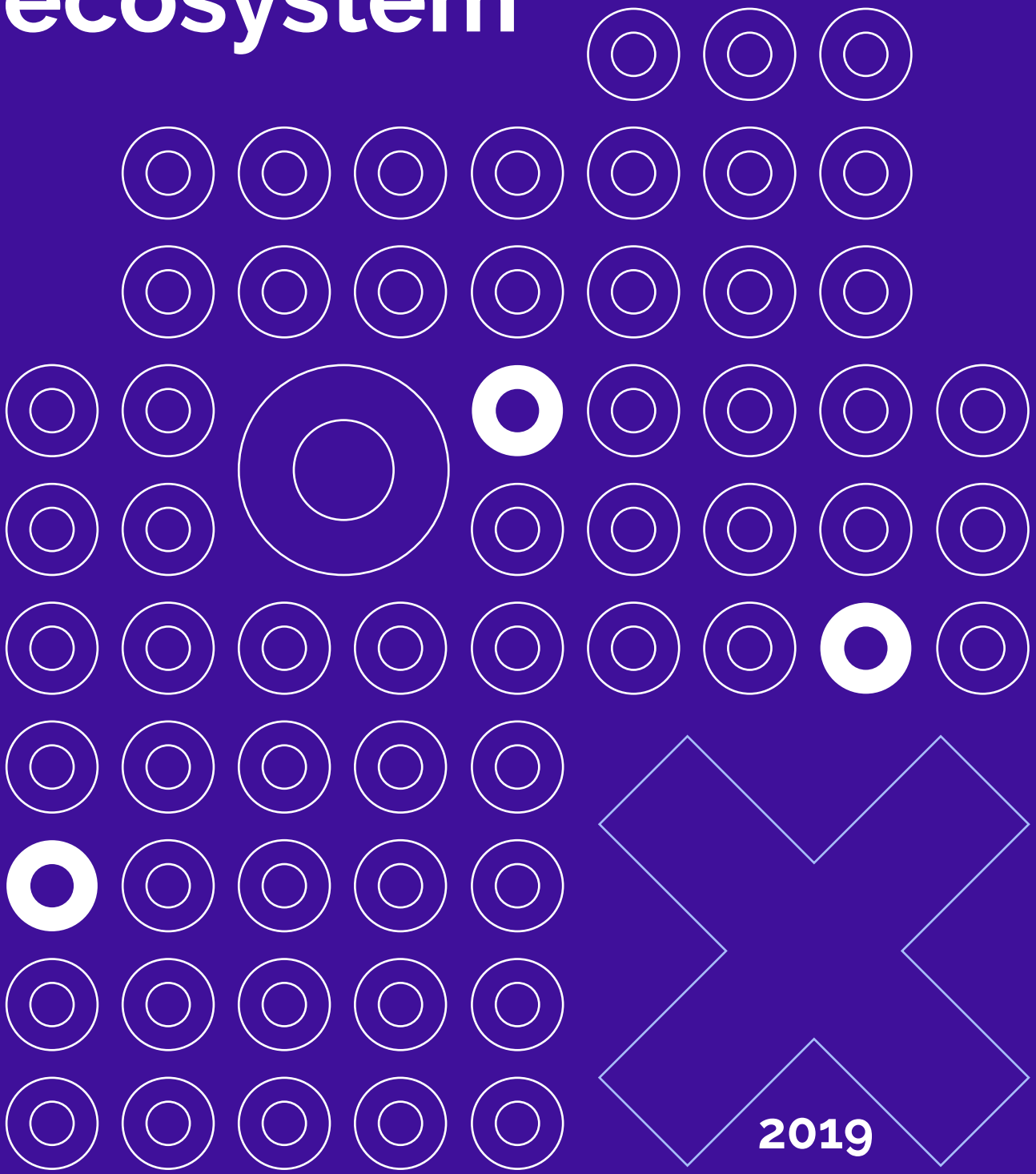
Review of the **Lithuanian innovation ecosystem**



2019

Contents

ABBREVIATIONS AND ACRONYMS

MoE – Ministry of Environment of the Republic of Lithuania
MoEn – Ministry of Energy of the Republic of Lithuania
CERN – the European Organization for Nuclear Research
CLARIN-ERIC – European Research Infrastructure for Language Resources and Technology
OECD – The Organisation for Economic Cooperation and Development
EE – Republic of Estonia
MoEI –Ministry of the Economy and Innovation of the Republic of Lithuania
EIS – European Innovation Scoreboard
EC – European Commission
ESA – European Space Agency
EMBC – The European Molecular Biology Conference
EMBL – The European Molecular Biology Laboratory
EUIPO – European Union Intellectual Property Office
EU – European Union
ESS-ERIC – European Social Survey European Research Infrastructure consortium
FP7 – European Union Research and Innovation Program for 2007-2014
H2020 – European Union Research and innovation funding programme Horizon 2020
INVEGA – the guarantee institution PLLC „Investment and business guarantees"
MoND – Ministry of National Defence of the Republic of Lithuania
MoC – Ministry of Culture of the Republic of Lithuania
LRVK – Government Office of the Republic of Lithuania
LSD – The Lithuanian Department of Statistics (Statistics Lithuania)
LT – Republic of Lithuania
LV – Republic of Latvia
MITA – Agency for Science, Innovation and Technology
MSI – Research and Higher Education institution
R&D – Research and Development
STI – Science, technology and innovation
PK – Office of the President of the Republic of Lithuania
PL – Republic of Poland
PPO – Public Procurement Office of Lithuania
RCL – Research Council of Lithuania
S3 – Strategy for Smart Specialization
MoSSL – Ministry of Social Security and Labour
STRATA – Government Strategic Analysis Center
MoESS – Ministry of Education, Science and Sport of the Republic of Lithuania
MoJ – Ministry of Justice of the Republic of Lithuania
VMI – State Tax Inspectorate
VPB – The State Patent Bureau of the Republic of Lithuania
MoI – Ministry of the Interior of the Republic of Lithuania

Introduction

The purpose of the Review of the Lithuanian Innovation Ecosystem is to provide a concise overview of the changes that have taken place in the Lithuanian innovation ecosystem in a reader-friendly format and to monitor the progress. STRATA plans to prepare the Review annually in parallel with the reviews of education and science ecosystems. The innovation ecosystem encompasses a wide variety of actors, resources and other components necessary for innovation (as well as elements of education and research systems). Indicators describing the innovation ecosystem were selected in collaboration with the ecosystem stakeholders. As a source of structured data, the publication is intended for everybody who has a stake in the Lithuanian innovation ecosystem globally and at a national level, particularly innovation policy makers and implementers, other participants.

An efficient ecosystem allows to create value that would not be created by ecosystem participants working separately. This means that the links among ecosystem stakeholders are necessary to create a greater added value. Each participant which has contributed to the innovation cycle, in one way or another influencing the innovation process from idea to new product in the market is considered as a stakeholder of innovation ecosystem.

The Review of the Lithuanian Innovation Ecosystem discusses the main indicators reflecting the potential and progress of all three components of the ecosystem – the skills required for innovation, the creation of new knowledge and technology transfer, and the introduction of new products to the market. Furthermore, the national innovation policy has a significant impact on the entire innovation ecosystem. Therefore, a separate chapter on innovation policy achievements is provided to review the contribution of the government sector. A look at the Lithuanian innovation ecosystem in a broader international context makes it possible to assess whether the progress made is sufficient for international cooperation. In order to review the situation in a macro regional context some indicators of Lithuania's innovation ecosystem are compared with the other two Baltic countries – Latvia and Estonia, and neighboring Poland.

We hope that this Review will provide useful information about the Lithuanian innovation ecosystem, give an impression of its strengths and weaknesses, and encourage deepening into the specifics of this ecosystem.

Summary

The Lithuanian Innovation Ecosystem is rather young, but it has developed considerably. Lithuania is singled out as the most advanced EU country in terms of the growth of the Summary Innovation Index. The first Lithuanian unicorn “Vinted” can be treated as one of major achievements of Lithuanian innovation ecosystem of the year 2019. Currently, more than 700 start-ups have their headquarters in Lithuania. Since 2013, more than 500 million EUR have been invested into Lithuanian start-ups and in the period of 2013-2018 the average annual growth of investments in Lithuanian start-ups was the highest among the Baltic States. The share of innovative enterprises is growing and according to the latest data accounted for almost half of all enterprises in the country and in the period of 2012-2018 the number of business enterprises engaged in R&D activities increased by almost 3.5 times as well as the number of persons employed in R&D grew by almost 10% over the period of 2015–2018.

In 2018 Lithuania's total R&D expenditure amounted to 0.88% GDP (396.8 million EUR), of which 0.55% was spent in higher education and government sectors and 0.33% of GDP was spent in the business sector. In 2018 the innovative expenditure accounted for 2.4% of total turnover of innovative enterprises. However, the share of knowledge in innovation activities remains low and the majority of innovation expenditure is spent on machinery and equipment.

The role of educational institutions within the innovation ecosystem is vital. Lithuanian can brag about the highest number of 30-34 year aged persons with higher education among other EU countries. In 2018 the level of life-long learning in Lithuania was slightly lower than the EU average.

EU structural funds investments in the field of STI are concentrated in the priorities of S3, which has a significant impact on the Lithuanian economy. In the period of 2013-2018 the development of sectors corresponding S3 was relatively faster than in the entire Lithuanian economy. In 2018 sectors corresponding to the S3 priorities generated almost a quarter of Lithuania's GDP and amounted nearly 10 B EUR, 70% more than in 2013. In addition to direct non-repayable support, stakeholders of the innovation ecosystem can benefit from financial engineering instruments provided by the public sector. During the period of 2013-2018 almost half of over 500 M EUR venture capital funds invested came from these public sector and foreign institutions, and the volume of venture capital funds from all these sources increased.

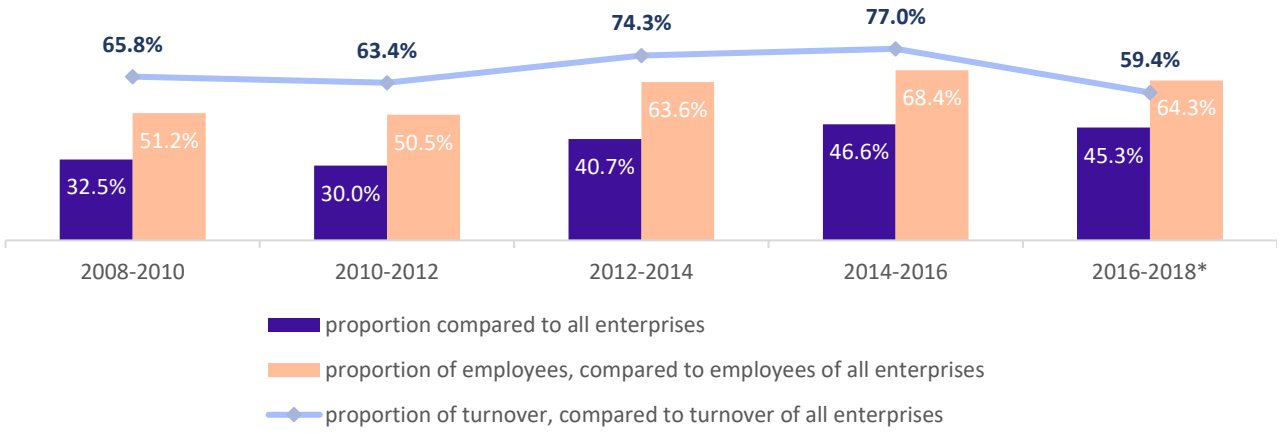
Potential and achievements of innovation ecosystem and conditions for innovative growth

The innovative business sector is the axis of innovation-driven economic growth. It attracts and mobilizes the necessary resources for the development of innovation. Sufficient volume of innovative business as well as an ability to create or attract new knowledge and technologies, investments in the field of STI and high quality of R&D activities determine the national level of innovation. Moreover, digitization and international relations create preconditions for growth and progress. In addition, an active, creative, educated, lifelong learner is the backbone of the innovation ecosystem. The viability of the innovation ecosystem depends on how many people are or can be involved, what is the supply of qualified staff to the science and business sectors.

Scope of innovative business

Comprehensive overview of data on innovating and fast-growing companies reflects the scope of Lithuania's innovative business. According to the preliminary data of the period of 2016-2018, the share of innovative enterprises accounted for almost half (45.3%) of all enterprises in the country, which is 12% more than over the period of 2008-2010. (Figure 1).

Figure 1. Innovative enterprises



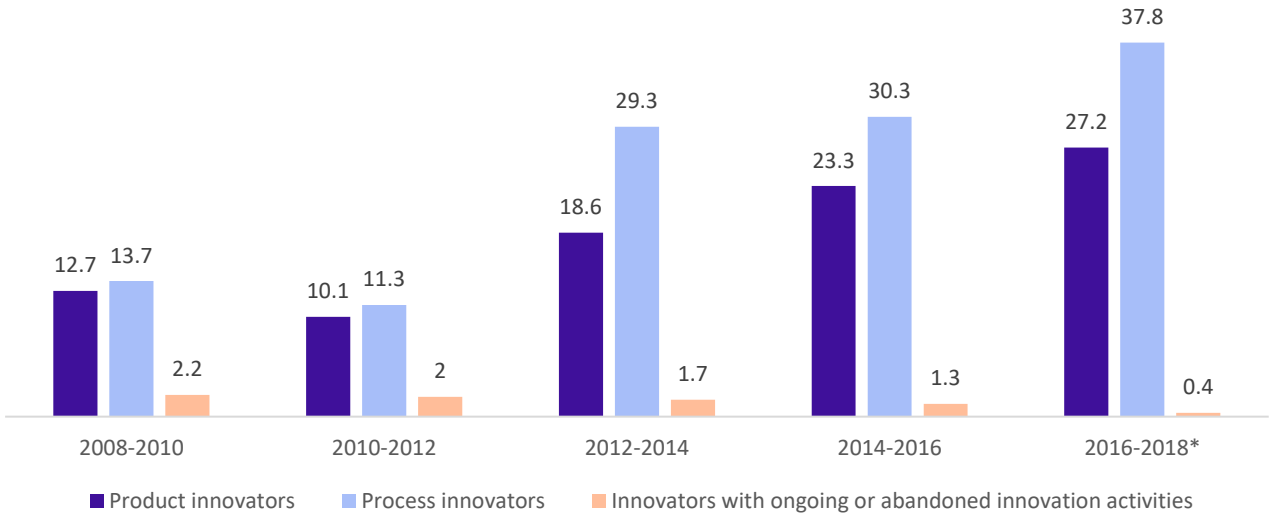
* – preliminary data

Source: LSD, VMI

Compared to the data of the previous period, this share has changed insignificantly, although the analysis of the share of enterprises that have implemented technological and non-technological innovations separately shows opposite trends. The share of companies that have implemented technological (product and technological process) innovations, has grown (Figure 2). Meanwhile, according to preliminary data for period of 2016-2018, the share of

companies that have implemented non-technological (organizational and marketing) innovations has decreased quite significantly. Compared to 2014-2016, the share of organizational innovators decreased by one third and the share of marketing innovators decreased by 43%.

Figure 2. Proportion of technological innovation enterprises compared to all companies

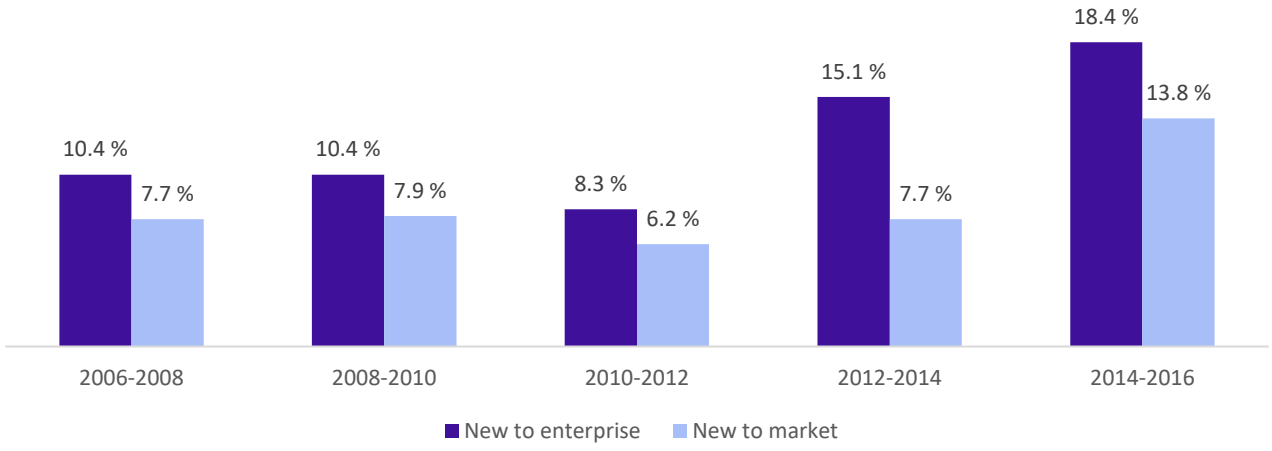


* – preliminary data

Source: LSD

The share of companies that introduced product innovations was increasing since the period of 2010–2012 (Figure 3). During the period of 2014-2016 the share of companies that introduced a “new to market” product amounted to 13.8% and the share of companies that introduced “new to enterprise” amounted to 18.4% and this is the best result since the period of 2006-2008.

