from 0.78% to 1.04% of GDP over 2010-2015, but it is still behind the target of 1.9% pursued by the Europe 2020 strategy. If the target is to be met, the growth of GERD should accelerate. Considering longer time-series there is a sharp increase in funds from the EU, which was 0.09% of GDP in 2009, but by 2014 it was already 0.32% (31.06% of total GERD).

Meanwhile, R&D funded by the government fluctuates, without significant changes (0.38% of GDP in 2011 and 0.37% in 2015). There was some decrease that can be seen from 2009 and this may relate to the increasing role of the EU funds and the economic crisis which forced the government to limit its expenditure. For example, EU funds constituted 92.38% of the Government's intramural expenditure on R&D (GOVERD) in 2013 compared to 21.03% in 2009. Table 5 shows trends in the main R&D indicators.

Table 5: Main R&D indicators

Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2015)
GERD (as % of GDP)	0.78	0.89	1.03	1.04	2.04
GERD in national currency	219.59	298.37	376.83	387	NA
R&D funded by abroad % of GDP	0.16	0.3	0.35	0.36	0.2 (2014)
R&D funded by EC (% of GDP)	0.14	0.25	0.32	NA	NA

Source: ESTAT 2016

2.1. Government

At government level, there exists a certain level of fragmentation. The main policy making institutions responsible for RDI policies are the Ministry of Education and Science and the Ministry of Economy. The Ministry of Education and Science is responsible for the R&D, while the Ministry of Economy implements the D&I parts of the RDI policy. Therefore, on the one hand, policies adopted by these institutions might complement each other, while allowing each of them to concentrate on a specific part of the RDI cycle. On the other hand, this creates overlaps and potential competition between difference instruments used (OECD, 2016b). Furthermore, there are a high number of agencies responsible for monitoring of the RDI system and administering the financial aid provided (see Annex 5 for more details).

Table 6 Main R&D indicators - government

Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2015)
GBOARD in national currency	118.05	119.61	125.99	122.05	NA
GBOARD as % of GDP	0.42	0.36	0.35	0.33	0.64
R&D funded by GOV	0.36	0.36	0.34	0.37	0.66 (2014)
R&D performed by GOV	0.14	0.18	0.18	0.18	0.24

Source: ESTAT 2016

The government is an important funder of RDI, providing a third of total R&D funds. Over the period of 2007-2014, government provided funding worth €946.1m. The majority of it (71.6%) went to the higher education sector, while business enterprises were allocated only 1.8% of the total amount. The government is also important in distributing EU funds, which accounts for another third of total R&D funds (31% of GERD in 2014). Although the government acts either as the main funder or the main allocator of R&D funds, performs only 17.2% of R&D. The main funds for R&D in the government sector come from the government itself and abroad sources, mainly, the EU.

Due to the government being one of the main funding sources for R&D, it could be expected that the economic crisis (that triggered fiscal consolidation measures) reduced public R&D financing. However, there are is no strong evidence that fiscal consolidation had significant effect on public R&D spending in Lithuania. It only had a small negative impact on public support to the Lithuanian R&D expenditures, which is shown by a small decline in government budget appropriations or outlays on R&D (GBAORD) and government funded R&D over 2010-2015 (see table 6 above). One of the reasons behind being able to maintain similar levels of funding was the mentioned reliance on the EU funds. One of the reasons behind being able to maintain similar levels of RDI funding was the mentioned reliance on the EU funds, however structural change is not happening (Paliokaitė et al., 2016).

Overall, looking at trends of government-funded and -performed R&D, its share has been in a steady decline since 2008. This was not due to the growth of the business enterprise sector but due to increase in funds from abroad, mainly the EC, which indicates that structural change is not happening.

2.2. Academia

Academia does not play an important role as funder of RDI activities. Over 2007-2014 this sector funded only 0.8% of total GERD, and 86.2% of these resources were spent within the academia. On the other hand, higher education sector is one of the main performers of R&D. In 2014, it performed 55.9% of total GERD, 46.7% of which was funded by the government.

Table 7: Main R&D indicators - academia

Academia					
Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2015)
R&D performed by HES and funded by GOV (% of GDP)	0.26	0.25	0.24	0.27	0.37 (2014)
R&D performed by HES and funded by private BES+ PNP (% of GDP)	0.06	0.07	0.07	0.07	0.02
International scientific co-publications per million population	185.87	264.35	319.69	355.33	NA
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	5.2	3.58	NA	NA	NA
Research excellence composite indicator	NA	27	NA	NA	NA

Source: ESTAT 2016, Scopus 2016

Non-governmental sources play an important role for the higher education sector (HES), although not as significant as the government. The main non-governmental source is the EU. In 2014, it accounted for 38.9% of all R&D performed by HES. This share has steadily increased from 17.8% in 2010. A significant part of this amount went to acquiring research infrastructure development through the so-called 'valleys' projects, which accounted for approximately €400m.

Business funding of HES-performed R&D accounts for 12.1% of the total (2015). Thus, business does not fund a large share of R&D in the academia. Indeed, data from 2007-2014 shows that for the largest part, business sector mostly funds R&D that it performs itself. There are measures which encourage business to acquire R&D services from HES by leveraging EC and private funding, such as innovation vouchers (planned allocation €10.1m over 2014-2020), but they are not many. Regarding the issue of low academia-business cooperation, the need to strengthen the ties is stressed in the National Studies and R&D Development Programme 2013-2020 as well as the Lithuanian Innovation Promotion Programme 2014-2020, and given attention in the National Development Strategy 'Lithuania 2030'.

Like its predecessor programme, H2020 does not benefit the Lithuanian academia to a full extent. Data from 2014 shows that EU funding per EU's 7th research and innovation framework programme (2007-2013) (FP7) projects signed in 2014 was low in Lithuania, where the country lagged behind most of the other EU countries in funding per capita and per million EUR of GERD terms. H2020 funding provided to Lithuania in 2014 was also lower than the EU28 average in terms of share of GERD (2% vs. 2.79%), euros per researcher (€654 vs. €2,870) and euros per inhabitant (€2.53 vs. €15.56). Nonetheless, Lithuania had a high success rate (14.3%) in the Excellent Science Pillar (European Commission, 2016b).

Research could be more concentrated both thematically and institutionally. A research assessment exercise of 30 institutions conducted by MOSTA (2015b) showed that there are duplications of thematic areas between different, mostly public, research units (126 in total),

which lead to fragmented funding and more competition than synergies. However, the adoption of the Smart specialisation strategy, which identified six priority areas and 20 priorities, might help concentrate research efforts thematically.

At the same time, the National Audit Office of Lithuania (2016) claims that the Research Council of Lithuania does not sufficiently ensure the transparent evaluation and selection of competitive R&D projects. The Audit report completed in 2016 found that a) some members of the RCL were involved in planning of programmes, selection of project applications and implementation of projects; b) only 1.41% of applications were evaluated by foreign experts in 2015 (National Audit Office of Lithuania, 2016).

Regarding research excellence, it may be claimed that there are specific niches with high research excellence. However, steps should be taken to improve the quality of research which now suffers from institutional fragmentation, low incentives for researchers to carry out high level research, low skills in research management and low internationalisation. MOSTA (2015b) argues that research infrastructure and PhD students are of high quality in Lithuania. This may provide an impetus for improvement.

Despite a wide agreement that academia should provide more skills for business, entrepreneurial education is not frequently available. However, The Global Entrepreneurship Monitor (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, 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.

2.3. Business

Research and innovation in the private sector is dominated by business, as the private non-profit sector plays a miniscule role. With respect to business expenditures on R&D (BERD) Lithuania ranked 24th among 27 EU countries (except Ireland) in 2015. Most of the innovative companies in Lithuania are SMEs. Business R&D is a key area of the Lithuanian innovation system where substantial policy efforts are needed. Despite progress in 2014 (an increase in BERD of 37.5% in absolute numbers), the starting point is rather weak as the BERD/GDP indicator was 3.5 times below the EU average in 2014. Furthermore, in 2015 BERD dropped by 10.5%, meaning that lasting change did not occur. Analysis of flows of funding indicates that the majority of R&D funds from business enterprise sector (BES) remain in the same sector (68.8% of all R&D performed by BES, 2015). An important source of funds is the EU, which accounted for 17.3% of all R&D performed by BES in 2014. However, this also indicates that business R&D is largely self-sustaining without significant cooperation with the academia. Funding from abroad for R&D performed in business enterprises remained rather similar of 2011-2015 (change from 0.06% to 0.07% of GDP).

Table 8: Main R&D indicators - business

Business					
Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2015)
BERD as % GDP	0.23	0.24	0.3	0.28	1.3
R&D funded by BES (% of GDP)	0.25	0.24	0.34	0.29	1.13 (2014)
R&D performed by BES (% of GDP)	0.23	0.24	0.3	NA	NA
R&D performed by BES (% of GDP) funded by GOV	0.01	0.01	0.01	NA	NA
Turnover from innovation as % of total turnover	6.6	5.5	NA	NA	11.9 (2012)
SMEs introducing product or process innovations/ marketing or organisational innovations	NA	16.2	NA	NA	25.4 (2012)
World Share of PCT applications	0.01	0.01	0.02	NA	26.09 (2014)

Source: ESTAT 2016, WIPO

Overall, the share of innovative firms is increasing: 40.7% of firms introduced innovations over 2012-2014, compared to 30% in 2010-2012. Considering the innovativeness of firms by their size, absolute majority (85.8%) of companies with at least 250 employees have introduced innovations in 2012-2014, compared to 58% of companies with 50-249 employees or 35% of companies with 10-49 employees (Statistics Lithuania, 2016). All groups of companies increased the share of innovative firms. Overall, in the period 2012-2014, 67.7% of innovative companies were small, while 26.3% were medium and only 6% were big companies (Statistics Lithuania, 2016).

