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ANALYTICAL REVIEW OF THE LATVIAN SMART SPECIALISATION STRATEGY (RIS3)

The progress of Latvian science

(2008 – 2019)

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Ministry of Education and Science

THE NATIONAL DEVELOPMENT PLAN 2014-2020

EUROPEAN UNION
European Regional Development Fund

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Abbreviations (will be added or taken out if they are not used so often)

FTE – Full-Time Equivalent – a unit of measure for the comparative evaluation of workloads relative to standard full time working hours

RI – Research institution

HEI – Higher Education Institutions

CSB – Central Statistical Bureau

FARP – Fundamental and Applied Research Programme

NRP – National Research Programme

R&D – Research and Development

NEIS – National Education Information System

STEM – Science, Technology, Engineering, Mathematics

RIS3 – Research and Innovation Strategy for Smart Specialisation

EC – European Commission

Content

1 Introduction

The "Review of Research in Latvia" (hereinafter – the Review) has been prepared to provide the general public with an insight based on data analysis of the current situation and significant development trends in the Latvian research sector over the past 10 years, identifying future challenges for the national R&D system and science policy making.

Tasks for the R&D system at the national level

The main tasks for the R&D system defined by the government and public of Latvia are derived from the objectives set in NDP 2027, development priorities and defined tasks. The objectives and tasks of the STDI policy in the period of 2021-2027 are closely related to the planned development measures in the Education Development Guidelines for 2021-2027 and in the National Industrial Policy Guidelines for 2021-2027, incl. with regard to the implementation of RIS3, as well as various horizontal and sectoral policies (see Chapter 4 "Linking the Guidelines to National and International Policy Planning Documents").

The main tasks set for the R&D system:

- To develop the knowledge base and create new knowledge for the provision of quality and research-based education, to promote research excellence and the development of a skilful, smart and creative society;
- To develop sustainable R&D human capital through the development of talents and skills, as well as to promote international and intersectoral mobility and expanding the co-operation network;
- To ensure training of highly qualified, professional and diverse specialists, especially in the context of digitalisation, industrial transformation and transition to a climate-neutral economy;
- To develop new technologies for the production of innovative products and services by promoting the efficiency, technological transformation of corporate resources, and incorporation in value chains of a different scale;
- To find innovative solutions for societal challenges – to improve and strengthen public health, reduce inequality, ensure access to high-quality food, clean and efficient energy and provide inclusive public services, create a safe and high-quality living environment;
- To develop research and innovation capacity with the purpose of raising business productivity and improving the efficiency of public administration processes to promote the balanced development of the regions of Latvia.

It follows the main vision of Latvian science policy for 2021–2027:

- ►**Excellent research**
  High quality and internationally recognised research is being implemented in Latvia, incl. for innovative organisations and business development.
- ►**Innovative and Technologically Developed Business**
  High added value technologies, products and services that are competitive and demanded on European and international markets are developed in Latvia.
- ►**Smart, Skilful and Innovative Society**
  Latvian society is capable of creating, developing and introducing innovations and evaluating knowledge and the socioeconomic value of research.

In the period of 2021-2027, the goal, sub-goals and directions of action of science policy are set and the tasks to be performed are planned based on two main studies of the EC Policy Support Facility – "Development of the Human Capital for Research and Innovation in Latvia" (2019)[1] and "Latvian Research Funding System" (2018)[2]; the main recommendations are:

- To increase R&I funding by balancing the amounts of funding by the state and EU structural funds and increasing the ratio of state funding, considering the variable availability of the structural funds;
- To develop a performance funding system for the strengthening of university research profiles, as well as to increase the attraction of external funding;
- To reduce the institutional fragmentation of the R&D system, to improve management efficiency and resource sharing of higher educational institutions and research institutions;
- To increase the attractiveness of an academic career and to introduce a tenure system, as well as to improve the quality of doctoral studies and increase the number of doctoral degree recipients;
- To improve the co-operation and integration of Latvian researchers on an international level and in global scientific developments and to support the mobility of academic personnel, including from abroad to Latvia, as well as to attract talents from abroad;
- To promote the mobility of academic personnel in the business sector;
- To develop and strengthen the culture of entrepreneurship and innovation at higher educational institutions and scientific institutions to promote entrepreneurship as a promising career choice.

In addition, Latvia's science policy is based on the following documents:

OECD report "Going Digital in Latvia" (2020)[3];

- Informative report *Smart Specialisation Strategy Monitoring*. Second report (2020)[4];
- Research on open science and on the development of an action policy roadmap (2020)[5];

[1] Available at: https://op.europa.eu/lv/publication-detail/-/publication/e84a9d0f-b98a-11e9-9d01-01aa75ed71a1/language-en/format-PDF/source-106068252
[2] Available at: https://www.izm.gov.lv/lv/media/4690/download
[3] *OECD* Going Digital in Latvia, 2020. Available at: https://www.oecd.org/latvia/going-digital-in-latvia-8eec1828-en.htm
[4] Available at: http://polsis.mk.gov.lv/documents/6682
[5] Available at: https://www.izm.gov.lv/lv/media/4681/download

- Conceptual report "On the introduction of a new doctoral model in Latvia" (2020)[6];
- EC 2020 report on Latvia (2020)[7];
- EC 2019 report on Latvia (2019)[8];
- Informative report "Smart Specialisation Strategy Monitoring" (2018)[9];
- World Bank research on the management of higher education and development of academic personnel (2018)[10];
- Diaspora of Latvian researchers: co-operation networks and opportunities (2018)[11].

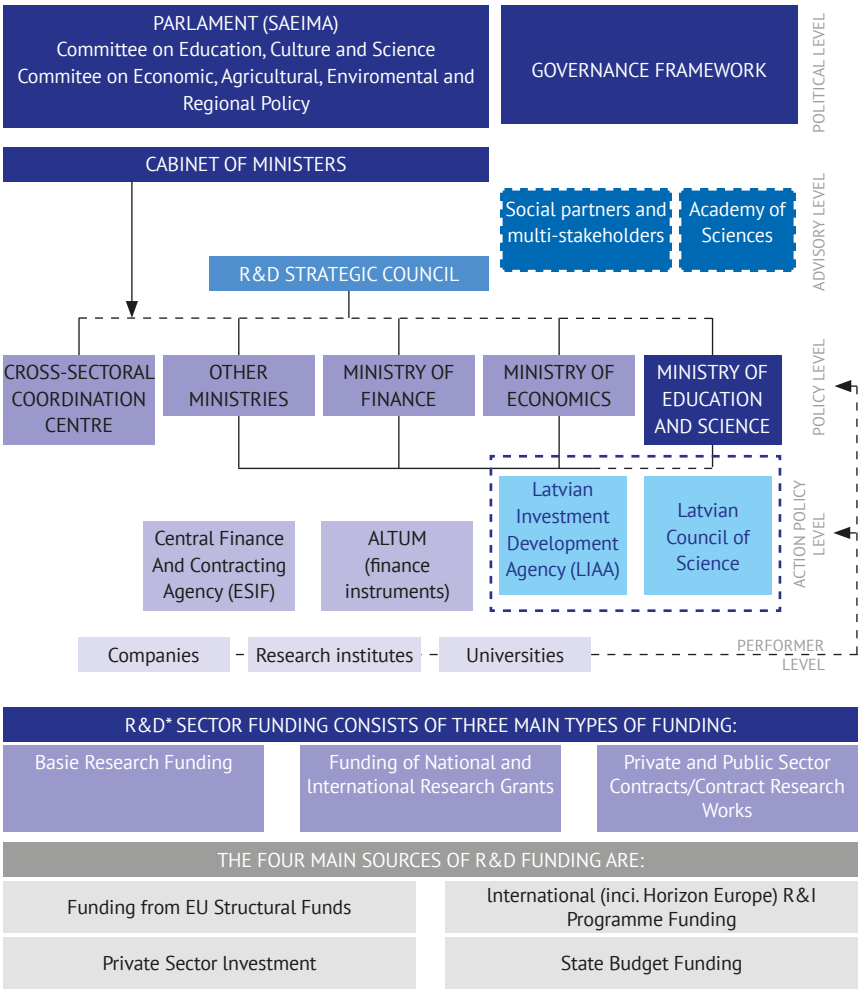
Research system in Latvia

The research system in Latvia is being developed as part of the European Research Area (ERA), implementing measures to synchronise the Latvian research system with the systems of other European Union (EU) member states and to bring the research environment and performance closer to international standards. The priority issues to be addressed within the framework of the science policy are related to the need to increase investment in R&D, promote the renewal of human capital of research and knowledge creation in all fields of science, and develop research infrastructure to increase research and innovation capacity.

Since 2015, science policy in Latvia has been developed in accordance with the Latvian Smart Specialisation Strategy *(RIS3)* to purposefully focus research and promote knowledge and technology transfer in line with sectoral growth priorities and stimulate social and economic transformation towards the more efficient use of resources and creation of new, higher value-added products and services.

Science policy is developed by the Ministry of Education and Science in accordance with national development priorities, while the institution responsible for the implementation, management, development and coordination of international policy is the Latvian Council of Science. Innovation policy, in the context of increasing business productivity and competitiveness within the framework of national industrial policy, is developed by the Ministry of Economics, which is implemented by the Latvian Investment and Development Agency in the form of various support measures. In addition, the availability of investment capital is ensured by the state development financial institution ALTUM, jointly managed by the Ministry of Economics, the Ministry of Finance and the Ministry of Agriculture **(Figure 1.1)**.

[6] Available at: https://likumi.lv/ta/id/315685-par-konceptualo-zinojumu-par-jauna-doktoranturas-modela-ieviesanu-latvija
[7] Available at: https://eur-lex.europa.eu/legal-content/LV/TXT/HTML/?uri=CELEX:52020SC0513&from=EN; https://eur-lex.europa.eu/legal-content/LV/TXT/PDF/?uri=CELEX:52020DC0500&from=EN
[8] Available at: https://ec.europa.eu/info/sites/info/files/file_import/2019-european-semester-country-report-latvia_lv.pdf
[9] Available at: http://polsis.mk.gov.lv/documents/6682
[10] Available at: https://www.izm.gov.lv/lv/izglitiba/augstaka-izglitiba/augstakas-izglitibas-finansesanas-modelis/pasaules-bankas-petijums-par-augstakas-izglitibas-parvaldibu
[11] Available at: https://www.izm.gov.lv/lv/media/4687/download



* Research and development

Figure 1.1. Latvian science and innovation policy management framework.

Research Institutions

Latvia's R&D system is very diverse. There are 60 research institutions registered in the Register of Research Institutions of Latvia (01.04.2021), a third of which are financed from the state budget (12 universities, 10 research institutes).

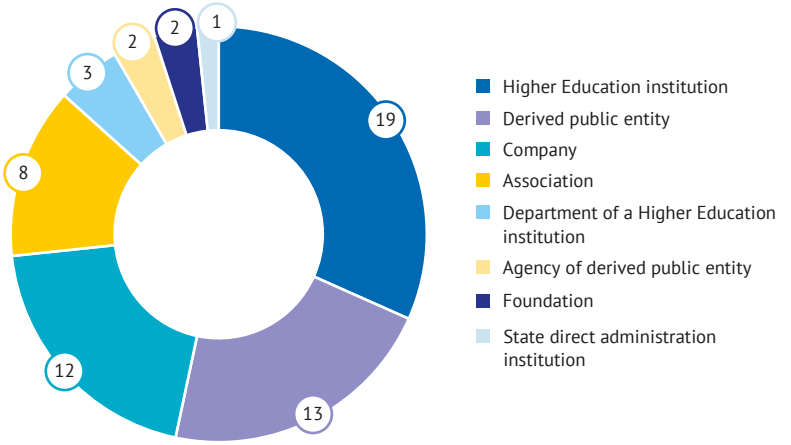


Figure 1.2. Distribution of scientific institutions by type (Source: NRIS)

Research institutions in Latvia differ both in legal form **(see Figure 1.2)** and institution size, functional and management structure, as well as in research capacity and thematic specialisation of scientific activity, which still maintains the topical issue of the most successful models and the need to reduce the fragmentation of the R&D system.

Data sources and methodology used

The review is prepared for the period from 2008 to 2019 (or until the latest available year). Regarding Latvia's participation in Horizon 2020, data for the period from 2014 to January 2020 are used. The report uses data from the following databases – *Web of Science* and/or *Scopus*, Eurostat, CSB, NRIS, NEIS and Cordis.

The section "Research funding" of the report uses the data available in the CSB and Eurostat databases for the period from 2008 to 2018 (the last available year).

The section "Human Capital of Research" of the report uses the data available in the CSB, Eurostat and NRIS databases for the period from 2008 to 2018 (the last available year).

The section "Research Results" and "International Cooperation" of the report uses the data from the *Web of Science* database for the period from 2008 to 2019, using the In Cites analytics tool.

The section "Research Productivity" of the report uses the data available in the *Web of Science* database for the period from 2008 to 2019, processing them in the In Cites analytics tool, as well as the Cordis database data on the success of "Horizon 2020" for the period from 2014 until January 2021.

2 Research funding

Research in Latvia receives funding from the state budget, international research grants, and from the commercial sector, etc. Over the last ten years, Latvia's R&D funding, both in absolute terms and as a percentage of GDP, has been low but relatively stable. In 2019, for the first time since 2009, R&D funding in absolute numbers has exceeded the level of 2008 "before the economic crisis", mostly due to state budget funding. Latvia's R&D investment (% of GDP) accounts for about 30% of the EU-28 average investment level and has remained stable over the last 10 years; no increase to equalise with the EU average level is seen. Compared to the other EU-28 Member States, Latvia has the fourth lowest investment in R&D, with Latvia slightly ahead of Lithuania (22nd place) and Estonia (13th place).