Figure 3. Product innovators by product novelty level compared to all companies

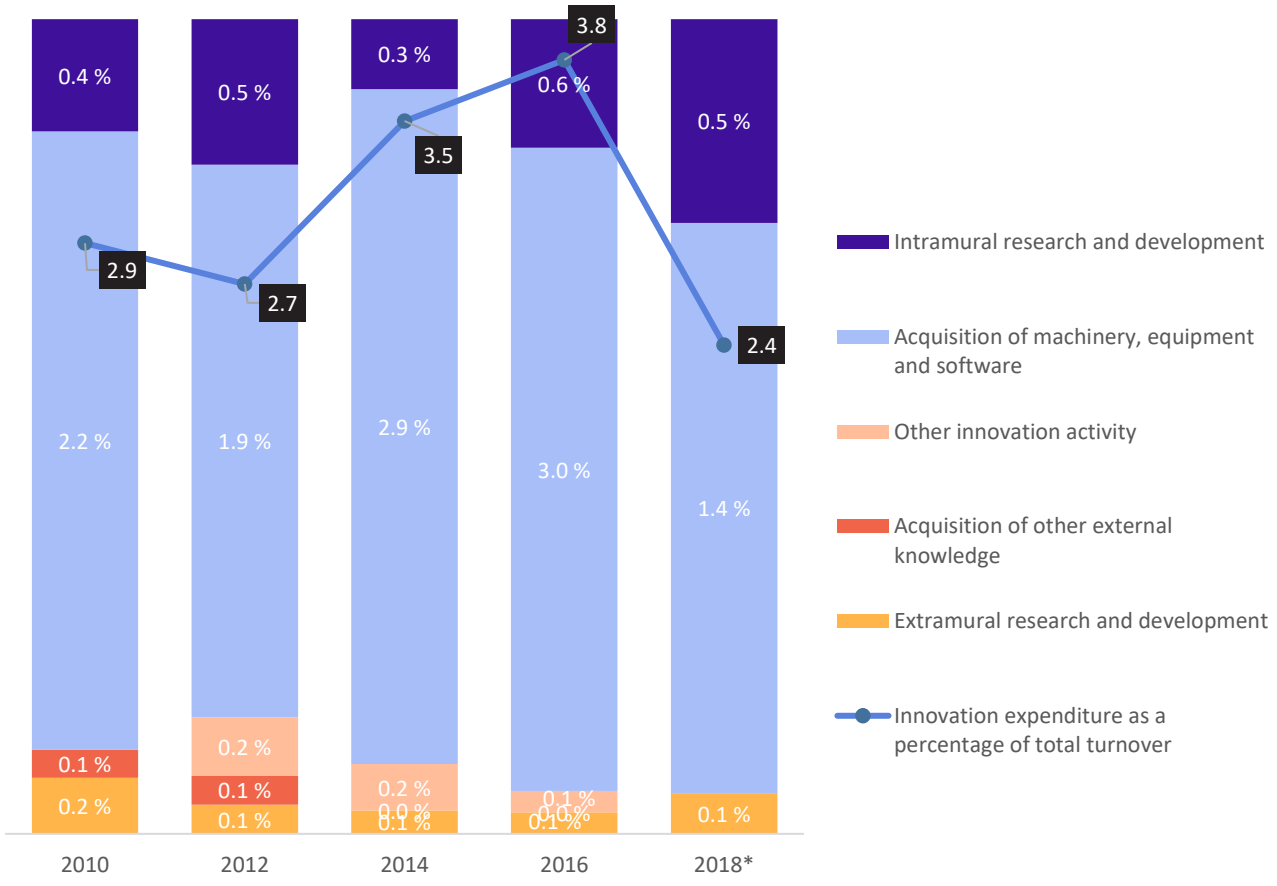


Note. After the issue of the Lithuanian version of the Review the data for the period of 2016-2018 became available: the share of companies that introduced a "new to market" product amounted to 16.9% and the share of companies that introduced "new to enterprise" amounted to 22.1%.

Source: LSD

In 2018 the innovative expenditure accounted for 2.4% of total turnover of innovative enterprises. Until 2016 this data was gathered only from companies that have implemented technological innovations, therefore we cannot compare annual data (Figure 4). The share of knowledge in innovation activities remains low and the majority (almost 80%) of innovation expenditure is spent on machinery, equipment and software.

Figure 4. Innovation expenditure as a percentage of total turnover of innovative enterprises



* – preliminary data

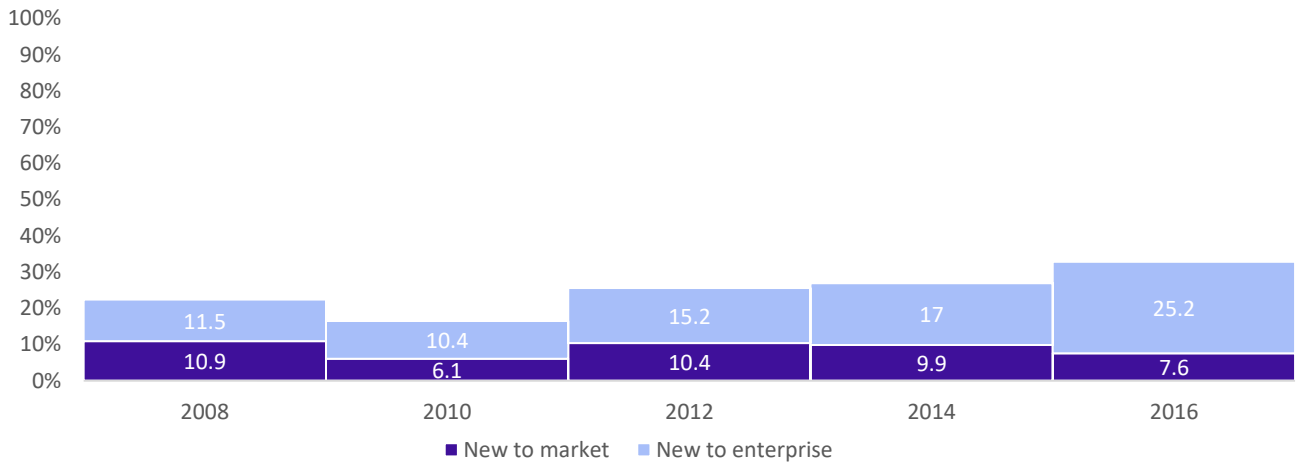
Note. No data available for "Other innovative activities" and „Acquisition of external knowledge, but this was the case.

Source: LSD

The share of turnover of innovative products increased in the period of 2008–2016. This increase was determined by the increased proportion of sales of products "new to enterprises" (by almost 120%) (Figure 5). In 2016 the share of turnover of products "new to enterprise" accounted for a quarter of the turnover of companies that provided innovative products. At the same time, the turnover of products "new to market" accounted for 7.6% and this was

the lowest value since 2012. In fact, turnover from unchanged or slightly modified products amounted the majority (more than 67% in 2016) of the turnover of companies that provided innovative products.

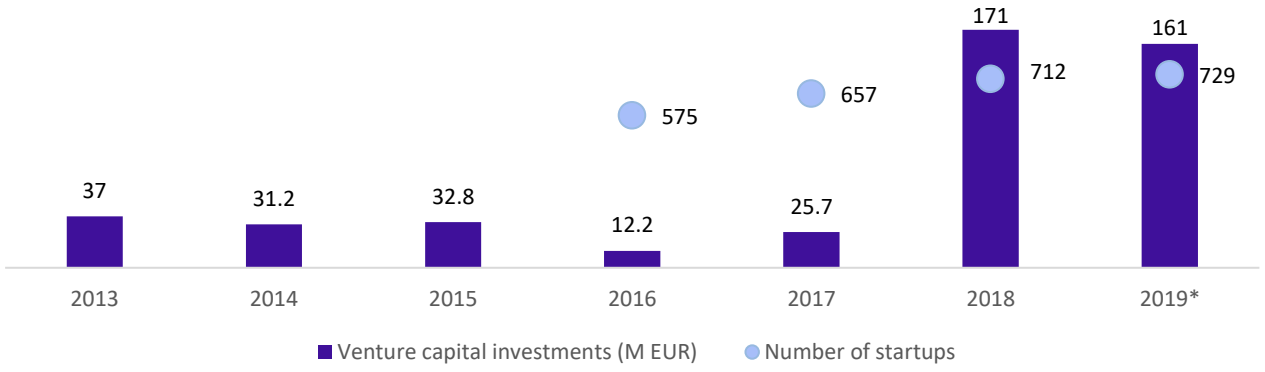
Figure 5. Share of the turnover of innovative products (% of the turnover of product innovators)



Source: LSD

Currently, more than 700 start-ups have their headquarters in Lithuania (Figure 6). The number would be higher (about 900) if start-ups established by Lithuanians abroad were figured in. In the period of 2016-2019, the number of start-ups was growing by an average of 8% per year. Since 2013, more than 500 million EUR have been invested in Lithuanian start-ups (in comparison, Estonian start-ups got more than 1.2 B EUR, Latvian – almost 120 million EUR). In the period of 2013-2018, the average annual growth of investments in Lithuanian start-ups was the highest (120%) among the Baltic States (for comparison, 88% in Estonia and 8% in Latvia).

Figure 6. Start-ups and attracted funding

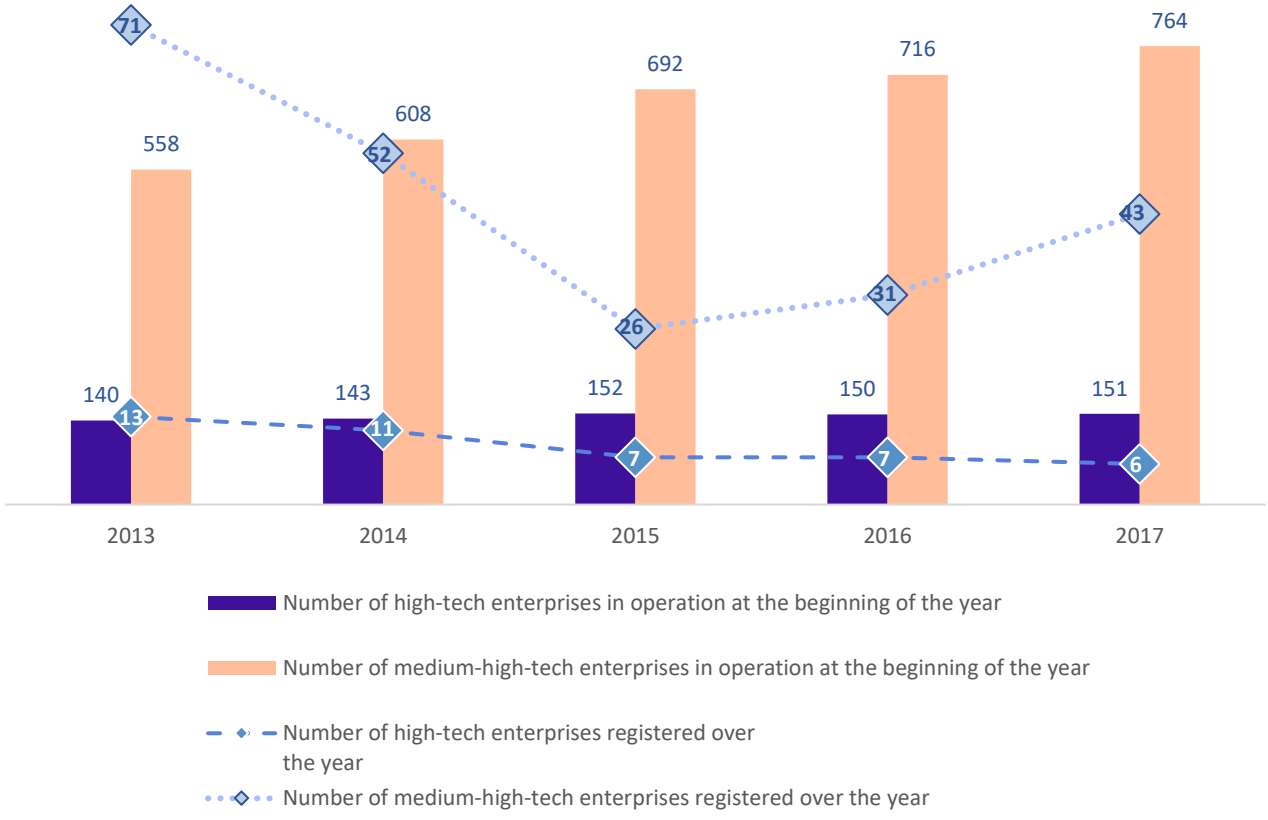


* - data until November 2019

Source: Startup Lithuania; „Dealroom.co“ study, STRATA calculations

According to the study State of the Lithuanian Startup Ecosystem[1] 16% of Lithuanian start-ups fall under deep tech category. They are developing R&D-based breakthrough technologies and require more investment to achieve commercial success. The overall development of high and medium-high-tech manufacturing sectors is growing mainly due to the development of medium-high-tech sector, as the number of high-tech manufacturing enterprises is hardly growing (Figure 7).

Figure 7. High- and medium-high-tech manufacturing enterprises

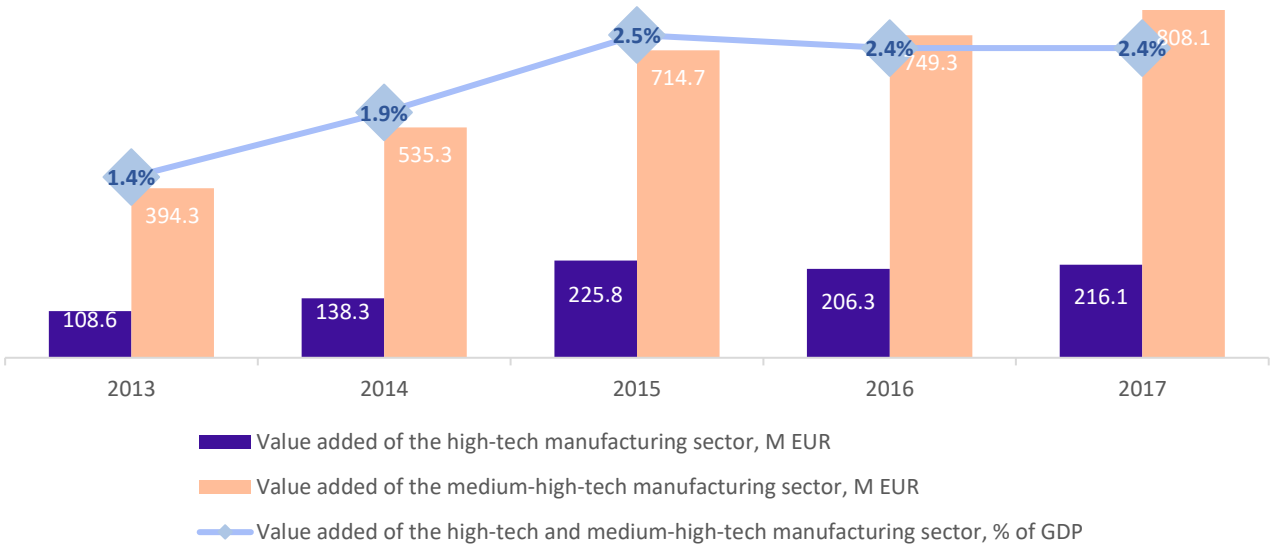


Source: LSD

The value added of the high and medium-high-tech manufacturing sector has not grown since 2015 and accounted for 2.4% of GDP in 2017 (Figure 8). However, this manufacturing sector had a small average annual growth (0.55 percentage points) from 1.4% up to 2.5% from GDP over the period of 2013-2015.

