Estonian Research Council



ESTONIAN RESEARCH 2025

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INTRODUCTION

ANU NOORMA **Director General, Estonian Research Council**



You have opened another collection that provides an overview of Estonian research statistics from the past three years. The Estonian government has been allocating progressively larger sums to research, development and innovation to achieve the financial target set in the 2019 Research Agreement. Compared to three years ago, the share of funding as a percentage of GDP has not changed significantly, but the role of sectoral ministries and the private sector has increased. Additionally, we are now among the top countries in terms of state budget allocations as a share of GDP in international comparisons.

The Ministry of Education and Research and the Ministry of Economic Affairs and Communications are working together to develop the focus areas of the Estonian Research and Development, Innovation and Entrepreneurship Strategy (TAIE 2035[1]). The Estonian Research Council has been implementing the research programmes of several ministries, including 'Viable Estonian Society, Language and Cultural Space', and launched major new measures to promote centres of excellence and renew research infrastructures.

Given Estonia's population, our research productivity surpasses that of most countries worldwide in terms of the number of publications and is close to the Western European average. Estonia also ranks highly in terms of overall innovativeness of society.

However, this is not enough. Research policy challenges related to sustainability, security and accountability have grown. There is an increasing awareness of the need to integrate knowledge and researchers into social debates to tackle major social challenges.

We have many reasons for concern, both regarding the next generation of researchers and the shortage of specialists with doctoral degrees. As Toomas Vaimann, President of the Estonian Young Academy of Sciences highlights in an article in this collection, 'The human resources in Estonian research represent the greatest asset of our society, the appreciation and development of which will determine the future of our research.' However, it is not just the future of research that depends on young people, but also the future of society as a whole. Bottlenecks in the next generation of researchers affect both the quality of our education and the development of a research- and innovation-driven economy in the near and distant future.

Technological solutions in security and energy production play a crucial role in defending national strategic interests. To diversify the economy and develop sustainable economic models and new high-tech sectors, evidence-based education must prepare new generations to thrive in a rapidly changing technological world and adapt to the era of artificial intelligence. Therefore, we must place greater emphasis on the humanities and social sciences than before – without a deeper understanding of people and society, problems cannot be solved and well-being cannot improve.

During the period under review, the Ministry of Education and Research has been working on amending the new basic law of the research sector. As a result, the time is approaching when the current work organisation and funding instruments within the research system could undergo significant transformation.

The collection Estonian Research 2025 is the fourth[2,3,4] in its series and serves as a logical continuation of its predecessors. To maintain historical comparability, the basic structure of this collection has been kept similar to previous editions. The main articles focus on analysing the resources essential for conducting research – funding and human capital. The results of research are further explored, offering an overview of the publishing activities of Estonian researchers in an international context and the impact of research on the economy and social organisation. The data presented in the articles in the first section of the collection are, in many ways, comparable to those in previous editions, enabling a retrospective analysis and assessment of progress. The second half of the collection features short articles that address current issues in research policy discussions.

[1] Estonian Research and Development, Innovation and Entrepreneurship Strategy 2021–2035. Online: https://www.hm.ee/sites/default/files/documents/2022-10/taie_arengukava_kinnitatud_15.07.2021_211109a_en_final.pdf (02.01.2025).
[2] Estonian Research Council (2016). Estonian Research 2016 (ed K. Raudvere). Online: https://www.etag.ee/wp-content/uploads/2015/12/TA_teaduskogumik_ENG_veeb.pdf (02.01.2025).
[3] Estonian Research Council (2019). Estonian Research 2019 (ed K. Raudvere). Online: http://dx.doi.org/10.15158/DISS/0004
[4] Estonian Research Council (2022). Estonian Research 2022 (ed K. Raudvere). Online: https://doi.org/10.23673/tead/002

This collection is available both as an online publication on the website of the Estonian Research Council and as a printed publication available from the Estonian Research Council, in both Estonian and English (as with previous collections). All raw data and figures are available for download in table format, allowing those interested to conduct further analysis on their own. The compilation of the collection was led by an editorial board, which included, in addition to the Director General of the Estonian Research Council, Professor Krista Fischer from the University of Tartu, Leading Researcher at the Tallinn University of Technology and President of the Estonian Young Academy of Sciences Toomas Vaimann, Head of the Division for Innovation at the Faculty of Engineering of Lung University and Associate Senior Lecturer Mart Laatsit, Executive Director at the Estonian Research Council Karin Jaanson and Kadri Raudvere from the Department of Strategic Analysis. Our special thanks go to Tiina Pärson, Chief Statistician at Statistics Estonia, and Anne Ostrak, Analyst at the Ministry of Education and Research, for providing the data. We would also like to extend our thanks to all the authors of the articles and photographs used in this publication.

The overview includes the most recent data available at the time the articles were compiled (the end of 2024). Some international data are from a couple of years earlier, as they often take several years to compile. The overview mainly uses data reported by OECD, Eurostat, the Estonian Ministry of Education and Research, Universities Estonia, Estonian Research Council and the Estonian Research Information System (ETIS). The statistical output of ETIS data is available on the continuously updated TeadusSilm online platform[5].

Through the articles and data presented in this collection, we aim to provide a comprehensive overview of the current state of Estonian research, stimulate debate and support fact-based discussions on the development of Estonian research and the economy. As the overview is also published in English, it will allow for Estonian research to be introduced internationally. Therefore, it could be of interest not only to researchers, but also to policymakers, officials and anyone else interested in the state of Estonian research.

A few years ago, it seemed that the future would only require fine-tuning, but now the major challenges have become evident. The future needs the brave and the wise.

[5] Teadussilm. https://www.etis.ee/Teadussilm



Estonian research system is diverse.

Authors/owners: Simo Sepp, Lauri Veerde, William Kass, Andres Tennus, Estonian University of Life Sciences, Estonian Business School, Estonian Academy of Arts, Icosagen AS.

ESTONIAN RESEARCH SYSTEM

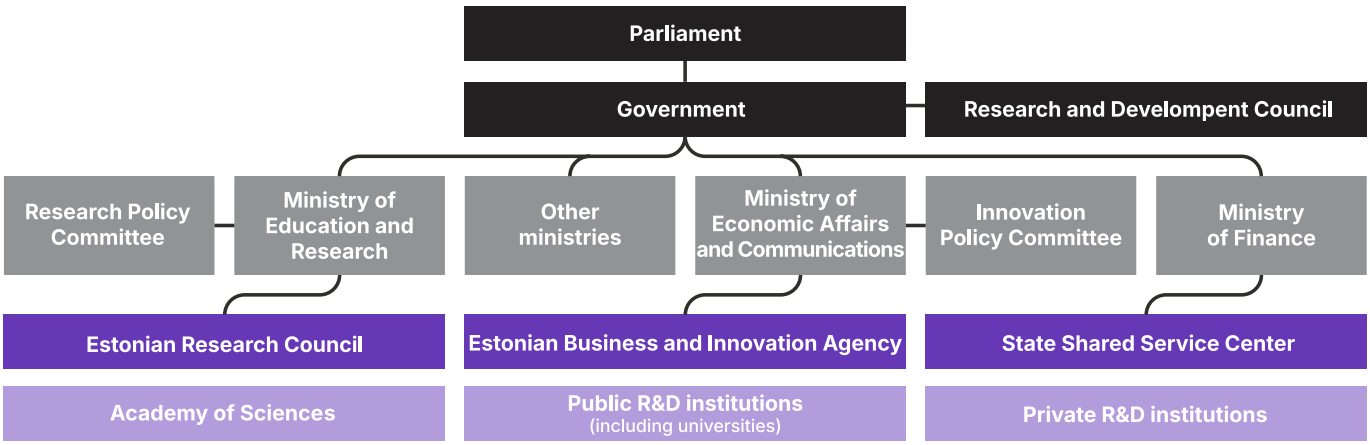
KADRI RAUDVERE R&D Analyst, Estonian Research Council

The functioning of the Estonian research system is based on the Organisation of Research and Development Act[6] (TAKS), which was adopted in 1997 and has been amended over twenty times in more than twenty years. In 2020, planning began to streamline and modernise the entire Act. This process, led by the Ministry of Education and Research, has involved representatives from research institutions, other ministries, and business sector. The entry into force of the new Organisation of Research and Development and Innovation Act (TAIKS), which also covers innovation, will bring several changes. At the time of publication of this collection, the Estonian research system was still based on the TAKS. Therefore, the following description of the Estonian research system is also founded on it.

The scheme below 'The research and development organisation structure in Estonia' provides an overview of the Estonian research system and all its parts. The different parts of the system have the following functions.

- The Government of the Republic, together with the parliament, shapes policy. The Government of the Republic prepares and submits development plans for research, development, innovation, and entrepreneurship to the parliament for discussion and then approves them. Once a year, the Prime Minister provides the parliament with an overview of the execution of the development plan[7].
- The Research and Development Council (TAN)[8], consisting of the Prime Minister, four ministers, and ten government appointees[9], guides national research and innovation policy and advises the government on these issues.
- Ministries are responsible for planning and implementing sector-specific policies, as well as financing the necessary research and development within their areas of government. Among the ministries, the Ministry of Education and Research and the Ministry of Economic Affairs and Communications have the highest number of R&D support activities and the largest budgets for supporting research. The Research Policy Committee[10] advises the Ministry of Education and Research and the Innovation Policy Committee[11] advises the Ministry of Economic Affairs and Communications.
- The Estonian Research Council (ETAG), under the area of responsibility of the Ministry of Education and Research, is the main state R&D funding body. Estonian Business and Innovation Agency is the principal institution funding innovation and business development within the area of responsibility of the Ministry of Economic Affairs and Communications.
- Both public sector (primarily universities) and private sector research institutions carry out research and development activities. The majority of Estonian researchers are employed by universities where most of the research is conducted.

Additionally, the Estonian Academy of Sciences[12], which is an independent association of top-level scientists aimed at contributing to the development and representation of Estonian science, promoting the application of research in economic and social practice in Estonia, and enhancing Estonian science and scientific thinking, acts on the basis of its own law.



The research and development organisation structure in Estonia

Source: Estonian Research Council.

[6] Organisation of Research and Development Act. Passed by Riigikogu on 26 March 1997 – Riigi Teataja I 1997, 30, 471. Online: https://www.riigiteataja.ee/en/eli/525062014003/consolide (09.08. 2024).
[7] Estonian Research and Development, Innovation and Entrepreneurship Development Plan 2021–2035. Ministry of Education and Research. Online: https://www.hm.ee/sites/default/files/documents/2022-10/taie_arengukava_kinnitatud_15.07.2021_211109a_en_final.pdf (09.08.2024).
[8] Research and Development Council. Government of the Republic. Online: https://www.valitsus.ee/valitsuse-eesmargid-ja-tegevused/teadus-ja-arendusnoukogu-tan (09.08.2024).
[9] Approval of the membership of the Research and Development Council. Order of the Government of the Republic, adopted on 21 November 2019 – Riigi Teataja, III, 2019, 281. Online: https://www.riigiteataja.ee/akt/326112019002 (09.08. 2024).
[10] National organisation of the research system. Ministry of Education and Research. Online: https://www.hm.ee/korgharidus-ja-teadus/teadus-ja-arendustegevus/teadussusteemi-riiklik-korraldus (07.11.2024).
[11] Procedures and rules of procedure for the establishment of the Research Policy Committee and the Innovation Policy Committee. Regulation of the Government of the Republic, adopted on 19 May 2005 – Riigi Teataja, I, 2023, 31, Art 231. Online: https://www.riigiteataja.ee/akt/902696?leiaKehtiv (07.11.2024).
[12] Estonian Academy of Sciences. Online: akadeemia.ee (09.08.2024).

ESTONIAN RESEARCH INSTITUTIONS

Pursuant to the Organisation of Research and Development Act[13] in force, research and development institutions are institutions and legal entities whose principal activity is research and development (R&D) and which have passed the regular evaluation. The status of a research and development institution grants access to public R&D funding – baseline funding and competitive public R&D funding. Changes to the organisation and principles of evaluation are also anticipated with the new Organisation of Research and Development and Innovation Act.

Upon regular evaluation, ie external evaluation[14], the level of a specific field of the research and development institution is assessed, comparing it with the international level. The regular evaluation results are valid for seven years; after this, the institution must undergo re-evaluation.

IMPORTANT TERMS AND THE METHODOLOGY USED

The use of terminology and the presentation of statistics in this overview is generally based on the methodology set forth in the Frascati Manual[15]. Statistical offices in different countries also use the same methodology for collecting statistics, including Statistics Estonia[16].

Public sector – for the purposes of this overview, the higher education sector and government sector.

Private sector – for the purposes of this overview, the business sector and private non-profit sector.

The understanding of individual entities within the public and private sectors is based on international methodology, according to which:

• **business sector** – includes all enterprises, organisations and institutions whose main activity is the production of goods or the provision of services (other than higher education) at an economically viable price;

• **higher education sector** – includes universities and other institutions that offer higher education and all institutions associated with them or under their direct control (research institutes, clinics, scientific centres, etc), regardless of their source of funding and legal status;

• **government sector** – includes agencies and offices funded by the state or the local government whose main activities are not related to the production of goods or the provision of services and which do not belong to the higher education sector, additionally, this sector includes non-profit institutions primarily financed by the state;

• **private non-profit sector** – includes non-profit organisations, societies, funds, and their research units (excluding those primarily funded by the state and those serving private enterprises).

The higher education, government, and private non-profit sectors are also called the non-profit sector to distinguish them from the business sector.

Research and development (R&D) – creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. Research and development covers three types of activity: basic research, applied research and experimental development.

[13] Organisation of Research and Development Act. Passed by Riigikogu on 26 March 1997 – Riigi Teataja I 1997, 30, 471. Online: https://www.riigiteataja.ee/en/eli/503062019008/consolide (09.08.2024).
[14] Regular evaluation. Estonian Research Council. Online: https://etag.ee/en/activities/rd-evaluation/ (12.08.2024).
[15] OECD. Frascati Manual 2015. Online: http://oe.cd/frascati (12.08. 2024).
[16] Statistics Estonia. Research and development. Methodology and quality. Online: https://www.stat.ee/en/find-statistics/methodology-and-quality/esms-metadata/21701#3-Statistical-presentation-2 (12.08.2024).



Photo from Pexels.