The number of start-ups and young innovative companies is increasing as well. An analysis of 42 information technologies and life sciences start-ups carried out by Enterprise Lithuania found that before 2011 only one or two were established per year, comparing to 11 start-ups in 2012 and 20 in 2013 (Versli Lietuva, 2014). The availability of venture capital investments increased radically in the last three years. For example, €46m were invested by venture capital in 2014, 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 as well (62,889 in 2012, 79,840 in 2015).

Innovation in companies seems to be related to turnover. However, due to confidentiality of data the conclusions regarding causality cannot be drawn based on hard evidence and statistics are more indicative than asserting. Compared to 2012, turnover of innovative companies in 2014 increased by 10.9 p.p. and made 74.3% of the turnover of all companies. Regarding turnover from products new to companies, in 2014, it accounted for 17% of turnover of those companies that introduced product innovations (15.2% in 2012). In 2014, turnover from products new to the market made 9.9% of total turnover of companies that

introduced product innovations. In this case, however, a decrease was registered, as the indicator for 2012 was 9.4% (Statistics Lithuania, 2016).

There is no strong data-based evidence on the effects of innovation on new goods or services. Nonetheless, data shows that 11.4% of companies introduced goods new to the market, while 10.6% of companies introduced services new to the market (Statistics Lithuania, 2016).

2.4. Private non-profit

In Lithuania, private non-profit sector is virtually non-existent. It funded 0.3% of total R&D in 2015. Data on R&D performed by the private non-profit sector are however not available. Due to the small size of the sector, its importance for Lithuania's innovation system is low.

2.5. Networks, cluster, platforms, linkages

In Lithuania, 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 (reflections of path-dependency): overdependence on basic science, outdated public R&D base and unattractive research careers, confrontation between high- and low-tech industries, lack of social capital and network failures, weak innovation diffusion system, and low motivation to learn (Paliokaitė & Antanavičius, 2015).

Table 9: Main R&D indicators – linkages

Linkages					
Indicator/inputs & outputs	2010	2012	2014	2015	EU average (2015)
Public R&D funded by business	0.08	0.09	0.09	0.09	0.05 (2014)
Enterprises co-operating with universities or other higher education institutions	NA	18.9	NA	NA	13 (2012)
Enterprises co-operating with Government, public or private research institutes	NA	11.7	NA	NA	8.9 (2012)
Enterprises engaged in any type of co-operation	NA	44.5	NA	NA	31.2 (2012)
Public-private co-publications per million population	8.59	4	1.7	NA	33.88 (2014)

Sources: ESTAT 2016, Scopus

To overcome those barriers, the country has been implementing various policies since 2010 to facilitate networks, clusters and other inter-sectorial linkages. For example, as a direct result of the cluster-development policies, about 40 clusters emerged in the period 2010-2016. There are also specific policy measures aiming at increasing public-private cooperation. Such policies had mixed effects so far. A more substantial focus was put on this in the new policy mix (2014-2020), for example, by implementing:

- Innovation vouchers, available to companies, especially those lacking RDI experience. These vouchers can be used to acquire R&D services from the public

sector organisations. Priority is given to projects implementing last the stages of technology development (prototyping, testing versus idea feasibility studies).

- Measures aimed to support projects implemented jointly by businesses and universities or public research institutes. The main research funding programme in the operational programme 2014-2020 was split into two (i.e. 'Intellect. Joint research-business projects' and 'Joint research-business projects'), one for business, and the other for research and higher education institutions. It means that effectiveness of this measure will depend on the effectiveness of synergies between activities of the beneficiaries of these instruments.
- Development of technology transfer offices, technology parks and technology scouts (for details see sub-chapter 4.1). An important public-private collaboration challenge relates to exploitation of public RDI infrastructures acquired or upgraded during 2007-2015. Lithuania has 25 Open Access Centres and 9 Science and Technology Parks. The next period's challenge is to create a professional technology transfer and an R&D collaboration system that provides access to these infrastructures to those interested from outside academia.

On their side, universities are encouraged to cooperate with the business enterprise sector by competitive institutional funding rules. The Research Council of Lithuania (LMT) carries out an assessment that determines funds allocation every three years. Two of the components of the final score, which impacts the amount of funds allocated to a particular institution, are: a) funding received from R&D contracts with business companies; b) public funding from participation in joint R&D projects with business companies (funding of business subcontracts).

Despite these initiatives, there is yet room for improvement. In 2012-2014, only 6.9% of innovative companies cooperated with universities or other higher education institutions, and 4.1% collaborated with government or public research institutes (Statistics Lithuania, 2016). The outputs of joint RDI are also below the EU28 level. There were 1.7 public-private co-publications per million population in 2014 in Lithuania, compared to the EU28 average of 33.88, which is nearly 20 times more. What is most worrying, however, is that between 2011 and 2014 there was a steady decline in the number of co-publications. This indicates a decline in collaboration between business and academia.

Despite the emergence of a significant number of clusters, Lithuania ranks only 87th out of 140 countries with respect to the state of cluster development (World Economic Forum, 2015). A study on clusters (Knowledge Economy Forum, 2012) showed that they primarily emerged in services (including information technologies), chemical industry and food and beverage sectors, centred in the most populous locations (Vilnius, Kaunas, Klaipėda, etc.) or those with specific strengths (e.g. spa cluster in Druskininkai). Existing clusters are small (most below 10 companies) and depend on external funding, including funds from the EU. In almost all cases the investment of the members of the cluster into activities of clusters was no more than 60%. Most (84%) of the clusters indicated that they experienced increased turnover, and 83% agreed that their exports were also higher than at the beginning of the cluster (Knowledge Economy Forum, 2012). However, it is not clear how much of the increase can be attributed to the clustering itself.

All in all, given the above, while there are policies which aim at increasing public-private cooperation and building networks, the results are modest so far. The biggest challenges are: a) creating internal incentives in the PROs facilitating public-private collaboration and R&D commercialisation, and b) creating synergies between a variety of existing initiatives such as S&T parks, clusters, science 'valleys', technology transfer offices, joint business-science projects, etc. (Paliokaitė et al., 2014).

3. Innovation challenges

Innovation challenges for Lithuania remain similar to those faced last year. Although steps were taken to overcome the challenges (see chapter 4 for more elaborate discussion), these challenges still are potentially harmful to innovation effects in Lithuania. The challenges are discussed below in the following order: 1) improving the coordination of innovation policies; 2) addressing human resources shortages in R&I; 3) encouraging private investments in R&I; 4) exploiting opportunities for commercialisation of public R&D results.

Challenge 1: improving the coordination of innovation policies

Lithuania's research system remains highly fragmented, both in the private (e.g. existence of approx. 50 clusters) and the public sectors (large number of higher education and research institutions for the country of Lithuania's size, over 20 open access centres, 8 science and technology parks, etc). Fragmentation at the level of research performance creates burden in several ways: a) potential synergies are not achieved due to research being carried out in different institutions with little collaboration; b) there are overlaps and duplications in research carried out, as well as potential duplications in infrastructures. This wastes opportunities to achieve better research outcomes. For example, pre-commercial procurement is under the responsibility of the Lithuanian Business Support Agency (LVPA) when funded from ESIF sources. If other sources are used, then pre-commercial procurement falls under responsibility of The Lithuanian agency for science, innovation and (MITA). It is still not clear how similar or different regulations will be, since ESIF-funded instrument still lacks final approval for project funding terms for specific measures (PFSA).

Fragmentation is also evident at the policy and governance level. Since there are overlaps in competence areas of ministries responsible for R&I policy, as well as a high number of lower-level agencies, this leads to missed opportunities as well as wasted efforts (OECD, 2016b; Paliokaitė, 2015). A higher level of coordination could help mitigate the challenge, leading to more and stronger links between implemented policies and instruments. Although there are bodies which are in charge of coordinating policy initiatives (e.g. inter-institutional body responsible for smart specialisation strategy), the coordination is still lacking (OECD, 2016b; Paliokaitė, 2015). Collaboration across all the relevant funding and development agencies and funding sources (supply and demand, national and international, etc.) has to be ensured to facilitate streamlined, joined-up implementation of the smart specialisation strategy (RIS3) and to implement a holistic government approach by integrating innovation policy into other policies.

Another challenge for effective R&I policy is the modest capacities of policy institutions (mainly at policy making level) and lack of strategic policy intelligence (Paliokaitė et al., 2016). One of the problematic areas is the lack of coherent usage of evaluation activities which would cover all steps of policy making (ex-ante, interim, ex-post) and which would be relied upon by policymakers to modify policies according to the obtained evidence. This creates an obstacle for policy learning.

A positive sign is that consensus and evidence-based policy making is becoming more common, as signified by the process of preparing Lithuania's Smart specialisation strategy. In this case, an important role was played by MOSTA, which is responsible for monitoring and evaluation of higher education and research. Its increased institutional autonomy since 2017 as induced by recent changes in the Law on Research and Studies, MOSTA may have a positive effect on supply of intelligence data in midterm (see sub-chapter 4.1).

Looking further to the 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 the European structural and investment funds (ESIF), more emphasis on policy impacts and even better coordination due to the need to exploit policy synergies for achieving more with less. Lithuanian policy makers should use the 2016-2020 period to prepare for these challenges, achieve the necessary policy effects and to develop necessary capacities

Overall, the challenges for the Lithuania's R&I system remain mostly similar over the years. This indicates that policies used in the previous financing period were not optimal in finding solutions. The new policy mix addresses them to some extent. Its success remains to be seen. Specific responses to these challenges are addressed in the following chapter on innovation policy and its developments (section 4.1.).