The amount of R&D funding has a critical impact on the growth and long-term development of R&D human capital, the quality of R&D, the provision of effective knowledge and technology transfer, and the capacity to successfully engage in international co-operation networks. The amount of R&D funding is one of the main systemic challenges that Latvia needs to address in order to ensure that R&D can become a significant stimulus for national economic transformation.

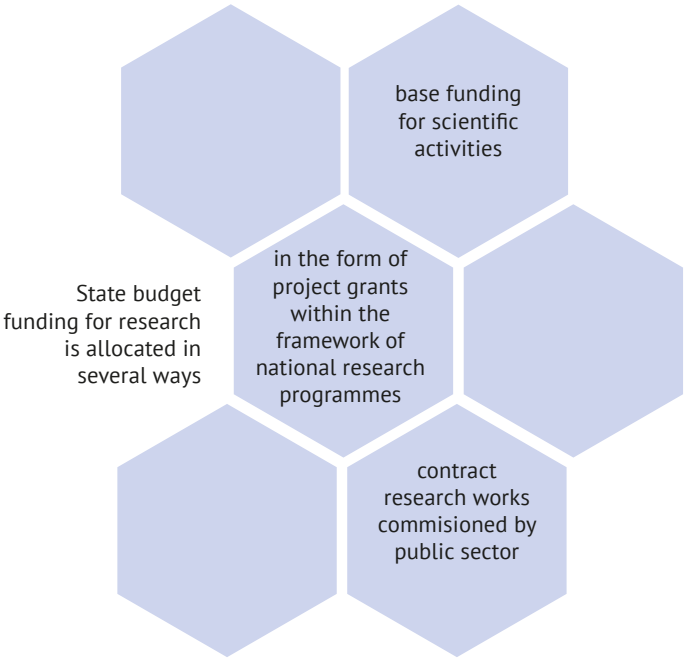
Expenditure on R&D covers all expenditure that ensures the implementation of the research process – both the scientific personnel remuneration and the scientific and technical and service personnel remuneration, as well as the expenditure on infrastructure maintenance, renewal, etc.

R&D sector funding consists of three main types of funding:

Scientific activity base or institutional funding	Funding of national and international research grants	Private and public sector contracts/contract research vorks

The four main sources of R&D funding are:

- Funding from EU structural fonds
- Foreign (incl. Horizon Europe) R&I programme funding
- Comercial sector investment
- State budget funding



Base funding of scientific work – funding granted to research institutions by the founder for the maintenance of the material and technical support of research institutions, remuneration of scientific personnel, preparation of research results for commercialisation and reaching of other targets determined in the operational strategy of the research institution.

Research project grants are provided within the framework of two state budget research programmes: *fundamental and applied research programmes (FARP) and National Research Programmes* (NRP) for solving issues specific to the development of sectors. In 2017, changes were introduced in the implementation of the FARP programme, ensuring the organisation of annual project tenders and international expertise for the evaluation of project applications. Since 2018, when changes were made to the regulatory framework, line ministries have had the opportunity to place an order with the research sector, implementing national research programmes to study and address issues relevant to the sector.

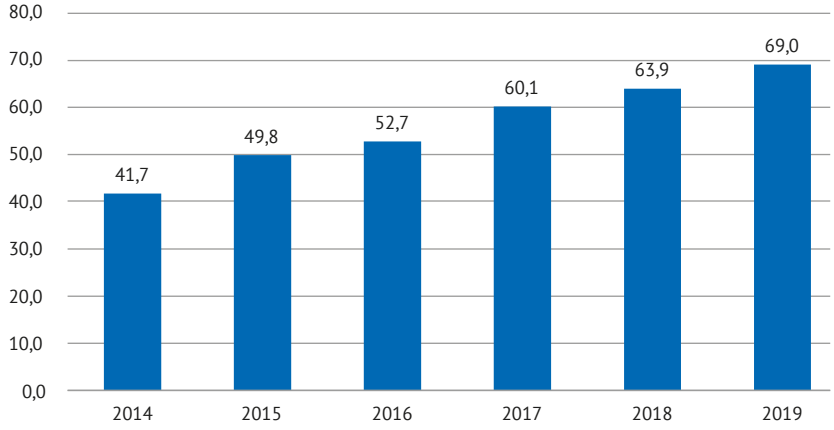


Figure 2.1. Total state budget R&D investment (million euros) (Source: CSB)

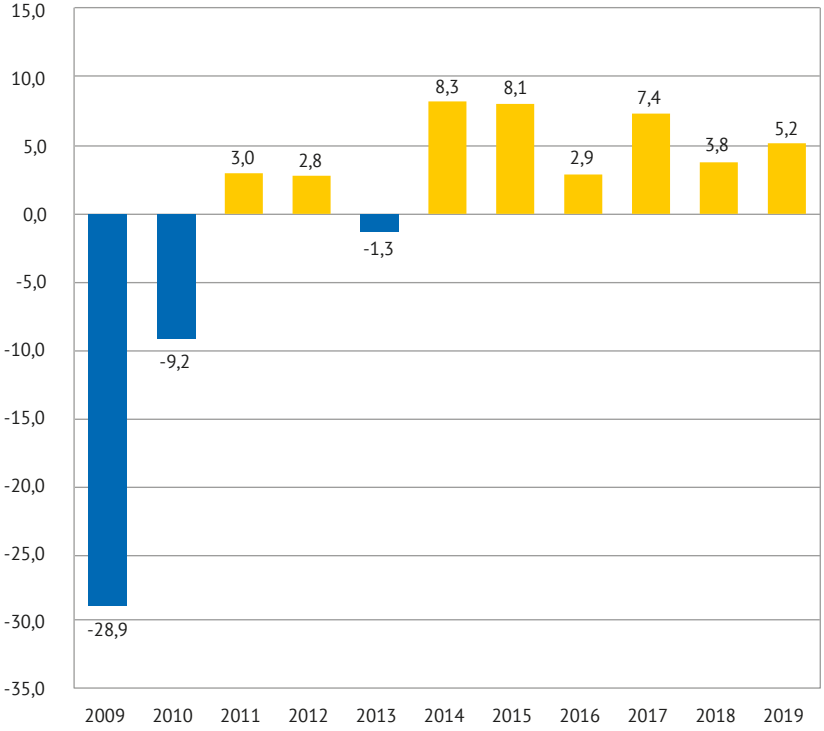


Figure 2.2. Changes in state budget R&D investment year over year (million euros) (Source: CSB)

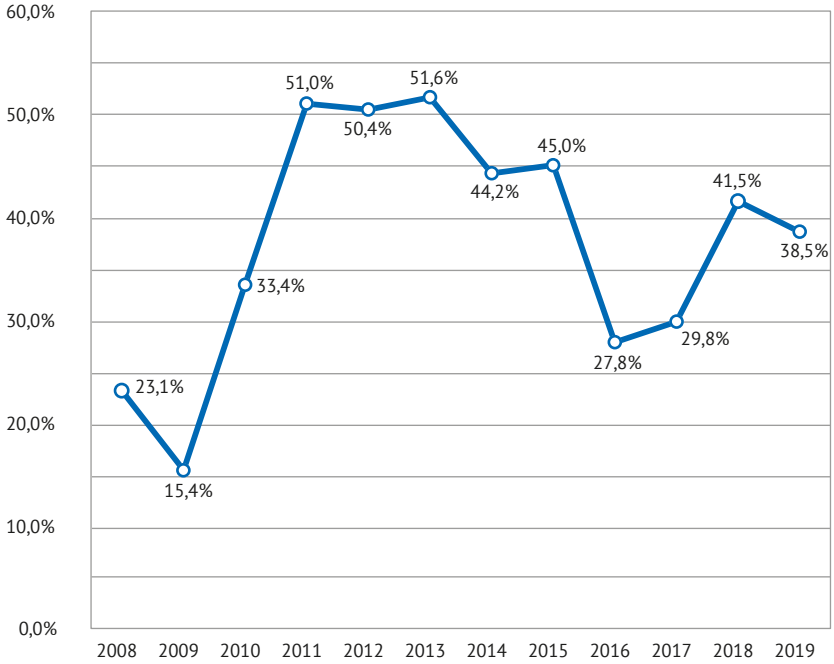


Figure 2.3. Total foreign R&D investment (% of total R&D investment) (Source: CSB)

In recent years, Latvia's R&D funding has been low but relatively stable both in absolute terms and as a percentage of GDP **(Figure 2.4)**. Since the lowest level of funding as a percentage of GDP in 2016, which was mainly related to the decrease in EU structural fund investments, the amount of R&D funding has significantly increased, promoting the development of more intensive research processes. On the other hand, since 2014, when the scientific base funding was significantly increased, there has been an increase in funding for research in the state budget every year **(see Figure 2.2)**.

In turn, foreign funding for Latvian R&D fluctuates from year to year and in some years it plays a significant role in the total amount of Latvian R&D funding due to the persistently low state budget and corporate R&D investment **(see Figure 2.3).** In recent years, there has been a tendency to gradually reduce the dependence of the Latvian R&D system on foreign (EU funds) funding. This marks a continuation of the positive trend towards a more stable R&D system, as, for example, between 2010 and 2012, more than half of R&D funding was foreign (EU funds) funding.

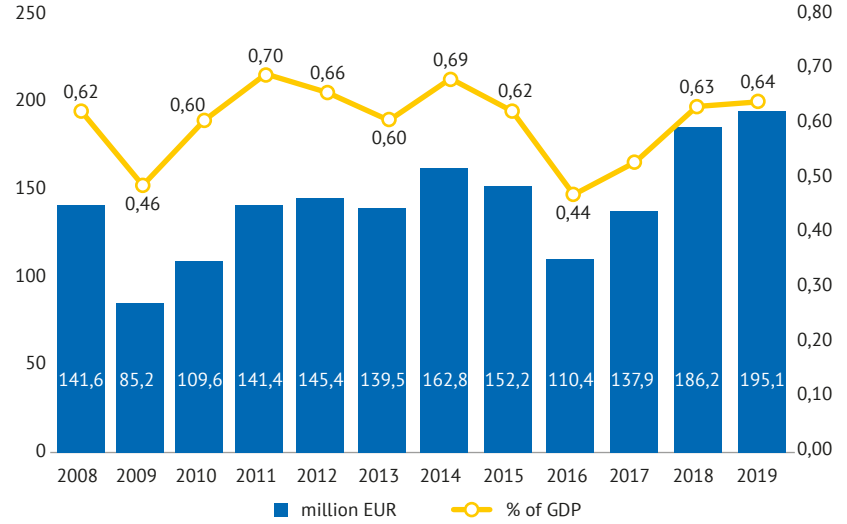


Figure 2.4. R&D intensity or total R&D funding, 2008-2019 (Source: CSB)

Compared to the other EU-28 Member States, Latvia has the fourth lowest investment in R&D **(Figure 2.5)**. In recent years, Latvia has been able to slightly improve its situation (in 2016, Latvia was 27th among the EU-28 countries in terms of R&D investment, % of GDP), but this is one of the main systemic challenges that Latvia needs to address to enable R&D to become a significant stimulus for national economic transformation.

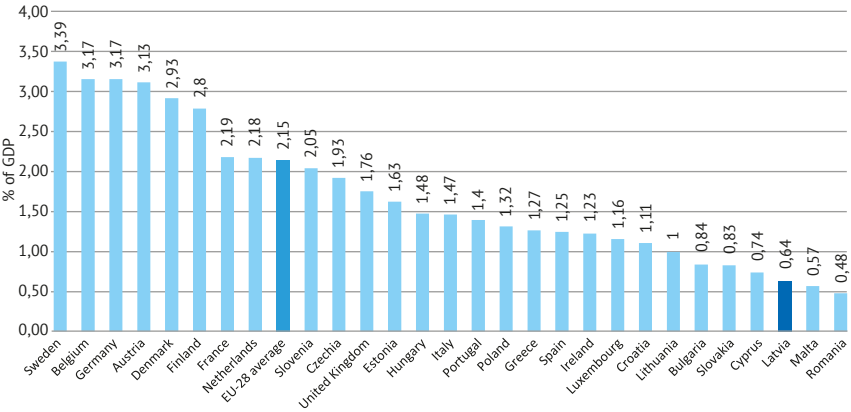


Figure 2.5. Expenditure on research in the EU-28 countries in 2018 (% of GDP) (Source: *Eurostat*)

Latvia's R&D investment (% of GDP) remains unchanged at around 30% of the EU-28 countries average, and no significant increase is currently taking place **(Figure 2.6.).** It has a critical impact on the growth and long-term development of R&D human capital, the quality of R&D, the provision of effective knowledge and technology transfer, and the capacity to successfully engage in international co-operation networks.