RESEARCH AND DEVELOPMENT FUNDING

KARIN JAANSON **Executive Director, Estonian Research Council**

The fact that research and innovation have a key role to play in human development and the economic success of a country is an established truth and undisputable. The real debate, however, revolves around how to fund research in ways that enhance its social and economic impact. Taxpayers are the primary contributors of public research and development, contributing through state and local government budgets. It is up to the politicians to decide the scope of research, the recipients of funding and the terms of allocation. The objective is to ensure that Estonian research is world-class and internationally competitive, that higher education is of excellent quality, that technological development is supported, that important decisions are evidence-based and that the well-being of people is enhanced. With its broad array of tools, research policy strives to meet these objectives and improve the efficiency and effectiveness of public research investments.

Global experience demonstrates that climate change, the COVID-19 pandemic and Russia's war of aggression against Ukraine have further underscored the critical role of research in shaping sound policies and ensuring success. Global challenges mobilise countries and researchers to tackle urgent problems and crises, resulting in greater investment in research and development and more strategic research targeting.

Over the last decade, the research and development (R&D) policy of Estonia has aimed to increase overall R&D volume and decrease project-based research to boost economic competitiveness and maximise the social impact of research. A turning point in Estonian research policy came with the signing of the Social Agreement to Ensure the Further Development of Estonian Research and Innovation[17] in December 2018 by the leaders of eight political parties and representatives of researchers and entrepreneurs, expressing support for increasing public sector funding for research and development and innovation (R&D&I) to 1% of gross domestic product (GDP). Following the conclusion of this agreement, the R&D budgets of both the Ministry of Economic Affairs and Communications and other ministries have grown more rapidly since 2020. To reduce the project-based nature of funding, the volume of baseline funding was increased in 2019[18] to match the amount of research grants issued by the Estonian Research Council.

The increase in funding for R&D&I has enabled the introduction of new instruments to the funding system. In 2023, for the first time, the Ministry of Education and Research allocated 5%, or 2.7 million euros, of its activity support to strengthen the research capacity of the Universities of Applied Sciences it oversees. This support will be ongoing. In 2024, the Ministry of Economic Affairs and Communications piloted a new financial incentive, based on the R&D expenditure of companies, aimed at making it more affordable for companies to recruit and retain R&D staff. Companies will receive a refund of 25% of the income tax paid on these employees.

HOW MUCH MONEY DO WE HAVE FOR RESEARCH AND DEVELOPMENT?

Understanding the full picture of research and development funding and spending can be challenging due to the different methodologies used to calculate it, which often lead to varying results. This can create confusion, particularly in the context of the research agreement that specifies the allocation of the 1%. Therefore, it is important to understand exactly what is being measured.

Internationally, one of the key indicators of a country's success is R&D intensity, which is measured by the ratio of R&D expenditure to GDP. This is due to the significant correlation between R&D investment and national revenues.[19] This indicator is a useful tool for comparing and assessing the research intensity and progress of different countries, setting national strategic development directions and shaping research and innovation policies.

Statistics Estonia measures the volume of R&D expenditure by funding source and expenditure type, collecting data through a survey that is mandatory for all EU Mem-

[17] Estonian Research Council. Estonian Research Agreement. A Social Agreement to Ensure the Further Development of Estonian Research and Innovation. Online: https://www.etag.ee/wp-content/uploads/2019/05/Estonian-Research-Agreement-2018-_ENG.pdf (06.01.2025).
[18] Estonian Research Council. Statistics on R&D funding in Estonia. Online: https://etag.ee/en/activities/analysis/statistics-rd-funding-estonia/ (06.01.2025).
[19] Karo, E. (2019). 'The Future and Societal Importance of Estonian Research and Development'. – Estonian Research 2019 (ed K. Raudvere), pp 47–60, Estonian Research Council, Tartu. Online: https://dx.doi.org/10.15158/DISS/0004.

ber States and specified by the relevant regulation. This approach ensures comparability across Member States in both time and content. In addition, Statistics Estonia presents data provided by the Ministry of Education and Research on state budget allocations to research and development, broken down by socio-economic objective. The data collected by Statistics Estonia meets the definitions of the 2015 Frascati Manual[20] and does not include data on the activities supporting the R&D system.

In recent years, the government has highlighted its commitment to funding R&D at 1% of GDP under the research agreement when adopting the state budget. However, the statistics do not support this, as the state budget reflects both the funds directed to the R&D system for direct research according to the Frascati Manual as well as funds meant to support the system. System subsidies refer, for example, to the operating costs of research collections, research libraries and databases as well as of the Estonian Research Council and the Estonian Academy of Sciences. State budget allocations represent a plan, but actual expenditures, as measured by Statistics Estonia based on the Frascati Manual, may exceed or fall short of these estimates if not all plans are implemented or if GDP growth varies from expectations. Funds received from foreign sources and companies also affect the total expenditure. For this reason, a clear distinction must be made between R&D funding and expenditure.

Since Statistics Estonia presents data on R&D expenditure reported by institutions and the allocations planned for the entire R&D system in the state budget based on the Frascati Manual definition, the volume of R&D funding and expenditure in a given year often differ.

In Estonia, the intensity of R&D expenditure initially declined over the past decade and then started to increase, as private sector investments have grown significantly over the last five years (Figure 1.1). The increase in private investment has been driven by both the need to add value for competitiveness and by national R&D support measures. The continuation of this trend is evidenced by the fact that the number of companies reporting R&D expenditures has increased significantly (232 companies in 2013, 399 companies in 2022, 467 companies in 2023).[21] Public R&D expenditure has remained steady at just under 0.8% of GDP. This does not mean the research agreement is being violated, as the figures are calculated using different methodologies.

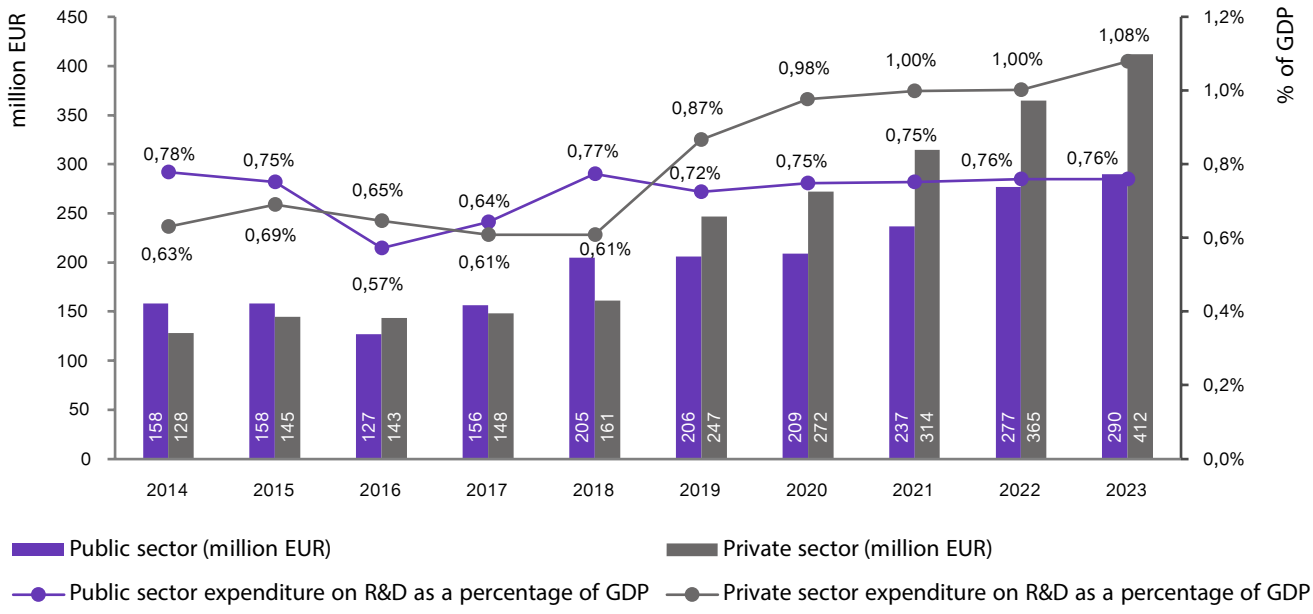


Figure 1.1. Gross domestic expenditure on R&D in Estonia (million EUR and as a percentage of GDP) from 2014 to 2023.

Source: Statistics Estonia, calculations by Estonian Research Council.

Estonia ranks 15th among OECD countries in R&D intensity (Figure 1.2, 2022). However, compared to leaders and the Nordic countries, there is still much work to be done. Estonia also remains far from the ambitious target of investing 3% of GDP in R&D, established several years ago.

When comparing Estonia's public sector R&D expenditure to the EU average (0.73% of GDP), we see that Estonia has exceeded the average at 0.76%. However, seven countries, including Denmark, Finland and Sweden, have spent more. Our gap with these countries is much smaller when we compare Estonia's private sector R&D intensity to that of the countries ahead of us. In the private sector, our R&D intensity is more than twice as low as that of the countries mentioned above. To achieve the R&D funding targets set in the Estonian Research and Development, Innovation and Entrepreneurship Strategy 2021–2035 – 2% of GDP from the private sector and 1% of GDP from the public sector – both entrepreneurs and the state still have significant work to do.

[20] OECD. Frascati Manual 2015. Online: http://oe.cd/frascati (06.10.2025).
[21] Statistics Estonia. www.stat.ee

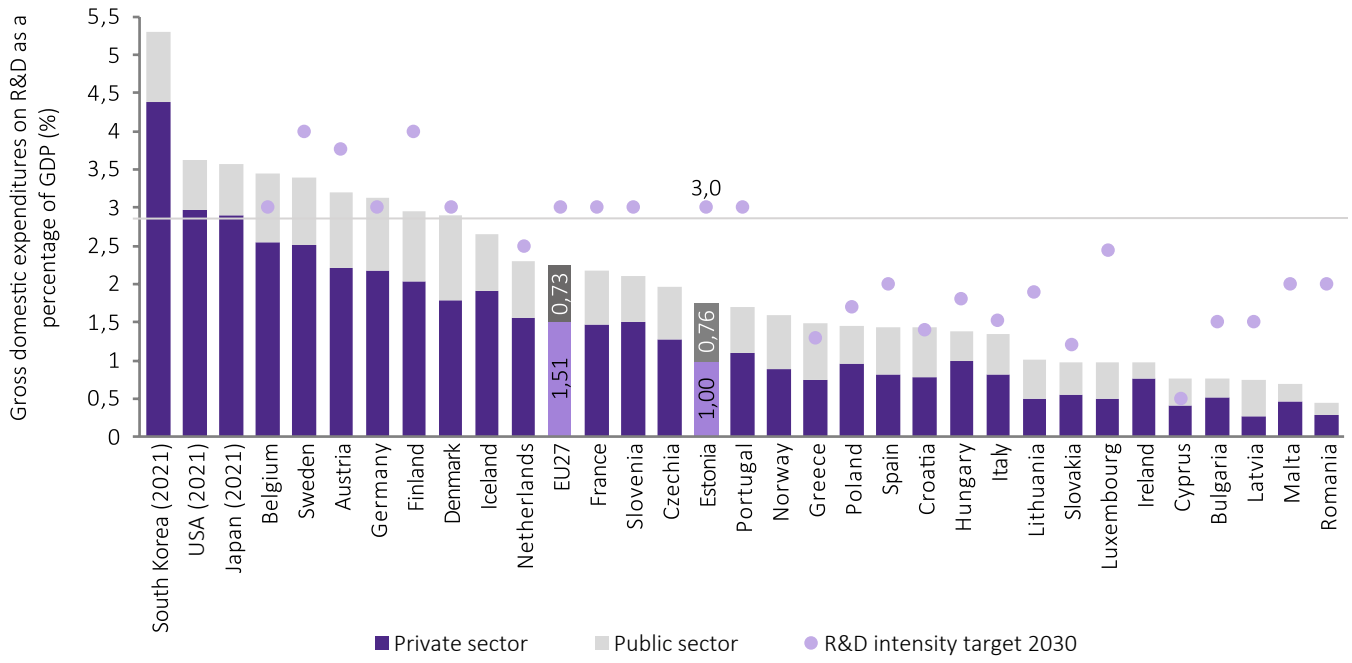


Figure 1.2. Gross domestic expenditure on R&D as a percentage of GDP in 2022.

Source: OECD and Eurostat, calculations by Estonian Research Council.

ROLE OF THE STATE

States play a crucial role in financing R&D by supporting knowledge creation and dissemination, providing a skilled workforce and fostering an environment that promotes R&D and innovation. In 2023, Estonia's state budget allocations for R&D reached 0.88% of GDP for the first time in history (Figure 1.3). Among European Union countries, this result placed us on the 2nd place, just behind Germany - even surpassing Finland and Sweden.This is an excellent result. The EU average was 0.72%. However, the success of the system is not determined by the amount of funding alone. Equally important are the organisation of R&D&I and a funding system that has a balanced set of instruments to fund both knowledge creation and applied research, and which takes into account the needs of companies and, at the same time, ensures the continuity and development of Estonian-language educational and cultural space.

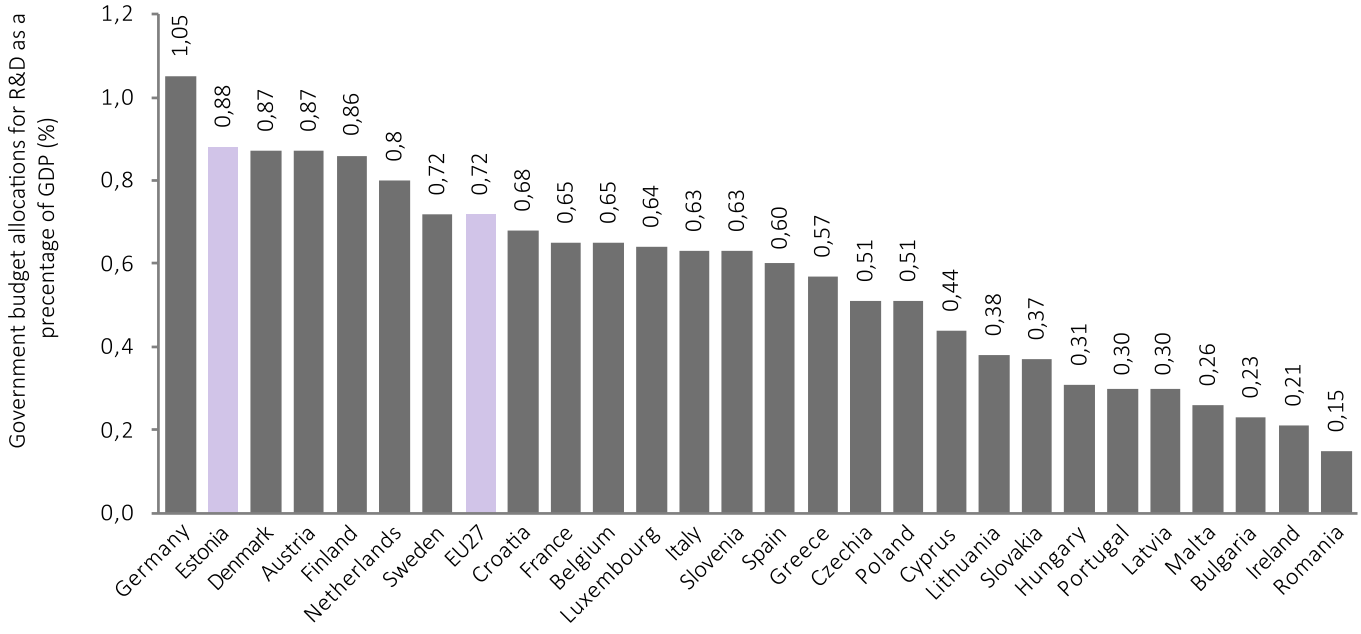


Figure 1.3. Government budget allocations for R&D as a percentage of GDP in the European Union countries in 2023.