Challenge 2: addressing human resources shortages in R&I

This challenge forms a part of a deeper issue faced by Lithuania's economy – skills supply and demand mismatch (cf. Reymen et al., 2015). In the general context, due to negative demographic tendencies (ageing society and emigration which includes brain drain), the labour force in Lithuania is shrinking. According to the data provided by the Association of Lithuanian Higher Education Institutions, in 2016 the number of contracts signed between first year undergraduate students and universities fell by 9.4% compared to 2015. A fall of 8.8% was also felt in other tertiary HEIs (LAMA BPO, 2016). This indicates a diminishing pool of human resources from which talents could be attracted to R&I.

Therefore, there is smaller supply of any workforce irrespective of its skills. At the same time, the quality of higher education is deteriorated, which means that university graduates are equipped with lower skills than are demanded in the market (MOSTAb, 2014b; OCED, 2016b). Only one of the Lithuanian universities (Vilnius University) has been accepted among the top 500 World Universities (QS World University Rankings 2016–2017) in 2016. On top, these trends are further reinforced by non-attractive working conditions and unattractive career prospects for researchers (MOSTA, 2016).

Skills supply and demand mismatch is also strongly felt in the R&I area. Research indicates that in technology field, the mismatch is increasing (Paliokaitė et al., 2014). Thus, for example, a third of companies in manufacturing industries agree that they lack engineers, technology designers, etc. for their R&I activities. Being unable to employ enough R&D personnel they are forced to limit their R&I activities. Although positive change seemed to emerge in 2014, which saw an increase in the number of researchers in the business enterprise sector of 37.7% (in FTE), by 2015 the number decreased by 20.5% (in FTE). Similar tendency is noticeable if head count is taken into account.

The challenge of modest human capital in the field of R&I is further reinforced by inadequate working conditions and unattractive career prospects for researchers (MOSTA, 2016). The salaries are low compared to other EU countries, which creates incentives for experienced, young and potential researchers to emigrate. This creates a twofold problem: on the one hand, there is a short supply of young people willing to pursue research careers, therefore there are too few doctoral students and early stage researchers. On the other hand, experienced researchers, lacking younger assistants in research are overloaded with work. On top of that there is little actual distinction between researchers and professors, meaning that researchers spend a significant share of their time giving lectures and carrying out similar activities (MOSTA, 2016).

The challenge of insufficient human capital in R&I also affects the upgraded research infrastructure. Even though it is upgraded and up to date, there might not be enough researchers to use it to its full extent. This shows that not only is the modest human capital issue in itself, but it also lowers the chances that other instruments will have high returns. Further infrastructure development should also take into account the availability of human resources (Paliokaitė & Antanavičius, 2015).

The issue of skills mismatch in the area of R&I also relates to the previously discussed challenge of modest research capacities in the private sector. If more firms were innovative and had capacities to carry out R&I activities private sector could serve as an alternative career choice for researchers. However, as long as the challenge of low private sector capacities is not resolved, this career path does not provide many opportunities.

This challenge has a potential to shortly become a bottleneck for achieving any of the midterm and long term R&I goals. A mix of instruments and strategic decisions are needed, from structural reforms in the higher education sector to financial instruments for young

researchers and talents from abroad and upgrading of research career indicators, salary system and contracts.

Challenge 3: Encouraging private investments in R&I

Indicators related to Lithuanian business R&I remain below EU28 average, and it is not likely that BERD will reach 0.9% of GDP by 2020 as aimed. Recent efforts by responsible institutions to ensure better statistics and accountability of business R&D will have some effect on the 2015 and 2016 BERD indicators, but this effect will be 'cosmetic' rather than a 'game-changer'. The challenge is of the structural character. Traditional sectors form the backbone of the economy and the focus remains on exploitation of relatively cheaper factors of production. This indicates lower interest in innovation-based growth. This is problematic due to the decreasing competitiveness with regards to the traditional factors of production, which are more favourable in other countries.

2014 marked a significant increase in BERD (37.5% in absolute terms if compared to 2013). Nonetheless, by 2015 the same indicator decreased by 10.5%. This shows that the 2014 increase was a one-of, and might have been a result of changes in data collection. However, there was growth between 2013 and 2015 albeit more gradual than radical. Thus, a breakthrough in private R&I has not taken place yet.

The policy mix for 2007-2013 was mostly concentrated on developing public research infrastructures and supporting R&I in mature firms (Paliokaitė, 2015). The studies and evaluations so far unveiled two main weaknesses of the previous approach: a) the concentration on "hard" investments did not allow contributing significantly to strengthening of "soft" capacities; b) structural changes in the economy were not encouraged due to insufficient attention to new and potential innovators.

A limited number of top-tier research groups and few knowledge-based companies make the core of the existing target group for the excellence-based competitive R&D measures in Lithuania. Raising the business R&D allocations without simultaneously dealing with capacity building via innovation facilitation/promotion services, leads to absorption problems (Paliokaitė, Antanavičius, 2015). Too much focus on science-based R&D on the one hand, and lack of focus on business R&D absorptive capacities on the other, creates a vicious circle, largely leaving possible newcomers (start-ups, traditional industries). A focus on mature R&D-based innovators means that a very small number of companies are affected. For example, a study of R&I policy and SMEs in Lithuania showed that business R&D-based policies only reached 270 SMEs in 2007-2013 (Paliokaitė & Antanavičius, 2015). Design of the instruments was also non-optimal. For example the instruments did not cover the full innovation cycle, and only less than a half of R&I-related projects led to additionality (Paliokaitė & Antanavičius, 2015).

The 2014–2020 period may be a 'make or break' for Lithuania in terms of achieving significant structural changes and breaking out of the 'middle-income trap'. Given the above, the key challenge for Lithuania, 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. 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. It would help upgrading the role of 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 the export-oriented and high value added market segments where Lithuania has the capacity to attain a potential competitive advantage. At the same

time, the accessibility of instruments should be reviewed, so that high administrative burden would not discourage firms from experimenting, and would not facilitate the substitution effect.

Challenge 4: exploiting opportunities for commercialisation of public R&D results

The majority of the overall modest R&D efforts in Lithuania are funded by the public sector and performed by public research institutions. Key PROs have upgraded their research infrastructures from funds available in 2007-2013. Other PROs also hope to expand their infrastructure thanks to the ESIF funds available for 2014-2020. A measure aiming at the development of infrastructure totals €188m. Therefore, research infrastructure has significantly benefited from public spending and still attracts a significant share of funds available for R&I.

Despite the huge potential, weak capacity to commercialise and exploit public research for economic benefits becomes more evident after heavier investments in research production. Key indicators covering quality of Lithuanian research output as well as economic R&D results are below the EU average. For example, the indicator of public-private co-publications was only 1.7 in 2014, and has been decreasing since 2011. Data on patenting, spin-offs and other R&D outputs are also well below the EU average. Due to the modest levels of commercialisation of public research results public investment in R&I does not bring expected economic returns. This creates a problem for the economy since public investment does not have lasting effect and the society does not benefit enough to justify resources spent. For example, through support of public research infrastructure the policy mix for 2007-2013 public R&I created a chance to attract firms to use public resources through open access centres. However, studies indicate that open access centres will not be able to sustain themselves and will have to rely on public resources. Furthermore, by 2020 these infrastructures will additionally require approximately €118m for upgrading of outdated equipment (Technopolis Group, Ernst and Young, 2014). The annual maintenance costs will increase the burden on the public resources. Therefore, instead of further upgrading R&D infrastructure policy should focus on its exploitation, so as to ensure that the investment bears returns. From this perspective there remain two issues.

First, the entrepreneurial culture in the Lithuanian universities needs to be urgently developed, as studies indicate that it is currently low (OECD, 2016b) It requires a change of the mind-set at the universities via incentive systems, e.g. modifications to the research funding (e.g. more focus on the outcomes of R&D) and researchers' career criteria, university IPR policies, development of the knowledge transfer offices, and entrepreneurial training.

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 currently 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 (Paliokaitė et al., 2016). The virtual R&D infrastructure network could allow developing innovation from idea to pilot manufacturing. All public research institutes and research centres with a mandate to engage with industry, and especially the open access centres in the 'valleys', must develop a distinctive industry-focused culture. They have to become better at marketing their research to the business sector.

4. Innovation policy

2015 and 2016 mark the beginning of the new 'chapter' in the implementation of innovation policies in Lithuania. The new policy mix has been planned, and first measures were launched in 2015 and 2016, the remaining measures will be launched in 2017. The recent developments are discussed in sub-chapter 4.1. The remaining sub-chapters focus on implementing the Smart specialisation strategy (4.2), stakeholder initiatives (4.3) and monitoring and evaluation culture (4.4) with a focus on changes or initiatives that took place in 2016.

4.1. Recent developments in innovation policy

The main developments in innovation policy over 2016 relate to:

a) the approved revisions to the Law on Research and Studies and consequent upgrade of the status of the main R&I analytical institution (MOSTA);
b) the approval of the Lithuanian Science and Innovation Policy Reform Guidelines by the President of the Republic of Lithuania;
c) the development, approval and initial implementation of the new R&I policy support measures under the Operational Programme 2014-2020 Thematic Objective 1, aimed at implementing the Lithuanian Smart Specialisation Strategy;
d) other less significant changes.