[1] The State of the Lithuanian Startup Ecosystem

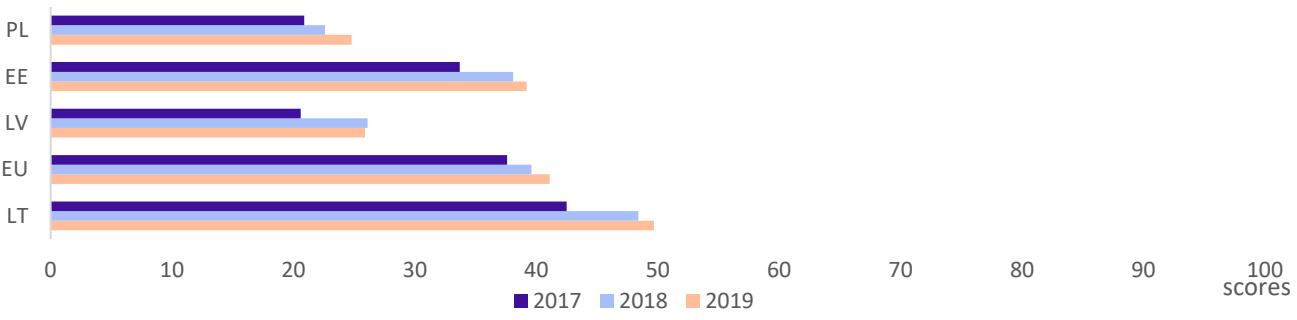
Figure 8. Value added of the high- and medium-high-tech manufacturing sectors



Source: LSD

Digitization has a significant impact on economic growth, so the use of digital technologies in business is one of the preconditions for the development of an innovative business sector. According to the Digital Economy and Society Index (DESI) 2019, the level of Lithuanian digital technology integration in business (49.7 points) is the highest among the Baltic States and exceeds the EU result (41 points) (Figure 9). According to this indicator, Lithuania ranks 8th in the EU.

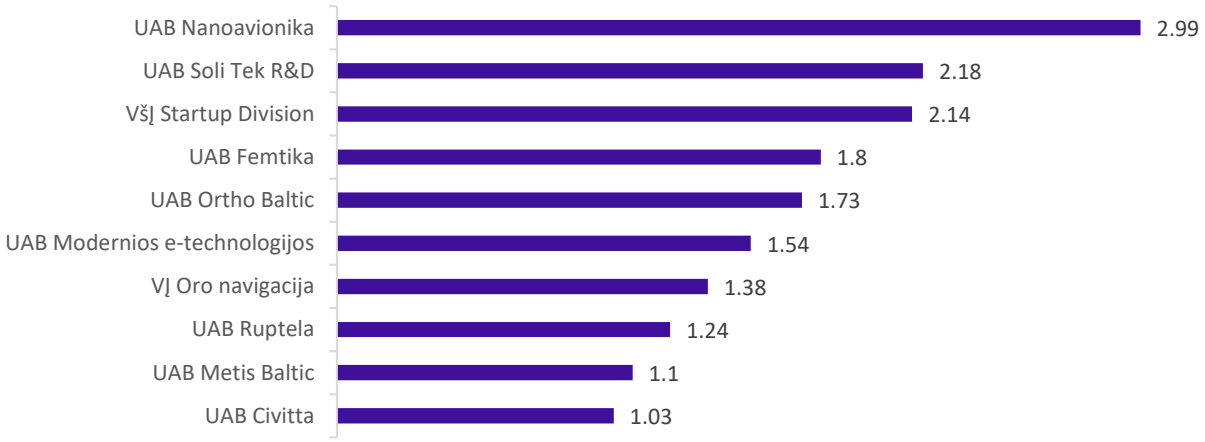
Figure 9. Integration of digital technology in business according to the DESI



Source: EK

Participation in international R&D&I programs also strengthens the innovation potential of businesses. For example, a company implementing a H2020 program project can benefit not only from received funding (Figure 10), but also from useful international partnerships, transferred and acquired new knowledge, engagement in strategic value chains.

Figure 10. TOP 10 business enterprises according to received H2020 financing, M EUR



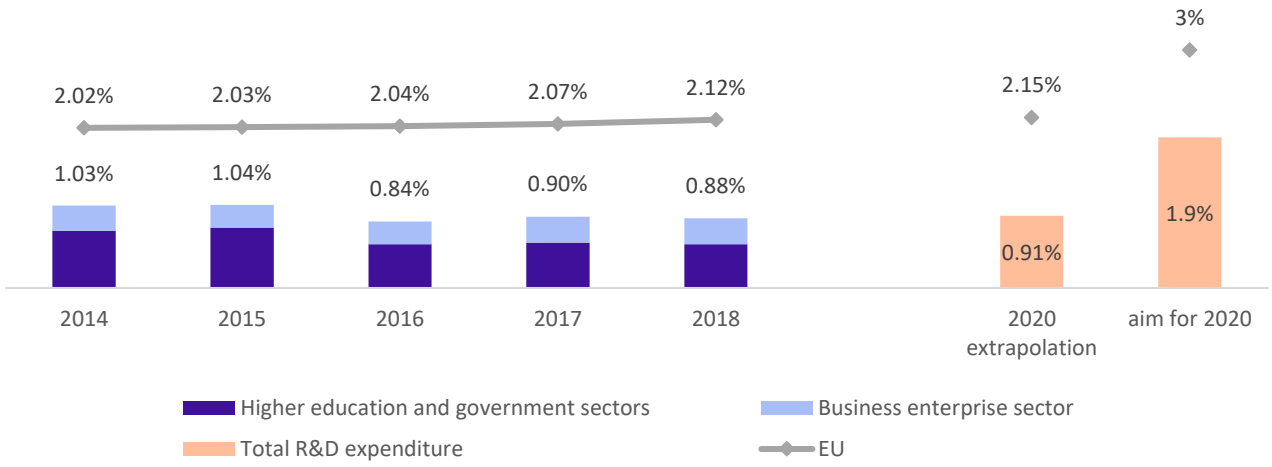
Source: H2020 database „Horizon Dashboard“ (October 2014-2019 data)

R&D activities and potential for science-business collaboration

New knowledge and technology are a source of innovation. To reflect the potential of R&D activities, indicators showing the capacity of R&D human resources, the extent to which R&D performance is internationally competitive and is able to respond to the needs of society and business are reviewed. The strength of business-science network to transfer new knowledge, commercialize and improve the performance of the innovation ecosystem are also summarized.

Summarized data on total R&D expenditure and the ratio of this expenditure to GDP show the preconditions for innovation at the national level (Figure 11). In 2018 Lithuania's total R&D expenditure amounted to 0.88% GDP (396.8 million EUR), of which 0.55% spent in higher education and government sectors and 0.33% of GDP spent in the business sector. The trend of the last five years shows that Lithuania is not likely to reach the strategic goal for 2020 – 1.9% of GDP expenditure on R&D.

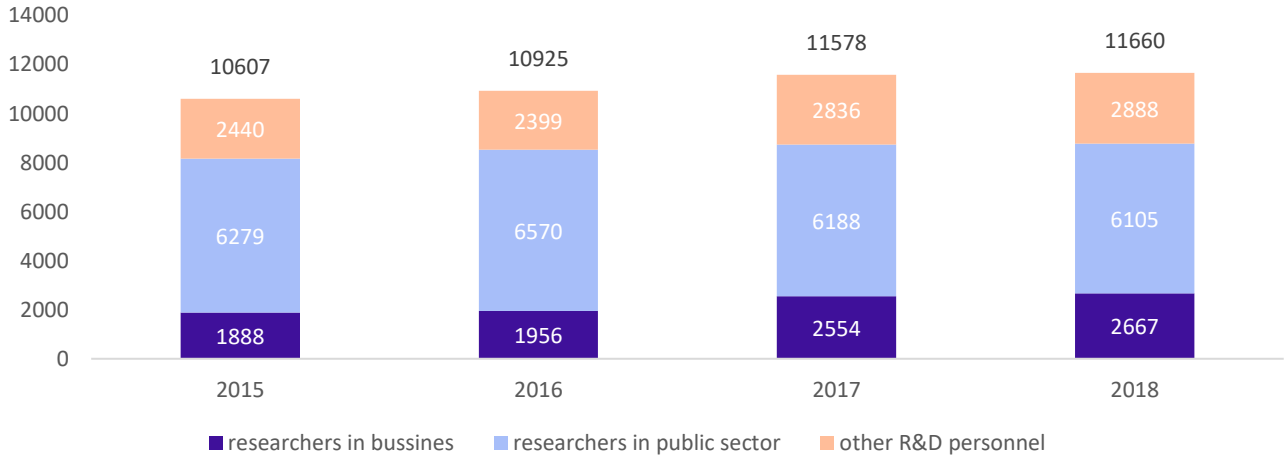
Figure 11. Total R&D expenditure, compared to GDP



Source: LSD, STRATA calculations

The number of persons employed in R&D (in full time equivalent) grew by almost 10% over the period of 2015–2018. The number of researchers employed (in full time equivalent) in the business sector grew the most (41%) (Figure 12). In 2018 employment in full time equivalent of researchers accounted for 75% of total R&D employees. The distribution of researchers by sector is uneven – 30% of them worked in the business sector and 70% worked in the public sector.

Figure 12. Persons employed (in full-time equivalent) in R&D

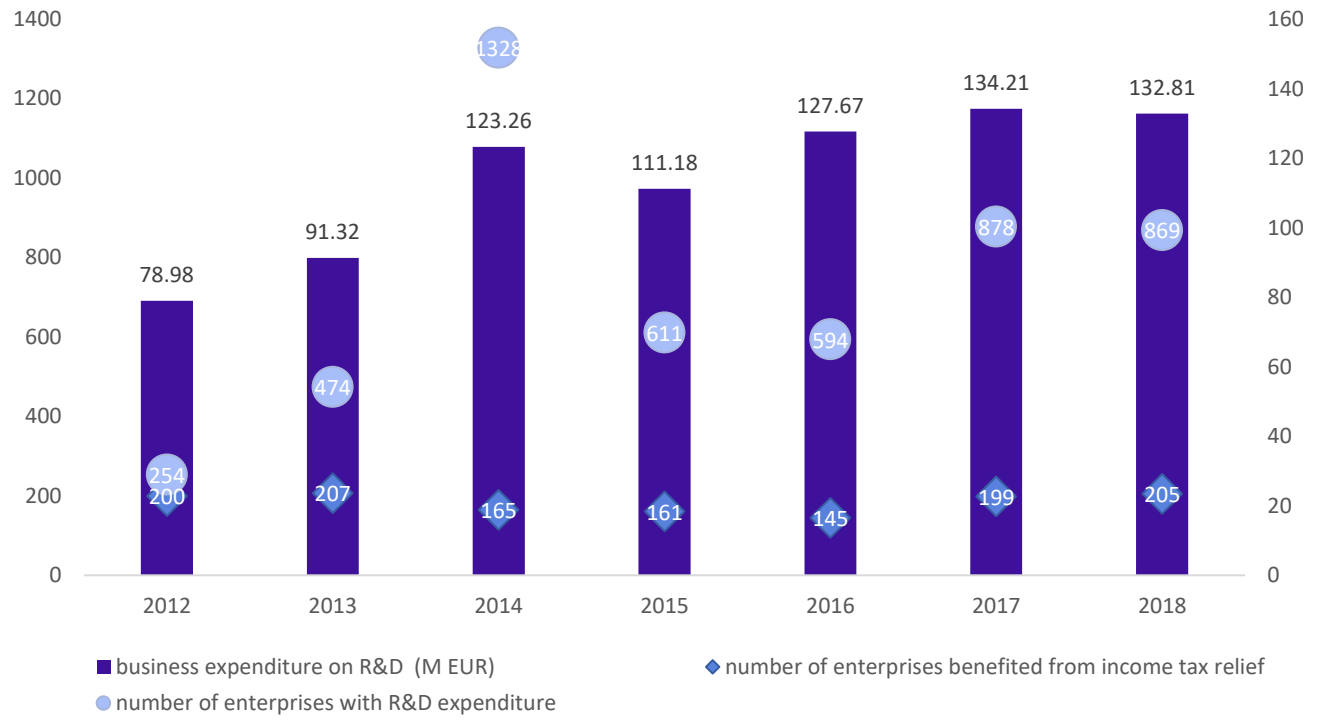


Source: LSD

The involvement of business enterprises in R&D activities is increasing. In the period of 2012-2018 the number of business enterprises engaged in R&D activities increased by almost 3.5 times (Figure 13). The ability of business enterprises to recognize R&D activities is also increasing. A sharp jump in the number of companies with R&D expenditure in 2014 was recorded due to the intensive consultations by MITA on identifying and declaring their R&D activities. In 2018 R&D expenditure of business enterprises amounted to 132.8 M EUR or 33% of total Lithuanian R&D expenditure.

Moreover, it is also worth to note that the gap between the number of enterprises that have incurred R&D expenditure and the number of enterprises that have benefited from the income tax relief for R&D expenditure has widened during the period of 2012-2018. The number of enterprises with R&D expenditure was four times higher than the number of enterprises that benefited from the income tax relief for R&D expenditure. During the period 2014-2018 the number of beneficiaries that benefited from income tax relief increased insignificantly – only by 40 companies (from 165 to 205 business companies). The reasons could be the following: businesses do not make a profit or profit is low, the administrative burden of declaring R&D expenditures is too high, there is too little information about the income tax relief for R&D expenditures, etc.

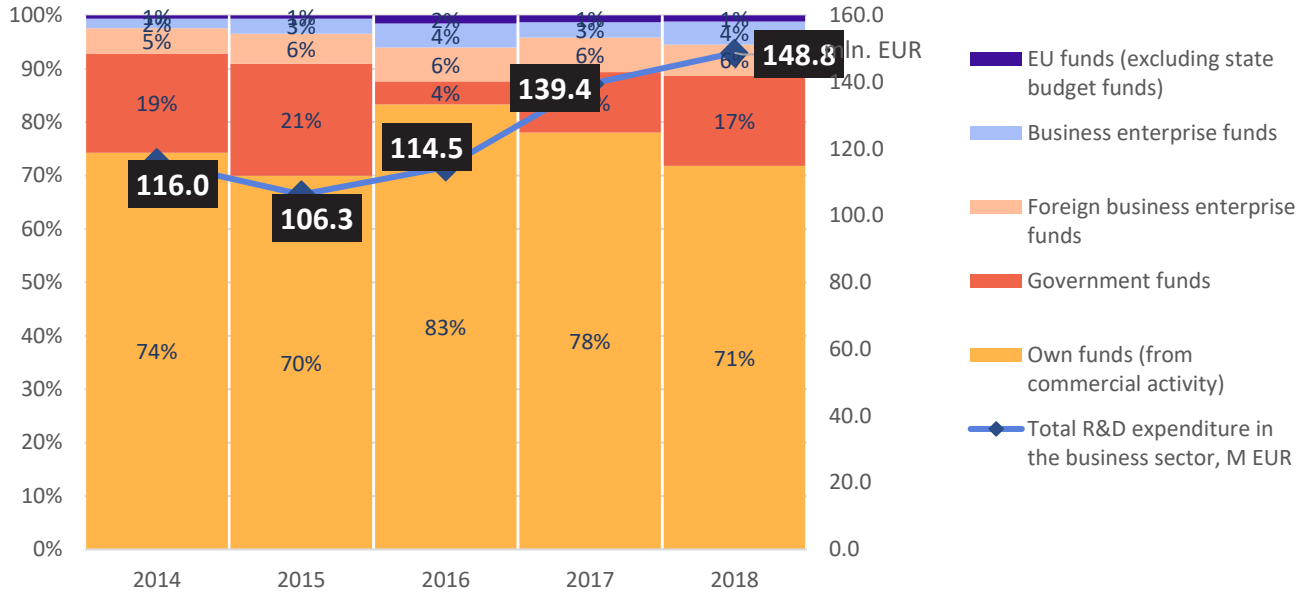
Figure 13. Business in R&D



Source: LSD

Most (71%) of the R&D expenditures in the business sector in 2018 (148,8 million EUR) were financed from own funds. (Figure 14). Since 2015 R&D expenditure in the business sector increased by 42.5 million EUR.