Source: Eurostat.

SOURCES OF FUNDING

Figure 1.4 illustrates the links between sources of funding and expenditure, distinguishing between those who fund R&D and those who carry it out, ie those who incur the expenditure. As funding from Structural Funds is considered part of funding received from the state budget in Estonia, these amounts are reflected in public funding sources.

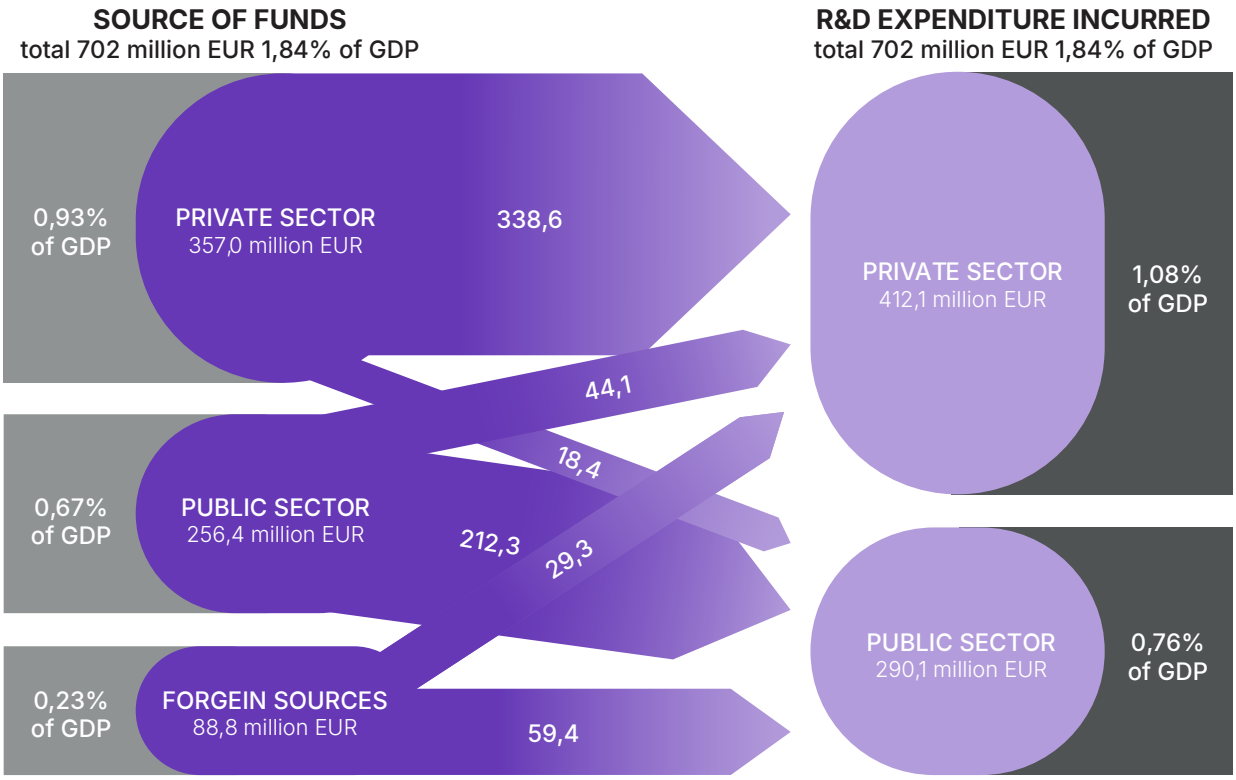


Figure 1.4. Flows of funding and incurred expenditures on R&D between sectors in Estonia in 2023 (million EUR & percentage of GDP).

Source: Statistikaamet, ETAG-i arvutused.

R&D is carried out by public sector institutions (primarily universities and state agencies) and private sector institutions (primarily enterprises).[22] Sources of funding include the public sector (primarily the state) and the private sector, as well as foreign sources.

In addition to own funds, the R&D expenditure of the private sector is covered in part by public and foreign sources of funding. Thus, part of the 1% of GDP planned in the state budget goes to the private sector. In 2023, 17.2% of public R&D funding, amounting to €44.1 million, was allocated for private R&D expenditure. Meanwhile, 17.8% of private R&D expenditure, or €73.4 million, was funded by foreign sources and the public sector.

In addition to state funding, public sector institutions also use funds received from abroad for R&D, primarily from the European Union Framework Programme for Research and Innovation – the world's largest funding programme of all fields of research in terms of budget, number of participants and research projects – as well as funds received from entrepreneurs as part of contractual co-operation. Between 2013 and 2023, public sector institutions received an average of 17.4% of their R&D funding from foreign sources. This is an excellent result and highlights the high level of our research (Figure 1.5). In 2023, funds received from foreign sources accounted for 20.5% of public expenditure, while 6.3% came from the private sector. Between 2014 and 2023, the volume of funding from foreign sources grew nearly twice as fast (161%) as total public expenditure (83%). During this period between 2014 and 2023, the share of foreign sources ranged from 14.1% (2013) to 20.9% (2018). In the private sector, the share of funding from foreign sources is lower than in the public sector, averaging 8.8% between 2014 and 2023. However, both sectors have shown an upward trend in the share of foreign sources.

[22] For more information on the methodology, see the chapter 'Estonian Research System' in this collection.

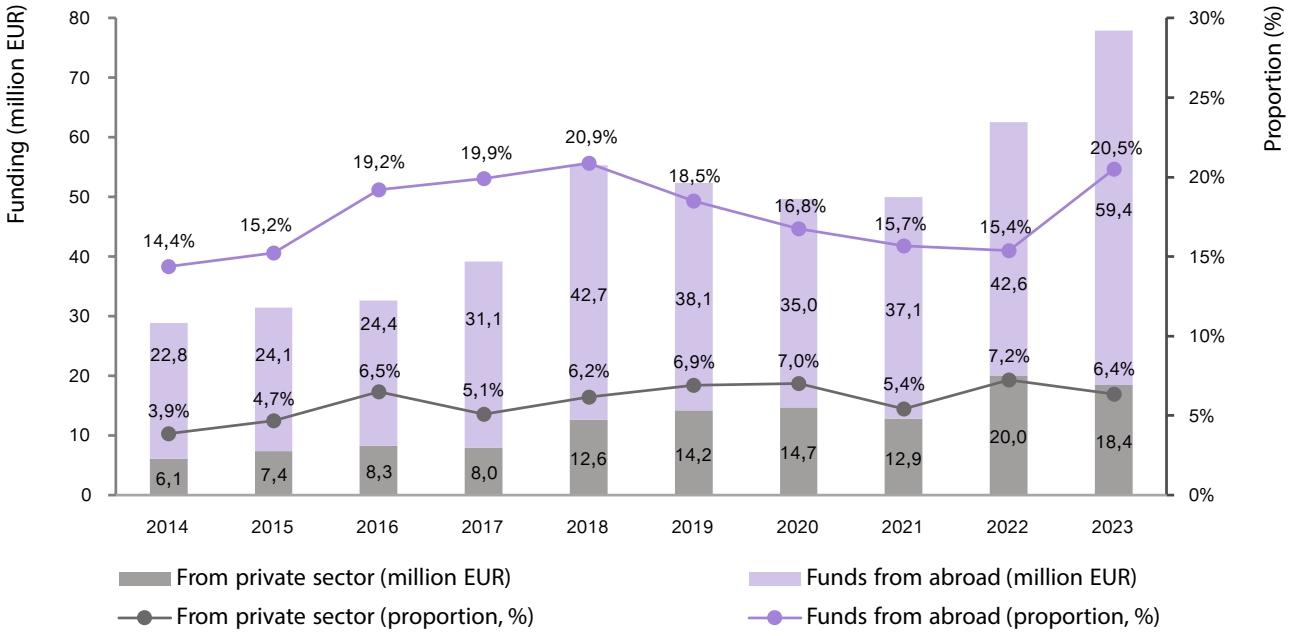


Figure 1.5. Public sector R&D funding from private sector and funds from abroad in 2014–2023 (million EUR and proportions from public sector total funding, %).

Source: Statistics Estonia, calculations by Estonian Research Council.

In international comparison, the share of the private sector in Estonian public sector expenditure is modest (Figure 1.6). In 2022, private sector funds covered only 7.2% of public sector expenditure. On the one hand, our private sector R&D expenditure as a share of GDP is lower than the R&D intensity of many countries ahead of us. On the other hand, there is potential to increase co-operation with R&D institutions.

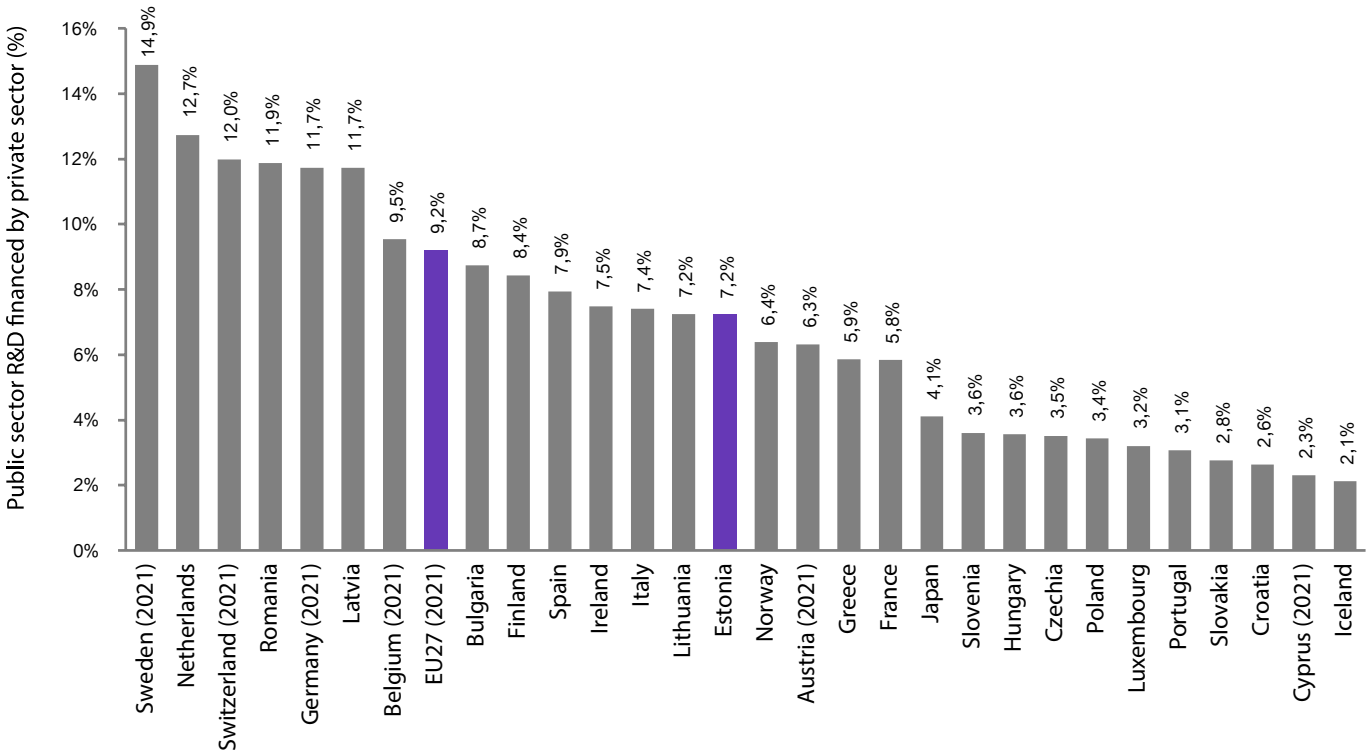


Figure 1.6. Public sector R&D financed by private sector (%) in 2022 (or last available year).

Source: Eurostat, calculations by Estonian Research Council.

Figure 1.7 provides an overview of the dynamics of the proportions of the main sources of R&D funding. While the proportions have changed over the years, in recent years we have seen the private sector investing more than the public sector. In 2023, the private sector contributed 51%, while the public sector contributed 37%.