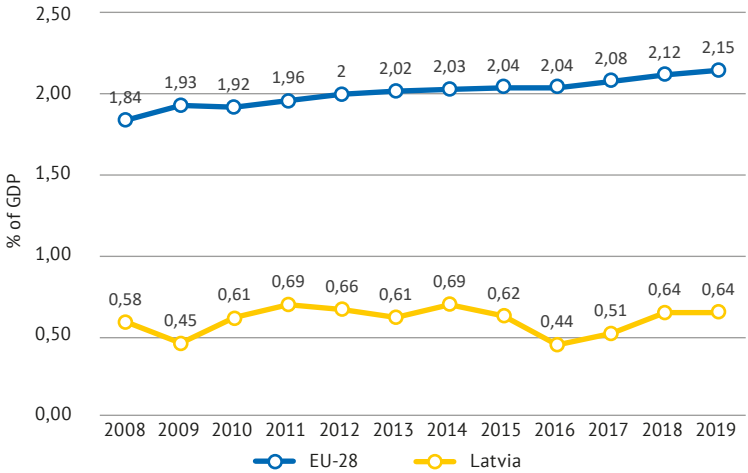


Figure 2.6. Investment in R&D in Latvia and on average in the EU-28 countries, 2008-2018 (% of GDP) (Source: *Eurostat*)

2.1. Investment in R&D by sector

In Latvia, scientific research measured by the amount of investment in R&D is mostly carried out in public sector institutions, mainly higher education institutions and the scientific institutions under their supervision, whose role has increased in recent years due to the consolidation of scientific institutions. Private sector R&D activities account for about a quarter of total Latvian R&D investment and have a downward trend. In recent years, the volume of public R&D investment in Latvia has gradually increased from a relatively low position, mainly due to the investment of EU structural funds.

Investment in R&D is divided into three sectors:

1. **higher education** – higher education institutions which carry out research and scientific institutions under the supervision of these higher education institutions;
2. **state** – non-university research institutions, mainly state research institutes;
3. **business sector** – merchants (individual merchants and commercial companies) whose main activity sectors according to *NACE* Rev. 2 corresponds to sections A to T; data on scientific research work in companies are obtained in a sample survey from economically active statistical units.

In Latvia, research after R&D investments is mostly carried out in public sector institutions (mainly in the higher education sector) **(Figure 2.7)**, whose role has increased in recent years. The amount of R&D investment in the higher education sector has increased due to the consolidation of scientific institutions, which was carried out after the international evaluation of scientific institutions in 2013. In the private or commercial sector, on the other hand, R&D activities are implemented to a much lesser extent than in the public sector, accounting for about a quarter of the total activities **(Figure 2.7).**

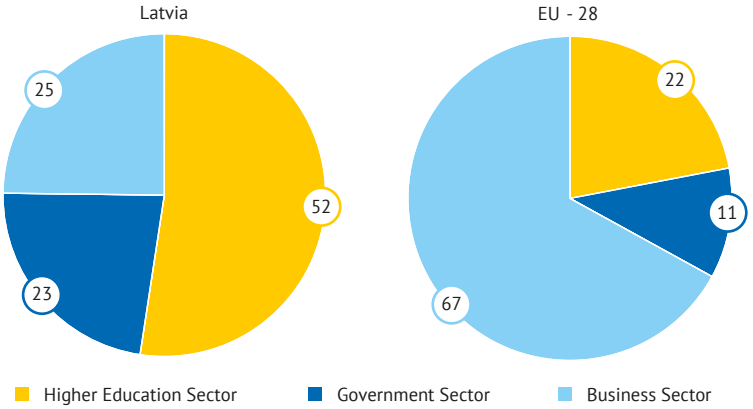


Figure 2.7. Source of funding for R&D by sector in Latvia and in EU-28 countries in 2018 (Source: CSB, *Eurostat*)

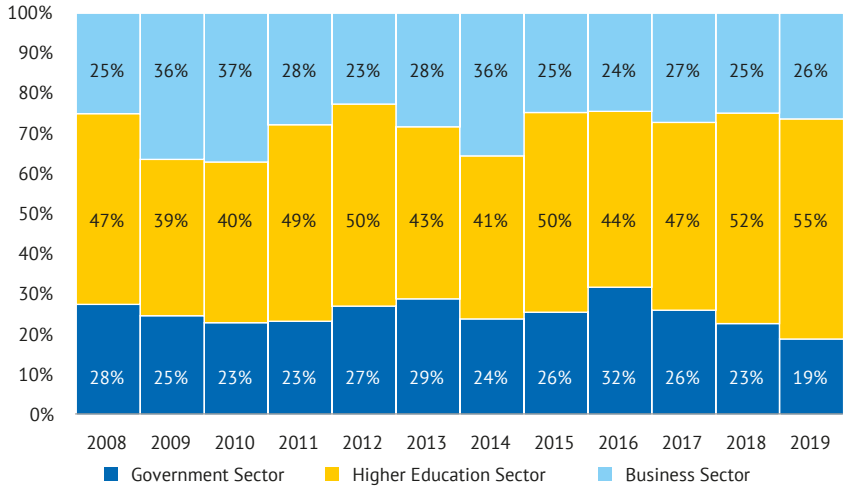


Figure 2.8. Investment in R&D 2008-2018 by sector in Latvia (% of total) (Source: CSB)

In recent years, the volume of public R&D investment in Latvia has gradually increased from a relatively low base, mainly due to investment from EU Structural Funds **(Figure 2.3).** In turn, the share of business sector investment in R&D in Latvia has been fluctuating, but in absolute terms, the amount of business investment has increased from the lowest level in 2016 and, compared to the level in 2016, it doubled in 2019. This is a positive signal for economic transformation processes, but Latvia is still one of the countries in the EU with one of the lowest business investments in R&D.

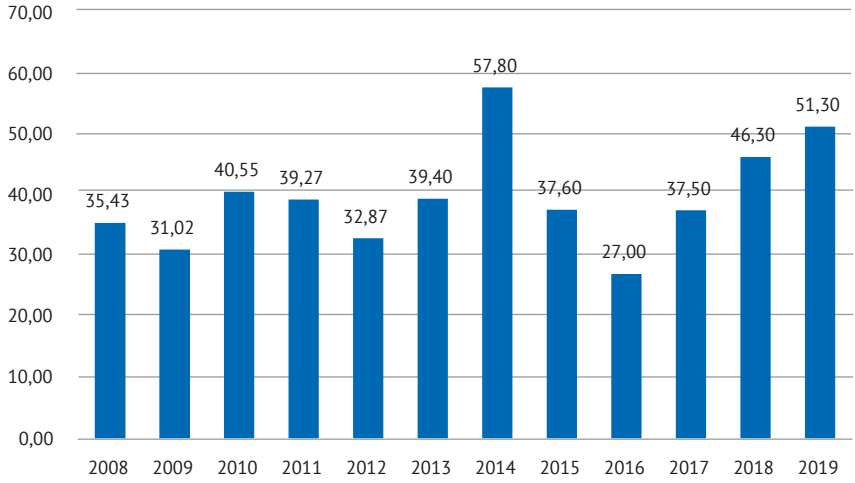


Figure 2.9. Investment in Business Sector (million euros) 2008 - 2019 (Source: CSB)

2.2. R&D funding and employment

The amount of R&D funding per 1 researcher in terms of FTE is similar in both the public and business sectors, while it is significantly lower in the higher education sector **(Figure 2.8)**. This is partly due to the different profile of R&D fields among sectors – the business sector and the public sector have a greater focus on cost-intensive groups – science, engineering and medicine, while social sciences and humanities play a key role in the higher education sector. At the same time, investment in R&D as a whole and in terms of FTE per researcher has increased in recent years**.**

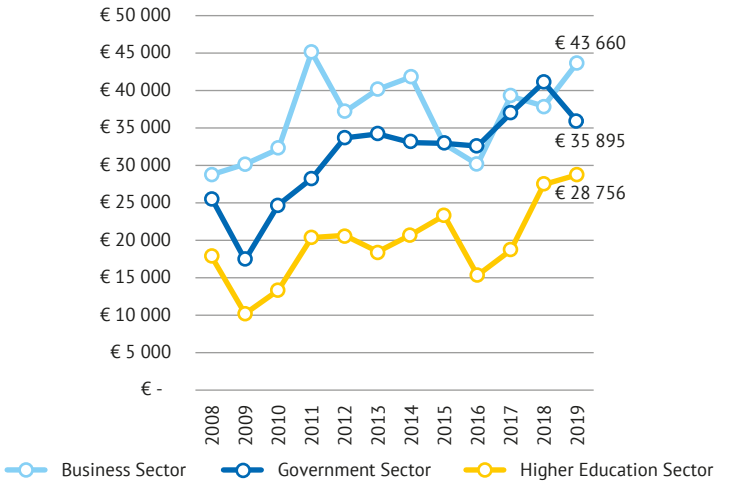


Figure 2.10. Investment in R&D 2008-2018 per researcher in terms of FTE by sector (Euro) (Source: CSB)

Compared to the EU-28 countries, Latvia has one of the lowest R&D investments per researcher in terms of FTE (33% of the EU-28 average). Thus, researchers in Latvia have significantly more limited opportunities to implement top-level R&D projects compared to other EU Member States. Low investment in R&D is a significant factor in the migration of the most talented Latvian researchers to other countries.

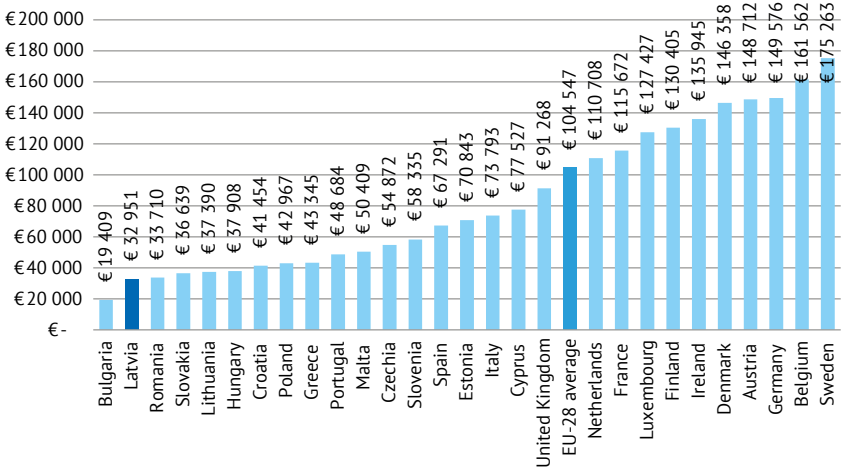


Figure 2.11. Total R&D investment in 2018 in the EU-28 per 1 researcher in terms of FTE (Source: *Eurostat*)

3 Human capital of research

The main key to the contribution of Latvian science to the country's growth is human capital of research, which includes all those employed in research with skills, knowledge and creative abilities that are able to create social or economic value. The low public and private demand for research over the last decade has not been conducive to a stable replacement of human capital of research.

The number of employees in scientific research is measured by two parameters:

1. Number of scientific personnel	number of scientific personnel in individual units
2. Number of researchers in terms of FTE	number of researchers formed by summing workloads according to normal working hours individual units

The number of scientific personnel (scientific personnel, scientific technical personnel, scientific service personnel and other scientific personnel) has fluctuated since 2008 and has increased slightly in recent years **(Figure 3.1).** In recent years, the increase in the number of people working in scientific research does not indicate fully-fledged career opportunities, as the number of part-time employees has increased significantly since 2008 – from 61% in 2008 to 75% in 2018. The average workload of researchers in research work in 2019 is less than 0.5 FTE and only 24% are full-time researchers. The number of researchers in terms of FTE has increased only slightly over the last ten years and remains lower than in 2008 **(Figure 3.1)**.

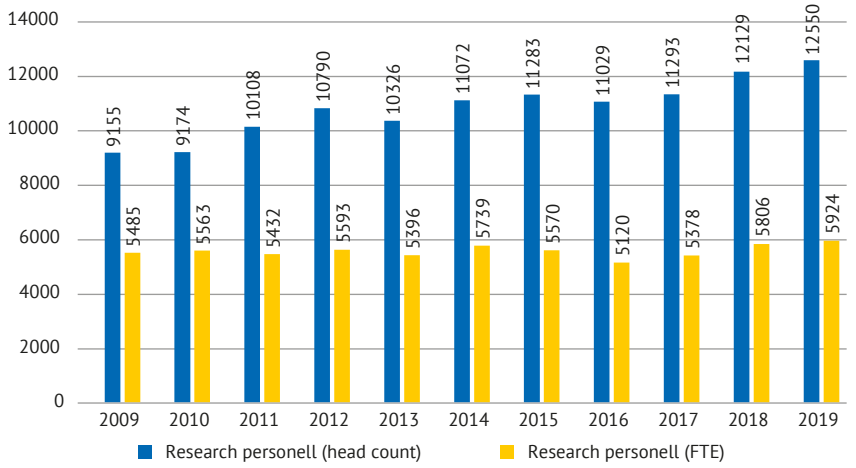


Figure 3.1. Number of researchers and number of researchers in terms of FTE from 2008 to 2018 (Source: CSB)

Comparing the share of researchers (in terms of FTE) in the total employment structure among the EU-28 countries, Latvia has one of the lowest indicators – only 0.67%, which is about 3 times less than the EU-28 average. This indicator directly reflects the structure of the Latvian economy with a particularly low proportion of researchers.