Figure 14. R&D expenditure in the business sector by source of funds

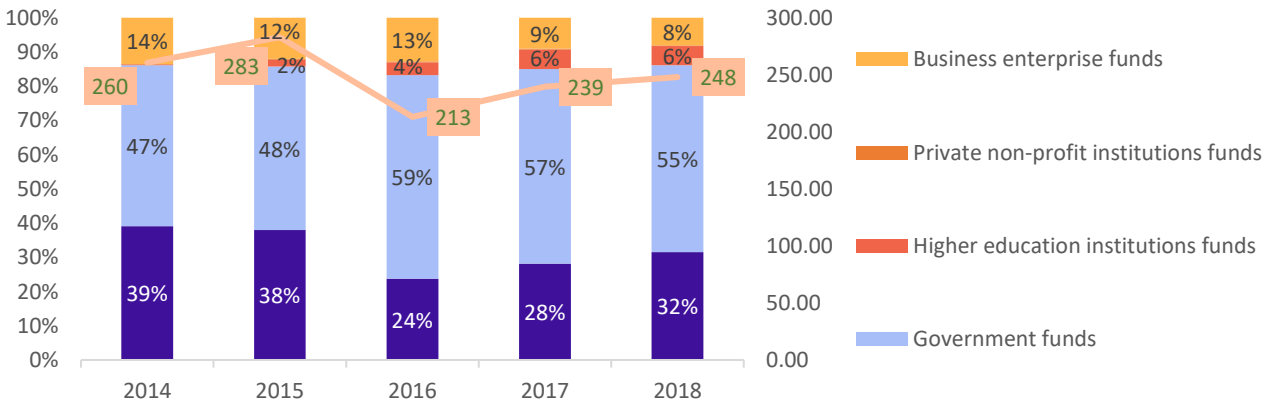


Note. EU funds except funds provided through the state budget, funds from international organizations except funds provided through the state budget, other sources accounted for a small share of total R&D expenditure in the business sector (ranging from about 0.07 to 0.54%) and were not included in the Figure 14.

Source: LSD

R&D in the higher education and government sectors is financed mainly by government funds (Figure 15). This share remained steady during the period 2016–2018.

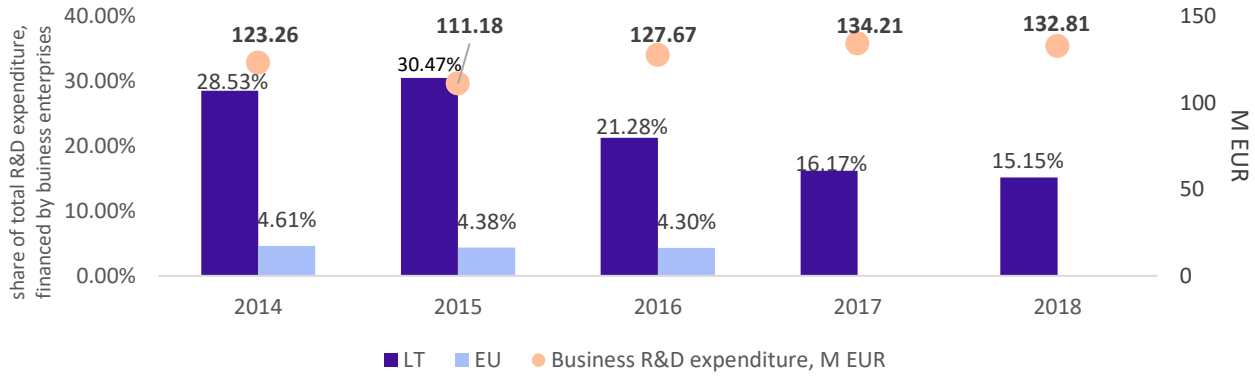
Figure 15. R&D in the higher education and government sectors by source of funds



Source: LSD

In fact, the share of R&D financed by business enterprises is small, but the R&D expenditure of enterprises in the government and higher education sectors accounted for one sixth of the total expenditure of enterprises on R&D (Figure 16). In 2015 business R&D expenditure in these sectors accounted for a third of total R&D business expenditure and exceeded the EU average by 7.5 times.

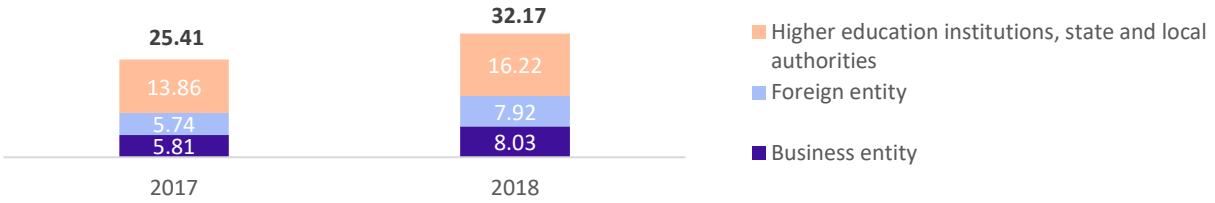
Figure 16. R&D in the higher education and government sectors financed by business sector



Source: LSD and Eurostat, STRATA calculations

Revenue of HESIs* and university hospitals** from licensing agreements and R&D activities shows the ability to attract funds from sources other than the state budget (including EU structural funds investments) or international programmes and, to some extent, the volume of R&D commercialization. The trend of recent years shows that the revenue of MSI and university hospitals from R&D orders of economic entities and licensing agreements is growing. Growing revenue from Lithuanian business and foreign entities reflects the growing demand of the Lithuanian private sector and foreign entities for the knowledge developed in Lithuanian HESIs and university hospitals and reflects the funds received from non-public sources. The revenue of HESIs and university hospitals amounted to about 11.6 million EUR in 2017 and almost 16 million EUR in 2018 (Figure 17). However, this revenue accounted for only a small fraction of the total revenue of HESIs and university hospitals.

Figure 17. Income of higher education and science institutions and university hospitals from R&D activities and licensing, M EUR

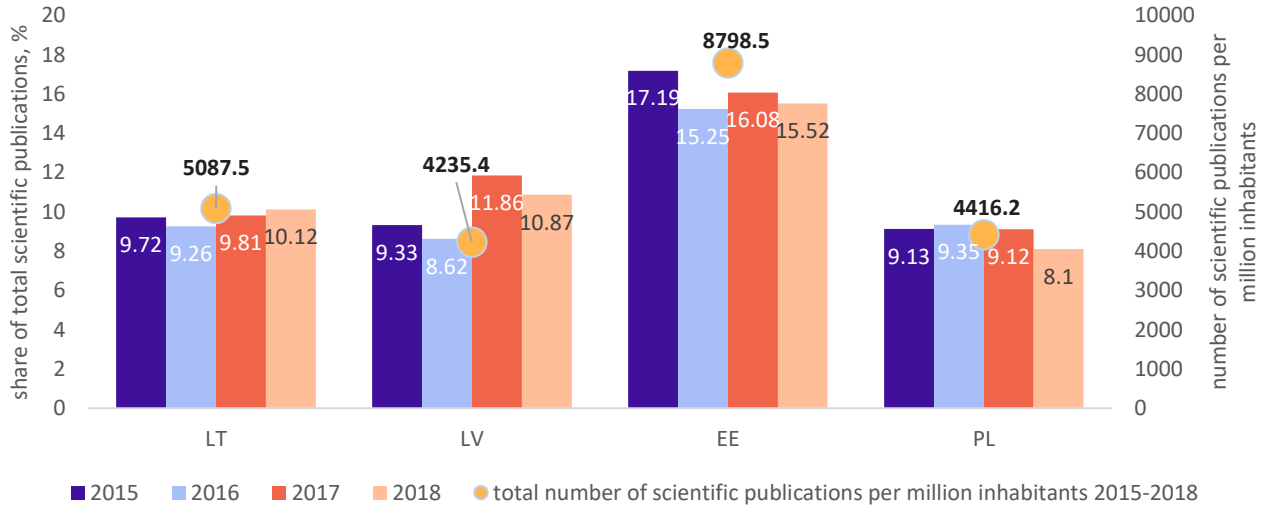


Note. Higher education and science institutions refer to state, non-state universities, state research institutes; university hospitals refer to Hospital of Lithuanian University of Health Sciences Kaunas Clinics ir Vilnius University Hospital Santara Clinics.

Source: LMT

The relevance of Lithuanian R&D on international level can be measured by number of citations in scientific publications. During the period of 2015-2018 Lithuanian results have increased insignificantly and the value of the indicator was similar to Latvia's (Figure 18).

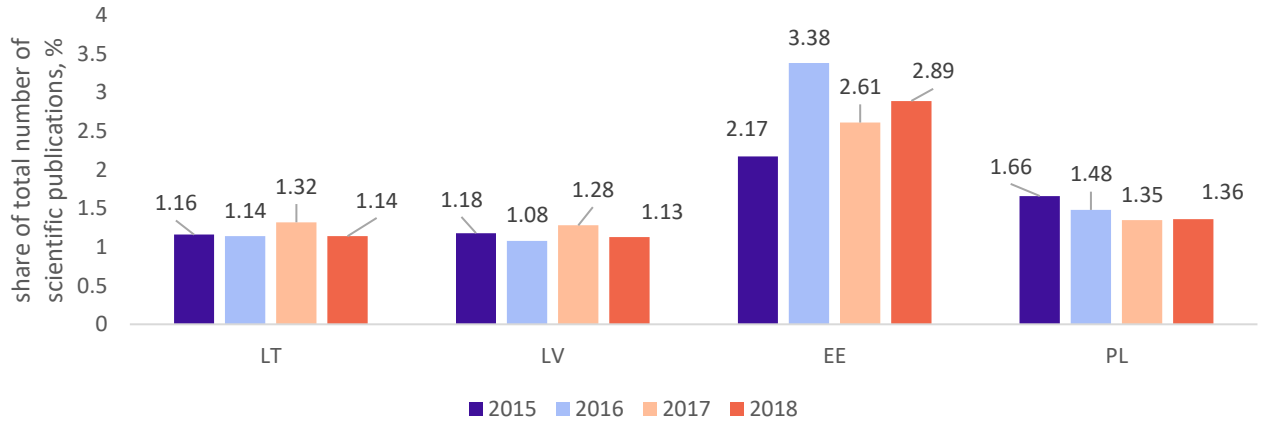
Figure 18. Scientific publications in TOP 10% of most cited scientific publications



Source: WebScience, STRATA calculations

The intensity of science and business collaboration is evident not only from the financial transactions between these sectors, but from science-business co-publications as well. The share (1,14% in 2018) from all publications during 2015-2018 period hasn't changed much and was similar to Latvia (1,13% in 2018) and Poland (1,36% in 2018), although was smaller than Estonia (2,89% in 2018) (Figure 19).

Figure 19. Science-business co-publications



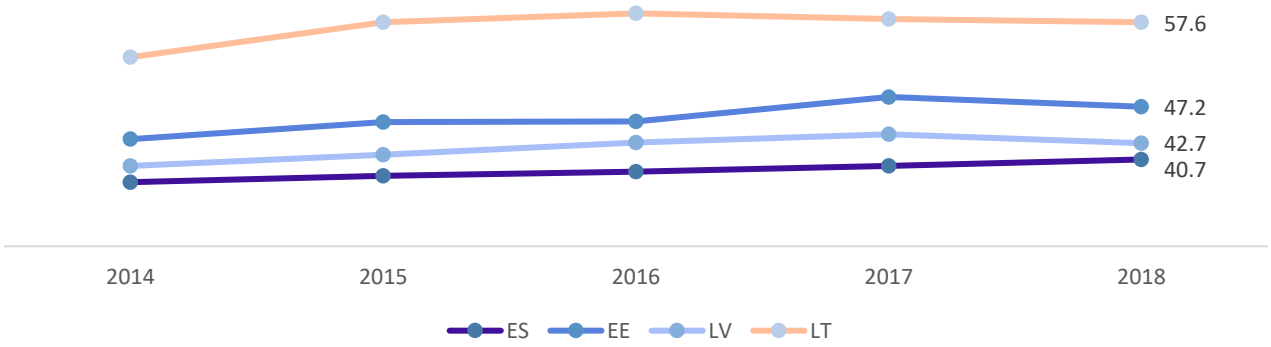
Source: Clarivate Analytics, Web of Science: InCites, 2015-2018 m.

Human resources for innovation development

For sustaining the innovation-based growth, it is necessary to disseminate the culture of innovation, to support entrepreneurship, creativity, critical thinking and other market-relevant skills and knowledge. It makes the role of educational institutions within the innovation ecosystem very important.

Lithuania can brag about the highest number of 30-34 year aged persons with higher education (57,6% in 2018) among other EU countries (average of 40,7% in 2018) (Figure 20).

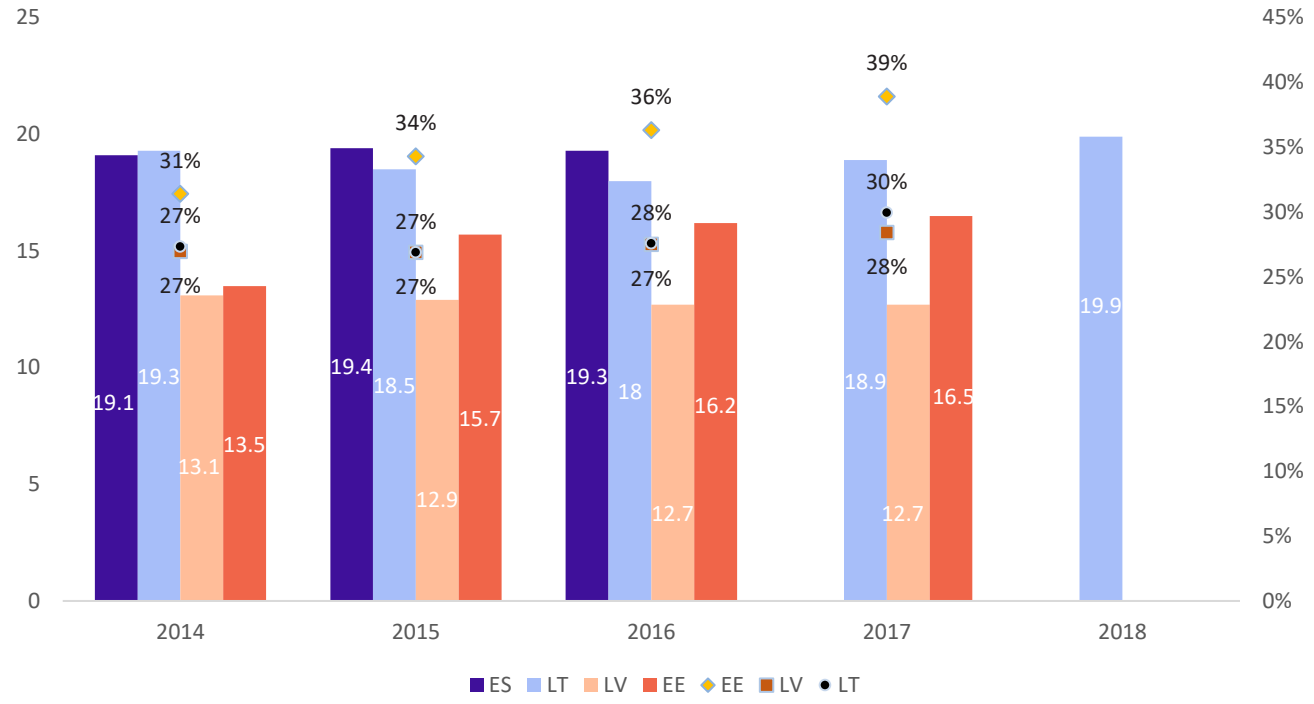
Figure 20. Tertiary educational attainment (aged 30–34)



Source: Eurostat

The impact of nature, technology, medicine and health, agriculture sciences is widely acknowledged to innovation process. Education in science, mathematics, computing, engineering, manufacturing, construction offers not only the specific knowledge of the subject, but also engineering creative problem-solving abilities. Lithuania had the largest proportion of graduates from mentioned sciences among Baltic States in 2018 (Figure 21). However, the proportion from the total number of graduates in Lithuania accounted for one third and Estonia had the lead (39% in 2017), which increased the proportion by 26% during 2014-2017. In this period Lithuania has made increase of 11%.