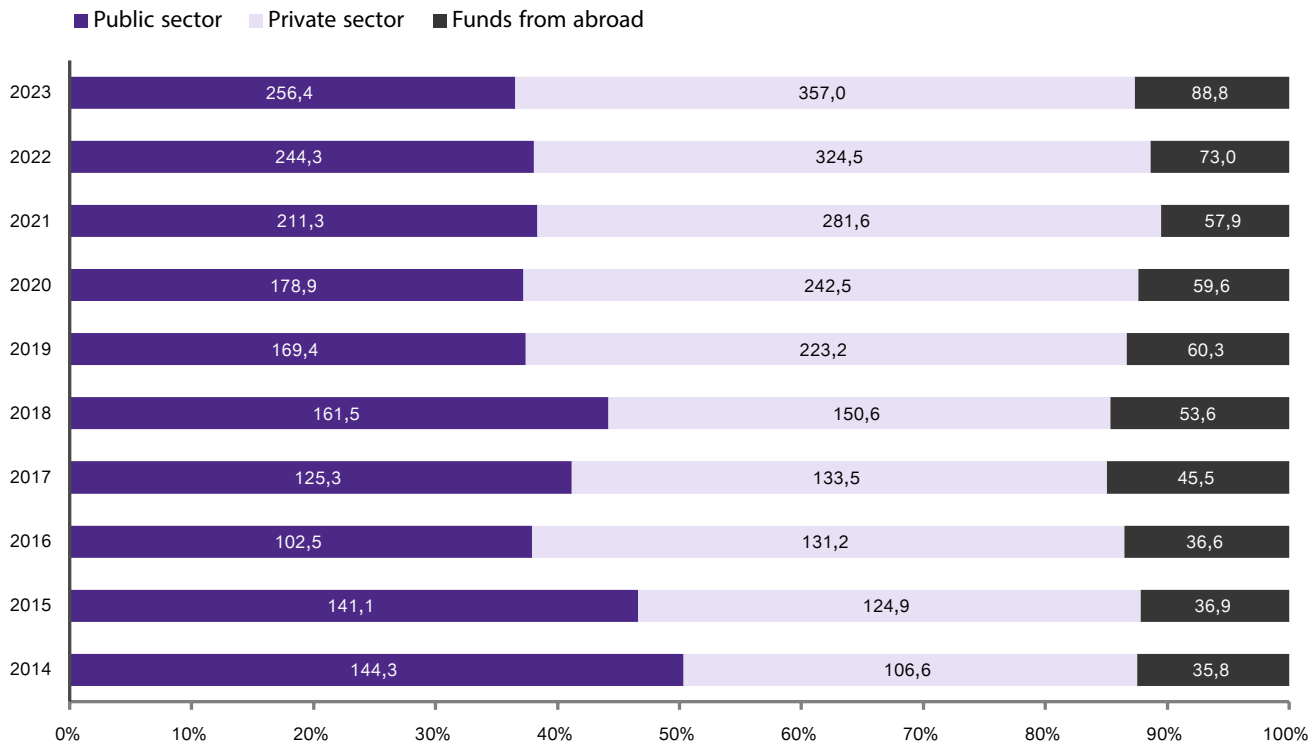


Figure 1.7. Gross domestic expenditure on R&D in Estonia by source of funds from 2014 to 2023 (million EUR).

Source: Statistics Estonia, calculations by Estonian Research Council.

The total R&D expenditure of Estonia grew by 144.9% between 2014 and 2023. Privately funded expenditure grew at a faster rate, reaching 234.8%. Expenditure on Estonian R&D supported by foreign sources grew by 148.0% during the same period, while public sector funding increased only by 77.7%.

THE MINISTRY OF EDUCATION AND RESEARCH AND OTHER MINISTRIES

Following the conclusion of the research agreement, the allocation of additional funding was determined for the ministries, based on advice from the Research and Development Council, with the aim of steering research in the right direction. To enhance the impact of research, a larger share of the funds was primarily directed to the Ministry of Economic Affairs and Communications and other sectoral ministries (additional funding proportions: Ministry of Education and Research 40, Ministry of Economic Affairs and Communications 40 and other sectoral ministries combined 20). As a result of the rapid increase in state budget R&D funding and the proportions of the allocation of additional funding, the share of the Ministry of Education and Research in state R&D funding has decreased from 78.7% in 2019 to 55.3% in 2024. Meanwhile, the share of the Ministry of Economic Affairs and Communications has increased from 8.2% to 26.9% over the same period (Figure 1.8). This significant growth in funding for the Ministry of Economic Affairs and Communications has made it possible to create new support measures and to shape a favourable environment for the development of research-intensive entrepreneurship. New measures have been implemented to strengthen co-operation between companies and research institutions, for instance, to enhance the capacity of R&D institutions in research areas with business potential, promote intersectoral mobility and establish an applied research centre based at AS Metrosert. The rapid increase in the number of deep technology companies and their turnover is one good policy performance indicator.[23]

Structural shifts in the funding system are essential to drive change, but their long-term impact on the development of the research system must also be assessed. The determination of proportions took place during a period of very rapid growth, so a significant reduction in the share of the Ministry of Education and Research could jeopardise the functioning of the research system.

[23] Kredex. 'Eesti idusektori kasvu veavad süvatehnoloogia ettevõtted'. Online: https://www.kredex.ee/et/uudised/eesti-idusektori-kasvu-veavad-suvatehnoloogia-ettevotted (07.08.2024).

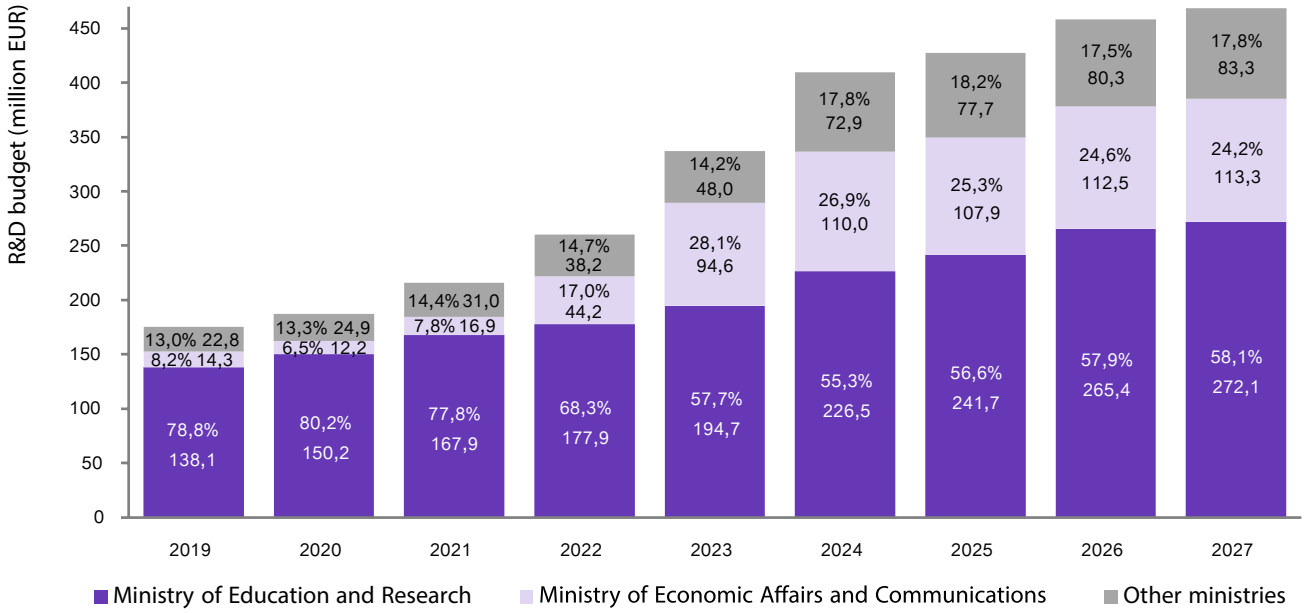


Figure 1.8. Distribution of ministries' research budgets in 2019–2027 (million EUR).

Source: Ministry of Education and Research.

Although reducing project-based funding for research has been a goal of research policy for many years, the increase in funding from and the share of sectoral ministries in R&D has, in fact, led to a rise in project-based funding. Compared to other countries, the research system of Estonia stands out due to its high project-based nature, a fact highlighted in 2014 by the research funding working group convened on the initiative of the then Minister of Education and Research Jevgeni Ossinovski. This working group proposed redesigning the main research funding instruments so that the ratio of baseline funding to competitive research grants would shift from 20:80 to 50:50. Although this target was met in 2019, the share of competitive funding in our research system has not decreased but rather increased (Figure 1.9). In 2019, the share of competitive funding in total public R&D funding was 74%, rising to 83% by 2024. This is because the growth in national R&D funding has been more than twice as fast as the increase in baseline funding for R&D institutions from ministries. Reducing the project-based nature of the system is essential for achieving long-term stability and allowing researchers to focus on their research rather than on writing project proposals.

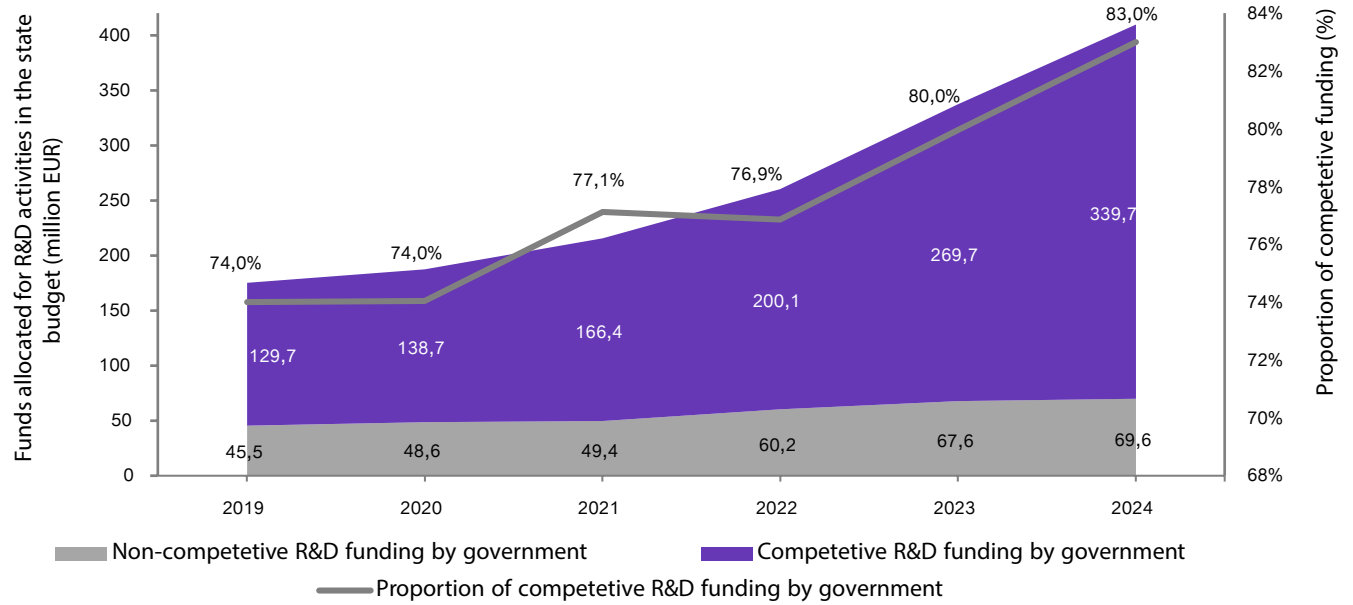


Figure 1.9. Share (%) of competitive R&D funding in state budget allocations between 2019 and 2024. Up to 2023, the figures represent state budget allocations and, from 2024, they reflect the planned amounts in the state budget. The competitive funding is calculated by subtracting from all government funding the baseline funding.

Sources: Statistics Estonia, Ministry of Education and Research, Ministry of Social Affairs, Ministry of Culture, calculations by Estonian Research Council.

Foreign funding, especially from the European Union's Structural Funds, constitutes a significant portion of state budget allocations. Foreign funding accounted for 10% of the 2025 state budget. Since R&D is a key driver of the country's development, Structural Fund measures have played a crucial role in both the level of R&D funding and shaping its direction.

Due to the rapid growth of the Estonian economy during the previous Structural Funds period (2014–2020), the share of grants from these funds in R&D expenditure has significantly decreased in recent years (see Figure 1.17a in the article by A. Noorma). In 2017, Structural Fund measures accounted for 47% (€63.4 million) of the research budget (including state co-financing) of the Ministry of Education and Research. However, in the 2024 budget, their share has decreased to 14% (€27.8 million). In the coming years, the share of funds received from Structural Funds is expected to rise again, as all the measures for 2021–2027 will be fully implemented.

SUPPORT FOR ENTERPRISES

Governments finance the development and innovation of enterprises through both direct and indirect instruments. Direct funding allows government authorities to target specific R&D initiatives and direct the efforts of enterprises to such R&D areas that offer high social returns but low profitability. In contrast, indirect government funding, such as tax incentives, allows companies to choose the areas of research to invest in while also taking into account the market potential. Indirect funding is generally more market-friendly and neutral compared to direct funding.

In Estonia, the support provided to enterprises to stimulate R&D is very modest compared to developed countries (Figure 1.10). In 2021, it amounted to just 0.07% of GDP, while the average for OECD countries was 0.21% of GDP. Estonia only implements direct funding, which also includes performance-based baseline funding for positively evaluated enterprises. To our knowledge, no similar support measure is implemented elsewhere in the world. Of the €30.1 million in government funding for private R&D in 2022, baseline funding for enterprises accounted for 22%, or €6.6 million. At the same time, Estonia is one of the few OECD countries that does not implement tax incentives. In 2023, a total of 33 out of 38 OECD countries applied tax incentives to support the growth of private sector R&D.[24] In Estonia, the topic of tax incentives has been extensively discussed, and in 2024, financial incentives were piloted to support the coverage of labour taxes for R&D-related employees in companies. The support amounts to up to 25% of the income tax paid on an employee's wages. The main objective of the support is to increase the volume of private sector R&D and to maintain and create new jobs requiring high qualifications. In the first round, 54 companies submitted applications for a total of 445 R&D employees.[25]

[24] OECD. OECD R&D tax incentives database. Highlights from the April 2024 update. Online: https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/rd-tax-incentives/oecd-rd-tax-highlights.pdf (18.11.2024).
[25] Ministry of Economic Affairs and Communications.