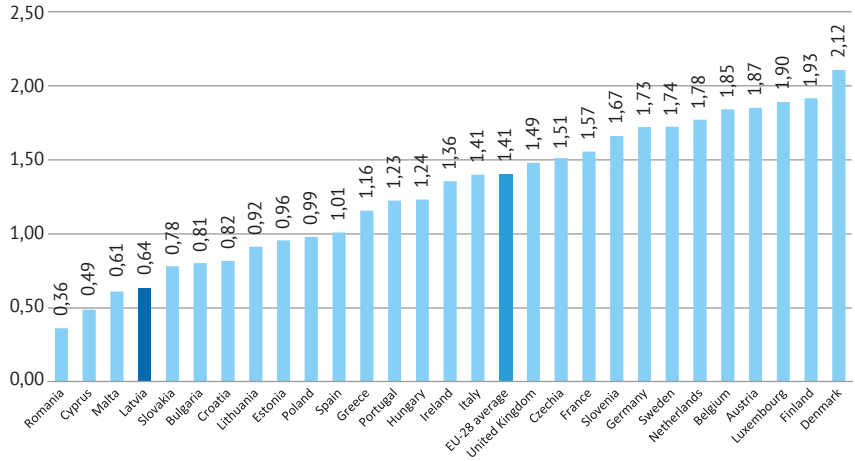


Figure 3.2. The share (%) of number of researchers (in terms of FTE) in the total employment structure in the EU-28 in 2018 (Source: *Eurostat*)

Over the last 11 years, the number of researchers in terms of FTE by sector has fluctuated slightly, with the majority employed in universities (95% of them in public universities), while less than 40% are employed in companies and research institutes combined **(Figure 3.3).**

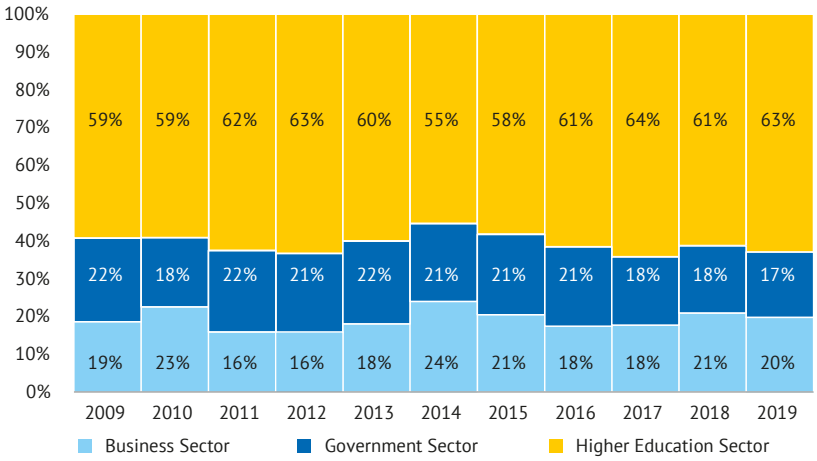


Figure 3.3. Proportion of researchers (%) in terms of FTE by sectors (Source: CSB)

The highest share of employees in scientific research work in terms of FTE is in the fields of natural sciences and engineering sciences and technology **(Figure 3.4)**. In the natural sciences field, the number of scientific personnel is higher in the higher education and public sector, while in the engineering sciences and technology field – in the business sector **(Figure 3.5)**.

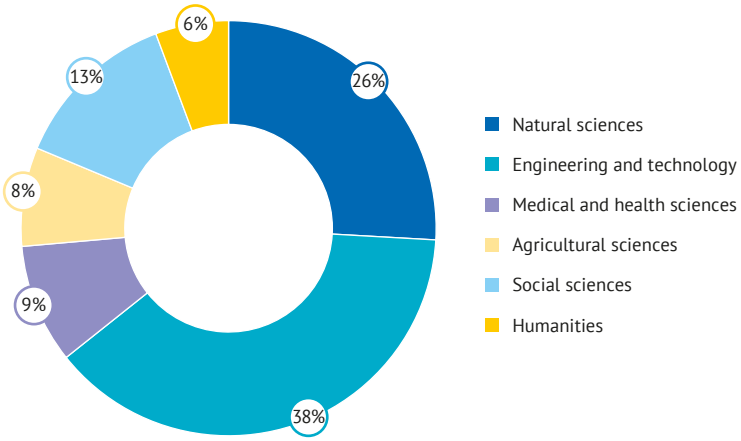


Figure 3.4. Proportion of researchers in Latvia in terms of FTE by fields of science in 2018 (Source: CSB)

The high share of scientific personnel in the engineering sciences and technology field in the business sector indicates the potential for economic transformation and opportunities for the future development of new, innovative and competitive high and medium-high technology fields in the business sector.

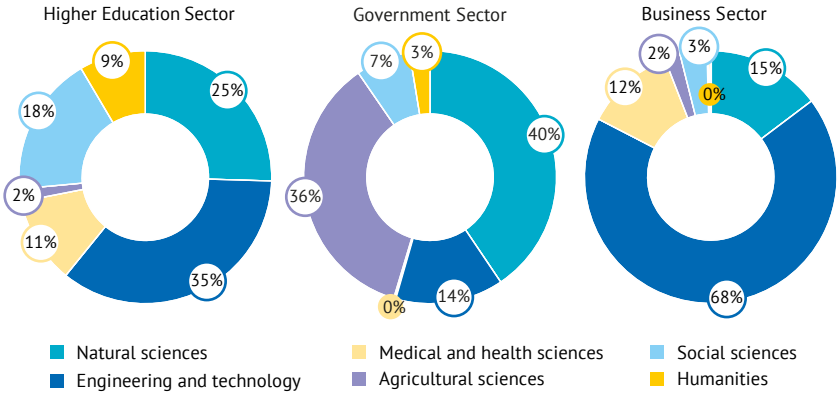


Figure 3.5. Number of researchers in terms of FTE by science fields and sectors in 2018 (Source: CSB)

In general, the gender composition in the structure of scientific personnel is equal, however, in terms of sectors, a higher proportion of women is observed in the public sector (public and higher education sector), but a higher proportion of men in the business sector **(Figure 3.6)**. There are also differences in the gender composition among the fields of science **(Figure 3.7)**, where there is only an equal gender composition in the field of natural sciences.

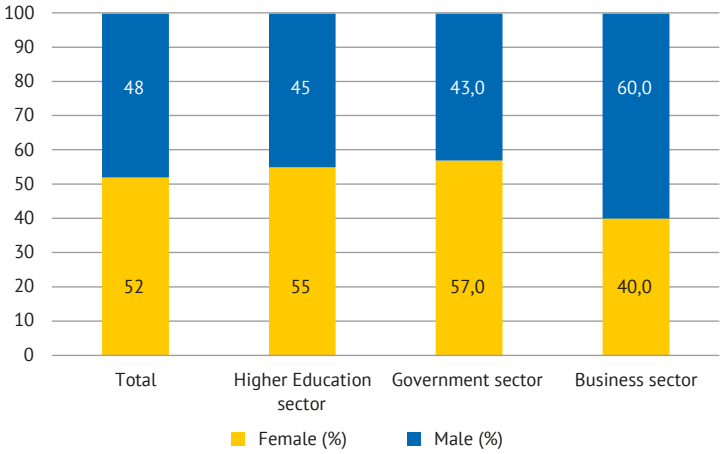


Figure 3.6. Number of researchers in FTE by gender and sector of employment in 2018 (Source: CSB)

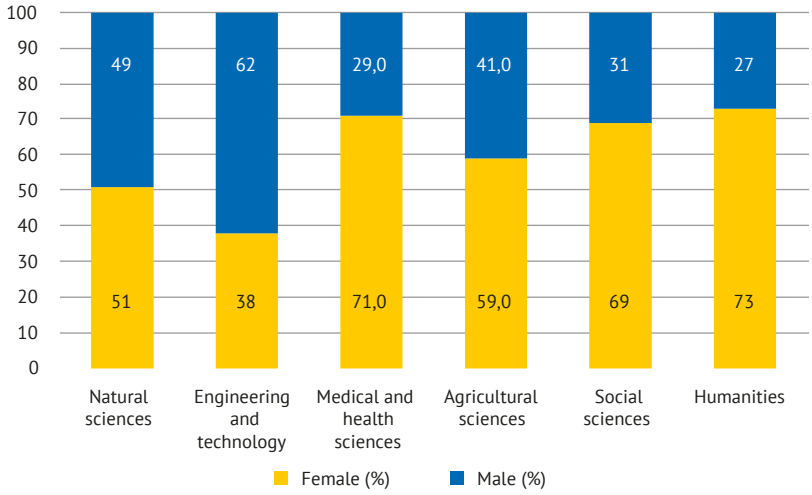


Figure 3.7. Proportion of researchers (in terms of FTE) by gender and field of science in 2018 (Source: CSB)

The largest age group of researchers is between the ages of 25-44, which has been largely facilitated by the EU Structural Funds scholarships for doctoral students in 2008-2015, promoting the slow but growing renewal of scientific personnel. The majority of scientific personnel, by elected scientific positions, consists of leading researchers and researchers **(Figure 3.8)**, where according to the Law on Scientific Activity, persons with a doctoral degree can be elected to the position of a leading researcher, and persons with a doctoral or master's degree can be elected to the position of a researcher.

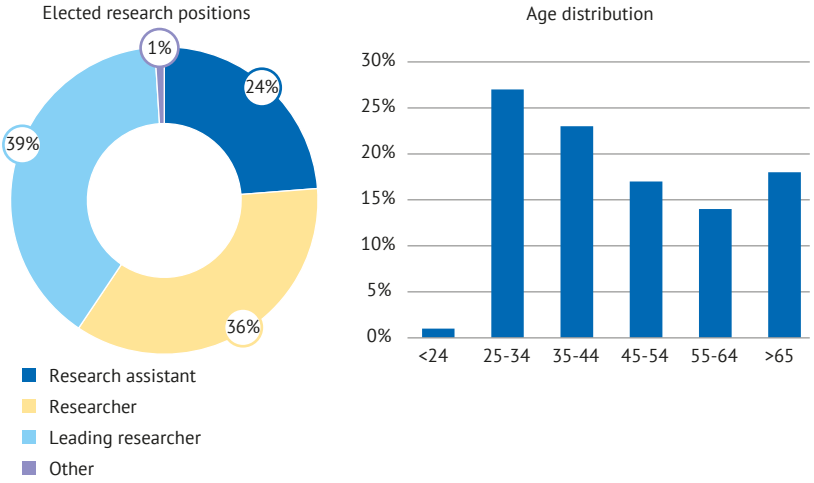


Figure 3.8. Distribution of elected scientific personnel by positions and total age structure in 2018 (Source: NRIS) *Data available from NRIS on elected scientific personnel in 2018 have been used. The data do not include information on elected scientific personnel employed during normal and part-time work, but show a general trend in the structure of elected scientific personnel).

The renewal of research personnel has long been hampered not only by low investment in R&D, but also by a historically separate system of doctoral studies, which has influenced the fact that the proportion of doctoral students and graduates in Latvia has long been lower than the EU-28 average. In the period from 2010 to 2014, a faster increase in the number of doctoral graduates was facilitated by EU structural fund scholarships **(Figure 3.9)**.

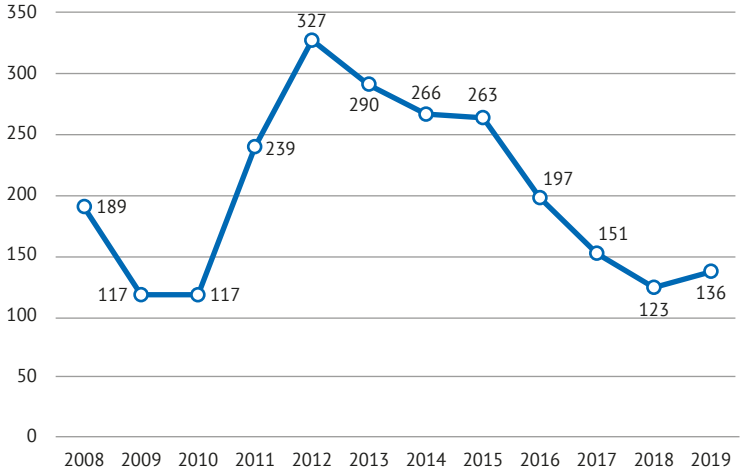


Figure 3.9. Trend of doctoral graduates from 2008 to 2019 (Source: MES report on higher education)

4 Research results

The research results are reflected in a measurable way through the dissemination of knowledge and data created within the framework of implemented R&D projects to the research community and society in the form of scientific publications on a national or international scale, which also shows international cooperation links and international competitiveness of Latvian research.

4.1. Publications

The number of scientific publications in internationally indexed journals is one of the most visible and quantifiable indicators of scientific activity. In terms of the total number of publications, a rapid increase can be observed starting from 2013, reaching the maximum number in 2017 – 2560 publications **(Figure 4.1)**.

It should be noted in particular that the number of scientific articles has significantly increased in the last 5 years, while the number of articles in conference proceedings has decreased 2 times since 2017, which correlates with the introduced quality requirements for R&D project selection **(Figure 4.2)**.