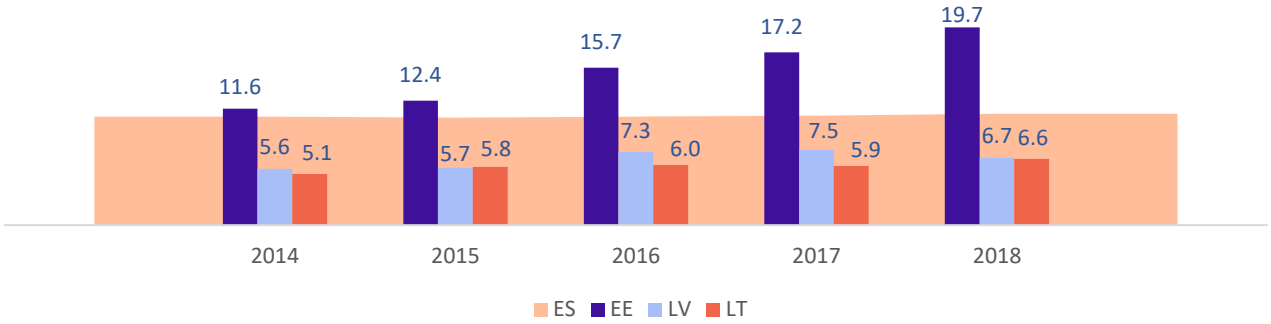
Figure 21. Graduates in tertiary education in science, math., computing, engineering, manufacturing, construction, per 1000 of population aged 20-29 and share of total graduates



Source: Eurostat, STRATA calculations

The level of life-long learning, meaning what proportion of 25-64 year-old members of society had had learning activities during the past four weeks, can reflect the level of society's adaptability to the changing environment. In 2018 the level of life-long learning in Lithuania (6,6%) was similar to Latvia (6,7%) It was 4,5% lower than the average of the EU and one third of Estonia's result (Figure 22).

Figure 22. Lifelong learning

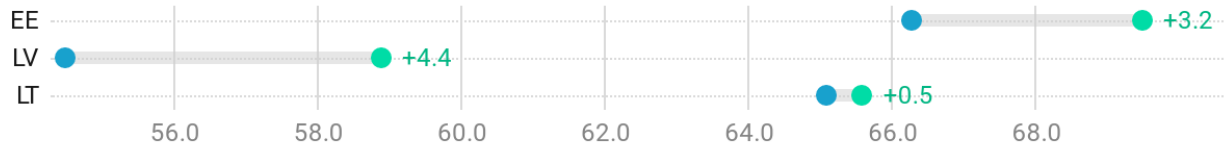


Source: Eurostat

Achievements of innovation ecosystem

Labor productivity, which is measured by created added value per one hour of work, is commonly used to measure the progress of the state and innovation-led growth. In 2018 the labor productivity in Lithuania was almost 66% of EU average and has increased by 0.5% during 2014-2018 (Figure 23). This is the least progress among Baltic States, however, Lithuanian labor productivity exceeded Latvian labor productivity.

Figure 23. Change in labour productivity 2014–2016



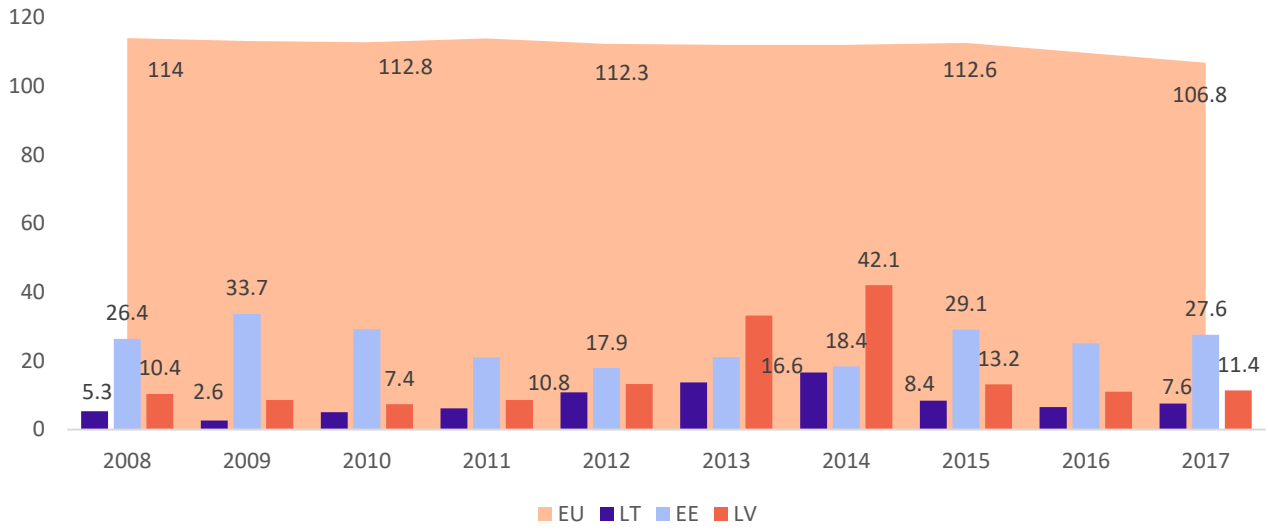
Source: Eurostat

The gap in labor productivity between Lithuania and EU could be reduced by increasing the share of knowledge-based activities in the economy and technological innovation. Therefore, the Lithuanian innovation output is reviewed by indicators used in European Commission's Innovation output indicator report[2]. Indicators such as patent applications, share of employment in knowledge-intensive business industries, share of medium- and high-tech products in total exports, knowledge-intensive services exports as percentage of total service exports, employment share in fast-growing enterprises in innovative sectors – show if the new knowledge reach the market and become new products. These indicators represent the scope of new products or ideas, the efficiency of innovation ecosystem performance and to what extent the R&D results are relevant on the global scale.

According to the data of The State Patent Bureau of the Republic of Lithuania, the number of industrial property objects (trademarks, patents, designs) during 2012-2018 has increased by 20% and reached 2930 applications. In 2018 the Lithuanian applicants submitted 81 national applications (30 applications by HEIs and 51 by businesses). Lithuanian businesses are paying increasing amount of attention for the protection of export products to the EU. In the first half of 2019, compared to 2018, applications for EU trademarks has increased by 68%. In comparison to other Baltic States, the results of Lithuanian intellectual property protection are scarce (Figure 24). From 2014, the number of applications to EPO per 1 million inhabitants has decreased by 50% and amounted to 7,6 applications. That is 3,6 times less than in Estonia, 1,5 times less than in Latvia and 14 times less than EU average (106,8). However, the number of applications reflects the number of inventions and is only partially connected with technological commercialization.

2 Vértesy, D., Damioli, G. The Innovation Output Indicator 2019, EUR 30104 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-16413-5, doi:10.2760/540233, JRC119969.

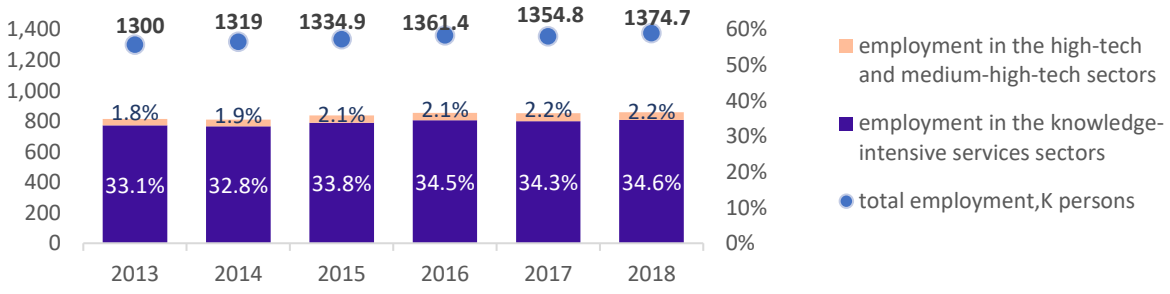
Figure 24. Patent applications to the European patent office per 1 million inhabitants



Source: Clarivate Analytics, Web of Science: InCites, 2014-2018 m.

Employment in medium-tech, high-tech and knowledge intensive sector during 2013-2018 has increased by 5% and was 36,8% of all employed in Lithuania (Figure 25). Employment in medium-tech, high-tech sector stayed almost the same (about 2%) and grew only in knowledge intensive sector. After two years' standstill, in 2018 employment in knowledge intensive sector has reached 10,4% (increase by 0,7%). According to 2019 data, employment in start-ups was 0,2% (6564) of all persons employed in Lithuania and has increased 2,4 times since 2017 (2744 employed).

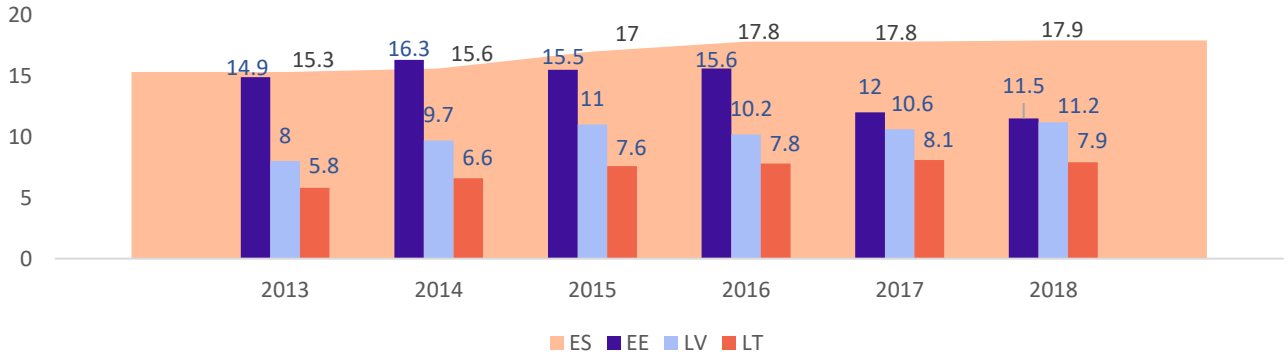
Figure 25. Persons employed in the high- and medium-high-tech manufacturing and knowledge-intensive service sectors



Source: Eurostat; LSD

In 2018 the share of Lithuanian high-tech exports did not account for more than 8% from total exports and it was the lowest share among Baltic States (Figure 26). Moreover, the rising share of EU high-tech exports (on average 18% from all exports in 2018), left all three Baltic States increasingly behind.

Figure 26. Exports of high-tech goods



Source: Eurostat

The first Lithuanian start-up that have reached 1 billion euros market value can be attributed to the achievements of Lithuanian innovation ecosystem of the year 2019. Second-hand clothing online store "Vinted" became the first Lithuanian unicorn. The table below provides the market value of Lithuanian start-ups, while the value of majority (82%) is unknown, the major part of start-ups with known market value has attribution up to 1 M EUR (Table 1).

Table 1. Number of start-ups and their market value

Market value of a start-up (M EUR)	0-1	1-10	10-25	25-50	50-100	100-200	200-300	1000+	Data not available
Number of start-ups	82	33	9	2	1	1	1	1	599

Success stories complement aggregated statistical data and remind, that behind the numbers stands the human creativity, efforts, and knowledge. Therefore, for better idea of Lithuanian innovation ecosystem international achievements of firms and researchers are provided.

Innovative business

- Bus manufacturer „Altas Auto" received silver medal at 2019 „A'Design Award" for middle class tourist bus design "Altas Viator" (designer Dominykas Budinas).
- International consultancy and audit firm „Deloitte" published the top 50 fastest growing West European technology firms. For the first time in the „Fast 50" the first place was given to Lithuanian firm „Voltas IT".
- Two solutions by Lithuanian start-ups are among the best 40 global digital innovations. In the initiative established by United Nations "The World Summit Awards" the best solution in the category of health and wellbeing was nominated "ChestEye CAD" by "Oxipit"for the AI- based solution for automated X-ray image description.
- BigDegree" learning platform was nominated in the category of learning and education".

Researchers

- For the discovery of CRISPR-Cas9 technology the senior researcher dr Virginijus Šikšnys from Life Science Center was awarded with biannual Kavli prize, together with two other researchers from Germany and United States.
- The clinical research performed by oncologists and surgeons from Lithuanian Health Science University was cited in the 2018 version of cancer treatment guide by The National Cancer Institute of the United of America.
- Achievements in chemical science by Kaunas University of Technology was awarded in „CEEC-TAC5 and Medicta 2019“ conference with „Outstanding Young TA&C Researcher in Central & Eastern Europe“ award.
- Gold medal was awarded for „Vilnius-Lithuania iGEM“ senior team at the international synthetic biology competition, while the project „CAT-SEQ“ by this team was recognized as the best computer modeling project. The junior team was awarded with a bronze medal for the project „SynDrop“.

National innovation policy design and implementation

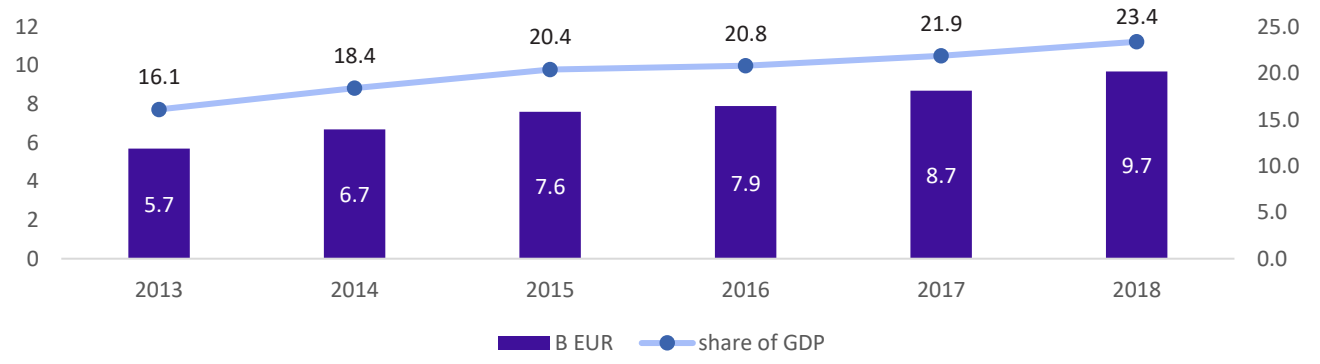
Innovation policy can be considered as the efforts of the Government to promote the development and efficiency of the innovation ecosystem. Consensus on strategic objectives and policy mix to achieve them effectively, sufficient resources, political support for integration into international innovation ecosystems, an innovation-friendly regulatory environment, and innovative solutions in the public sector are particularly important in a context of high uncertainty and financial risk. Basically, all these define the role of the Government in the innovation ecosystem.

Measures for innovation development

EU structural funds investments in the field of STI are concentrated in the priorities of smart specialization[3]. The aim is to ensure the economic growth based on knowledge and innovation using limited public resources in the areas of a greatest potential. The budget of the S3 measures[4] amounts 716, 64 M EUR, out of which 620, 16 M EUR were allocated till 18 Nov 2019.

In 2018 sectors corresponding to the S3 priorities generated almost a quarter (23.4%) of Lithuania's GDP and amounted nearly 10 B EUR, 70% more than in 2013. (Figure 27).

Figure 27. Added value produced by sectors corresponding to S3 priorities



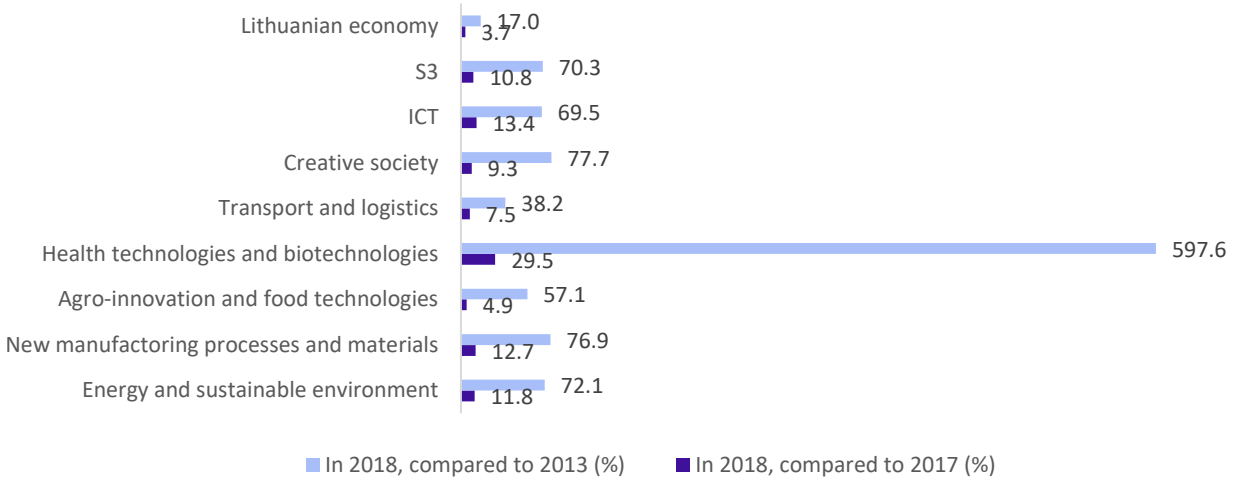
Source: LSD

3 S3 priorities

4 *„Pre-commercial procurements LT“; „Inno-vouchers“; „Innoconnect“; „Innogeb LT“; „Inoklaster LT“; „Inostartas“; „Innovation vouchers“; „Intellect. Joint science-business projects“; „Intellect LT2“; „Innopatent“; „Promotion of activities of competence centres and innovation and technology transfer“; "Development of R&D and innovation infrastructures and integration into European infrastructures"; "Promoting the commercialization and internationalization of R&D results"; Smart FDI; Smartinvest LT; Smartinvest LT +; Smartpark LT; Technoinvest; "Targeted research in the field of smart specialization"; “Strengthening the Capacities of Scientists and Other Researchers”, “Development of Scientific Competence of Scientists, Other Researchers, Students through Practical Scientific Activities”, “Promotion of Excellence Centers in Smart Specialization Areas”.