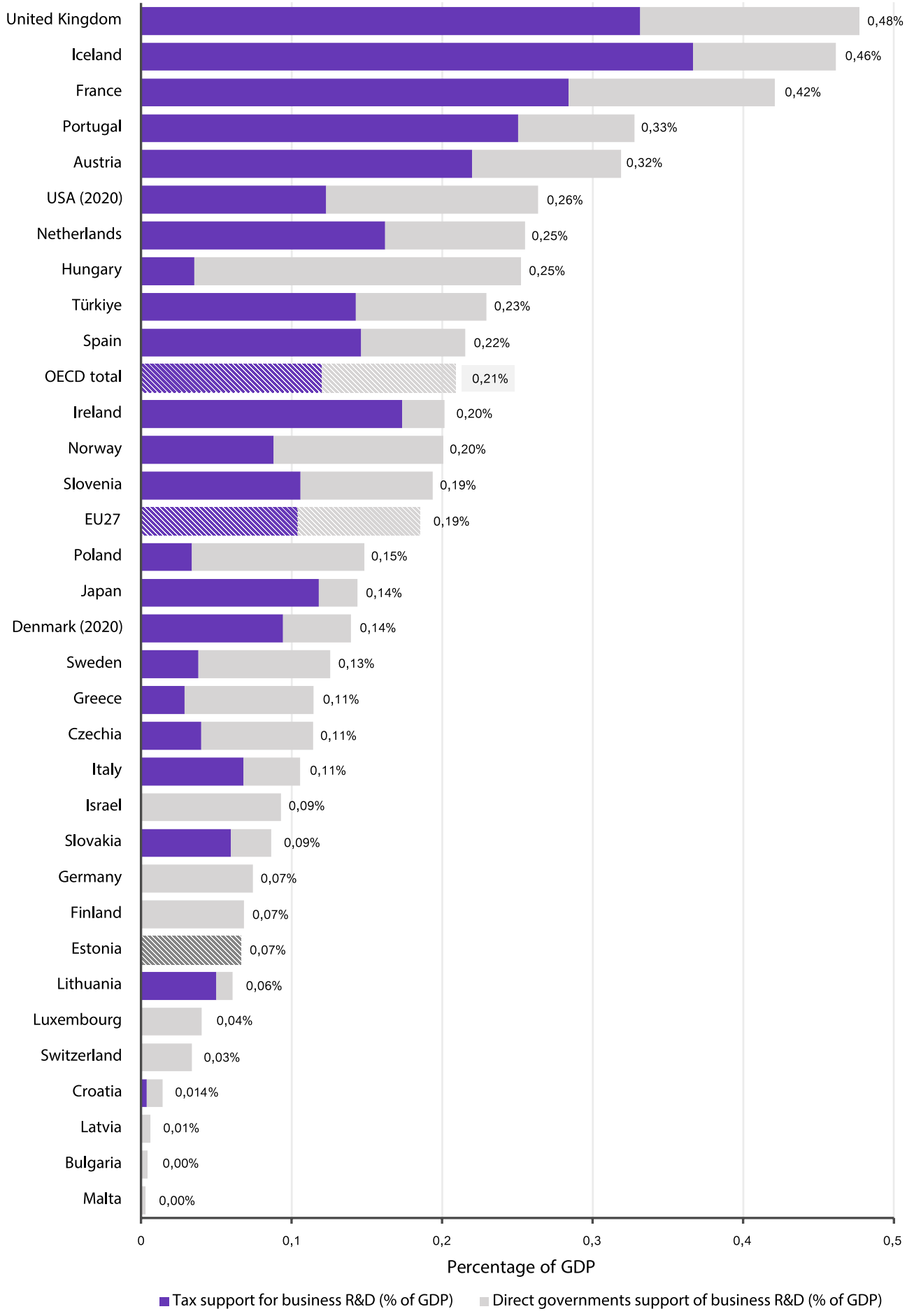


Figure 1.10. Direct government funding and tax support for business R&D in 2021 (or last available year).

Source: OECD.

INTERNATIONAL RESEARCH CO-OPERATION

Today, advancing to and remaining at the forefront of research is impossible without engaging in international research co-operation. Global co-operation accelerates the development of research and enables the tackling of both global and local challenges. International research co-operation allows researchers to combine efforts to implement large-scale research projects and optimise the use of resources such as laboratories, equipment, databases and funding. The success of Estonian researchers and entrepreneurs in international research co-operation is best demonstrated by the rapid growth and substantial volume of funding received from the EU Framework Programme (Figure 1.11), driven by the steadily increasing participation of Estonian researchers and entrepreneurs in the Framework Programme year after year. For example, in the Seventh Framework Programme, there were 560 instances of participation, while in Horizon 2020, the number increased to 905 by the end of the programme. In addition to public R&D institutions, the participation of enterprises has also seen significant growth: 195 in the Seventh Framework Programme, 277 in Horizon 2020 and 189 in Horizon Europe by its approximate mid-point in 2024.[26]

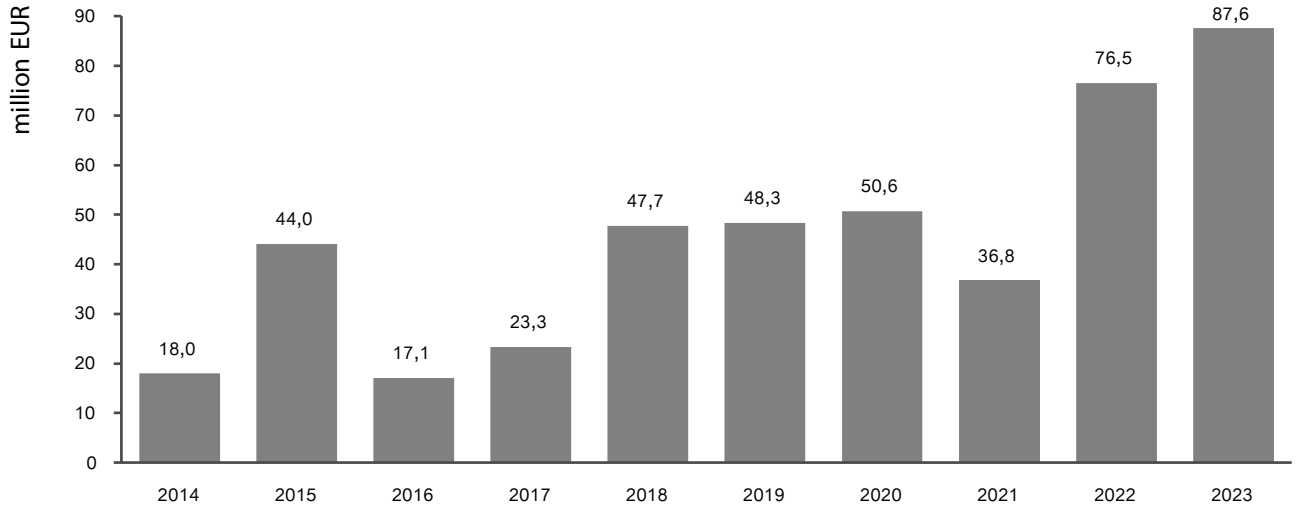


Figure 1.11. Financial contribution from EU Framework Programmes to Estonia from 2014 to 2023 (million EUR). The annual mounts correspond to the financial volume of the contracts signed in that year. Funding is used for the organisation of projects over the next several years.

Source: eCORDA.

Estonia also stands out for its success in participating in the Framework Programmes compared to other EU27 countries (Figure 1.12).

This growth can also be attributed to the overall increase in the volume of Framework Programmes. For instance, the European Union's ninth framework programme Horizon Europe has a 24% larger budget than its predecessor, Horizon 2020 (H2020), with a total budget of €95.5 billion. The increase in the budget of the Framework Programmes also partly explains the growth in the volume of contributions received in Estonia. Comparing the average volumes of contributions received in Estonia during the years under H2020 and Horizon Europe (€34.3 million in the case of H2020 and €58.6 million in the case of Horizon Europe by the end of 2023), it is clear that Estonia has been even more successful, as the annual volume of contributions received has grown by more than double (70.6%) the growth rate of the Horizon Europe budget itself. In just three years, €237.6 million has already been allocated to Estonia through different projects under the programme.[27] The competitiveness of Estonian research is further confirmed by the funding of two Teaming Centres of Excellence: the Centre for Digitalised Bioengineering and the Centre for Personalised Medicine at the University of Tartu.

Compared to other countries, Estonia stands out with received financial contribution from the EU per GDP, which was 280% of the EU27 average in early December 2024, as well as the received financial contribution per citizen, which was 205% of the EU27 average (EU27 = 100%) (Figure 1.12). In terms of GDP, only Cyprus and Greece are ahead of us, while in terms of financial contribution by citizen, only six countries are ahead of us.

[26] External Common Research Datawarehouse (eCORDA) data as of 8 November 2024. Online: https://webgate.ec.europa.eu
[27] External Common Research Datawarehouse (eCORDA) data as of 8 November 2024. Online: https://webgate.ec.europa.eu

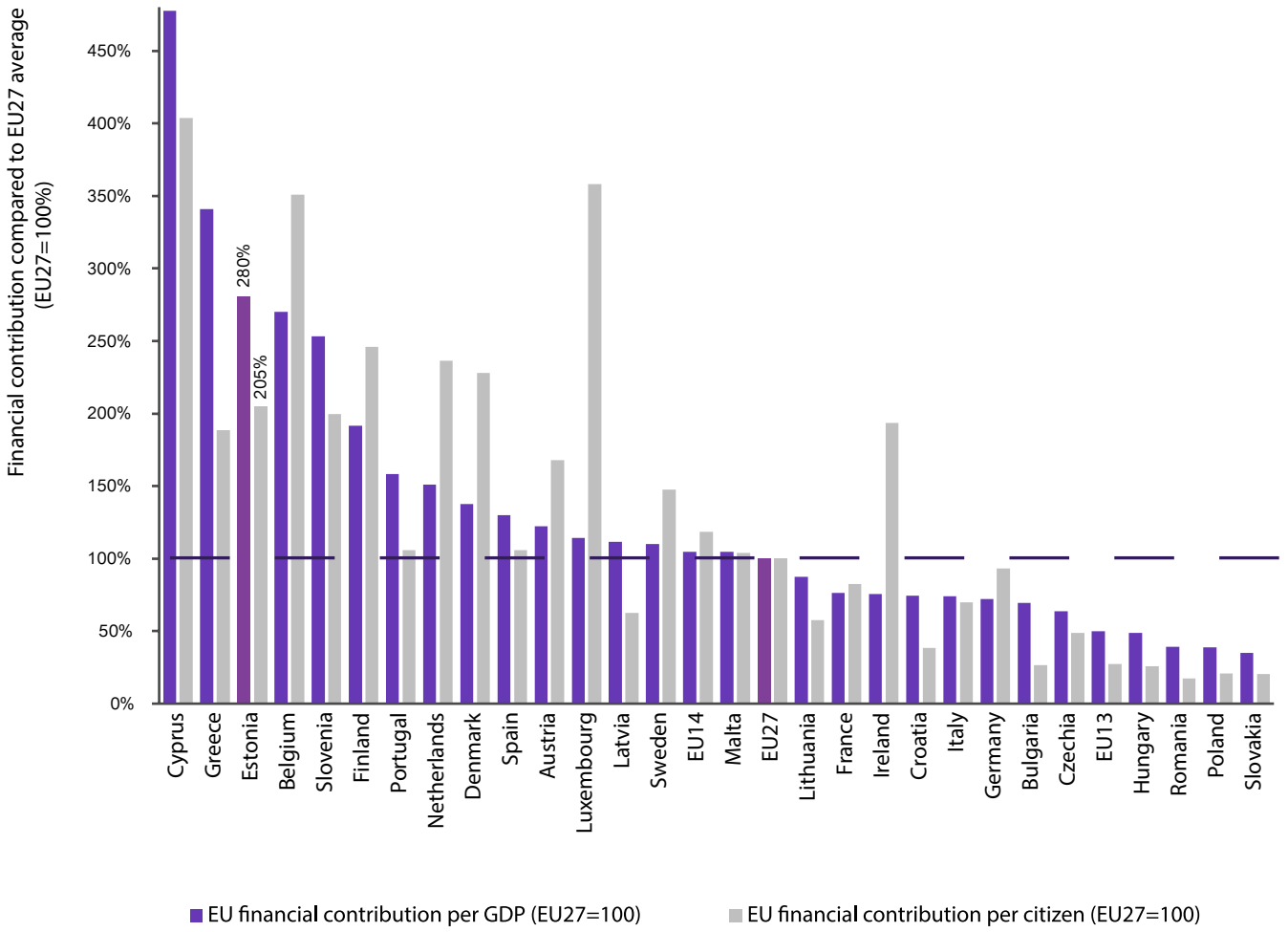


Figure 1.12. EU financial contribution from Horizon Europe of participating EU27 countries per GDP and per citizen compared to EU27 average.

Sources: eCORDA and Eurostat, calculations by Estonian Research Council.

FIELDS OF RESEARCH

Competitive research funding, where the proportions of funding for each field are determined, occasionally raises the question of whether these proportions should be adjusted to ensure the diversity of research fields and support the development of Estonia. This is an important question because the diversity of research fields drives the expansion of knowledge to meet societal needs and balanced funding across fields helps sustain this diversity. The diversity of research fields fosters new discoveries and innovation. In 2023, the research grants of the Estonian Research Council accounted for 19.1% of all public R&D expenditure (see the article by A. Noorma, Figure 1.16). Research grants lay the foundation for knowledge and ensure an evidence-based higher education, making them a main instrument in funding the research system. Therefore, they influence the breakdown of public R&D expenditure by field, the statistics of which are limited to the data collected by Eurostat for the six main fields of the Frascati Manual. This is far too little to assess the diversity of research more broadly.

The proportions of public R&D expenditure have changed slightly between 2019 and 2023 (Figure 1.13). The share of agricultural and veterinary sciences increased from 5.2% to 6.0% and for humanities and the arts from 10.6% to 14.2%. In contrast, the share of medical and health sciences as well as social sciences declined over the same period. A comparison of the field-specific distribution of research grants awarded by the Estonian Research Council with the field-specific distribution of public expenditure on the basis of data from Statistics Estonia reveals a similar distribution. Natural sciences receive the highest share of funding, whereas agricultural and veterinary sciences receive the least. If this comparison is used to assess the importance of the fields at the present time (2023 data), the natural sciences have received proportionally less funding from other sources compared to research grants (47.4% of research grants, 36.8% of total public expenditure). In contrast, medical and health sciences have received significantly more (13.7% of research grants, 17.0% of total public expenditure). The sectoral distribution of research grants funded by the Estonian Research Council is discussed by A. Noorma in their article (see Figures 1.20 and 1.21).