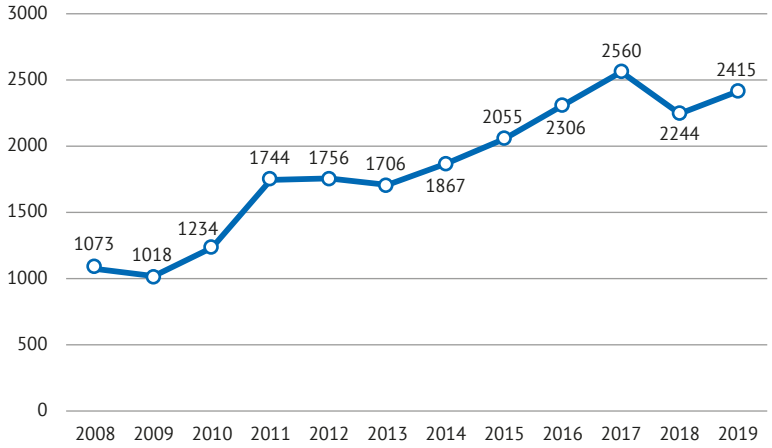


Figure 4.1. Trend of the number of Latvian publications in the period from 2008 to 2019 (Source: *Web of Science*)

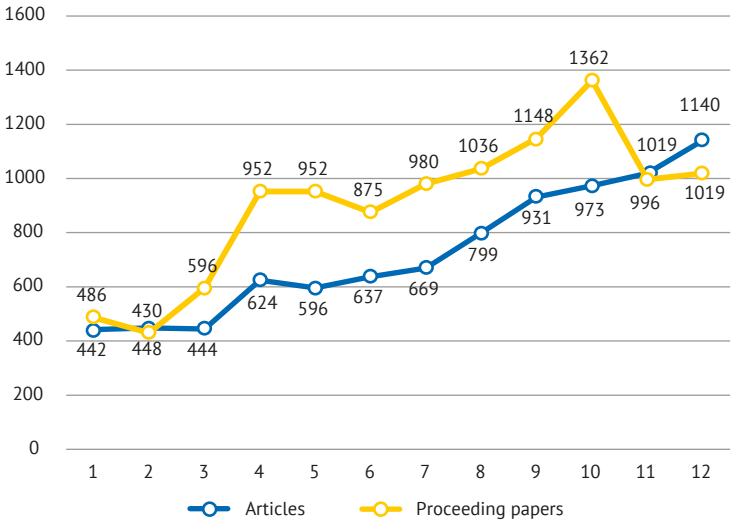


Figure 4.2. Trend of the number of Latvian scientific articles and articles in conference proceedings in the period from 2008 to 2019 (Source: *Web of Science*)

The share of open access scientific publications, i.e. publications available to readers free of charge, has significantly increased in the total number of scientific publications. For example, the share of open access publications in the *Web of Science* database has increased 2.2 times since 2016, surpassing the EU-28 average by 11% **(Figure 4.3),** incl. ranking 1st among the EU-28 in terms of the proportion of publications published in Gold Open Access journals[12].

[12] https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor/trends-open-access-publications_en

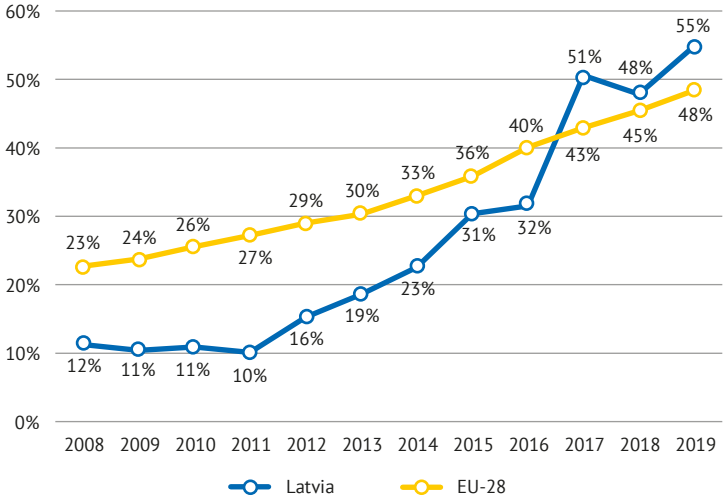


Figure 4.3. Proportion of open access publications in Latvia and the EU-28 average from 2008 to 2019 (Source: *Web of Science*)

Comparing publishing trends among scientific fields, the number of publications has increased the most in Natural Sciences **(Figure 4.4)**, but this is largely related to the Memorandum of Cooperation between Latvia and the European Organisation for Nuclear Research (CERN) concluded in 2015 [2], where, taking into account the international nature of the research carried out, the authors of the relevant scientific publications include all representatives of the participating countries. There has been a steady increase in the number of publications in the Medical and Health Sciences sector, but the number of publications has remained low in humanities and agricultural sciences, while engineering and technology and social sciences have the most pronounced annual fluctuations.

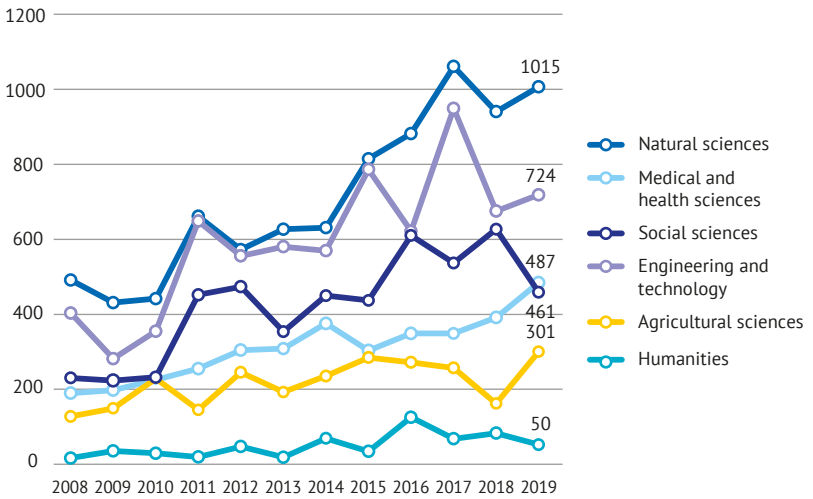


Figure 4.4. Trends of the number of Latvian publications by fields of science from 2008 to 2019 (Source: *Web of Science*)

The quality of scientific publications and the thematic relevance and the novelty of research is indicated by the proportion of scientific publications in Q1 (Top25%) journals or Top10% of the most cited journals, which also indirectly illustrate scientific excellence, recognition, reputation and international competitiveness. Since 2008, the share of Latvian publications in Q1 journals has significantly increased, reaching 50.4% in 2019 **(Figure 4.5)**, which is not only the highest among the Baltic states, but also above the EU-28 average – 48.4%. **(Figure 4.6).**

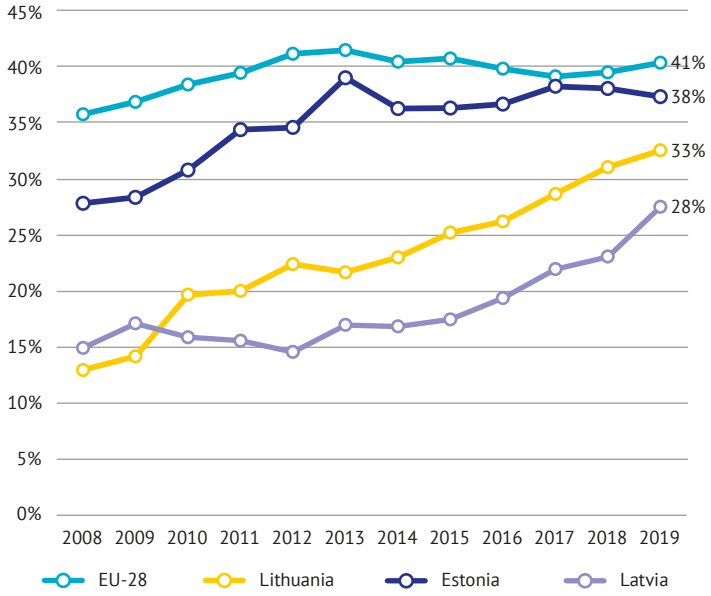


Figure 4.5. Publications in Q1 journals (%) compared to the Baltic states and the EU-28 average from 2008 to 2019 (Source: *Web of Science*)

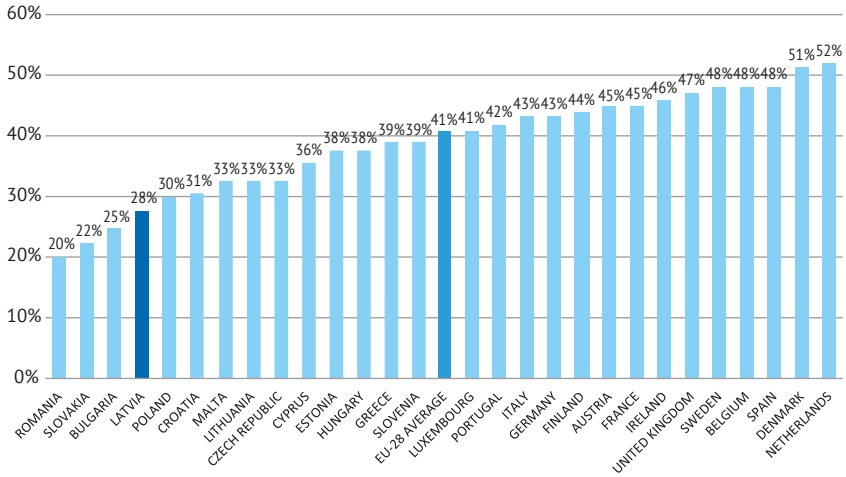


Figure 4.6. EU-28 publications in Q1 journals (%) in 2019 (Source: *Web of Science*)

Comparing the publications in Q1 journals with the average indicators of the EU-28 countries in 2019, it can be seen **(Figure 4.7)** that in almost all fields of science Latvia's indicators are equal to the EU-28 average indicators, except in Agricultural sciences, where Latvia's performance lags behind the EU-28 average by about 10%.

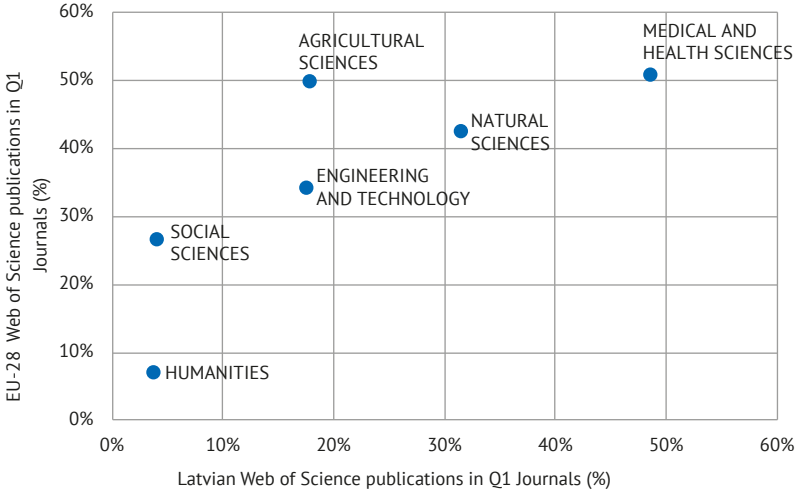


Figure 4.7. Proportion of Latvian and EU-28 publications in Q1 journals by fields of science (%) in 2019 (Source: *Web of Science*)

[1] https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en
[2] https://www.rtu.lv/lv/aef/dalinu-paatrinataju-tehnologijas/starptautiskie-projekti/fcc

4.2. International joint publications

Since 2013, the share of international joint publications has grown rapidly **(Figure 4.9)**, indicating the successful development of international cooperation projects within the framework of Horizon 2020, the European Economic Area and Norwegian financial instruments, CERN and other international research programmes **(Figure 4.10)**.

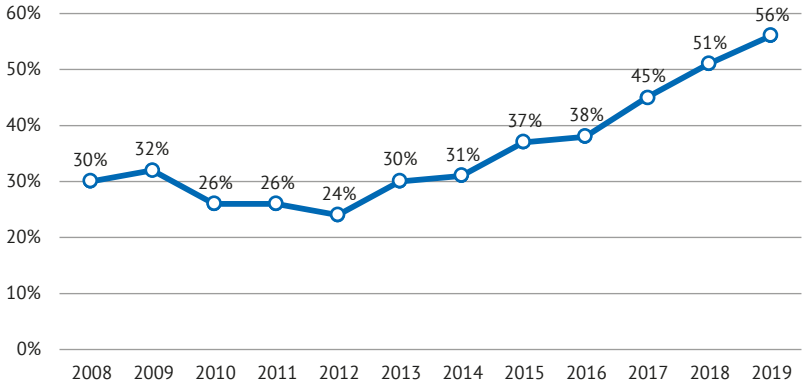


Figure 4.8. Internationally co-authored publications as a share of all publications from 2008 to 2019 (Source: *Web of Science*)

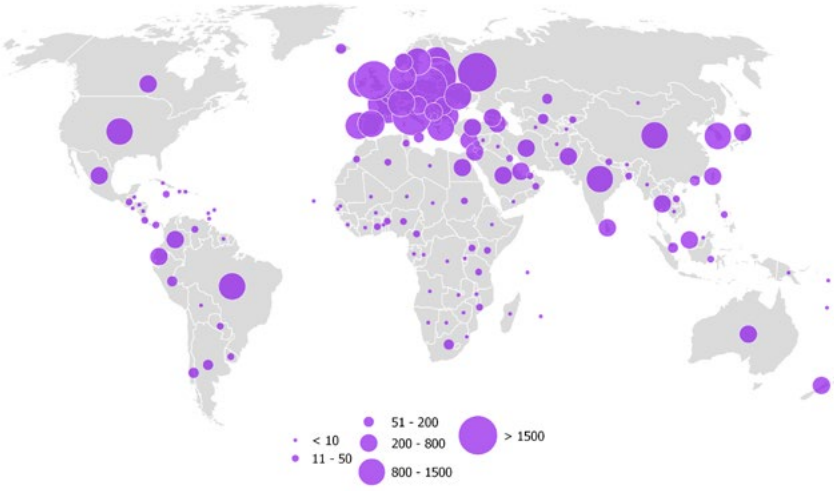


Figure 4.9. Number of Latvian international joint publications by geography from 2014 to 2019 (Source: *Web of Science*)

Latvia has had the largest number of international joint publications with countries that also include Latvian diaspora scientists – Germany, the United Kingdom, the United States, as well as with neighbouring countries – Russia and Lithuania **(Figure 4.10**). It should be noted, however, that some of the international joint publications are related to Latvia's participation in various large-scale research consortia, for example, in recent years in the fields of high-energy particle physics, resulting from Latvia's involvement in CERN research activities. Germany, which is the largest among all countries in terms of the number of joint publications, is also Latvia's leading cooperation partner in Horizon 2020, implementing 262 joint research projects in the period of 2014-2019.