These developments are discussed in more detail below.

a) Approved revisions of the Law on Research and Studies

In June 2016, the Lithuanian Parliament approved the proposed revisions of the Law on Research and Studies. Some relevant changes, mainly in the higher education sector are:

- Contracts with higher education institutions concerning education accessibility and results, research and education quality, and domestic and international cooperation. The contracts will be renewed every three years based on a set of indicators.
- Introduction of minimal acceptance criteria for new students in order to reduce acceptance of low quality students.
- Possibility to implement three year bachelor studies.
- Possibility to implement industrial/professional PhDs in collaboration with business companies.
- MOSTA will be accountable to the Government instead of the Ministry of Education and Science.
- Non-state higher education and research institutions will have possibility to access to the state budget funds for R&D.
- Budget funding for administrative costs, associated to higher education and research institutions, will be distributed according to their R&D performance (from 2017).

However, since most of the new provisions enter into force only on January 1st 2017, the previous revision remains valid during 2016. Until then, some of the details, such as the specific role that MOSTA will play, still remain unclear. Furthermore, the article concerning contracts with higher education institutions will only become enforced on January 1st 2018. Several changes enter into force at other times over 2016-2017 but they are not important for the scope of this report.

Most of the approved revisions can be considered rather cosmetic/incremental, except for the introduction of contracts with higher education institutions, which in practice means a return to the previously existing (before 2009) model of 'State planning', which can give some control over the quality of research and studies back to the State. However, some experts doubted whether it will be enough to achieve considerable improvement in the field of education quality considering the high fragmentation of institutions and the already depreciated value of higher education diploma. Nonetheless, if handled correctly, it might help strengthen human resources.

Another important change concerns the role of the main analytical institution in the studies and R&I area – the Research and Higher Education Monitoring and Analysis Centre (MOSTA). According to the approved revisions, MOSTA becomes accountable to the Government of Lithuania, not to the Ministry of Education and Science. It can be expected that MOSTA will gain more autonomy in monitoring and evaluation of R&I policies and also more power in the existing institutional system.

b) The Lithuanian Science and Innovation Policy Reform Guidelines

In June 2016, the President of the Republic of Lithuania proposed Guidelines to reform the Science and Innovation Policy. They were approved by the Parliament in September 2016.

They also constitute a good example of stakeholders' involvement, as over fifty representatives from the academic and business community, NGOs and other experts contributed to their drafting. The Parliament instructed the Government to prepare a plan for implementation of the Guidelines by the 1st of December. Among the most important action areas set in the Guidelines are:

- Reform of the institutional R&D assessment and funding system (more focus on indicators from international research and innovation activities monitoring system);
- Consolidation of the potential of research and higher education institutions, valleys and technology parks;
- Reform of R&I policy coordination. According to the Guidelines, the Parliament should ensure clear responsibility for innovation policy design, and the Strategic R&D and the Innovation Council under the Government would become responsible for innovation policy coordination.
- Independent monitoring and evaluation of R&I policies should be strengthened by involving society and scientists to a wider extent, and increasing the focus on evidence-based policy learning.

The guidelines are broad and aim at addressing many of the challenges faced by Lithuanian R&I system at the strategic level. They may contribute to improved coordination of the system, due to emerging political will. However, it is too early to tell whether these results will be significant enough.

c) Development and approval of the new R&I policy mix for 2014-2020

The new policy mix is funded mainly from the first and ninth priorities of the Operational Programme (OP) for 2014-2020. The first priority axis 'Strengthening research and development and innovation' has two investment priorities: a) 1.1, which concentrates on infrastructure and centres of competence; b) 1.2, which concentrates on promoting business investment in R&I, as well as commercialisation and technology transfer.

According to the intervention logic, investment in these priorities should complement each other. Better developed RDI infrastructure should be used by agents of the RDI system and should promote their research and innovation activities. At the same time, increased use of the infrastructure should diminish the costs of maintenance. The connection of Lithuanian research infrastructure to international networks should also promote its usage. Therefore, a mutual link between the two investment priorities exists and, if instruments are well designed, positive effects can be expected.

The ninth priority is broader and encompasses more than RDI. However, the specific objective 9.3.3, 'Strengthen the skills and capacities of public sector researchers for engaging in high level R&D activities' directly addresses the challenge of lacking high quality human skills in research. Implementation of this specific objective may help to achieve better results through the first priority axis, as public sector organisations will be better equipped to carry out RDI activities.

Approved relevant instruments (18 in the first priority axis and 3 relevant ones in the ninth priority axis) aim at achieving these objectives. However, although the operational programme already started in 2014, only a minority of the innovation policy instruments have

been launched by November 2016. Table 10 below provides information on the specific instruments.

Table 10: Approved instruments in the policy mix

Objective	Instrument	Budget	Calls launched
1 (Investments into R&D infrastructures)	Development of RDI infrastructure and its integration into European infrastructures	€188m	Two project agreements signed (€37.7m)
	Development of competence centres	€8.7m	no
1 (Start-ups)	Technoinvest	€17.6m	no
1 (R&D based FDI attraction)	Smartinvest LT	€5.8m	One project agreement signed (€2.35m)
	SmartPark LT	€13m	no
	Smartinvest LT+	€43.4m	Two calls closed, three agreements signed (€2.83m)
1 (Innovation support services, business networking and commercialisation promotion)	Inovation vouchers	€10.1m	no
	Inogeb LT	€8.7m	Two agreements signed (€3.44m)
	Inocluster LT	€26m	First call closed
	InoConnect LT	€1.5m	no
	InoPatent LT	€3m	no
1 (Business R&D grants)	Intellect LT. Joint business-science projects	€139m	yes
1 (Innovation demand)	Precommercial procurement LT	€29.4m	no[13]
1 (Promotion of public sector R&D commercialisation and technology transfer, incl. public-private collaboration)	Purposive R&D in the smart specialisation fields	€44.9m	no
	Facilitation of R&D results commercialisation and internationalisation	€13m	no
	Facilitation of activity of Competences centres and	€26m	no

[13] However, a separate measure for precommercial procurement funded from non-ESIF sources has had calls for two projects launched and managed by MITA.

	Technology transfer centres		
	Independent R&D projects*	€35.9m	no
	Joint science-business projects	€35.9m	no
9 (Development of research skills and capacities - human resources for R&I)	Development of research competences of scientists, other researchers and students through applied research activities	€68.4m	no
	Development of competencies of scientists and researchers in knowledge-intensive firms	€2.9m	no
	Development of competences of scientists and other researchers	€43m	Six project agreements signed (€28.08m).

Source: www.esinvesticijos.lt and www.e-tar.lt, updated 21st November 2016. * - According to the data provided by the Ministry of Finance, this measure will most likely be eliminated. However, no final decision on the elimination of his measure or reallocation of its funds has been made by 21 November 2016.

Instruments covering investment priority 1.1 move in two directions: a) developing existing R&D infrastructure and competence centres; b) acquiring new R&D infrastructure. According to the logic of the specific objective in the Operational Programme, the focus should be on promoting business agents to use the existing infrastructure. However, a significant role in these measures is given to acquisition of new infrastructure, which may distort the expected effects of this investment priority (namely, the use of the existing infrastructures by business).

Instruments addressing specific objective 1.2.1 are more diverse and address various aspects of the business RDI, mainly focusing on the later stages of the innovation process. They include: a) innovation promotion services; b) developing industrial parks and attracting foreign R&D investment; c) supporting financial instruments aimed at RDI in the private sector; d) promoting establishment of new innovating firms; e) promoting business-academia cooperation; f) supporting patenting, design registration, certification; g) cluster exploitation; h) internationalisation of SMEs in the RDI area; and i) building demand for innovation through pre-commercial procurement.

The list of supported activities shows that a wide range of them is directed at increasing private sector RDI capacities (especially towards the end of innovation process), but cover the whole development cycle. Although certain areas (such as the attention to emerging and potential innovators) could have been given a more important role, in general, the policy mix under the specific objective 1.2.1 is much more versatile and balanced compared to the previous period.

Specific objective 1.2.2 covers five measures which mainly aim at a) promoting public R&D commercialisation and internationalisation, including the development of technology transfer centres; b) supporting science-business projects. Under this objective more attention is given to the R&D part of the innovation development cycle. In combination with exploiting existing research infrastructure, these measures could lead to an increase of public R&D commercialisation. However, funding for public-private collaboration takes a relatively small share of the total funds allocated for this objective (about 23%).

Finally, specific objective 9.3.3 is supported through three instruments. All of them aim at strengthening human resources for RDI. Although the measures mainly concern researchers in the public sector, one of them addresses the need for researchers in knowledge-intensive firms. Such policy mix should bring benefits to both the public and the private sectors.

However, it is less likely that business will benefit significantly, since the development of competencies of scientists and researchers in knowledge-intensive firms is allocated only 2.5% of all funds to be distributed under the specific objective 9.3.3.

The development and approval of the new policy mix is also closely tied to the Smart specialisation strategy. According to it, Lithuania will concentrate a significant portion of RDI funding in six priority areas (which cover 20 priorities). Design of the policy mix, especially the project selection process, is related to smart specialisation in that it requires that projects are implemented in one of the 20 priorities. State funded and selected projects are generally connected to specific priorities. However, some infrastructure projects are difficult to link to benefits for the implementation of the Smart specialisation strategy due to their weak connection to the selected priorities. Secondly, for some measures, it is not clear what the distribution of funds between specific priorities will be. However, given the thematic concentration of investment and improvements in the policy mix, the potential of RDI policy to create a breakthrough in priority R&D fields is higher when compared to the previous period.