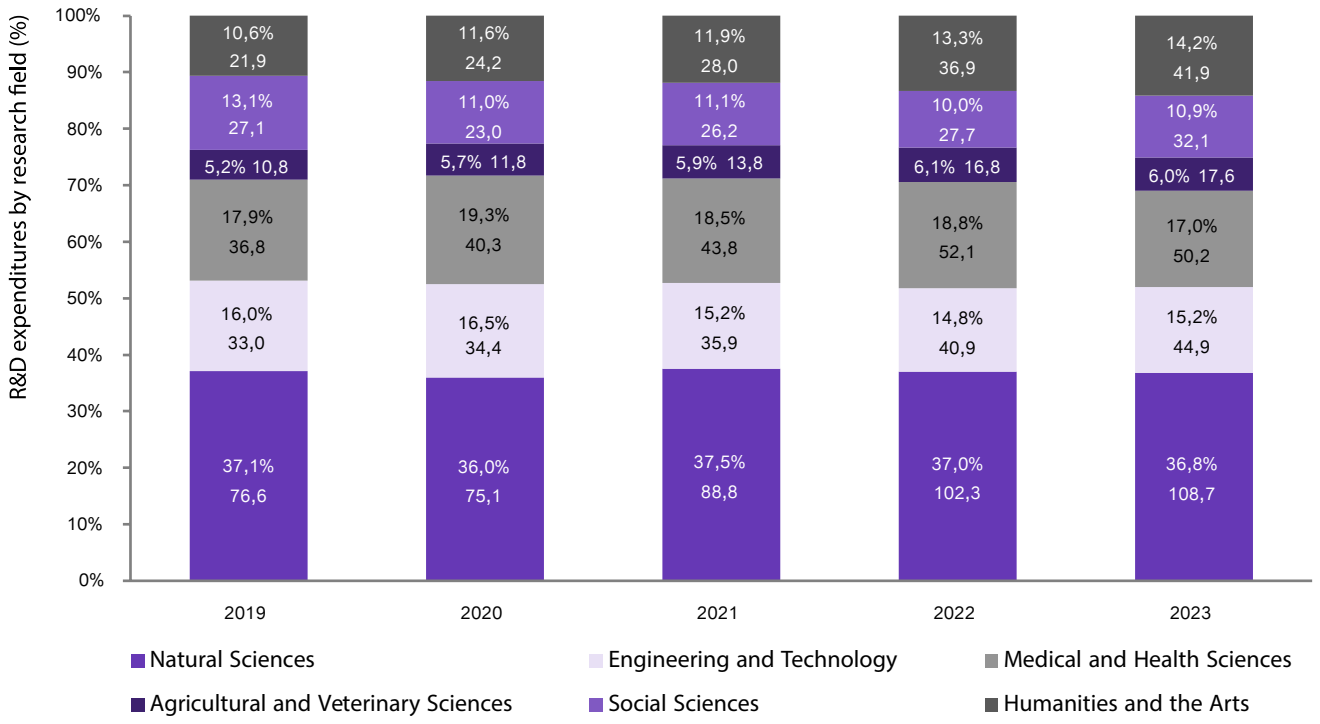


Figure 1.13. R&D expenditures in public sector by research field of science in 2019–2023 (million EUR, %). The figures in the columns indicate the funding volume per field.

Source: Statistics Estonia, calculations by Estonian Research Council.

The diversity of research fields is unique to each country, shaped by historical research policy decisions and national development priorities. That said, comparisons with other countries allow for a critical examination of whether and how field-specific funding proportions could be adjusted.

Compared to the Nordic countries, Estonia clearly stands out in that our share of expenditure on natural sciences (37.5%) is markedly higher than that of Finland (24.5%), Sweden (23.9%), Iceland (24%) and Norway (19.8%), while the share of expenditure on social sciences is lower (Figure 1.14). Additionally, Estonia's share of funding for medical and health sciences (18.5%) is lower than in the Nordic countries, with the exception of Finland (17.1%).

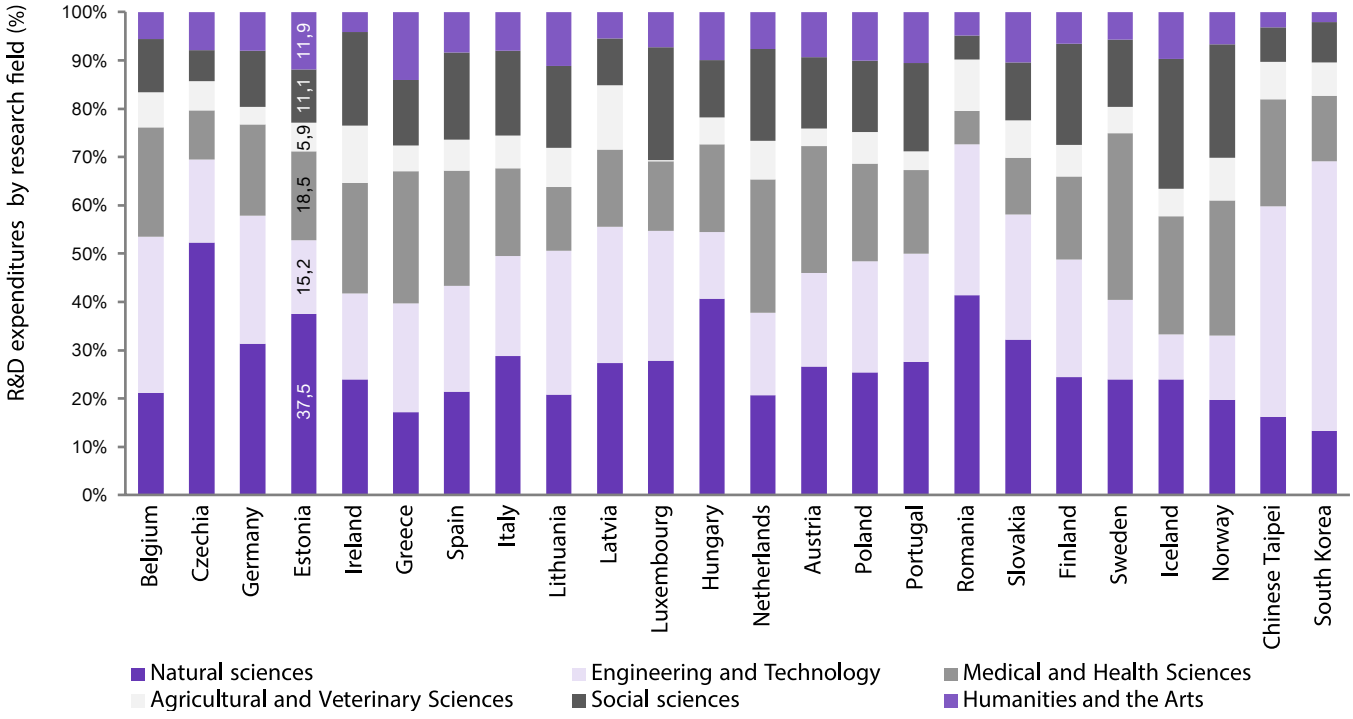


Figure 1.14. R&D expenditures in public sector by research field in 2021 (%).

Source: OECD, calculations by Estonian Research Council.

WHAT IS MONEY SPENT ON?

Aggregated data from Statistics Estonia on the economic content of R&D expenditure allow for an analysis of the changes in the cost structure over time. In a broader sense, the term 'research and development investment' refers to all R&D-related expenditure, as it represents long-term expenditure aimed at generating profit (for the development of our country). However, in terms of economic content, 'investments' are used in a narrower sense (eg expenditure on immovable property and laboratory equipment).

Between 2014 and 2023, the share of public investment in R&D expenditure was 10%, showing a clear downward trend. The volume of investment has been primarily influenced by EU Structural Fund measures, which have contributed to modernising the research environment (buildings and laboratories). The investment volumes during the start-up and wind-down years of the programming period were lower than those in the mid-period.

International comparisons show that the share of investment in R&D tends to be higher in countries with lower R&D intensity and lower in countries with higher R&D intensity. According to Eurostat 2022 data (which measures the share of capital investment in R&D expenditure), capital investment accounted for 3.1% of public R&D expenditure in Finland and 3.6% in Sweden (2021). In 2022, public capital investment in Estonia, Latvia and Lithuania accounted for 5.1%, 7.0% and 11.3% of R&D expenditure, respectively.

Labour costs accounted for more than half – 54% – of total expenditure between 2014 and 2023, ranging between 49% and 59% over the period (Figure 1.15).

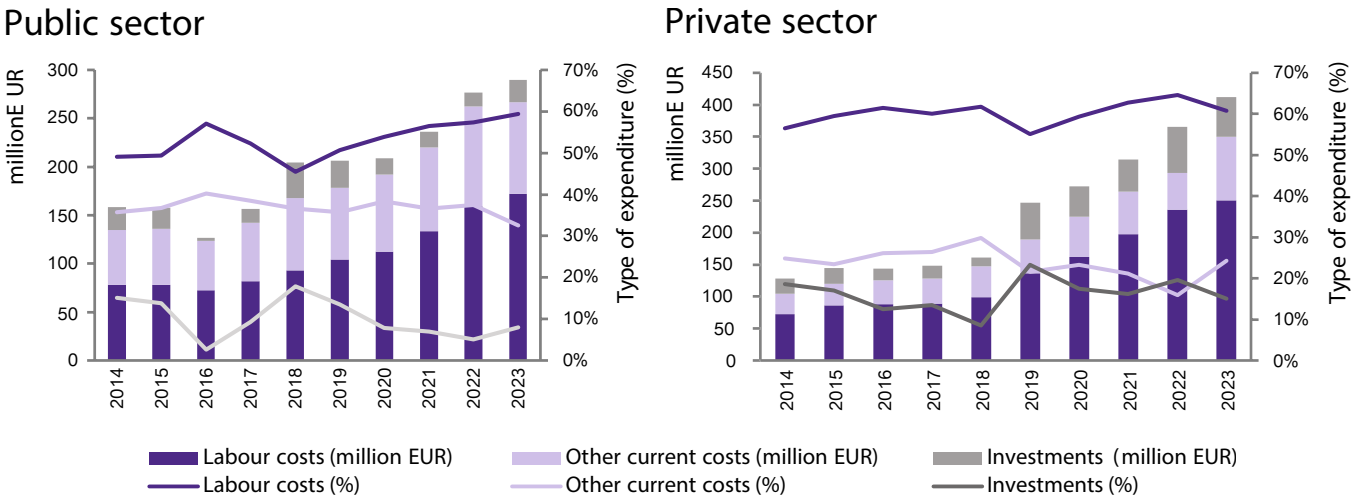


Figure 1.15. R&D expenditure in public and private sector by type of expenditure in 2014–2023 (million EUR).

Source: Statistics Estonia, calculations by Estonian Research Council.

The growth in the volume of private sector R&D and its expenditure structure are influenced by an increase in the number of companies engaged in R&D. However, no clear trend in the expenditure structure can be identified. Compared to the public sector expenditure structure, the private sector has a higher share of labour costs and investments, and a lower share of other costs. Eurostat data for 2022 shows a similar relationship between R&D intensity and the share of investment in the private sector as observed in the public sector. In Finland and Sweden, where private sector R&D expenditure accounted for 2.05% and 2.47% of GDP (2021), capital investments made up 7.7% and 7.5%, respectively. In Latvia (private sector 0.28% of GDP) and Hungary (private sector 1.24% of GDP), these figures were 20.1% and 12.6%, respectively.

SUMMARY

In summary, it can be said that, compared to three years ago, Estonian R&D funding has increased in absolute terms, but its share of GDP has remained unchanged. The new funding instruments include the measure of the Ministry of Education and Research to support R&D at institutions of professional higher education, as well as the measure of the Ministry of Economic Affairs and Communications to provide financial incentives for R&D at enterprises. In terms of funding, the role of sectoral ministries and competition have grown. In international comparisons, we have reached the top in state budget allocations and have slightly improved our position in the R&D intensity rankings. However, the private sector requires greater state support to bring more research-intensive products and services to the market. Success in international research co-operation has also continued, with both the volume of co-operation and the number of participants increasing.



"Ten Fighting Men", Antonio Pollaiuolo, reproduction. Photo from the University of Tartu Museum. • Marko Piirsoo

PUBLIC RESEARCH FUNDING INSTRUMENTS MANAGED BY THE ESTONIAN RESEARCH COUNCIL

ANU NOORMA **Director General, Estonian Research Council**

Throughout the entire period since the restoration of independence, over the past thirty years, the Estonian research system has been characterised by significant variability in both research funding and the number of institutions and researchers. Structural changes include the establishment of the Estonian Research Council (ETAG) in 2012 as the implementer of the research and development (R&D) policy of the Ministry of Education and Research to centralise the processing of public research grants[28] and ensure the uniform quality in the processing of different instruments.[29]

Funding for R&D has increased in line with the growth of the country's gross domestic product (see article by K. Jaanson in this collection, Figure 1.1), although the transitions between periods of European Union's (EU's) Structural Funds have been accompanied by cyclical fluctuations. The period covered in this collection, 2022–2024, is characterised by the launch of the new Structural Funds period. However, adherence to the research agreement,[30] which came into effect in 2019, has prevented a situation where public R&D funding would decrease, as occurred in 2015–2017 (Figure 1.7). At the same time, there is a need to direct additional funding towards measures that are crucial for our research system (research infrastructures, centres of excellence), but which cannot be funded from the Structural Funds in the new period.

During relatively good economic times, public funding for research has steadily increased. Although the research agreement has directed more funding to sectoral ministries (see Figure 1.8 in article by K. Jaanson), the overall share of the main instruments (research grants and baseline funding) in public sector R&D expenditure has remained relatively stable (at approximately 40% between 2019 and 2023). The volume of public research grants managed by the Estonian Research Council has grown relatively modestly, whereas baseline funding has increased rapidly and has been nearly equal to the volume of research grants since 2019 (Figure 1.16). Since 2018, research grants have accounted for 18% to 20% of public R&D expenditure, compared to up to 30% in earlier years.

As a competitive measure, research grants have been the main funding instrument managed by the Estonian Research Council. The budget of the Estonian Research Council has grown consistently, representing approximately 26–31% of public sector R&D expenditure between 2019 and 2023. In the Ministry of Education and Research's R&D and innovation programme budget, the share of the budget of the Estonian Research Council has remained at 32–37%. It is likely to increase in the coming years, as the priority in preparing the 2025 State Budget has been to maintain the main instruments at their current levels, despite cuts to other R&D expenditures.[31]

[28] Estonian Research Council. Teadusrikas Eesti. Online: https://etag.ee/teadusagentuur/publikatsioonid/teadusrikas-eesti/ (07.10.2024).
[29] Jaanson, K., Koppel, A., Noorma , A. (2022). 'The first ten years of the Estonian Research Council'. – Estonian Research 2022 (ed K. Raudvere), pp 103–106, Estonian Research Council, Tartu. Online: https://doi.org/10.23673/tead/001.
[30] Estonian Research Council. Estonian Research Agreement. A Social Agreement to Ensure the Further Development of Estonian Research and Innovation. Online: https://www.etag.ee/wp-content/uploads/2019/05/Teaduslepe.pdf (05.09.2024).
[31] Ministry of Finance. Explanatory memorandum to the State Budget for 2025, p 119. Online: https://www.fin.ee/sites/default/files/documents/2024-10/2025.%20aasta%20riigieelarve%20seletuskiri_final.pdf (01.11.2024).