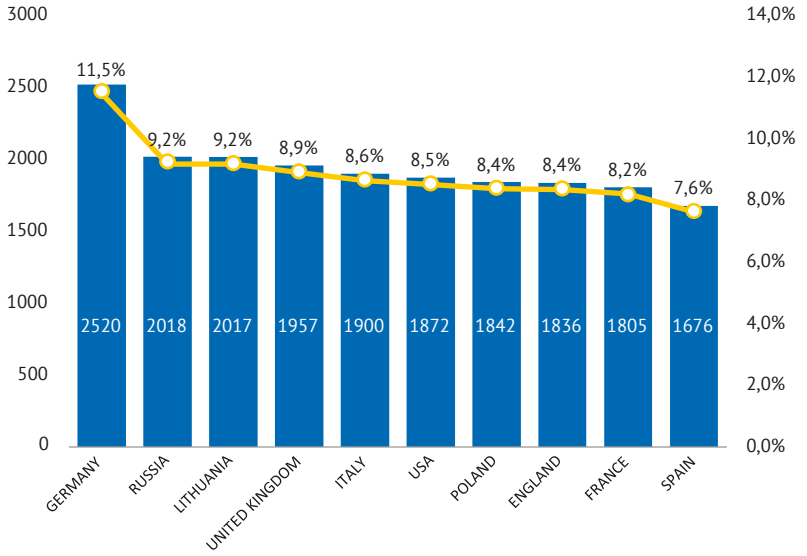


Figure 4.10. Top10 countries with which Latvia has the largest number of international joint publications from 2008 to 2019 (Source: *Web of Science*)

4.2.1. Cooperation with the countries of the Baltic Sea region

The volume of Latvia's co-operation with its neighbours – Lithuania and Estonia – has significantly increased since 2012, with the share of international joint publications increasing by approximately 5 times – from 7% in 2012 to 36% in 2019 **(Figure 4.11)**. The closest co-operation between the Baltic states has been established in the sub-fields of physics and astronomy and biological sciences, where the share of Lithuanian co-authors is 64% and 18% of the total number of publications in the field, respectively, while Estonia – 58% and 22%. Considerable co-operation between Latvia and Estonia has developed in the field of earth and environmental sciences, where the share of co-authors is 14% of the total number in natural sciences.

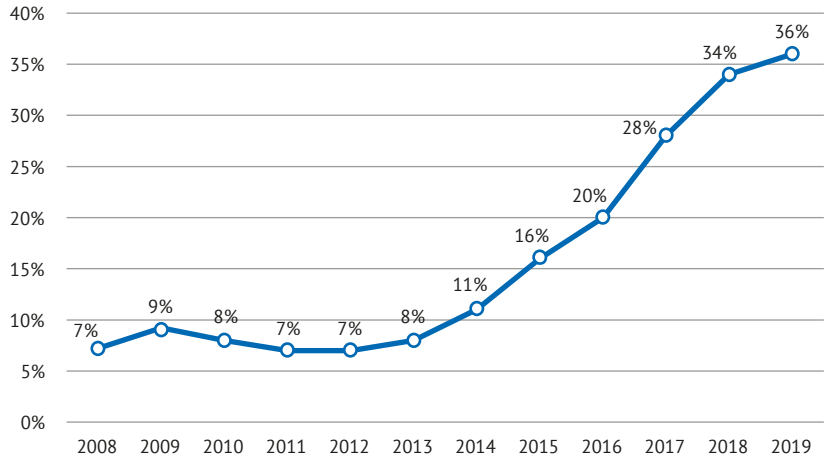


Figure 4.11. Trend of the share of Latvia's international joint publications with co-authors of the Baltic states from 2008 to 2019 (Source: *Web of Science*)

Latvia's international co-operation in research has also grown significantly within the Baltic Sea region. The highest increase in international joint publications is observed with Finland (9.3 times), Poland (9.1 times) and Denmark (7.3 times) **(Figure 4.12).** Also with the innovation leader – Sweden – the share of international joint publications in Latvia has increased by more than 3 times in 11 years – from 4% in 2008 to 13% in 2019. Although the largest share – 49% – is in Natural Sciences (leading – physics and astronomy), almost a quarter – 24% of total publications are in the field of medicine and health sciences, with the highest number of publications in clinical medicine – 57% of the total number in this field.

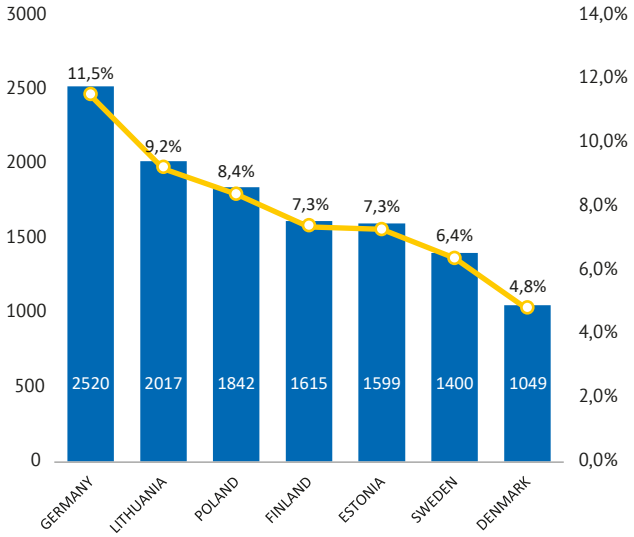
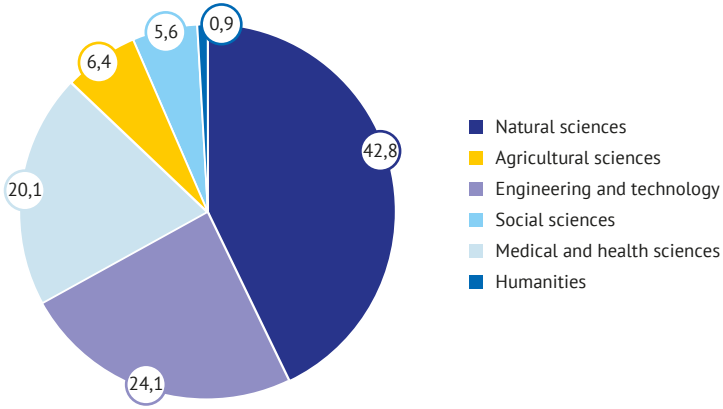


Figure 4.12. Number and share of Latvia's international joint publications with the countries of the Baltic Sea region in 2019 (Source: *Web of Science*)

In Horizon 2020, co-operation has developed in the same way for all the countries of the Baltic Sea region in the fields that address public health issues, namely health, energy and the bio-economy, and successful co-operation has been developed in the Information and Communication Technologies Thematic Group.

4.2.2. International joint publications by fields of science

Together, Latvian scientists have been authors between 2014 and 2019



The highest share of international joint publications (% of all publications of the field) is in Natural Sciences, which has increased almost 2 times during the last 11 years – from 39% in 2008 to 70% in 2019. A similar increase is observed in the field of engineering and technology, with the number of international joint publications increasing from 30% in 2008 to 58% in 2019, which is above the EU-28 average **(Figure 4.13)**.

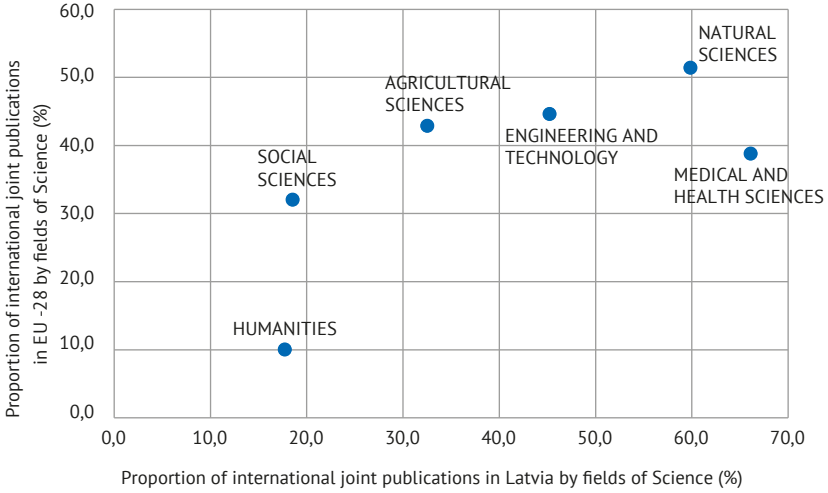


Figure 4.13. Proportion of international joint publications in Latvia and EU-28 on average by fields of science in 2019 (Source: *Web of Science*)

In the medical and health sciences, Latvia has a higher share of foreign co-authors than the EU-28 average, 68% and 40%, respectively. A similar situation is observed in the Humanities. In turn, Latvia's indicators in Agricultural Sciences and Social Sciences are below the EU-28 average.

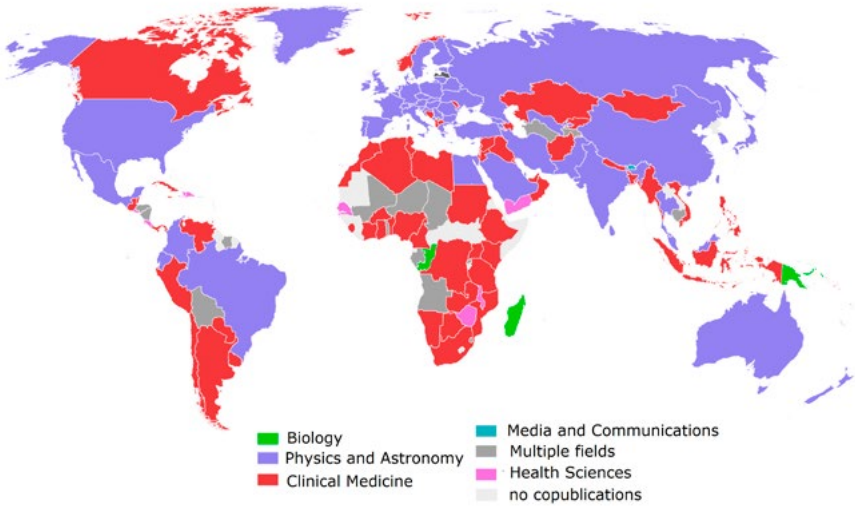


Figure 4.14. Latvia's international joint publications by the most thematically addressed field of science from 2014 to 2019 (Source: *Web of Science*)

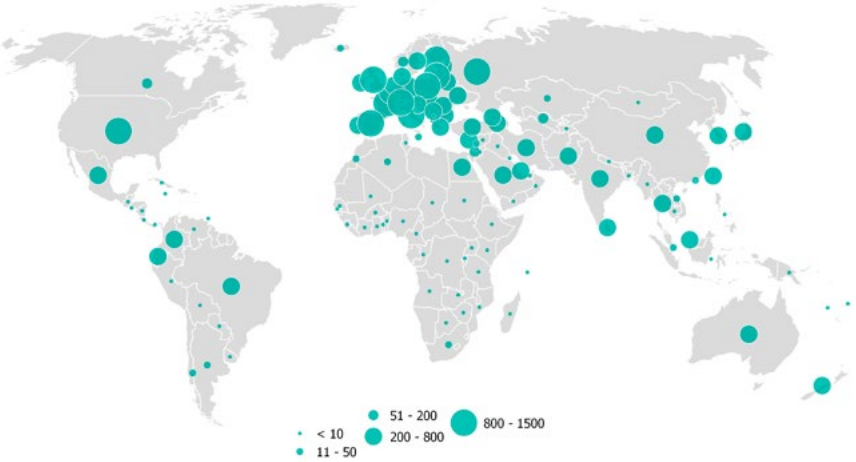


Figure 4.15. Number of Latvian international joint publications in Natural Sciences from 2014 to 2019 (Source: *Web of Science*)

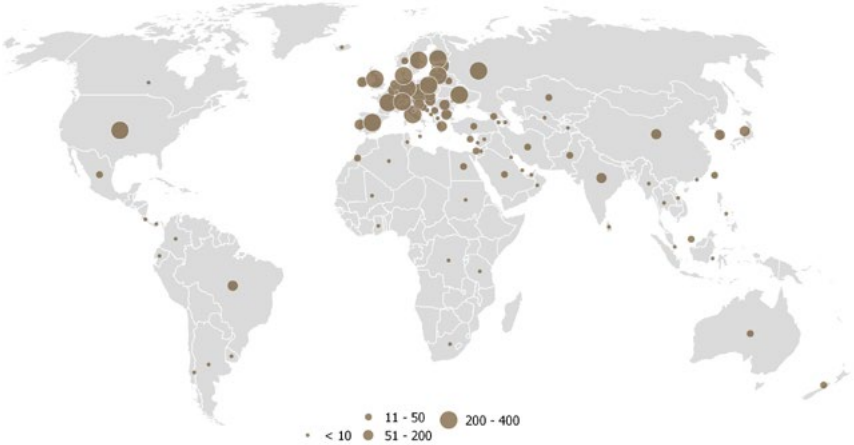


Figure 4.16. Number of Latvian international joint publications in Engineering Sciences and Technologies from 2014 to 2019 (Source: *Web of Science*)