The difference in the implementation of the above mentioned instruments indicates that the Ministry of Economy has made more rapid progress towards implementing the operational programme for 2014-2020. However, the Ministry of Education of Science is waiting for approval by the Ministry of Finance of its instruments. This relates to the coordination of the instruments with various stakeholders and the Ministry of Finance, which aims at ensuring high effectiveness of the instruments.

The Ministry of Economy is responsible for the D&I parts of the RDI, while the Ministry of Education and Science has competence over R&D parts. This leads to the more rapid implementation of the projects closer to the end of the innovation process, while projects covering its beginning are not financed yet. This lowers the chance of a successful initial interlock and continuation of RDI activities. Nonetheless, this could pose problems only initially, as later implementation of all instruments should catch-up.

Overall, despite several shortcomings, the new policy mix is more versatile, covers the whole innovation development cycle and addresses many gaps in the national innovation system, such as already identified challenges (low private R&I investment, lack of commercialization and insufficient human resources). Positive changes related to introduction of demand-side policies put more focus on commercialisation of public R&D, and better balance between 'hard' and 'soft' R&D investments (infrastructure vs human resources). Although the launch of most of the measures is late, with advancing approval of PFSAs the implementation of the policy mix should be expected to accelerate during the coming year.

d) Other developments in R&I policy

Other recent developments related to or affecting R&I policy are listed below:

- The Lithuanian Research Council published the updated Lithuanian Roadmap for Research Infrastructures (2015) in July 2016 (LMT, 2016). It describes in greater detail the list of infrastructures included in the roadmap already published in 2015, but the included research infrastructures remain the same. Therefore, there are no substantial changes to the suggested development of research infrastructures, except for a more elaborate description. The roadmap also describes links with European infrastructures which are related to the ones developed in Lithuania.
- The Lithuanian Parliament approved the proposed revisions of the Law on Legal Situation of Foreigners in July 2016. These revisions are more favourable for the immigration of skilled specialists and start-ups. For example, 'start-up visa' is introduced and start-ups and entrepreneurs from foreign countries will be able to get legal decision to live and work in Lithuania quicker (from 1 month to 15 days); previously existing requirement to employ at least three Lithuanians has been abandoned; immigration of skilled specialists from non-EU countries becomes easier; foreign students can start working from first year of studies (previously the Law only allowed to work from second year of studies) and they will not be required to pass a previously required 'labour market test'. These revisions will

contribute to solving one of the key pressing barriers – shortage of skilled labour force and new innovators – by helping attract talent from abroad.

- The Ministry of Economy is preparing to introduce a support measure for industrial doctorate from 2017. A voucher worth €16,500 will be provided for 4 years, covering half of the PhD studies costs. The rest will be funded by the collaborating business company. Currently the measure is being drafted. However, it is already clear that the measure should be funded from the EU's structural and investment fund (ESIF). Companies in any sector are eligible, but only PhD studies in the physical, biomedical and technological sciences fields will be funded.
- The OECD review was taken seriously and has significant impact to innovation system; therefore the Lithuanian Government approved its Implementation Action Plan. 32 specific recommendations in the OECD Innovation Policy Review of Lithuania are divided into 6 blocks: 1) favourable framework conditions for innovation; 2) the quality of human resources for innovation; 3) improving public governance of the innovation system; 4) balancing the policy mix and fostering innovation in the wider business sector; 5) enhancing the performance of the higher education sector; and 6) supporting international knowledge linkages. The Action Plan consists of 94 measures that address each of the OECD recommendations.The Ministry of Economy also plans to implement a system of technology scouts. Taking into account the needs of companies, scouts will help them identify new technologies and technological processes that could be developed. After that, technology scouts will try to locate these technologies or technological processes (related R&D competences) in the network of public research institutions. If the necessary R&D services and/or competences are identified, further step will be the evaluation of technology / technological processes, including their commercial potential. Scouts will also provide additional related consultancy services. Technology scouting will be implemented as part of the project 'Inospurtas' funded from ESIF through the Inogeb LT measure. It is planned that 80 consulted companies will create or adopt innovations, 15 technology transfer agreements will be signed and 35 prototypes (or concepts) of products, services or processes will be created.
- The Parliament of the Republic of Lithuania drafted a project for a decision regarding the optimisation of public universities. It proposes that the Government (or its authorised institution) analyses the potential and current situation of research and higher education institutions and prepare recommendations regarding optimisation of the network of public universities. These recommendations should then be submitted to the Parliament. However, given the recent Parliamentary elections in October 2016 that resulted in a radical shift of the parliamentary majority further actions have not been taken yet.
- The Law on Crowd Funding was adopted in November 2016. It sets up the conditions for crowd funding, crowd funding platform operator, the terms and conditions for mandatory disclosure of information provided in crowd funding platform, as well as crowd funding platform operator's maintenance procedures.
- The October 2016 elections led to a change in the Lithuanian Parliament's majority. On 13 December 2016 the Parliament (Seimas) adopted the Programme of the 17th Government, which had been drawn up by the coalition of the Lithuanian Peasant and Greens Union and the Lithuanian Social Democratic Party. Among other objectives, the Programme highlights quality of higher education and studies, implementing Smart Specialisation, and the implementation of the Science and Innovation policy reform guidelines approved earlier by the Parliament.

The policy developments are especially important in the light of the Country Specific Recommendations 2015-2016 and the European Semester Reports 2015 and 2016. In June 2016, the Council of the European Union presented Country Specific Recommendations (CSR) for Lithuania (Council of the European Union, 2016), including those relevant for R&I policies:

- Strengthen investment in human capital and address skills shortages, by improving the labour market relevance of education, raising the quality of teaching and pursuing more active labour market policies and adult learning.
- Take measures to strengthen productivity and improve the adoption and absorption of new technology across the economy.
- Improve the coordination of innovation policies and encourage private investment, inter alia by developing alternative means of financing.

The CSR are recent, therefore no new policy response was visible by November 2016. However, it should be noted that the Lithuanian Science and Innovation Policy Reform Guidelines proposed by the Lithuanian President and approved by the Parliament in September 2016 reflect some of the CSR, especially related to better policy coordination, addressing relevance of education (mainly by optimising the network of institutions and creating incentives for higher quality of education), and encouraging private investments. Related policy response remains to be seen.

The new policy mix also largely addresses the challenges indicated in European Semester Reports 2015 and 2016 for the area of RDI, such as: 1) low private R&I investment; 2) weak cooperation between science and business; 3) low internationalisation; 4) too much focus on 'hard' infrastructure; 5) fragmentation in policy, especially, regarding knowledge transfer. The first three of these challenges are addressed in the new policy mix, as shown in its description above. However, it is still too early to assess what their effects might be.

Regarding the investment in 'hard' infrastructure, the new policy mix includes a more varied scope of innovation support measures. However, instruments under specific objective 1.1.1 still allocate significant amount of funds to acquisition of research infrastructure (about €200m). Policy and institutional fragmentation is more difficult to counter with financial instruments, as solving it requires strategic level decisions. The Science and Innovation Policy Reform Guidelines show (at least some) political will to take steps in this direction. Additionally, attention to the need to develop human resources is also given. This challenge is addressed by measures under specific objective 9.3.3 of the operational programme 2014-2020.

4.2. National and regional Smart Specialisation strategies

Description and timing: The Lithuanian Government approved the programme on the implementation of the RDI priority (smart specialisation) areas and their priorities (Smart Specialisation Programme) in April 2014 and Action plans for implementation of the priorities in the first half of 2015. In August 2015 a general Action plan for this programme concerning the measures coordinated by the Ministry of Education and Science was also approved. These documents cover the implementation of six priority areas and their twenty specialisations – specific priorities.

Following the principles of coordination and monitoring provided in the Smart Specialisation Programme, the coordination group consisting of key stakeholders was established (in 2014) to monitor and coordinate the implementation of the priorities. By the end of 2014 the detailed procedures of evaluation and monitoring of Smart Specialisation Programme were adopted. The provisions provide that 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 and the Ministry of Economy.

New developments: From 2015 on, implementation of smart specialisation and thus monitoring and evaluation in Lithuania has started. The first calls for the projects were launched by the end of 2015 and beginning of 2016.

As of the second half of 2016, MOSTA and the Ministry of Economy have developed a project for the evaluation and monitoring system of research and innovation priorities covering output indicators, interim evaluation, impact analysis, foresight exercise, etc. The activities of the project are envisaged to start in 2017.

The monitoring and evaluation system will also be used for an interim review of the Lithuanian smart specialisation strategy implementation and to plan R&I policy after 2020.

In November 2016 the Government took the decision to reorganise MOSTA and make it responsible to the Government's Office and to extend its function for carrying out the evaluation and monitoring of the status of research, higher education and innovation in Lithuania.

Outstanding issues: There are plans to carry out a foresight exercise in order to find out whether priority areas and priorities remain relevant by 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 smart specialisation strategy (RIS3); however the dialogue among all actors involved in RIS3 design shall be continued in the strategy implementation phase. This task includes dialogue with the teams/institutions that conducted the EDP exercise, as well as actors involved in the management/implementation of the Operational Programme, down to the very individuals involved in drafting and managing calls for proposals.

The implementation of the Smart Specialisation Programme and its evaluation and monitoring will largely depend on how successfully the institutions responsible will manage to cooperate and whether there will be enough political will to respond to the changes.