Also, compared to 2017, the value added generated by each S3 priority has increased (Figure 28). Over the year, value added in the priority of Health Technologies and Biotechnologies (by 29.5%) grew the fastest and the slowest growth was recorded in the priority of Agro-Innovation and Food Technologies (by 4.9%). Compared to 2013, the value added generated by each S3 priority increased significantly. Value added in Health Technologies and Biotechnology also grew the fastest (by 7 times) while the slowest growth was recorded in Agro-Innovation and Food Technologies (by 57.1%) and Transport and Logistics (by 38.2%).

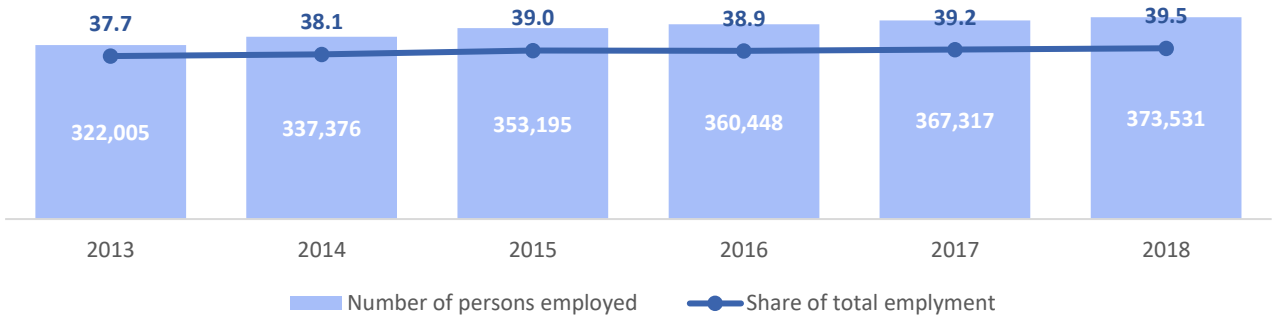
Figure 28. Change in added value produced by sectors corresponding to S3 priorities



Source: LSD

In 2018 more than 373 thousand people (nearly 40% of all employees) worked in the sectors corresponding to the S3 priorities. In 2018, as compared to 2017, the number of people employed in S3 increased by 1.7%, and compared to 2013, it increased by 16%. This is one and a half times faster than in the whole Lithuania's economy. (Figure 29).

Figure 29. Persons employed in and share of total employment (%) of sectors corresponding to S3 priorities



Source: LSD

S3 has a significant impact on the Lithuanian economy. The data of the Lithuanian Department of Statistics summarized in Table 3 shows that in the period of 2013-2018 the development of sectors corresponding S3 was relatively faster than in the entire Lithuanian economy.

Table 3. Progress of sectors corresponding to S3 priorities and the national economy 2013-2018

Measurement unit	National Economy	Sectors corresponding to S3 priorities	Share of sectors corresponding to S3 priorities
Added value	41 B EUR	9.7 B EUR	23.4 %
Export	34,2 B EUR	32,8 B EUR	97 %
Turnover	94,9 B EUR	33,3 B EUR	35 %
Persons employed	944 K	373 K	39.5%
Innovative enterprises	46,6 %	63,9 %	63,9 %
Share of turnover of innovative enterprises	77 %	81,1 %	81.1 %
Persons employed in innovative enterprises	68,4 %	77,9 %	77.9 %
R&D expenditure	148 M EUR	122 M EUR	82 %

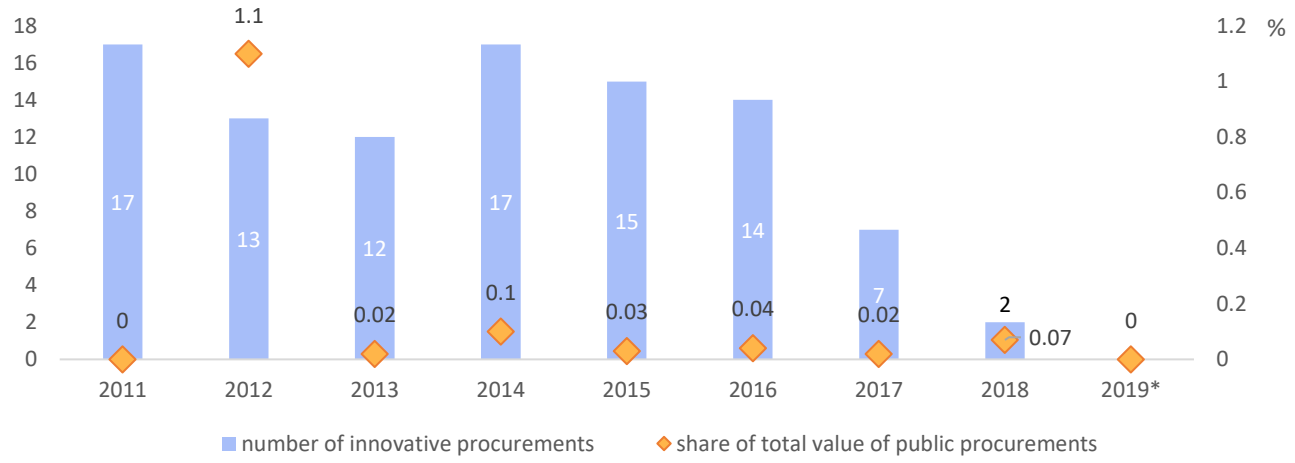
Source: LSD

Direct financial support for innovation can be supplemented by other incentives such as demand-side innovation measures. Well-harmonized measures of these types increase the efficiency of the innovation ecosystem. Possessing remarkable financial resources, the Government can incentivize and enhance innovation level by implementing innovative[5] and pre-commercial procurement[6]. However, the number of innovative procurements is diminishing (Figure 30). The largest number of innovative procurements (17 procurements per year) was implemented in 2011 and 2014. Only 2 innovative procurements were performed in 2018 and their total value was less than 0.1% of the value of all public procurements. The significant jump in the value of innovative procurements in 2012 was determined by the procurement of design and construction of the Center for Physical Sciences and Technology.

5 Guidelines of innovative public procurement 2014

6 Guidelines of pre-commercial procurement 2015

Figure 30. Dynamics of innovative procurements 2011-2019

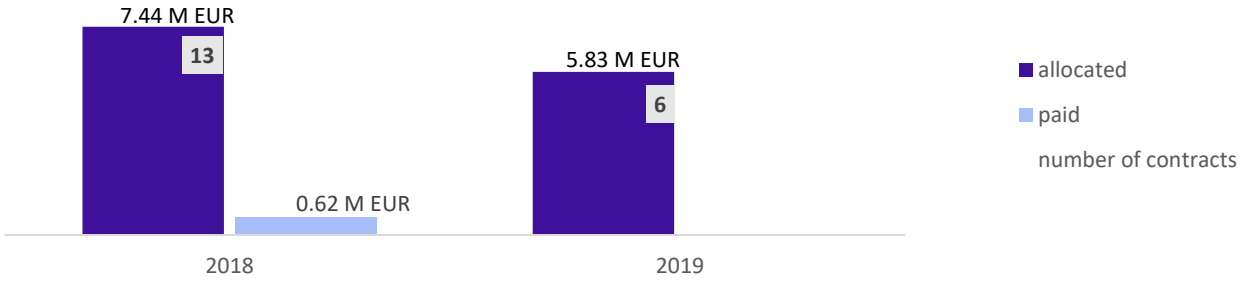


* - data of 2019 I-III Q

Source: PPO

The budget of the measure “Pre-commercial Procurement LT” dedicated for pre-commercial procurement amounts to 15.65 M EUR and by the end of 2019, 85% of total estimated budget was allocated (Figure 31). The year 2019 lags behind compared to 2018 in terms of the number of contracts signed and the funding allocated.

Figure 31. Dynamics of pre-commercial procurements

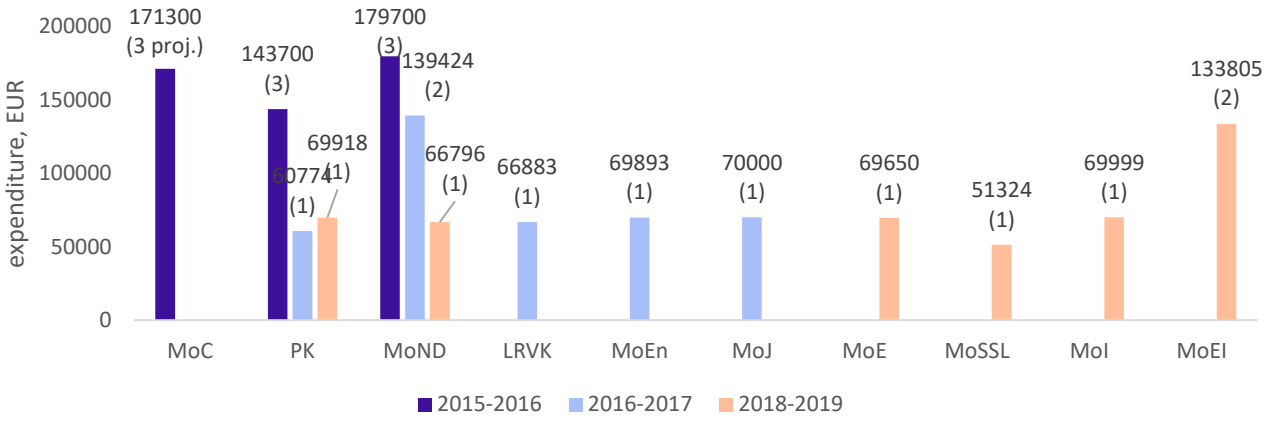


Source: www.esinvesticijos.lt

It is likely that the share of pre-commercial and innovative procurement in total public procurement will increase as the STI Council paid more attention to these measures and decided to increase the share of such purchases to 20% until 2030. In addition, the Government can stimulate the demand for new knowledge that will serve as a basis for innovative solutions. Since 2015, 1.36 M EUR was spent on 22 research projects commissioned by the State (Figure 32). Almost half of all research commissioned by the State in 2015–2019 was initiated by the Office of the President (5 projects) and the Ministry of National Defense (5 projects). The latter also accounted for the largest share of expenditure (386 K EUR). 2015–2016 period is the most active in terms of initiated projects of

research commissioned by the State (9) and allocated funds (494.7 K EUR). However, in later periods there was a higher involvement of institutions (in 2015–2016, the research commissioned by the State was initiated by 3 institutions, in 2016–2017 - 5 institutions in 2018–2019 - 6), but the total number of projects decreased (in 2015–2016 9 research projects commissioned by the State were initiated, in 2016–2017 - 6, in 2018–2019 - 7).

Figure 32. Expenditure on research commissioned by the State



Source: RCL

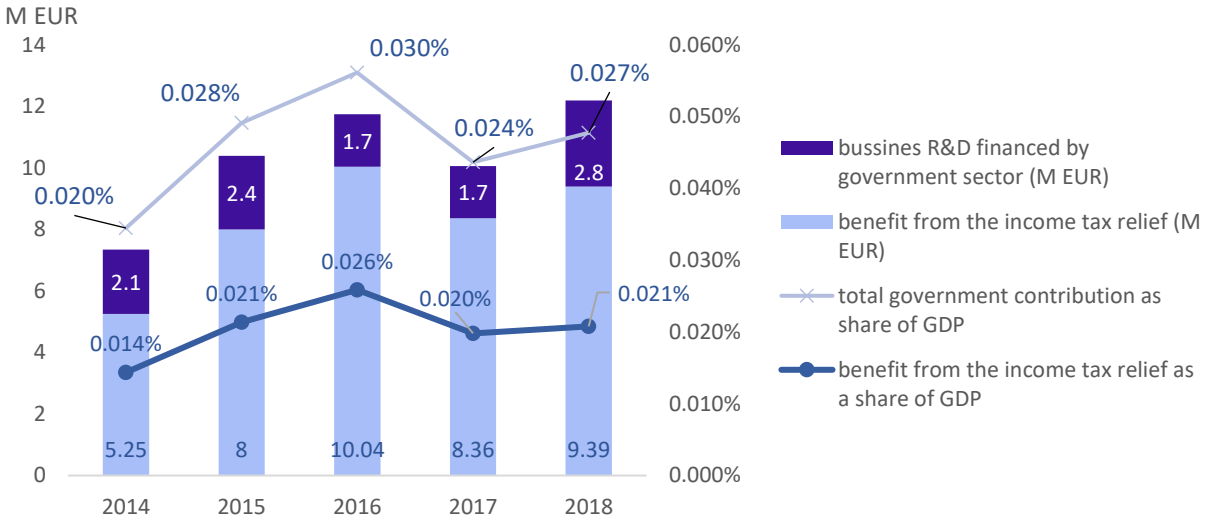
In addition to direct non-repayable support, participants in the innovation ecosystem can benefit from financial engineering instruments provided by the public sector. Venture capital funds such as Baltic Innovation Fund II (BIF), INVEGA-managed Co-investment Fund R&D&I, Early Stage and Development Fund I, Early Stage and Development Fund II provide access to private equity investment for innovative companies with high growth and development potential. Venture capital funds of foreign institutions European Investment Fund (EIF), European Bank for Reconstruction and Development (EBRD) also expand funding opportunities. During the period of 2013-2018 almost half of over 500 M EUR venture capital funds invested came from these public sector and foreign institutions, and the volume of venture capital funds from all these sources increased (Figure 33).

Figure 33. Public finance in venture capital funds, M Eur

Source: Lithuanian Private and Venture Capital Association

The legal regulatory framework also provides opportunities for R&D development. National Income tax law foresees a relief for companies developing new and/or improving existing products and services[7]. The total benefit from the income tax relief for R&D expenditure grew by an average of 18% per year over the period 2014-2018, totaling more than 41 M EUR. The benefit from the income tax relief make up the bulk of the total government contribution (71% in 2014, 83% in 2017, 77% in 2018) and together with the government-funded R&D in business sector accounts less than 0.03% of GDP (Figure 34).

Figure 34. Government support for R&D in business sector

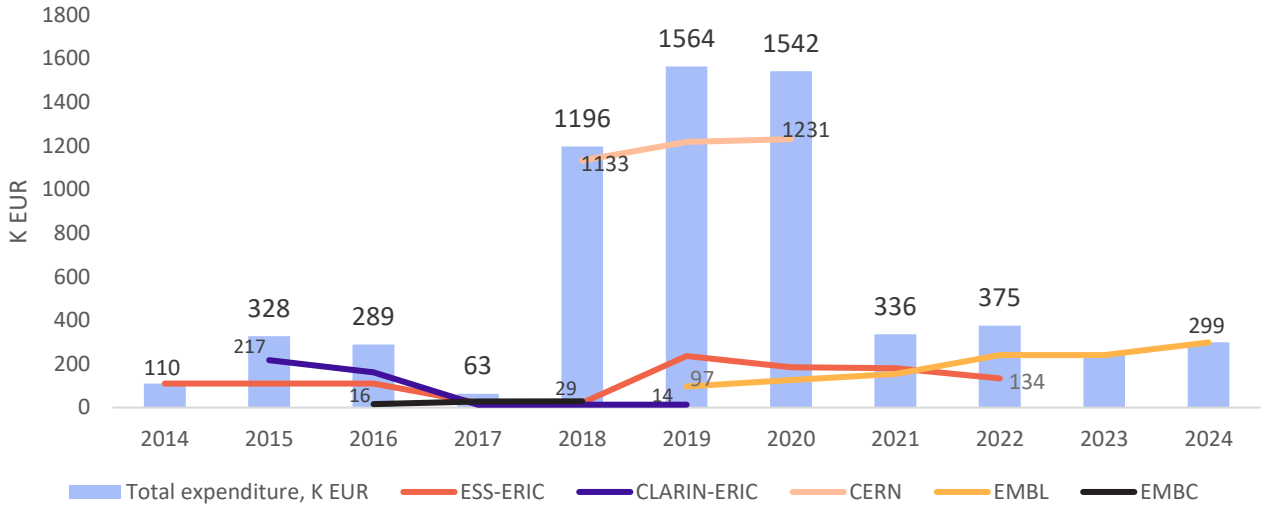


Source: State Tax Inspectorate; OECD (2019). "R&D Tax Incentives: Lithuania, 2018"

In order to meet the needs of the state and society, it is important to raise the quality level of new knowledge. Research infrastructures bring together researchers from one or different disciplines into an organized entity with the tools, resources, connections (local and international) needed to generate knowledge, ensure its high quality and apply it to the development of new technologies and innovations. Thus, to raise the level of the innovation ecosystem, the Government can help to get involved in the research infrastructures. Lithuania is currently a member of 4 international research infrastructures (Figure 35). Furthermore, compared to 2014 the costs of membership increased 14 times and in 2019 amounted 1,56 M EUR. So far, the bulk of this amount (78%) is the CERN membership fee (900 K EUR).