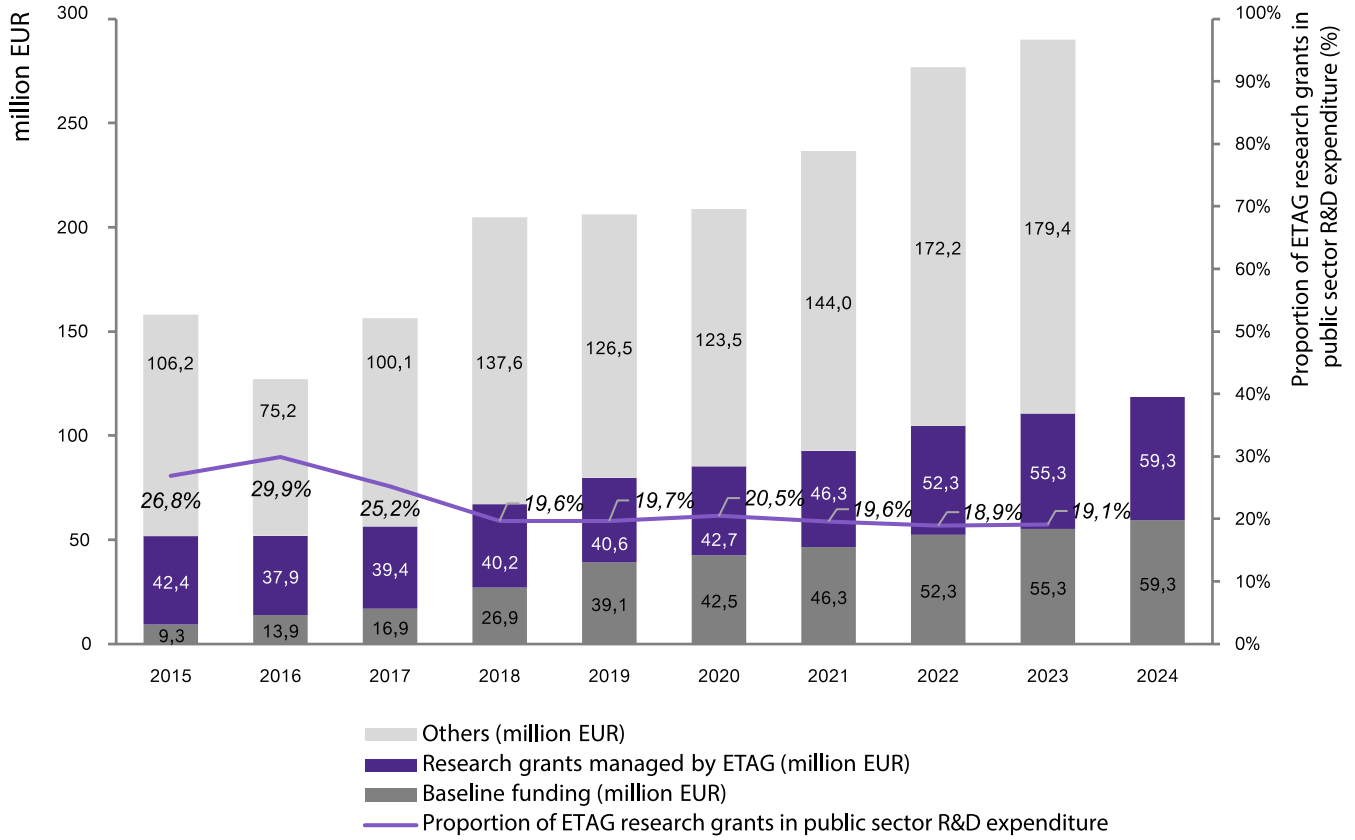


Figure 1.16. Public sector R&D expenditure (million EUR), including baseline funding and research grants (managed by Estonian Research Council) in 2015–2024. The line shows the share of research grants in public sector R&D expenditure.

Sources: Statistics Estonia, Ministry of Education and Research, Estonian Research Council. Calculations by Estonian Research Council.

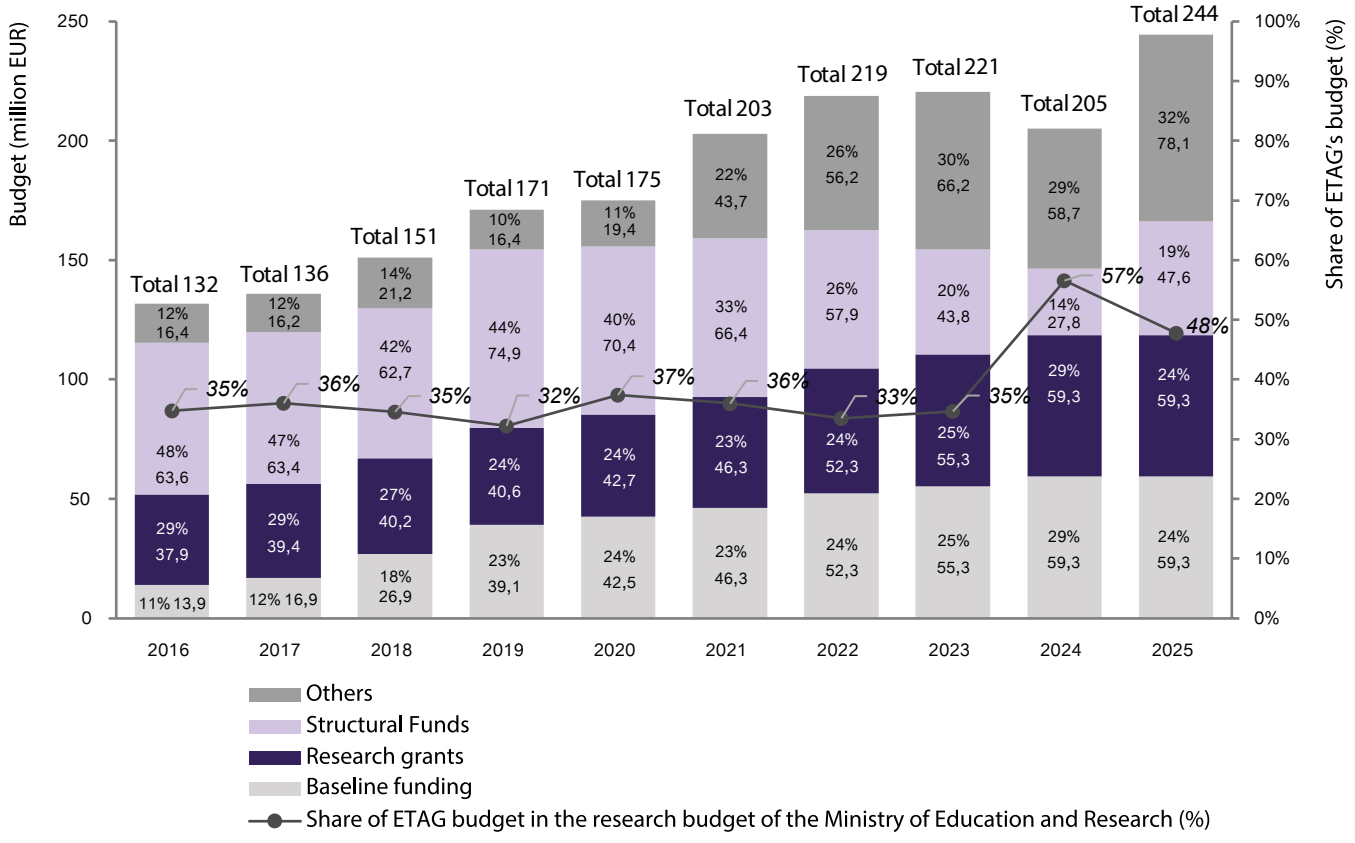
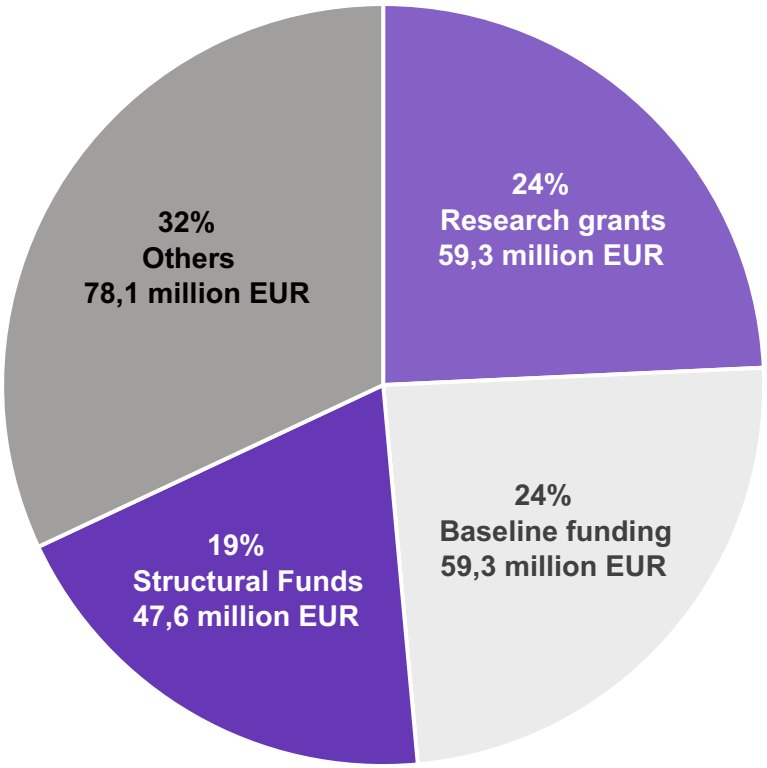


Figure 1.17a. The research budget of the Ministry of Education and Research and its main components in 2016–2025 (million EUR).

Source: Ministry of Education and Research.



Components of foreign sources:

- Astra + programme (including increasing institutional knowledge trasfer)
- RITA + programme
- SekMo +
- Mobilitas 3.0 programme
- Teaming projects
- Centres of Excellence and research infrastructure
- TeaMe 3.0
- Thematic R&D programmes
- Just Transition Fund increasing the scientific intensity of Ida-Viru business

Components of other sources

- Ensuring the EENet educational service
- International mobility grants (except TAIE smart spezcialization areas)
- Membership fees of international organizations, international research cooperation
- Target support for R&D activities of state universities of applied sciences
- National programmes
- Support for research infrastructures of national importance
- Salaries for junior researchers
- Centres of excellence
- Scientific collections
- Science communication, national science awards
- Participation in international infrastructure cooperation
- Research libraries
- Teaming for excellence projects co-financing
- Operating support (Estonian Research Council, Estonian Academy of Sciences, Ahhaa, Art Museum of Estonia etc)

Figure 1.17b. The research budget of the Ministry of Education and Research and its main components in 2025 (million EUR).

Source: Ministry of Education and Research.

All measures[32] from the previous period of the European Union Structural Funds (2015–2023) concluded in 2023, with only a small portion of funds from the new period allocated in the 2024 budget (Figure 1.18). Although not all planned measures for R&D in the new European Union Structural Funds period (2023–2029) have been launched, the main funding instruments managed by the Estonian Research Council have already been decided (a more detailed list is in Table 1.5).

A more detailed overview of the changes in the funding of public research grants and other measures managed by the Estonian Research Council is provided below. Research grants, as the main instrument of the research system, make up a significant, though decreasing, share of the total budget of the Estonian Research Council (77% in 2018, 50% in 2024). Figure 1.18 shows the most important programmes managed by the Estonian Research Council compared to personal research funding. Since 2024, the Estonian Research Council has also managed large-scale, long-term measures such as funding for research centres of excellence and public research infrastructures. The Figure does not include the relatively small-scale funding schemes of the Estonian Research Council (including international co-operation, application rounds of other ministries). From 2025 onwards, projected volumes are shown, which may change later.

[32] Rutiku, S. (2022). Competetive research and development funding instruments. - Estonian Research (ed. Kadri Raudvere), pps 25-33, Estonian Research Council, Tartu. https://doi.org/10.23673/tead/002

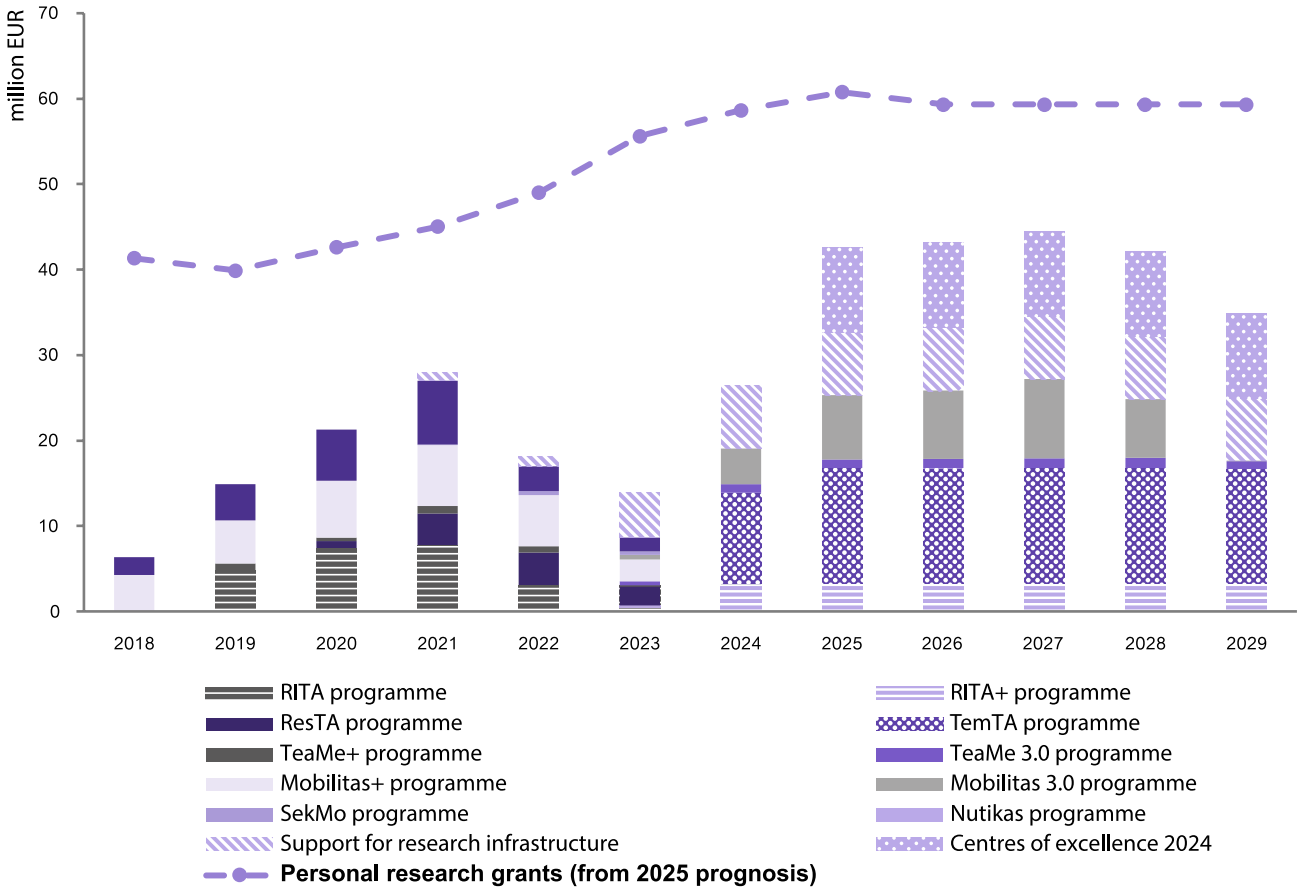


Figure 1.18. R&D funding through programmes and measures in 2018–2029 (million EUR). Due to the lack of precise data, total funding for the programme in the forecast years (from 2025) has been evenly distributed across the years, with figures refined annually based on actual expenditure.