4.3. Stakeholders' initiatives

The most important stakeholder initiative of 2016 concerns the Lithuanian Science and Innovation Policy Guidelines initiated by the President of the Republic of Lithuania and approved by the Parliament in September 2016 (see 4.1). Over fifty representatives of academic and business community, non-governmental organisations, experts and ministries made a contribution to the drafting of the mentioned Guidelines that were presented in June 2016 and later on submitted to the Parliament. The Guidelines set five specific strategic reform areas essential for increasing competitiveness: a reform of the scientific research system, the promotion of the development of innovations, an educational system reform, the coordination of science and innovation policies, and an impartial monitoring. Given that the document is strategic, its most important role might be in improving coordination of the R&I system. However, conclusions must be postponed until the Government prepares an implementation plan.

4.4. Monitoring and evaluation culture

At strategic level there is a lack of systematic (ex post and ex ante) evaluation, which may hinder policy learning and slow improvements in the design and implementation of policies. The monitoring and evaluation of smart specialisation strategy by MOSTA (especially, after gaining more autonomy in 2017) and the Ministry of Economy should partially fill this gap, although it might be difficult to get access to business data and the exercise might therefore rely on data related to the public sector.

Although there is a centrally-coordinated system of evaluations and efforts are concentrated on improving the evaluation capacities at the ministries and implementing agencies, and there have been improvements, the evaluation capacities are still weak (OECD, 2016b). Ex-post evaluation is fragmented, and the results are not available for all policy instruments at the time when a new programme is being designed. Especially, the use of counterfactual evaluation is limited due to the low availability of data, as illustrated by limitations in MOSTA (2015a).

The R&I policy evaluation system is in development. In October 2015 MOSTA finished the Development and Implementation of Research and Higher Education Monitoring and Analysis System project. Its purpose was to create and test a research and higher education monitoring and analysis system, which to some extent was achieved. In November 2015 it began to implement a project on creation and introduction of the system for monitoring and evaluating the progress of research and higher education. As a result of these projects various studies of the Lithuanian R&I system were carried out. This includes the 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. implemented by national stakeholders. Some of the developed tools are already used systematically, while others 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 2016, a specific system for monitoring and evaluation is being 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 (in 2018) and to plan R&I policy after 2020.

Additionally, State institutions carry out themselves or procure external evaluations. For example, in October 2016 the National Audit Office of Lithuania published two evaluation reports related to R&I. One of them covered a programme run by the Ministry of Education and Science called "Development of studies and science", and another one run by LMT, titled "Development of state's research and studies system". The Ministry of Finance has commissioned an interim evaluation of the new R&I policy mix coming from the Operational Programme 2014-2020, to be completed by June 2017. It covers instruments from thematic priority 1 and specific objective 9.3.3. The results are expected in June 2017. The Ministry of Economy has commissioned an external evaluation of the measure "InoVouchers LT", to be completed by March 2017.

5. Creating and stimulating markets

5.1. Demand driven innovation

Public procurement and other demand-led policy instruments for innovation have not been very much used so far in Lithuania. In general, public procurement rules have been interpreted in an overly restrictive manner, therefore discriminating against demand-led innovation, especially among SMEs. Lithuania also lacks developed administrative culture of organising tenders around innovative ideas (Paliokaitė et al., 2016) (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 (OECD, 2016b).

Since 2012, however, policy debate shifted towards demand-side oriented measures. 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 or prototype creation are 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 the Lithuanian agency for science, innovation and technology (MITA, which is the 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.

The new measure 'Pre-commercial Procurement LT' (€29.36m), funded by the European structural and investment funds. 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.

A survey of potential interest in such measure has been carried out by MITA and the Ministry of Economy. The Ministry of Economy announced in July 2016 that it has identified about 50 potential pre-commercial procurement projects, and has already received 15 project applications and 80 project ideas. The first call was launched in August 2016. It covers a project commissioned by the Ministry of Defence to create a prototype for 'scout observation system day/night'. The procurement consists of three stages: conception, prototype and pilot batch. Each stage ends with a competition between the participants and the selection of some of them to continue further on, thus, effectively decreasing the competition with each stage (up to three participants in the first stage, up to two in the second stage and one participant in the final third stage).

In total €29m from ESIF are allocated to pre-commercial procurement (in addition to other sources, such as national budget). The Ministry of Economy estimates that around 10 projects will be funded from ESIF, although it is not possible to define a specific number because of the differing demand for resources per project (e.g. the first non-ESIF call is for a project worth €1m, while another one is worth significantly less – €0.015m). At least for non-ESIF pre-commercial procurement, the projects will be selected based on the decision of the Ministry of Economy after having taken into account recommendations provided by the Innovative Economy Council.

Some success factors for the implementation of this measure were suggested by Paliokaitė et al. (2014):

- Regulatory measures, for example standards, testing, early stage certification, consumers' protection regulation, bio-safety regulation etc., could also stimulate the market for innovation.
- Good coordination between the interested parties is a necessary precondition for implementing the innovation demand-side measures, for example between the purchasing authorities and the Public Procurement Office.
- Necessary resources have to be allocated to increase the capacities and train potential users of innovation (e.g. responsible agencies and ministries, State companies), using pilot cases, demand surveys etc.

5.2. Regulations and standards

No systemic Government initiatives or policy actions dealing with the assessment of regulation impact on innovation were implemented in Lithuania.

Some attempts towards better regulation focus mainly on the reduction of the administrative burden. In Lithuania, a more consistent performance in this area started in 2008, when the Government approved the Programme on better regulation. In accordance with this programme, the Ministry of Economy has taken certain initiatives aimed at improving the regulatory environment. For example, by the end of 2012 two new laws were adopted in connection with better regulation – the Law on Reduction of Administrative Burden and the Law on Legislative Framework. In December 2013, the Government formed a special better regulation Supervisory Commission, which acted namely in the area of reducing administrative burden.

Changes in regulation in specific fields may also help foster innovation. For example, in October 2016, the Government approved changes regarding the remote identification of clients, which makes it easier for financial technology companies to operate. This should lead to increased investment and may also lead companies to innovate. Another case where regulation helps foster innovation is the 'startup visa', which aims at decreasing requirements set for foreigners when relocating to Lithuania, if they are moving startups into the country, as well as making it easier for individual specialists to immigrate. Thus, it helps increasing innovation potential in Lithuania.

According to the OECD (2016c), the requirement of proportionate regulatory impact assessment (RIA) is largely in place, but the RIA is mainly used to justify choices already made, and quality controls are diffuse. There are no clear guidelines on the laws or regulations which should undergo more in-depth RIA, and there are no mentions on assessment of impact on innovation. The only relevant recent RIA concerns ex-ante assessment of the impact of the proposed new law on innovation promotion in 2015. The new law did not progress to the stage of approval.

No visible Government initiatives aimed at increasing sectoral competition through deregulation and removal of market protection of incumbent firms, or at supporting commercialisation through the use of standards were identified.

The most visible trends relate to implementation of the pre-commercial procurement measure (see 5.1) and innovative public procurement. The Ministry of Economy in collaboration with the Public Procurement Office, introduced amendments in the law on public procurement that indirectly allow implementing innovative public procurement (public procurement, focused on innovative products or services). For example, a new method of competitive dialogue allows consulting with contractors at the early procurement phase regarding modern and innovative solutions (Ministry of Economy, 2015).

5.3. Increasing the internationalisation of companies

Business internationalisation is included in the present policy mix. Four national level agencies share responsibilities related to business internationalisation:

- The Lithuanian agency for science, innovation and technology (MITA) promotes business participation in Horizon 2020 and other international programmes by increasing the awareness on rules and opportunities to participate, organising consultations, presentations and other events for enterprises, as well as providing technical assistance for potential participants, proofreading their applications etc. In addition, the Ministry of Economy and MITA organize business missions, and constantly invest in new international cooperation agreements such as between MITA and MATIMOP (Israel) that resulted in joint Lithuanian-Israeli Eureka projects, or relations established with the European Space Agency (in 2010) and NASA. The Public Institution Lithuanian Business Support Agency (LVPA) provides funding for business innovation and development. In the new policy mix, there are two new measures addressing R&D internationalisation. InoConnect LT (€13.03m) will provide funding for participating in the initiatives facilitated by the

Enterprise Europe Network. InoPatent LT (€3.04m) will reimburse costs of international patent applications. The focus on internationalisation is also strengthened by giving additional points to projects that are involved in international programmes ('Intellect Joint business-science projects), international networks ('InoclusterLT'), and have partners in the Baltic Sea Region (BSR) or their project contributes to the BSR Strategy.

- Invest Lithuania promotes foreign investment (FDI) attraction, and works in collaboration with other agencies to attract FDI related to smart specialisation. Three financial measures are designed to promote R&D-based FDI: Smartinvest, Smartinvest LT+, SmartParkLT (altogether €62m) target R&D related FDI into smart specialisation areas, both product and organisational innovations, and facilitate science-business R&D subcontracts and partnerships (universities are eligible partners) and the development of industrial parks' infrastructure.
- Enterprise Lithuania supports export promotion, by providing counselling-support in the domestic and export markets, assistance and support with regards to the participation in trade fairs, exporter and importer missions and international exhibitions as well as state-supported export guarantees.

Additionally, continued implementation of bilateral or multilateral initiatives such as Green Industry Innovation programme (bilateral programme implemented with Norway), BSR Innovation Express (a joint call for projects implemented within the framework of the BSR Stars programme), Eureka and Eurostars help with the internationalisation of companies.

The remaining challenges concern better links between ESIF and Horizon 2020. Paliokaitė (2015) also concluded that Horizon 2020 projects are less attractive for private enterprises because they are perceived as very risky due to low success rate, having high administrative load and being very far away from the market. To address this challenge there is a need to strengthen the national framework for proactive position of Lithuanian entities in project preparatory activities through dedicated project assistance and partner search grant scheme available for both public and private R&D (currently financial assistance is only available for public research organisations).