[7] The income tax benefit is the amount that companies would have paid as an income tax if the benefit had not been granted. Deductions that led to a decrease in the income tax base in 2018 is 338.67 M EUR (business R&D expenditure 112.89 M EUR multiplied by 3).

Figure 35. Expenditure on participation in international research infrastructures



Source: MoESS

Changes in national legislation for innovation development

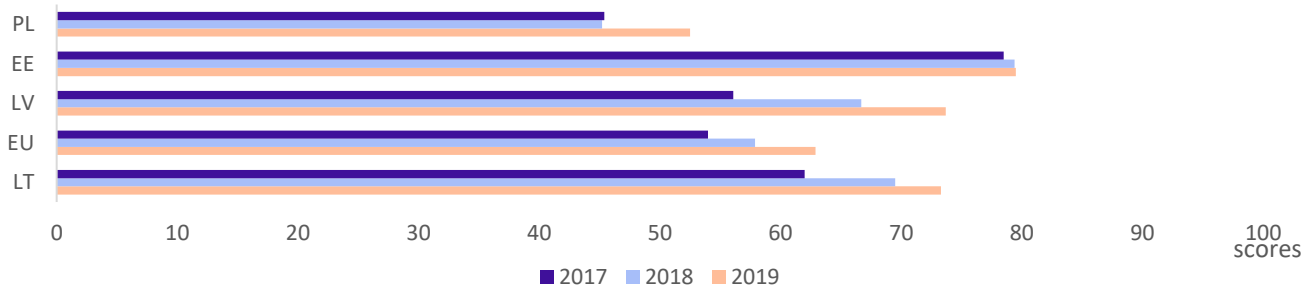
The innovation-friendly environment is largely determined by the regulatory framework. The flexibility of the regulatory framework itself allows (do not hinder) to look for innovative solutions and realize them. After the changes that took place in 2018 (the adoption of the Law on Technology and Innovation of the Republic of Lithuania and the separation of responsibilities of MoEI and MoESS in the field of STI) there have been no major changes that would have fundamentally transformed the innovation ecosystem. However, in 2019 separate S3 action plans were consolidated into one, as well as 20 thematical areas were concentrated to 7 STI priorities. Moreover, the definition of a start-up was determined in the Law of Small and medium business development[8].

[8] A start-up is a very small or small enterprise with a high and innovation-based business development potential, registered in the Register of Legal Entities for a maximum of 5 years

New national initiatives for innovation

With the growing influence of digitalisation and new technologies, the public sector also needs to transform and respond to the growing expectations of the population. According to the data of the Digital Economy and Society Index the progress of Lithuania over the period 2017-2019 is substantial (Figure 36).

Figure 36. Dynamics in the development of digital public services



Source: EU

In addition, it is worth to distinguish the most significant public sector innovations or initiatives that promoted innovation in 2019:

- GovTech Lab initiative enhancing public sector innovation was awarded at *The Innovation in Politics Awards 2019*.
- Lithuanian artificial intelligence strategy[9]. In April 2019 Lithuania was one of the first in the EU to present a legal and ethical basis for the application of artificial intelligence in Lithuania.
- A regulatory sandbox to test energy innovations. In order to facilitate and promote the development of energy innovations, amendments to the Law on Energy have been prepared.
- Online platform „Saulės parkai“, enabling the acquisition or rental of part of a remote solar power plant for the development of solar energy.
- Sandbox for real estate technology companies. The municipality of Vilnius city devoted part of the owned buildings to RealBox spaces established in Vilnius in 2018, where companies can test their innovative solutions.
- The Association of Research and Technology Organizations was established with the aim to expand the high value-added industrial sector by concentrating the potential of the strongest Lithuanian research centers - Center for Physical Sciences and Technology, Lithuanian Energy Institute, The Lithuanian Research Centre for Agriculture and Forestry and Science and Technology Park of Institute of Physics.

[9] Lithuania‘s artificial intelligence strategy

International dimension

Perception of how a country is doing on the international level can give decision-makers and other innovation ecosystem actors an idea about the ambition of the strategical goals set, the impact of innovation policy measures implemented or the growth of the country's international competitiveness.

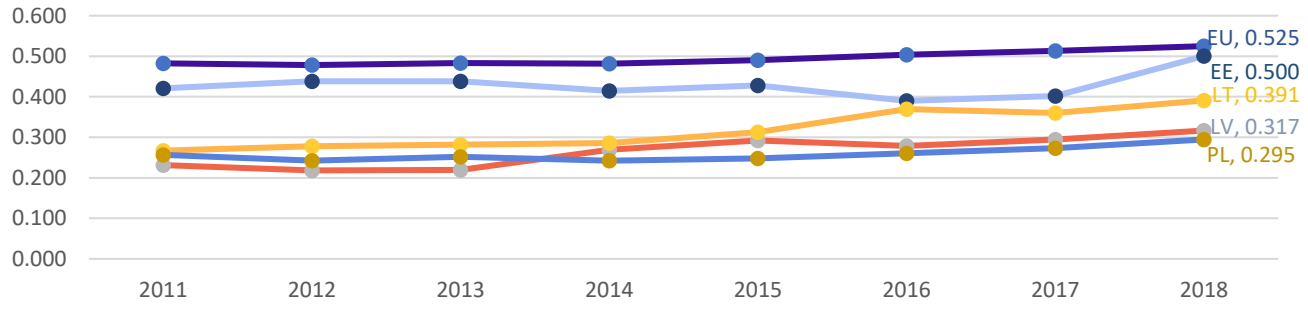
Positions in international innovation indexes

Global indexes are a tool for comparing individual economies and assessing the competitiveness of a national system among the rest of the world. The position of the Lithuanian innovation ecosystem in the international context is reflected in the Review by four on EU level and globally recognized indexes - the European Innovation Scoreboard[10], the Global Innovation Index[11], the Global Competitiveness Index[12] and the Digital Economy and Society Index[13].

The Global Innovation Index, published annually by the World Intellectual Property Organization, is one of the key benchmarks for assessing a country's innovation ecosystem on a global scale. It ranks the innovation performance of about 130 economies around the world. All indicators calculated for this index are grouped into 7 dimensions: institutions, human resources and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, creative outputs. According to the Global Innovation Index 2019, Lithuania ranks 38th among 129 countries in the world and is 23rd among 28 EU members.

The Summary Innovation Index published by the European Innovation Scoreboard is used to measure the achievement of the strategic innovation policy goals set in the National Development strategy “Lithuania 2030” and in the Lithuania’s Innovation Development Programme. As the Summary Innovation Index is to be included into the National development strategy 2021-2027, it will remain one of the most important points of reference in reviewing the positions of the Lithuanian innovation ecosystem on the international level. According to the Summary Innovation Index, Lithuania ranks 21st in the EU (ahead of Latvia and Poland) (Figure 37) and shows a performance level at 74.5% of the EU2018 average.

Figure 37. Summary Innovation Index across the region and EU



Source: EIS

10 European Innovation Scoreboard

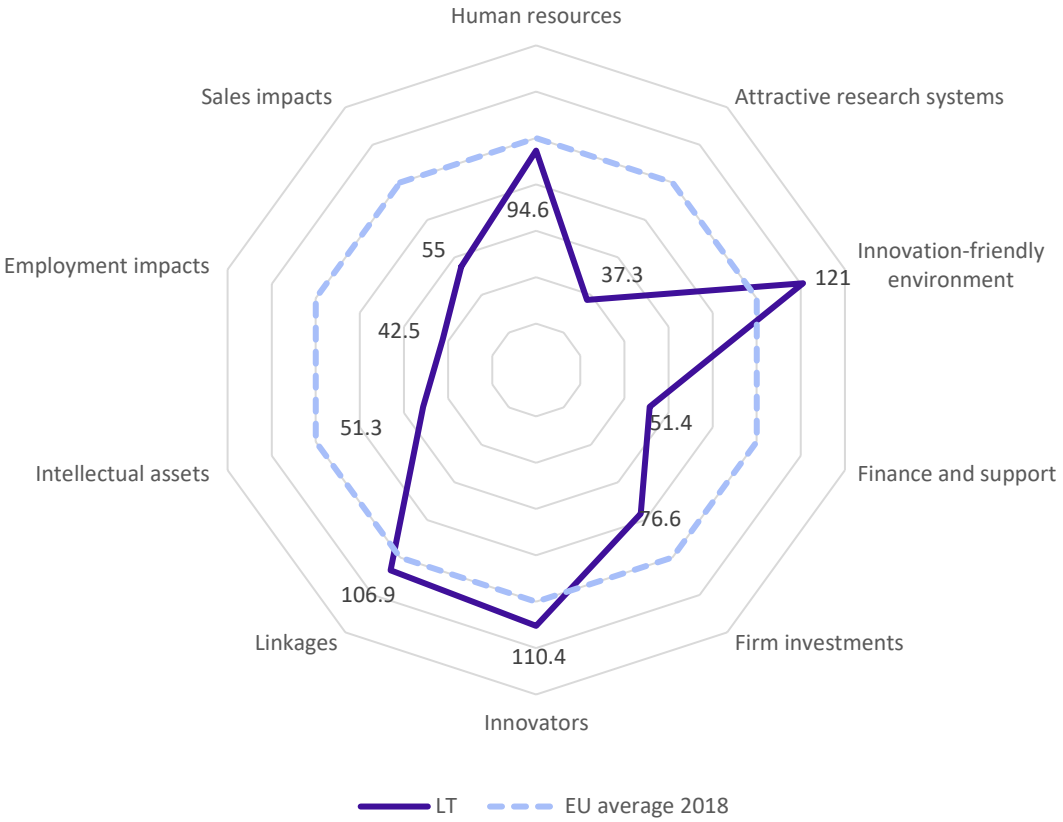
11 Global Innovation Index

12 Global Competitiveness Index

13 DESI 2019

This index provides a comparison of national innovation ecosystems at EU level evaluating 27 indicators combined into ten innovation dimensions. The strongest innovation dimensions where Lithuania exceeded EU2018 average scores were *Innovation-friendly environment* (121% of the EU average in 2018), *Innovators* (110% of the EU2018 average) and *Linkages* (106.9% of the EU2018 average) (Figure 38). There are 5 dimensions where the performance ranges around or below half of EU2018 average. These are *Attractive research systems* (37.3% of the EU2018 average), *Finance and support* (51.4% of the EU2018 average), *Intellectual assets* (51.3% of ES2018 average), *Employment impacts* (42.5% of ES2018 average) and *Sales impacts* (55% of ES2018 average).

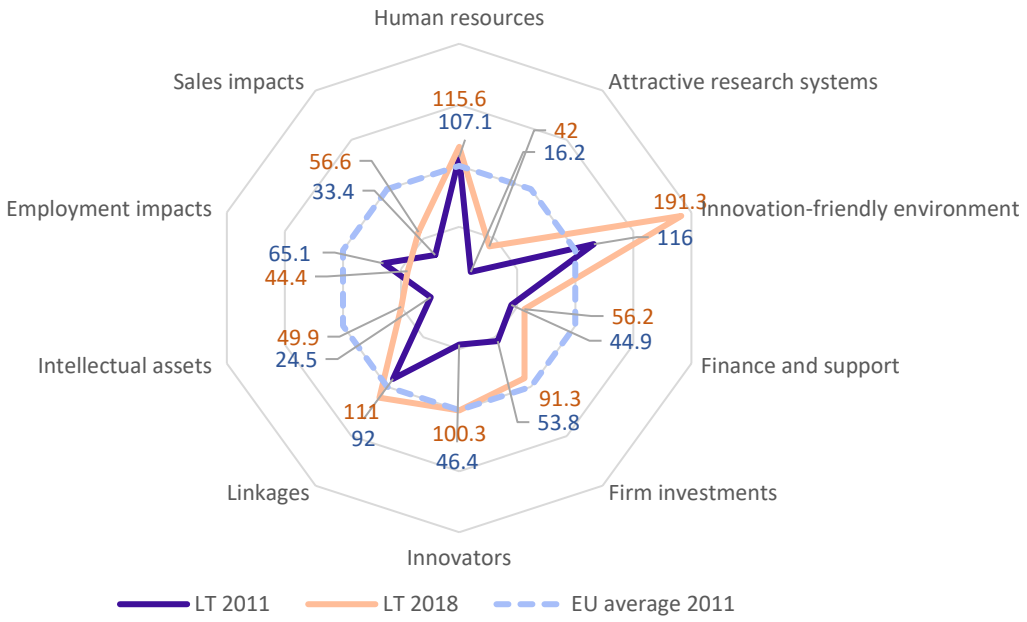
Figure 38. Scores according to dimensions of the Summary innovation Index 2018



Source: EIS

Lithuania is singled out as the most advanced EU country in terms of the growth of the Summary Innovation Index in 2011-2018 period (25.7%; EU average 8.8%). Reviewing Lithuania's 2011 and 2018 progress, the most significant improvement can be seen in the dimensions of Innovation-friendly environment, Firm investments, and Innovators (Figure 39).

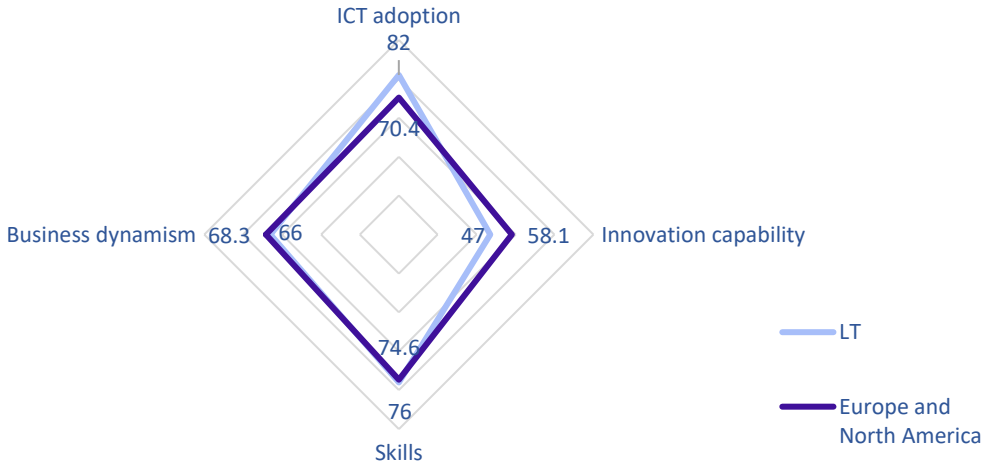
Figure 39. Scores according to dimensions of the Summary innovation Index 2011



Source: EIS

The Global Competitiveness Index, published annually by the World Economic Forum, measures the competitiveness and sustainable growth of about 140 countries. It is one of the indicators monitored by the National progress strategy „Lithuania 2030“. In 2018 the Global Competitiveness Index 4.0 was launched. It includes measures to assess progress according to a set of factors that determine productivity and growth of the competitiveness. The index covers twelve areas: institutions, infrastructure, ICT integration, macroeconomic stability, skills, health, product market, labour market, financial system, market size, business flexibility and innovation capacity. According to 2019 data, Lithuania ranks 39th among 141 countries in the world and 20th in the EU. The comparison of Lithuania and the region of Europe and North American in accordance with the areas directly affecting the innovation ecosystem is provided in Figure 40.