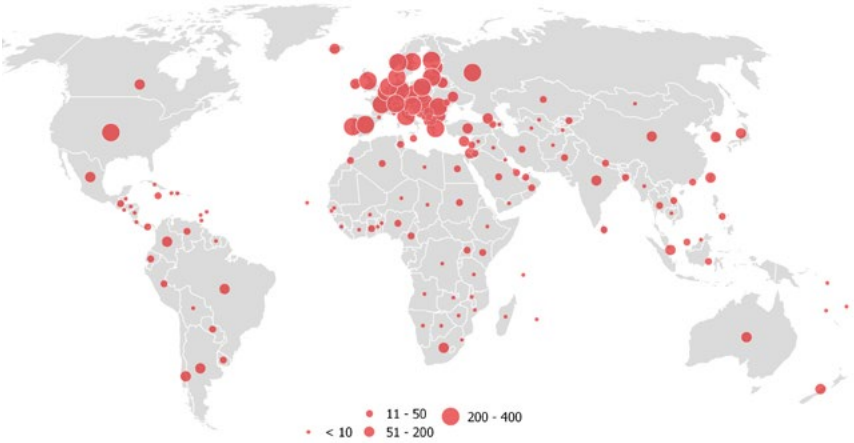


Figure 4.17. Number of Latvian international joint publications in Medical and Health Sciences from 2014 to 2019 (Source: *Web of Science*)

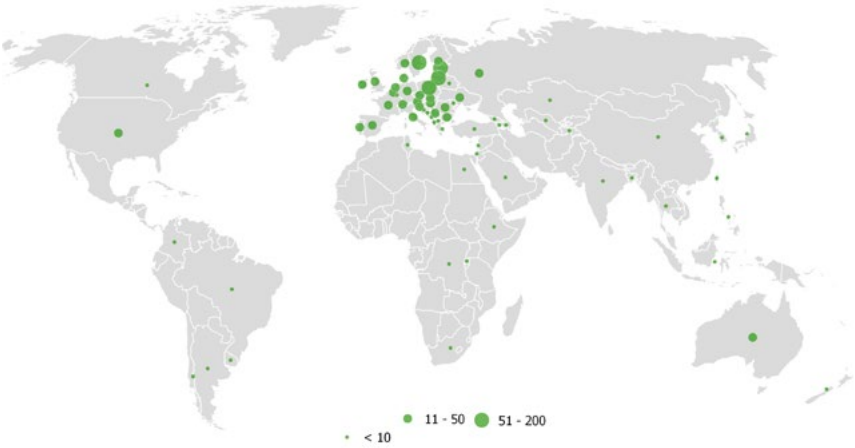


Figure 4.18. Number of Latvian international joint publications in Agricultural, Forestry and Veterinary Sciences from 2014 to 2019 (Source: *Web of Science*)

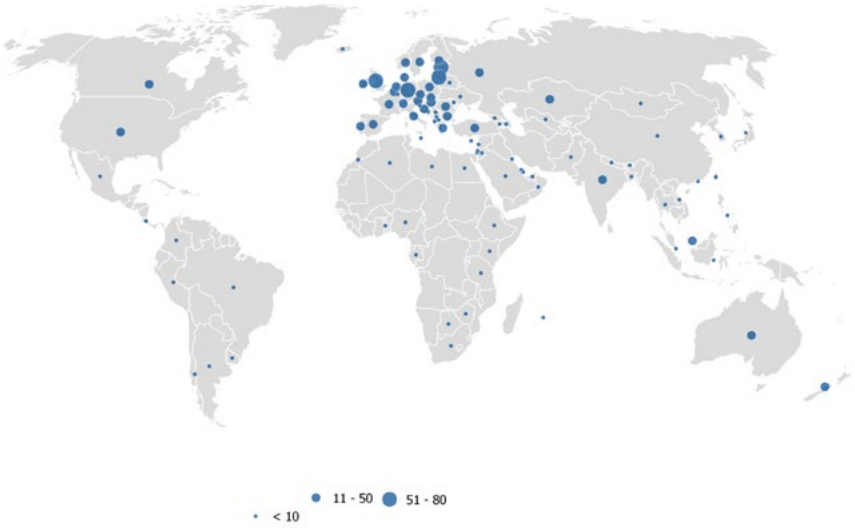


Figure 4.19. Number of Latvian international joint publications in Social Sciences from 2014 to 2019 (Source: *Web of Science*)

5 Wider research impact

Research results are understood as a variety of quantifiable and internationally comparable "Outputs", such as scientific publications, patents, etc. However, it is equally important to assess the wider added value from research or "research impact". The concept of research impact plays a particularly important role in innovation processes, incl. in social sciences and humanities, because bibliometric indicators only provide a partial insight into the added value of research, which is often created outside the academic environment[13].

The impacts of research are very diverse and difficult to measure, so peer-reviewed case studies or proxy measurements are usually used to quantify them. For example, to estimate the impact of an institution on policy, references can be tracked in policy documents where the names of researchers employed by the institution appear. Similarly, the impact on society can be estimated using data from social media or mentions in the media. Assuming that the number of viewers of the publication correlates with the impact of the publication on society, it is possible to compare data internationally from the *Scopus* database **(see Figure 5.2)**, where Latvia shows a relatively good performance.

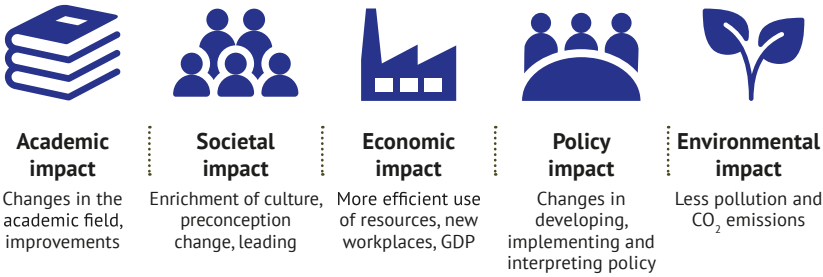


Figure 5.1. Types of research impact

[13] https://www.izm.gov.lv/images/zinatne/RIS_SHZ_0406.PDF

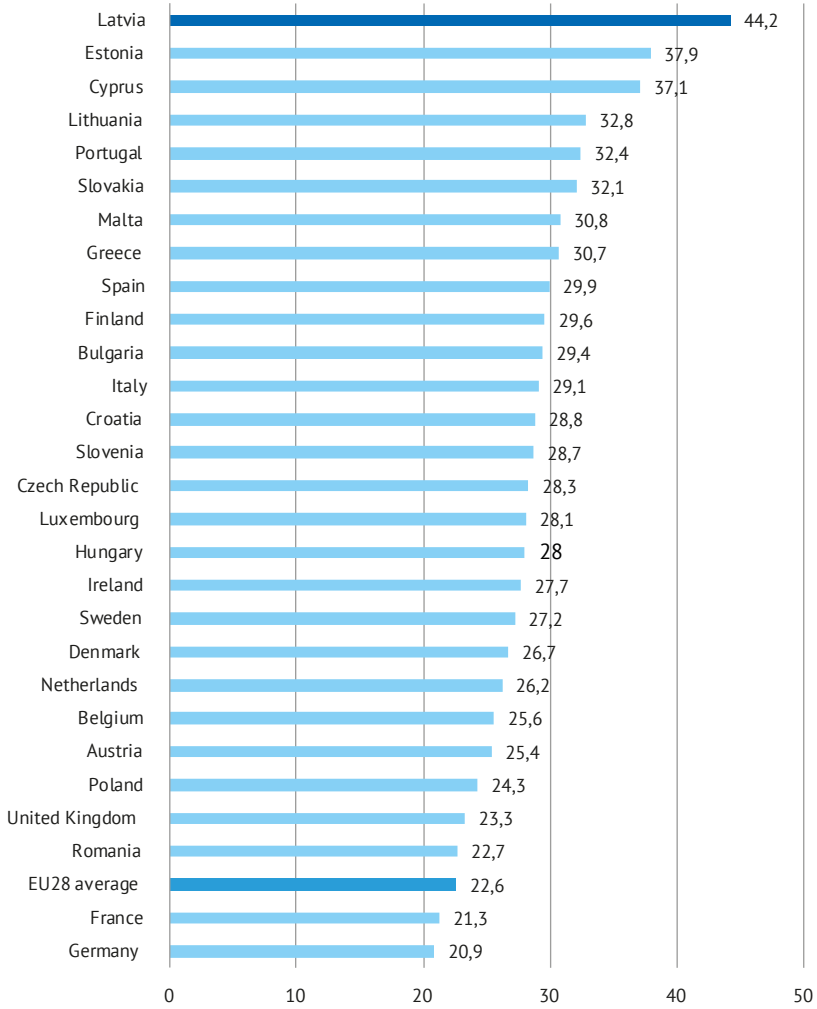


Figure 5.2. Average number of views per 1 publication for publications indexed in the Scopus database in EU-28 countries in 2019.

6 Gender equality in education and research

Gender equality, as one of the EU's core values and rights [2], is also a cornerstone of an innovative, competitive and prosperous academic and research environment, increasing work efficiency and creativity in the sectors concerned and fostering the creation of inclusive technologies [1].

Reducing gender stereotypes, which is a limiting factor for freedom of action and choice, including career choice, is one of the key tasks of the EU Strategy for Gender Equality 2020-2025. Great emphasis in the Gender Equality Strategy is placed on the digital sector, where gender equality is considered both in the context of knowledge and skills and competitiveness in the labour market. In the fast-growing digital age, where artificial intelligence is becoming an increasingly important driver of economic growth and playing an increasingly important role in the development of different sectors, various emerging technologies are perceived to be inclusive of different social groups and genders, in order to prevent the development and use of prejudice and the increase and spread of discrimination.

Although Latvia has improved in terms of gender equality since 2015, Latvia is still below the EU-28 average in many sectors. According to the Gender Equality Index 2019, Latvia ranks 18th with 59.7 points, below the EU-28 average of 67.4 points [3]. There are also positive but slow changes in the knowledge block of the Gender Equality Index, namely, Latvia's indicator has improved from 46.6 points in 2015 to 49.7 in 2019, but is still lagging behind the EU-28 average of 63.5 points [4].

Although stereotypes tend to decrease, career choices are still dominated by prejudices, which are clearly demonstrated by the chosen thematic areas of education for both sexes. There are differences not only between fields, but also between study levels. In teacher education and educational sciences at all study levels, a higher proportion of matriculated women is observed, namely, from 82% in college-level education programmes to 62% in doctoral-level education programmes. It should be mentioned that the proportion of matriculated men is increasing at higher study levels. Although the share of matriculated men in this field is low in all EU-28 countries, Latvia, with 9% of matriculated men in the educational sciences, ranks in the penultimate place among the EU-28 countries, lagging more than twice behind the average indicator – 21% (Eurostat; 2018). A similar situation is observed in the thematic areas of Health Care and Information and Communication Science. The area of social welfare is also predominantly chosen by women. In contrast, in Computer Science, a higher proportion of matriculated men is observed – from 85% in college-level education programmes to 67% – in doctoral-level education programmes. It should be mentioned here that as the level of studies increases, the proportion of matriculated women increases (NEIS; 2014/15-2018/19). Although Latvia has a significantly lower proportion of women in this thematic group of education,

in the context of the EU-28 countries Latvia ranks 12th with 18% in terms of the proportion of matriculated women, being around the EU-28 average – 19% (Eurostat; 2018). Gender issues in this sector are relevant in most EU countries.

Given the current fast-growing digital sector and the fact that around 90% of jobs require basic digital skills [5], it is essential not only to promote the acquisition of these skills, but to ensure the creation of inclusive digital technologies, the development process of which ensures the equal involvement of both sexes. Despite the low proportion of women studying in the field of ICT, the proportion of women employed in the ICT sector in Latvia is higher than the EU-28 average. According to Eurostat estimates in 2019, the share of women employed in the ICT sector in Latvia in relation to the total number of employees in this sector was 36%, ranking Latvia 1st among the EU-28 countries while twice exceeding the EU-28 average of 18%. This situation can be explained by the higher proportion of women graduates in relation to the number of matriculated women, where this indicator is lower for men. For men, a higher drop-out rate is observed at the bachelor's and master's level. The situation will level off at the doctoral level, where the number of graduates in relation to the number of matriculated people becomes equal for both sexes (NEIS; 2014/15-2018/19). A very similar situation is observed in the thematic groups of Engineering and Technology, Architecture and Construction, Transport Services and Environmental Protection, where men mostly choose to study.

Although men mostly choose to study in *STEM* fields, the share of women employed in science and technology is higher – Latvia is in second place among European countries in terms of the share of employed women in this sector **(Figure 6.1)**. This can be explained by the higher proportion of female graduates in *STEM* study programmes. In the thematic group of engineering sciences and technologies, starting with the bachelor's level study programmes and ending with doctoral studies, a higher proportion of female graduates is observed in relation to the number of matriculated women (NEIS; 2014/15-2018/19).