6. Conclusions

A summary analysis of the policy mix with an assessment on how the different policy measures contribute to tackling the structural challenges is provided in a table below.

Table 11: R&I challenges – summary

Challenge	Policy response	Expert Assessment
Improving the coordination of innovation policies	Smart Specialisation monitoring and review system (in progress). Review and upgrading of existing technology parks and innovation promotion system (in progress). Analysis performed by MOSTA. Upgrading the autonomy of MOSTA by placing this institution directly under the Government's Office. Approval of Science and Innovation Policy Reform Guidelines, which foresees: - Reform of institutional assessment and funding; - Consolidation of higher education and research institutions; - Reform of policy coordination; - Independent monitoring and evaluation policies.	The science and innovation policy reform Guidelines show political will to take steps to counter policy and institutional fragmentation. In addition, several new instruments demonstrate efforts for better coordination, such as the Intellect LT. Joint business-science projects and Joint business-science projects that can complement each other and are run by different institutions. The Lithuanian R&D system could be more concentrated both thematically and institutionally. The adoption of the Smart specialisation strategy which identified six priority areas and 20 priorities might help concentrate research efforts thematically. A positive sign is that consensus and evidence-based policy making is becoming more common, as shown by the process of preparing Lithuania's Smart specialisation strategy.
Addressing human resources shortages in R&I	The new law on Research and Studies foresees contracts with higher education institutions. A number of funding instruments are in the pipeline for researchers' capacity building (incl. post doc grants, various R&D grants, reintegration of 'brains', facilitation of participation in Horizon 2020, etc.), but none have been launched yet by September 2016. Researchers' placements in companies are planned. The industrial PhD programme is in the pipeline (initiated by the Ministry of Economy). Introduction of 'start-up' visa.	Availability of human resources for R&I can become a bottleneck for exploitation of RDI infrastructures. On the positive side, 'soft' funds planned for R&D (compared to infrastructure investments) are more substantial compared to the previous period. There is also more focus on the internationalisation and quality of R&D. Key risks to monitor are: - Availability of specific programmes for young researchers, making sure existing programmes are attractive to them; - Putting more focus on attracting talents from abroad. This includes 'smart' immigration policies and encouraging foreign researchers and high-level specialist recruitment at the Lithuanian companies, clusters and R&D institutions; - Reducing the administrative load of programmes implemented by the Lithuanian Research Council, where some general rules may have controversial effects. The newly revised Law on Research and Studies aims to increase research and education quality through contracts with higher education institutions. Most other

		changes are only incremental. Measures in the policy mix 2014-2020 may be effective, but it is still too early to tell and many have not yet been launched.
Encouraging private investments in R&I	Vast variety of support instruments will be launched from 2016, covering various types of innovating organisations, presented below: - Availability of business R&D grants covering the full innovation cycle. - Support for cluster development, and experimentation (vouchers). - Innovation promotion services, introduction of the 'technology scouts' (in the pipeline). - Pre-commercial public procurement (first call launched). - Tax incentives for R&D intensive companies, including support for applying and accounting for business R&D costs. - JEREMIE and ESIF co-funded venture capital, including a new instrument for innovative companies – Technoinvest. - Instruments for R&D-based FDI.	The new period's business R&D policy mix is more balanced, covering a variety of instruments and types of innovating organisations. Risks to monitor/weaknesses: - Effective implementation and coordination of these instruments (especially when linked to smart specialisation); - Ensuring that high administrative load does not facilitate the policy substitution effect, which was a problem in the 2007-2013 period; - 'Soft' R&I capacity building such as brokering/scouting, platforms for experimentation, mentoring and pipeline facilitation via technical assistance and support. These are necessary preconditions for higher absorptive capacities of potential innovators (currently non-innovative firms or firms losing competitive advantage due to the rising cost of production factors and that are looking for routes to restructure their business). These innovation services are somewhat underfunded (Inogeb, €8.9m) compared to other measures. - Availability of well-functioning start/seed/VC capital, acceleration and mentorship ecosystem for innovative start-ups. The Technoinvest fund (€17m) can become short in budget for a full period. Low investment 'ceiling' is attractive to ICT start-ups, but not capital-intensive start-ups from biotech and similar sectors.
Exploiting opportunities for commercialisa-tion of public R&D results	Key policy response (from 2016 on) consists of: - Development of technology transfer centres and services of S&T parks (including technology scouts). - Support for protecting intellectual property, and more focus on the IPR strategies - Support for spin-offs of public research organisations. - Innovation vouchers for R&D subcontracts with public research organisations. - Joint business-science projects (from at least €36m to €175m depending on how the instrument will be implemented).	There is clearly more focus on incentives for public R&D commercialisation and business-science collaboration in this 2014-2020 period. Effects of these instruments remain to be seen, and a lot will depend on these preconditions: - Effective technology transfer policies, procedures, capacities, human resources, professional and active promotion strategies (from 'they come to us' to 'we come to them') etc. developed by public research organisations; - Acquisition of new and development of existing research infrastructure must be linked to to these strategies; - Joint business-science projects having sufficient demand (created by smart design of financial incentives and selection criteria); - Sufficient human resources for R&I and – most

		importantly – creating incentives for higher attractiveness of research career and necessary incentives for commercialisation of R&D and related collaborations in the research career system (career indicators, salaries, contracts) as discussed in the 2015 RIO report.

Source: Author compilation

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Annex 2 - Abbreviations

BERD – Business expenditure on 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

DESI – Digital Economy and Society Index / Skaitmeninės ekonomikos ir visuomenės indeksas

EIF – European Investment Fund / Europos investicijų fondas

ERA – European Research Area / Europos tyrimų erdvė

ESFA – European Social Fund Agency / Europos socialinio fondo agentūra

ESIF – European structural and investment funds / Europos struktūriniai ir socialiniai fondai

EU – European Union / Europos Sąjunga

EU28 – European Union including 28 Member States / Europos Sąjunga apimant 28 Valstybes Nares

FDI – Foreign direct investment / Tiesioginės užsienio investicijos

FP7 – EU's 7th research and innovation framework programme (2007-2013)/ Septintoji mokslinių tyrinų ir inovacijų bendroji programa (2007-2013)

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 research and development / Bendrosios vidinės išlaidos MTEP

GOV – Government sector / Valdžios sektorius

GOVERD – Government expenditure on R&D / Valdžios sektoriaus išlaidos MTEP

HEI – Higher education institution / Aukštojo mokslo institucija

HES – Higher education sector / Aukštojo mokslo sektorius

H2020 – Horizon 2020 EU's framework programme for research and innovation (2014-2020) / Horizontas 2020, Europos Sąjungos mokslinių tyrimų ir inovacijų finansavimo programa (2014-2020)

ICT – Information and communication technologies / Informacinės ir ryšių technologijos

KTU – Kaunas University of Technology / Kauno technologijos universitetas

LMT – Research Council of Lithuania / Lietuvos mokslo taryba

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 stebėsenos ir analizės cetnras

MS – European Union Member State / Europos Sąjungos valstybė narė

NGO – Non-governmental organisation / Nevyriausybinė organizacija

PFSA – Project funding terms / Projekto finansavimo sąlygų aprašas

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

RDI- Research, development and innovation / Moksliniai tyrimai, eksperimentinė pėtra ir inovacijos

R&I – Research and innovation / Moksliniai tyrimai ir inovacijos

RI – Research infrastructure / Moskslinių tyrimų infrastruktūra

RIA – Regulatory impact assessment / Reglamentavimo poveikio vertinimas

RIS3 – Research and innovation strategies for smart specialisation / Mokslinių tyrimų ir inovacijų strategijos Sumaniai specializacijai

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

VC – Venture capital / Rizikos kapitalas

Annex 3 –Top R&D performers

Main public R&D performers, based on publications

Rank	Institution	Number of publications[14]
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 (2014a)

No data is available for private sector.

[14] Number of publications is taken from MOSTA (2014a) 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 4 – The European Research Area priorities

Lithuania has prepared a 2016–2018 action plan for the national programme for the development of studies, research and experimental (social and cultural) development for 2013–2020 (Action plan). This action plan is connected to European Research Area (ERA) priorities and their implementation. The following is an assessment of Lithuania's progress with respect to these priorities, as provided in the interface between this action plan and ERA priorities.

ERA priority 1. Effective national research system. The priority on effective national research systems covers three objectives for Lithuania: a) developing an environment favourable to capable and motivated individuals; b) creating new knowledge and promoting science, business and culture integration; c) ensuring functioning of a of the education and R&D systems. Since these objectives are rather broad, the new policy mix addresses them inescapably. The same can be said about legislative changes, such as the adoption of the new Law on higher education and research.

Suggested indicators correlate with those proposed by ERA to some extent – both cover publications and patenting. However, grants from the European Research Council (ERC) and Marie-Curie grants (an indicator for ERA priority) are not explicitly covered by indicators used in Lithuania. Due to the lack of updated data it is not possible to assess the progress towards the target for publications in 10% of the most quoted science publications in the world (8% by 2020). Targets for 2020 regarding patents are 150 international and European applications for all Lithuanian subjects and 50 applications for research and higher education institutions. In the first case, updated data is not available, and in the second case, the number of applications in 2014 was 43, thus already above the value set for 2016 (35).

ERA prioritiy 2a. Jointly addressing grand challenges; and 2b. make optimal use of public investments in Research Infrastructures. This priority covers: a) support for intersectoral cooperation; b) supporting European cooperation; c) ensuring the financing of high-level strategic research projects. The first and the second are addressed by the new policy mix through measures encouraging science-business projects as well as research internationalisation. The third is addressed through the smart specialisation strategy and its impact on the new policy mix. Particularly important role is played by the recently introduced purposive research and pre-commercial procurement measures.