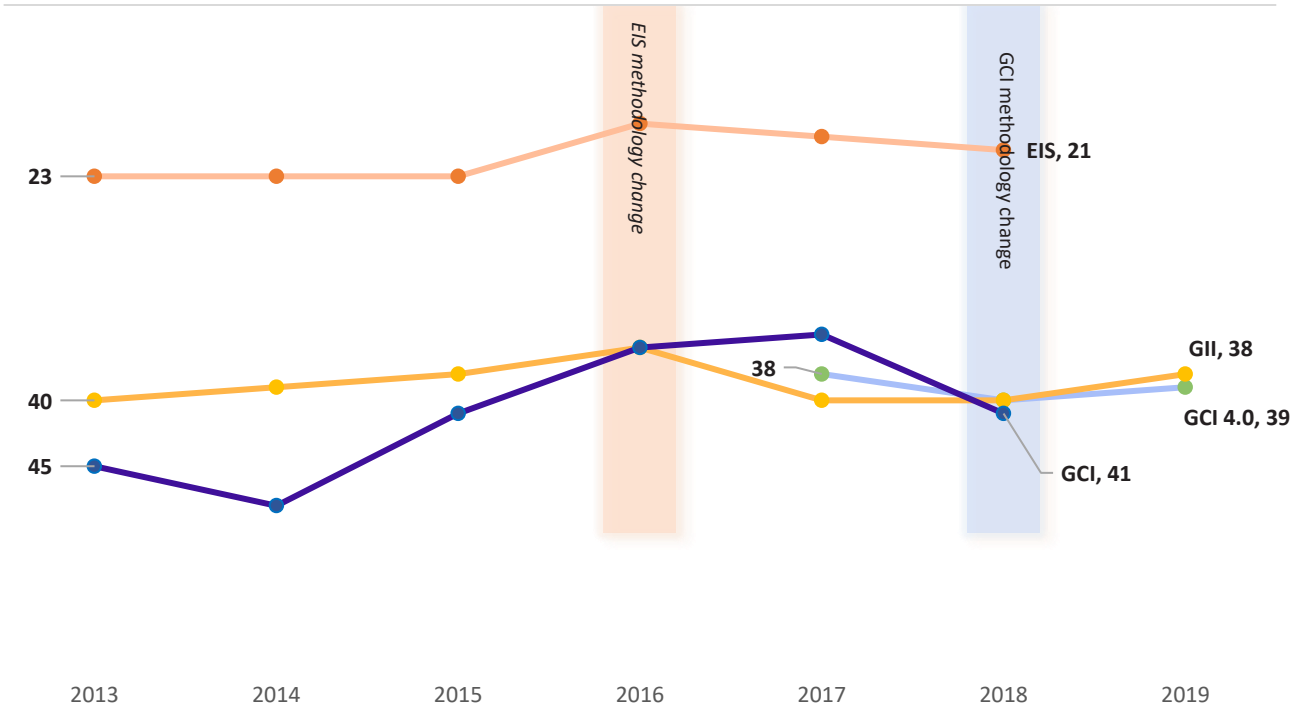
Figure 40. Scores according to certain areas of Global innovation index 2019



Source: World Economic Forum

In fact, there was no significant progress or decline in Lithuania's positions in the discussed indexes over a more extended period. In the five years since 2013, Lithuania's positions in the European Innovation Scoreboard and the Global Innovation Index rose by two positions, and in the Global Competitiveness Index - with some fluctuations (48th place in 2014 and 35th place in 2017) by four positions. However, the discussed changes of the positions in the international indexes should be viewed with more flexibility. Due to annual methodological improvements, changes in the calculation of individual indicators or the introduction of new indicators, the Lithuanian positions of individual years often become incomparable. For example, the methodology for compiling the Global Innovation Index changes slightly from year to year. The Figure 41 shows the dynamics of Lithuania's positions in international indexes in 2013–2019 period and substantial changes in methodology.

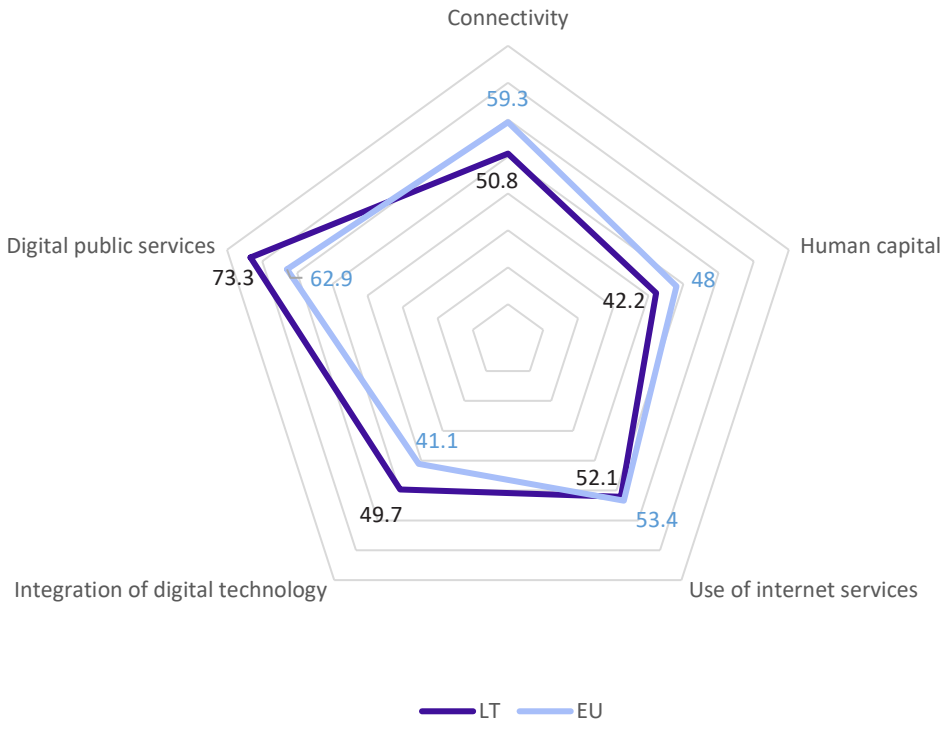
Figure 41. Dynamics of Lithuania's positions in international innovation indexes



Source: European Innovation Scoreboard, World Economic Forum, Word Intellectual Property Organisation

Competitiveness of the Lithuanian innovation ecosystem is affected by the readiness for the digitalization challenges. The potential for development is indicated by the Digital Economy and Society Index which measures the competitiveness of EU countries according to the five dimensions of digitization. Lithuania in 2019 was close (52%) to the EU average (52.5%) and ranked 14th in the EU (Figure 42).

Figure 42. Digital skills



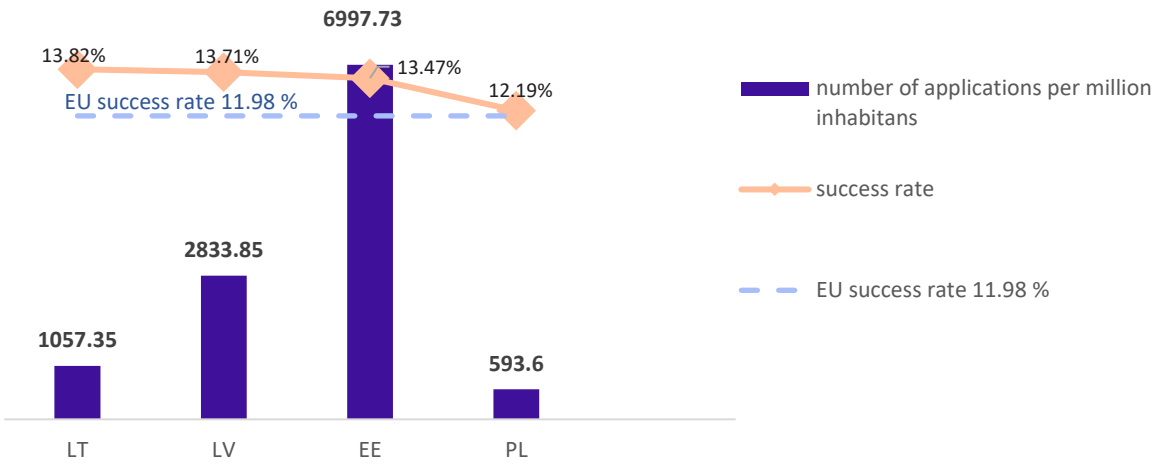
Source: EC

Participation in H2020

To boost economic growth and ensure global competitiveness, EU is implementing extensive research and innovation program “Horizon 2020”. EU has devoted over 80 B EUR for the period of 2014 - 2020. This EU financial instrument designed to drive breakthroughs and world-class innovation, aims to raise the level of research, reduce barriers to innovation and foster public-private partnerships. Thus, H2020 can be considered as a platform for cooperation and competition among EU innovation ecosystems, and data on the results of Lithuania's participation in this programme complements Lithuania's position in the international context. It also gives an impression of the potential and quality of Lithuanian innovation ecosystem participants to compete at EU and global level.

By the data of October 2019, the entities of Lithuania implemented 340 projects and 69 of these projects were coordinated by Lithuanian entities. Although the quality and success rate of Lithuanian applications (13.82% of submitted eligible applications) exceeded the EU average, Lithuania lags behind Latvia more than 2.5 times and Estonia more than 6.5 times in terms of the number of submitted applications per capita (Figure 43).

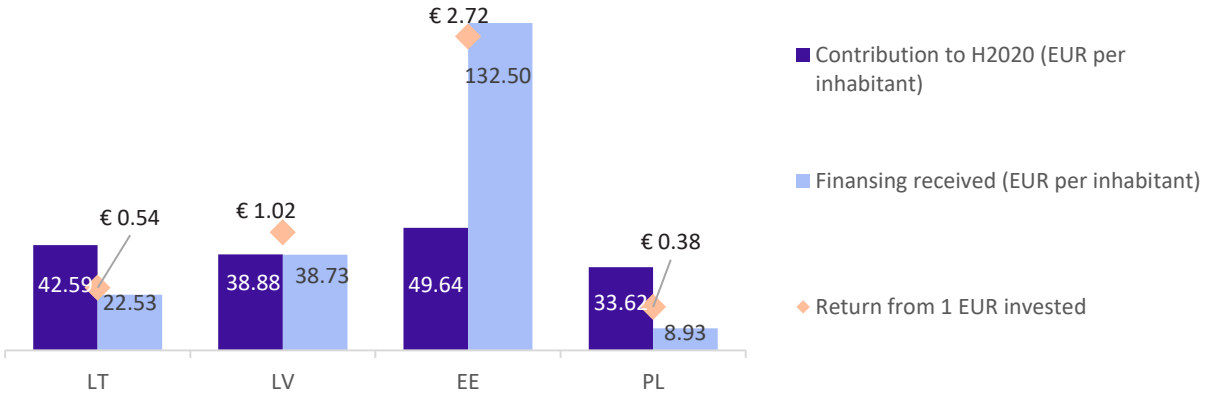
Figure 43. Number of applications submitted and success rate in H2020



Source: H2020 data base „Horizon Dashboard“ (extracted October 2019)

Assessing the results of Lithuania's participation in H2020 in terms of the investment returns, Lithuania has not yet used all the funding opportunities provided by the programme (Figure 44). The calculations show that Lithuania lags behind Latvia and Estonia and return equals 54 cents per 1 EUR.

Figure 44. Efficiency of participation in H2020

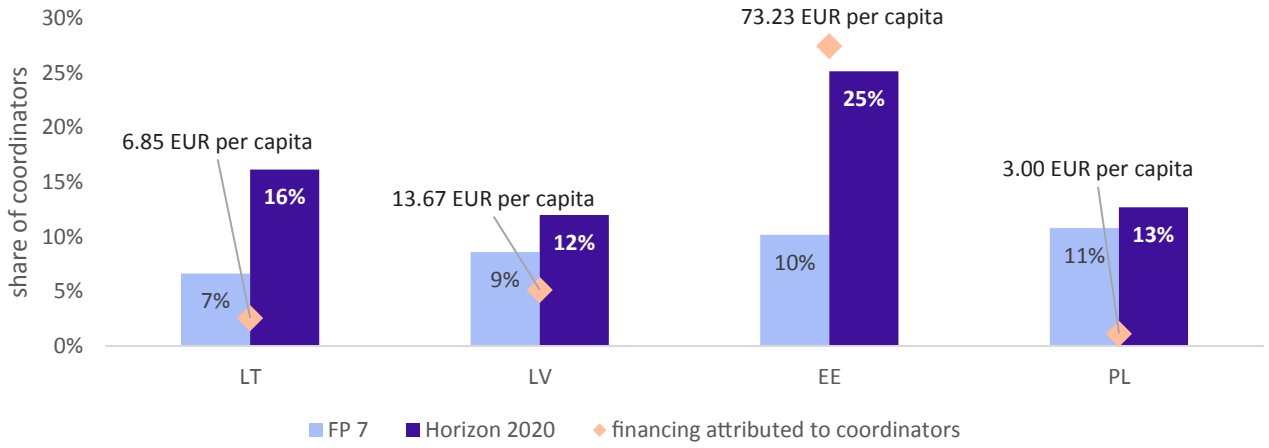


Note. National contribution to H2020 is calculated according to the proportion of national contribution to the EU budget

Source: H2020 data base „Horizon Dashboard“ (extracted October 2019), STRATA calculations

Compared to the period of 2007 - 2014, H2020 period was different – the share of Lithuanian coordinators more than doubled and reached 16 percent of all Lithuanian participants (Figure 45). The funding per capita received by the coordinators is less than 7 EUR which is 10 times lower than in Estonia (73.23 EUR per capita).

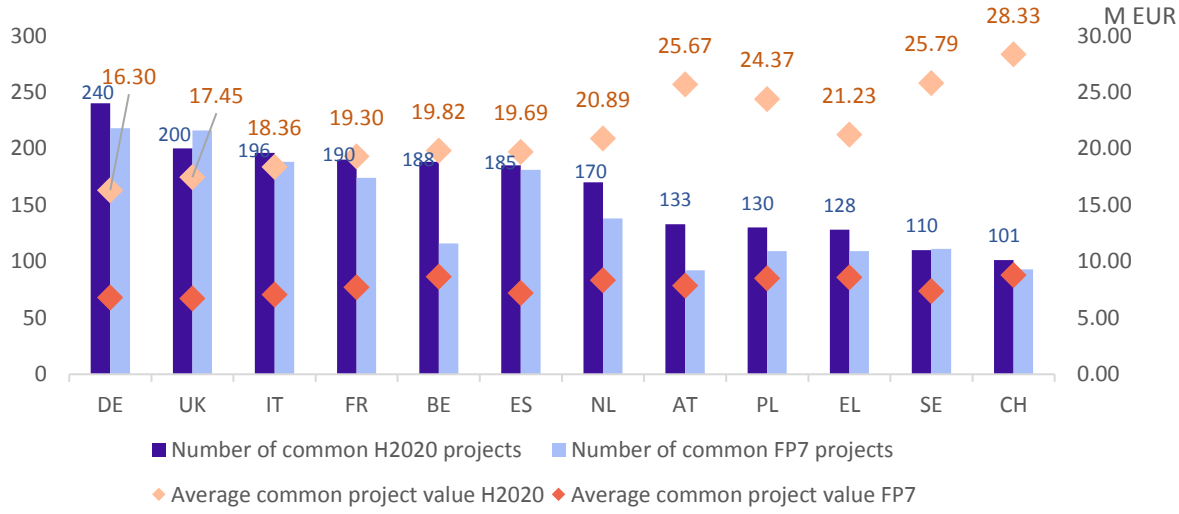
Figure 45. Lithuanian coordinators in H2020: share compared to all participants (%) and financing received (EUR per inhabitant)



Source: H2020 data base „Horizon Dashboard“

Lithuania's foreign partners in FP7 and H2020 did not change (Figure 46). However, the total number of ongoing projects has increased in H2020. Likewise, the average value of joint projects has also increased significantly.

Figure 46. TOP 12 foreign partner countries according to number of joint projects and average value (M EUR)



Source: EC data base

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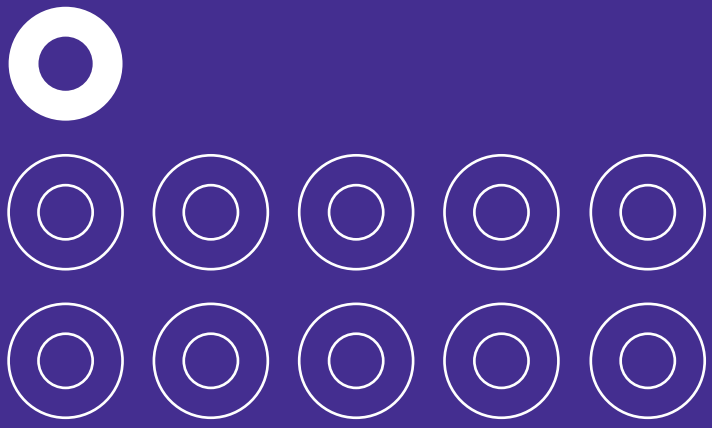

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