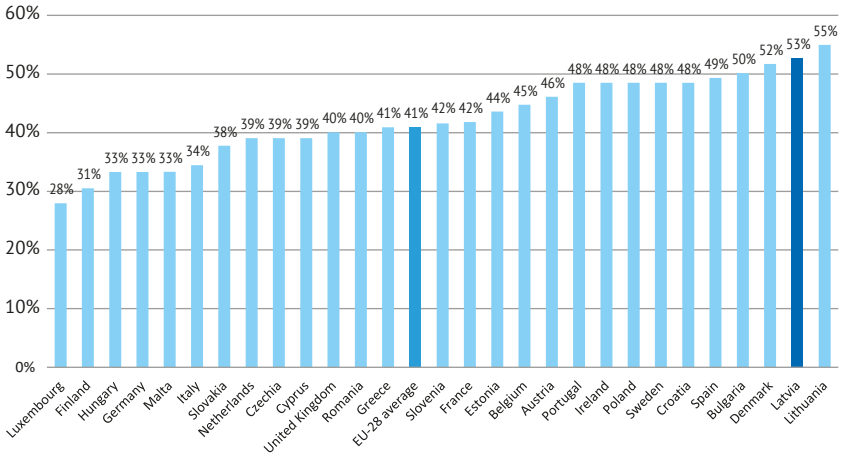


Figure 6.1. Proportion of women researchers and engineers in the EU-28 in 2019 (all sectors); Source: *Eurostat*

7 Scientific institutions in Latvia

Research competencies of state budget funded scientific institutions

(ranking by number of researchers in terms of FTE)

University of Latvia – conducts research in all fields of science: humanities and education; social sciences and law; exact sciences; medical and life sciences.
Priority areas of research

1. Innovative information technologies.
2. Atomic physics, optical technology, and medical physics.
3. Mathematical methods.
4. Nano- and quantum technologies, innovative materials.
5. Climate change and sustainable use of natural resources.
6. Biomedicine, pharmacy.
7. Regenerative medicine, biobanks.
8. Ecology and biodiversity.
9. Public health, quality of life and sustainability of the nation.
10. Critical thinking, innovation, competitiveness and globalisation.
11. Letonika, diaspora and intercultural communication.
12. Human and technology, quality of education.

In UL: Institute of Astronomy, Institute of Atomic Physics and Spectroscopy, Institute of Biology, Institute of Geodesy and Geoinformatics, Institute of Philosophy and Sociology, Institute of Physics, Institute of Cardiology and Regenerative Medicine, Institute of Clinical and Preventive Medicine, Institute of Chemical Physics, Latvian Institute of Productivity, Latvian Language Institute, Institute of Latvian History, Institute for Mechanics of Materials, Institute of Microbiology and Biotechnology, Institute of Numerical Modelling, Institute of International Indian Studies and Institute of Literature, Folklore and Art

Riga Technical University implements fundamental and applied research in engineering with the aim of analysing and providing solutions to technical and social problems.

Carries out interdisciplinary research in six scientific fields:

- Energy and the environment
  Research on sustainable energy, electricity, heat and transport fuels.
- Cities and Development
  Preservation of the environment and cultural heritage, provision of housing, mobility and infrastructure, employment and social problems.
- Information and communication technologies
  Electronics, software for their control and data transmission.

- Transport
  Research in this direction is related to increasing transport safety and energy efficiency, as well as solving various transport infrastructure problems.
- Materials, processes and technologies
  Research in the field of materials is very diverse – from nanoparticle synthesis to calculations of large, practical constructions, structural strength tests and longevity prediction. Extraction and research of innovative and intelligent multifunctional materials: nanofibers, nanomaterials, composites and biomaterials used in medicine, electronics, photonics and alternative energy are being developed. In parallel, the technological processes of material research are optimised and improved.
- Security and defence
  Interdisciplinary research in areas related to individual and national security. The research covers a very wide range of issues.

Research is carried out by: Faculties of Architecture; Construction engineering; Computer science and information technology; Electronics and telecommunications; Power and electrical engineering; E-learning technology and the humanities; Engineering Economics and Management; Materials Science and Applied Chemistry and Mechanical Engineering, Transport and Aeronautics, where scientific institutes operate.

The RTU Rudolfs Cimdins Riga Biomaterials Innovation and Development Centre – conducts research on biomaterials and develops research on implant materials for medical applications.

The RTU Centre of High Energy Physics and Accelerator Technologies is responsible for Latvia's international cooperation with **CERN** and its main tasks are promoting the development of the high-energy particle physics field in Latvia, participation in research on high-energy particle physics and accelerator technologies, and development of international master's and doctoral programmes within the Baltic CERN group.

RĪGAS STRADIŅA UNIVERSITĀTE

Riga Stradins University – conducts research in medicine, public health and social sciences. Research areas: Oncology; Occupational and environmental health; Infectious Diseases and Immunology; Pharmaceutical formulation technologies (pharmaceuticals); Rehabilitation and population ageing, nutrition and sports medicine; Maternal and child health; Neuroscience and research on human brain diseases; Chronic diseases, therapy algorithms, new treatment methods; Nuclear medicine, radiology and modern imaging techniques; Social sciences (social anthropology); Humanities (medical philosophy, medical ethics and deontology; bioethics and research ethics, medical history, medical terminology; literary research on human health, lifestyle and medical achievements). Cross-cutting science fields: Anatomy, embryology, histology, pathology, structural biology; Anaesthesiology and resuscitation, emergency and military medicine; Health care science; Public health; Social policy, health economics, management science, training technologies in health sectors.

Latvia University of Life Sciences and Technologies – conducts research in 3 priority directions:

- Life sciences – in the fields of agriculture, forestry and veterinary medicine
- Engineering – food technologies, bioenergy, smart machines and technologies (especially in agriculture, forestry), information technologies, bioprocess IT management, bio-based construction, wood processing, geodesy, environment and water management (including greenhouse gases (GHG) and agricultural runoff)
- Social sciences – economics and entrepreneurship (especially agrarian and regional economics), landscape architecture (also in the context of eco-services), land management.

The Latvian Institute of Organic Synthesis is a medical chemistry and pharmaceutical research centre that conducts both fundamental and applied research in organic chemistry, pharmacology, molecular biology and bioorganic chemistry. Research directions are organic chemistry; medical chemistry, pharmacology and physical organic chemistry. Competencies include the design of medicinal substances; physical organic chemistry and biophysical screening; pharmacological and biological research; process chemistry and custom synthesis.

Latvian State Forest Research Institute "Silava" – research is focused on the acquisition of new knowledge and the development of innovative technologies to promote the sustainable development and competitiveness of the forest sector. Research and knowledge transfer takes place in 6 research directions: increasing the capital value of forests; the interaction between forestry and the environment; non-timber services; tree plantations outside the forest; development of forest machinery; forest ecology (to support forest growing research); growing forest products; fauna and hunting.

LU Institute of Solid State Physics – conducts research in the field of materials science. Four main research directions: functional materials for photonics and electronics; nanotechnologies, nanocomposites and ceramics; theoretical and experimental studies on thin film and coating technologies, and the structure and properties of materials. The following topics are studied: materials for light emitters, sensors, photonics devices for ICT, batteries, hydrogen capture and storage, thermoelectric devices, as well as, nanomaterials and nanostructures, nanoceramics and polymer

nanocomposites, ferroelectric ceramic materials, prototyping of photonics and microelectronic devices, PVD, HIPMS, CVD, and PLD thin-film coating technologies, organic and inorganic wet spray technologies, theoretical material science, X-ray absorption spectrometry, optical spectrometry, microscopy and structural methods, and a metal testing laboratory.

(Since 2016, the "Excellence Centre of Advanced Material Research and Technology Transfer" has been implemented through the "Horizon 2020" framework programme – **CAMART2)**

Institute of Agricultural Resources and Economics conducts research in agriculture and other fields of bioeconomy, including its economic development, effects of innovation on production efficiency, competitiveness of farming and manufacturing industries, selective breeding and genetics in crop plants, agroecological and agrotechnical solutions, potential uses of crop plants in various fields, as well as the role of bioeconomy in the sustainable development of rural spaces.
Research directions: production of fodder and its raw materials; economics of sustainable development of bio-resource industries; evaluation of the quality of crop plants for their effective use; development of sustainable crop plant production technologies for different farming systems; research of sustainable development opportunities of territories; crop plant genetics and selection for an integrated and organic farming system, and efficiency of production processes and competitiveness of enterprises.

LU Institute of Mathematics and Computer Sciences – research directions: complex systems design methods and tools; graph theory and visual information processing; semantic web technologies; computer linguistics; bioinformatics; real time systems; computer networks and Grid technologies; mathematical modelling in engineering and natural sciences; theoretical research of mathematical methods and E-infrastructure. The Institute conducts national and international research in the interdisciplinary fields of language technology and computational linguistics. The institute develops and maintains major resources and tools (including infrastructure) pertaining to the Latvian language, such as corpora, dictionaries, thesauruses etc.). The institute is the national coordinator of the CLARIN ERIC research infrastructure.

Daugavpils University – priority research directions: mathematics, physics, nanomaterials and materials engineering; biology; educational sciences and regional studies, literature and the arts. As part of its 'Education studies' and 'Regional, literature and art studies' conducts research in economics, sociology, social psychology, political science and law, in social and public human safety, education (sustainable education, teaching theory, teaching in specific disciplines, lifelong education), and humanities (literature studies, linguistics, history, culture studies, youth studies). In the field of biology, research is conducted in the following topics: aquaculture and hydroecology; biodiversity and forest ecology; animal parasitology; coleopterology; nanobiotechnologies and nanobiosecurity; molecular ecology and behavioural and physiological ecology. There is an innovative microscopy centre in the field of technology; Belarus-Latvia Scientific Innovation Centre in the Field of Strengthening Technologies and Mathematical Research Centre.

Latvian Biomedical Research and Study Centre – conducts research in molecular biology, biomedicine and biotechnology.

Both fundamental and applied research is conducted in five main directions: human genetics and mechanisms of disease pathogenesis, cancer research, biotechnology and structural biology, molecular microbiology and virology, molecular pharmacology. A basic infrastructure for molecular and cell biology research has been established.

Latvian State Institute of Wood Chemistry conducts research in the subjects related to obtaining competitive materials and products from wood and lignocellulosic biomass, to developing technologies for processing their by-products, and to creating new products and analysing their life cycles.

Ventspils University of Applied Sciences – implements research in the fields of business, innovation, regional economics, finance, mathematical modelling, applied linguistics, comparative linguistics and translation studies, as well as ICT and electronics, optical signal technologies, astronomy and astrophysics, space technology and engineering electronics.

Scientific Institute of Food Safety, Animal Health and Environment "BIOR" – implements research in chemical science, environmental science, public and environmental health, fisheries and veterinary medicine. Conducts research on topics related to food and feed safety, their nutritional value and quality, as well as the state of the environment, the identification of sources of contamination, the development of methods for the detection and spread of environmental contamination, and environmental epidemiology and exposure studies. Research is also carried out on fish resources, biodiversity and ecosystems in the Baltic Sea and inland waters, and on the epidemiology of aquaculture and infectious diseases of agricultural and wildlife and the control of antimicrobial resistance, etc.

LLU Institute of Horticulture – performs the diversification and selection of garden plant varieties. Conducts research on environmentally friendly horticultural cultivation systems, storage and processing technologies, biological basis of horticulture and horticultural breeding, cultivation systems and storage and processing technologies.

Institute of Electronics and Computer Science – conducts research in the following directions: accurate timing of events, remote sensing and space data processing, robotics and machine perception, signal processing and embedded intelligence, smart sensors and the Internet of Things.

Liepāja University – conducts research at the Institutes of Educational Sciences, Kurzeme Humanities, Natural Sciences and Innovative Technologies and Management Sciences. Research topics include child-focussed education, a culture of cooperation in education, quality and sustainability of education, as well as language, literature and art within the Kurzeme cultural space, the Baltic and Nordic context, digital media and network art studies, languages, innovative economics and business development in the regions, cyclical economics, and maritime resources, use of wave energy and furcellaria, aquaculture, mathematical modelling of wave energy and coastal erosion, etc. topics.

Rezekne Academy of Technology – conducts research in the following directions: engineering and technology, humanities, social sciences and pedagogy. The researched topics are economics and business, bioeconomics and cyclical economics, law, civil security and defence, regional studies, creative and

cultural industries, Latgalian language, preservation and transformation of traditions, culture, education, etc., including special and inclusive, social welfare and rehabilitation technologies, human safety, knowledge and information society, smart energy, smart materials, renewable resources, laser technologies, robotics, local resources, ICT solutions, etc.

DU Latvian Institute of Aquatic Ecology – researches topics related to the Baltic Sea environment and ecology, as well as freshwater environment quality and processes. Research topics include marine monitoring methods, long-term changes in the Baltic Sea, seasonal cycles of saline plankton and benthic cenoses, substance gradients and vertical flows, benthic and pelagic relationships, coastal biodiversity, alien species in the sea, marine spatial planning solutions, algal toxins, eco-toxins and factors.

Vidzeme University of Applied Sciences – implements research in the fields of smart technologies and eco-buildings, virtual reality technologies, business, innovations, regional economics, financial mathematical modelling, as well as applied linguistics, comparative linguistics and translation studies.

Latvian Academy of Culture (LAC) – conducts research in theory of culture, cultural sociology, history and theory of art and literature, theatre and cinema theory and practice, cultural management, creative industries and intercultural communication, semiotics and philosophy, preservation of cultural heritage, traditions, values and other related fields.

Latvian Academy of Arts – conducts research in the fields of art history, design and creative industries, as well as architectural theory and history, urban planning, rural construction, building architecture, landscape architecture, visual arts, including painting, sculpture, graphics, applied arts, design, art and cultural theory. It focusses on interdisciplinary methods and maintains cooperation platforms between researchers and entrepreneurs for the transfer of industrial research, experimental development and innovation.

Jāzeps Vītols Latvian Academy of Music conducts research in systematic and historical musicology, ethnomusicology, and artistic studies. The academy carries out international and interdisciplinary projects in musicology, neuropsychology and psychology, music education, anthropology of music and computer science. LAM also issues the 'Mūzikas akadēmijas raksti' ('Academic Articles on Music') journal..

Ministry of Education and Science

THE NATIONAL DEVELOPMENT PLAN 2014-2020

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