Chosen indicators, however, only cover the internationalisation aspect of the priority, which is not the most important measure of addressing grand challenges and the optimal use of research infrastructures. ERA indicators cover both internationalisation (through measuring GBOARD usage) and national research and innovation roadmaps that Lithuania recently renewed (LMT, 2016).

It is expected that, by 2020, the revenue received by research and higher education institutions from participation in international programmes would reach €7.53m (compared to €6m in 2011, according to the National Studies and R&D Development Programme 2013-2020). However, only €4.5m was received from participation in international programmes in 2014 (according to the results of the assessment carried out by LMT). This indicates a lower probability of achieving the target. As for the international research infrastructures, which Lithuania is a member of, the originally intended target for 2016 – 2 international research infrastructures have been joined – is already reached (LMT, 2016). However, the action plan for 2016-2018 foresees that by the end of 2016, 3 international research infrastructures should be joined, and the number should increase to 6 by 2018. It remains to be seen if the processes of joining will be smooth enough to reach the intended targets.

ERA priority 3. Open labour market for researchers. The action plan outlines several actions that should be taken: a) involvement of firms in doctoral studies process; b) development of career development system; c) attracting researchers from abroad; d) encouraging research-intensive firms to employ researchers; e) developing researcher potential in institutions where research is carried out as parallel activity.

The new policy mix has taken some steps towards implementing these actions, including support for employment of researchers in knowledge-intensive firms and industrial PhD. 'Start-up' visas may also contribute to attracting talent from abroad.

Lithuania's Action plan is expected to lead to an increase in the number of researchers working in the private sector. While such approach covers part of this ERA priority, it leaves public researchers aside, and it has a vague linkage to the ERA variable 'posts advertised through the Euraxess jobs portal/thousand researchers in the public sector/year'. The number of private sector researchers is expected to reach 3,600 by 2016 (indicated number for 2011 was 3,200). For 2014 Eurostat reported 5,642 R&D personnel working in the private sector, 4,078 of which are researchers. Statistics Lithuania indicates that there were 2,722 researchers and 3,919 R&D personnel in Lithuanian business sector in 2015. These numbers concern head count rather than full-time equivalents. High fluctuation in numbers does not allow assessing whether the target will be achieved.

ERA priority 4. Gender equality and gender mainstreaming in research. The action plan outlines the following action to be taken: promoting structural changes to ensure equal opportunities for women and men. No specific indicator is foreseen. New RDI policies do not focus particularly on gender equality and mainstreaming in research issues. It must, however, be noted that in 2011, Lithuania was one of the leading countries with respect to women representation among researchers (MOSTA, 2014a). According to Eurostat, in 2014, there were 9,734 female researchers across all sectors (50.25%), which was higher than the EU average at 33.2%. Still, a disproportionate gender ratio in some scientific fields and senior positions requires attention.

ERA priority 5a. Scientific knowledge transfer and 5b. promoting open access to scientific publications. The action plan outlines several directions that should be taken: a) supporting development of competences and capacities of researchers, experts, employees of responsible institutions; b) attracting researchers from abroad; c) encouraging intersectoral cooperation; d) promoting international cooperation in R&D; e) ensuring commitment to international pledges and effective management; f) providing access to digital data resources and improving information infrastructure; g) raise awareness about Lithuanian R&D.

The new policy mix covers most of the actions envisioned in the Action plan and should contribute to knowledge transfer. While no specific actions envisage the promotion of open access to scientific publications, the Law on Higher Education and Research (adopted in 2016, entering into force on 1st January 2017) indicates that results of publicly funded research should be made publicly available unless issues regarding intellectual property, commercial, state or service secrets would emerge. Still, researchers are not keen to grant open access to their research results (Tautkevičienė, 2011).

There are many indicators for measuring the country's progress towards the ERA goals suggested in Lithuania's Action plan that cover knowledge transfer both intersectoral and international. However, none of them directly address the open access issue. ERA-level indicators are also not addressed directly. Due to the lack of updated data it is not possible to assess progress towards achieving specific targets, such as the share of research institutions, business-university cooperation and higher education successfully applying quality management systems or publications in 10% of the most quoted science publications in the world. Regarding other indicators, the progress needs to be more rapid if targets are to be achieved. Joint public and private sector publications per million residents should reach 10 by 2020, but since 2011 there was a decrease in this indicator.[15] Regarding revenue of HEIs received from transnational programmes, see discussion of ERA priority 2.

[15] However, due to possible differences in the method which is used to calculate publications, base value for 2011 differs between the one provided in the programme and the one obtained from SCOPUS.

Annex 5 - Governance of the R&I system

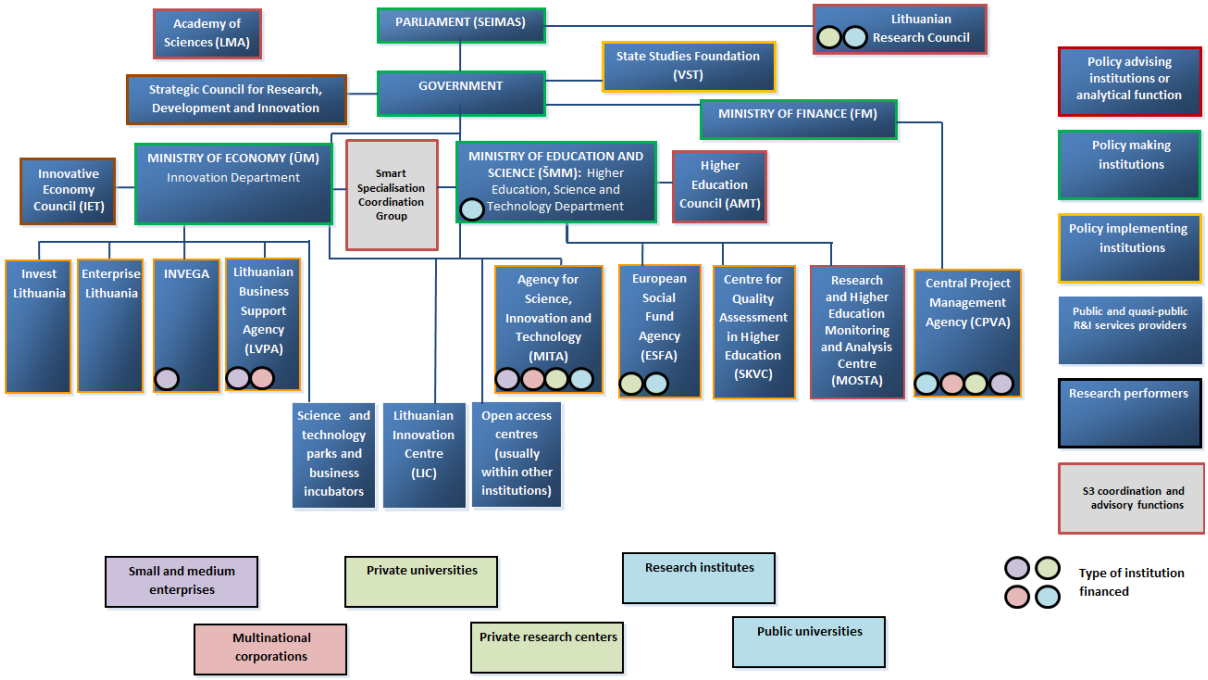
For a small country such as Lithuania the institutional system for the definition and implementation of research and innovation policy is rather fragmented. The two principal governing bodies, shaping R&D and innovation policy in Lithuania, are the Ministry of Economy, which is responsible for innovation policy, and the Ministry of Education and Science, responsible for higher education and (mainly public) R&D policy. The role of the R&I Council is played by the Strategic Council for Research, Experimental Development and Innovation (SMIT). During the development of the smart specialisation strategy (2012-2015), a coordinating group was established, and included members of the institutions and agencies responsible for RDI policy. This strategy also showed increased active involvement of other stakeholders, most importantly, representatives of science and business. They served as members and leaders of groups responsible for selection of priority areas and preparing policy roadmaps. The Science and Innovation Policy Reform Guidelines foresee that SMIT will be responsible for their implementation, which may strengthen its role.

The five main agencies (MITA, LVPA, European Social Fund Agency (ESFA), LMT, Central Project Management Agency (CPVA)) are responsible for the funding of research and innovation. These agencies have different thematic orientations. LMT focuses on funding research and researchers, especially in public institutions. LVPA funds business R&D and innovation activities, while MITA (established in 2010) has a 'connecting' role, focusing on intersectoral cooperation, consulting services, support for business and research and higher education institutions. ESFA and CPVA are responsible for specific projects. ESFA funds projects regarding development of human capacities, while CPVA is responsible for large infrastructure projects.

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 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. However, with recent changes to the Law of Higher Education and Research, MOSTA should become responsible directly to the Government on 1st January 2017.

During the last decade, the governance of RDI became broader and more varied, especially given the establishment of specialised agencies (MITA, MOSTA) and paying more attention to policy analysis. Another positive step taken is giving a more important role to stakeholders from science and business sectors. However, challenges emerging from the fragmentation of the system still remain.

Figure 1 Overview of Lithuania's research and innovation system's governance structure[16]



Source: based on Paliokaitė et al. (2016).

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[16] Despite adopting the new revision of the Law on Higher Education and Research, no changes to the factual structure were implemented in 2016, as the law enters into force only on 1st January 2017.