Sources: Estonian Research Council, State Shared Service Centre.

CHANGES IN THE ALLOCATION OF PUBLIC RESEARCH GRANTS

Shortly before the COVID-19 crisis broke out in 2020, a grant system had been reached in terms of public research funding that aligned with the framework[33] agreed in 2016 and the core of the grants consisted of three types related to a research career: postdoctoral research grant, starting grant and team grant (see Figure 1.16[34] in article by S. Rutiku and following Table 1.1). To improve the quality of the evaluation system (Estonian Research Council also joined the CoARA Consortium[35] in 2022) and address the growing conflict of interest in Estonia's small research community, a shift to international panels[36] was made in 2022. At the same time, the Evaluation Committee[37] of the Estonian Research Council faced two difficult challenges: 1) smoothing the cyclical nature of new annual funding rounds, and 2) changing the distribution between fields of research.

[33] Uurimistoetuste ja baasfinantseerimise uus kontseptsioon teadus- ja arendustegevuse rahastamise süsteemis. Estonian Research Council. Online: https://etag.ee/uurimistoetuste-ja-baasfinantseerimise-uus-kontseptsioon-teadus-ja-arendustegevuse-rahastamise-susteemis/ (06.09.2024).
[34] Rutiku, S. (2022). 'Competitive research and development funding instruments'. – Estonian Research 2022 (ed K. Raudvere), pp 25–33, Estonian Research Council, Tartu. Online: https://doi.org/10.23673/tead/002.
[35] Coalition for Advancing Research Agreement. Online: coara.eu (06.09.2024).
[36] Noorma, A. (2022). 'Roheline tuli, punased jooned ja hallid alad – muudatused riiklike uurimistoetuste eraldamises'. – Sirp, 4 March. Online: https://www.sirp.ee/s1-artiklid/c21-teadus/roheline-tuli-punased-jooned-ja-hallid-alad-muudatused-riiklike-uurimistoetuste-eraldamises/ (08.10.2024).
[37] The Evaluation Committee of the Estonian Research Council is an expert group of renowned researchers from different fields of research and development. It carries out one of the most important tasks of the Estonian Research Council – evaluating research grant applications – and also contributes to other tasks assigned to the Estonian Research Council by legislation. See also: Evaluation Committee. Estonian Research Council. Online: https://etag.ee/teadusagentuur/hindamisnoukogu/ (10.10.2024).

Table 1.1. Number of ongoing research grants in 2021–2025. Data for 2025 is based on funding decisions.

	Postdoctoral grants (PUTJD)	Starting grants (PSG)	Team grants (PSG)
2021	40	78	175
2022	37	74	193
2023	31	77	219
2024	30	84	226
2025	37	91	229

Source: Estonian Research Council.

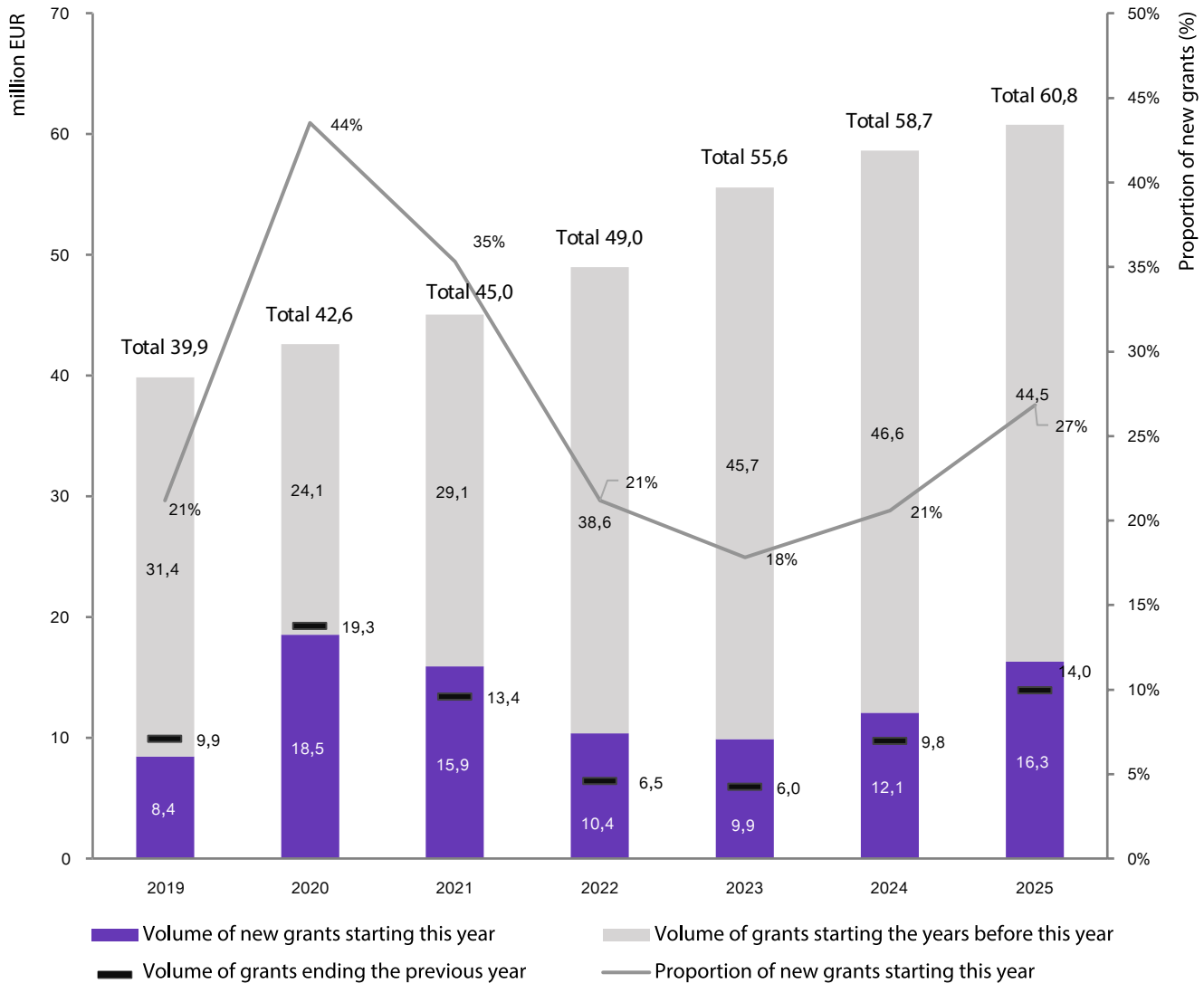


Figure 1.19. The volume of research grants (million EUR) ending in the previous year and starting this year or earlier during the years 2019–2025 (2025 amounts are forecast based on data based on funding decisions).

Source: Estonian Research Council.

The cyclical nature of the new funding rounds was reduced thanks to additional money allocated by the Ministry of Education and Research starting in 2022. The redistribution of funds also considered the long-term forecasts for ongoing and concluding projects in the research fields, as well as the harmonisation of success rates. Figure 1.19 shows that, thanks to additional funding, the volume of new rounds has remained above 10 million euros in recent years, accounting for a stable 18–21% of the total research grant volume. Meanwhile, funding has steadily increased across all research fields 2021 (Figure 1.20).

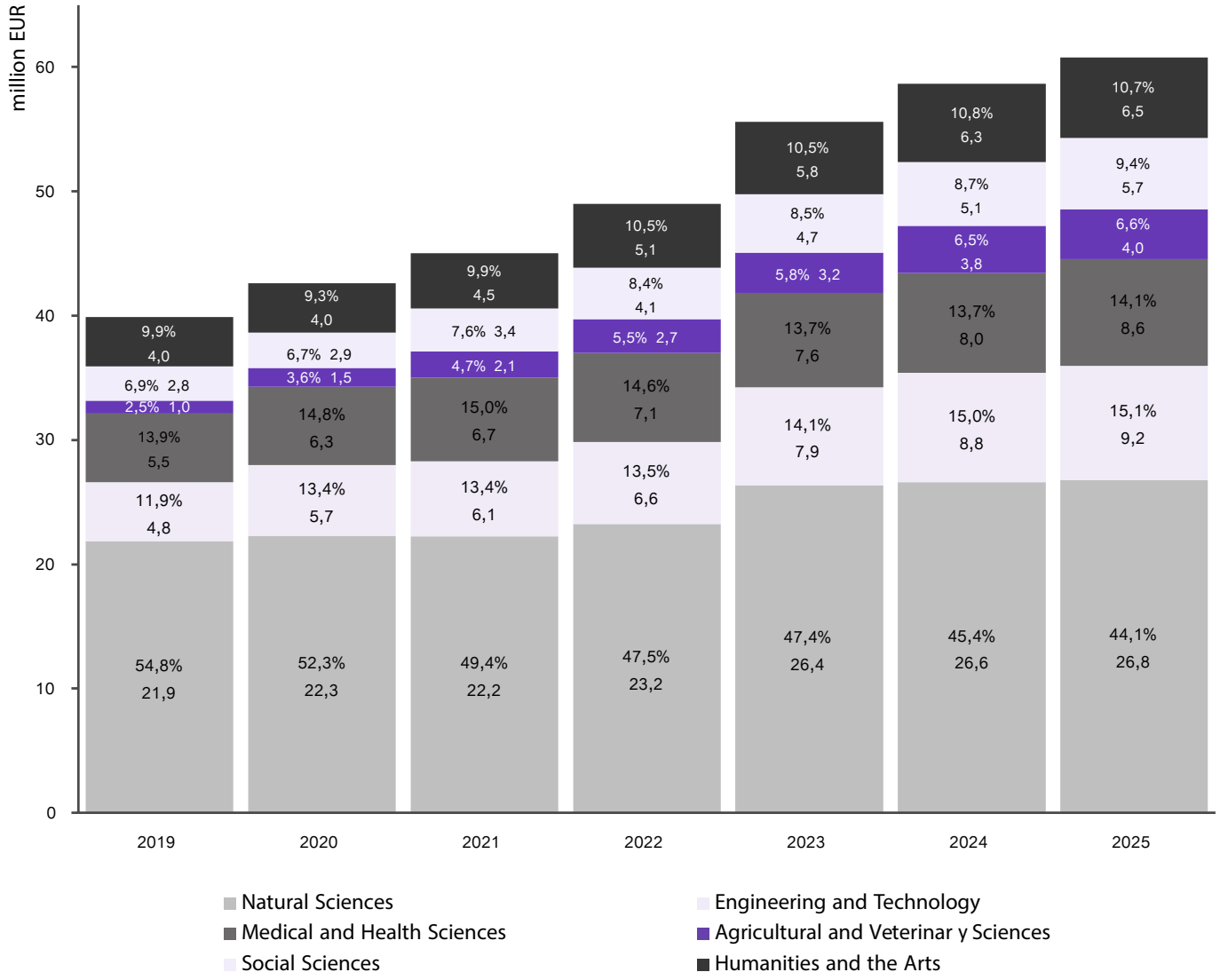


Figure 1.20. Division of research grants by research fields in 2019–2025 (2025 amounts are forecast based on data based on funding decisions). Projects are divided according to research field (each project is in one research field), but the exact sciences and bio- and environmental sciences are combined into one field of natural sciences.

Source: Estonian Research Council.

The issue of field-specific distribution of research funding was already under discussion in the Research and Development Council in 2020. Changes in the field-specific distribution of research grants have taken place over the past four years, which the decision of the Research and Development Council and the allocation of targeted additional resources by the Ministry of Education and research sought to achieve (Figure 1.21):

1) the share of natural sciences in the total volume of research grants has decreased (54.8% in 2019, 44.1% in 2025);

2) the volume of funding in the field of engineering and technology has continuously increased in 2019–2025, with its share of the annual total rising from 11.9% to 15.1%.

Since 2021, funding has increased in all fields.

In the Research and Development Council discussions, two target options were initially proposed: one algorithm-based (which could not be implemented due to the shift to panel evaluation) and the other based on fixed proportions. By now, proportions have developed that are roughly in line with the recommended ones, although the share of natural sciences has decreased further, while the shares of humanities and agricultural sciences have slightly increased.

The success rate for obtaining grants relative to the amounts applied for also varies significantly by field, being lowest overall in the humanities and arts, as well as in engineering and technology (Figure 1.21). Success rates are also highly volatile from year to year. In fields where a one-off funding increase was made through a research policy decision, the impact of this funding extends over several subsequent years (eg the success rate for agricultural and veterinary sciences has ranged from 12.7% to 38.5% between 2020 and 2025, while the success rate for engineering and technology has varied between 11.9% and 31.8%). For grants starting in 2025, the overall success rate across fields has exceeded 25%.

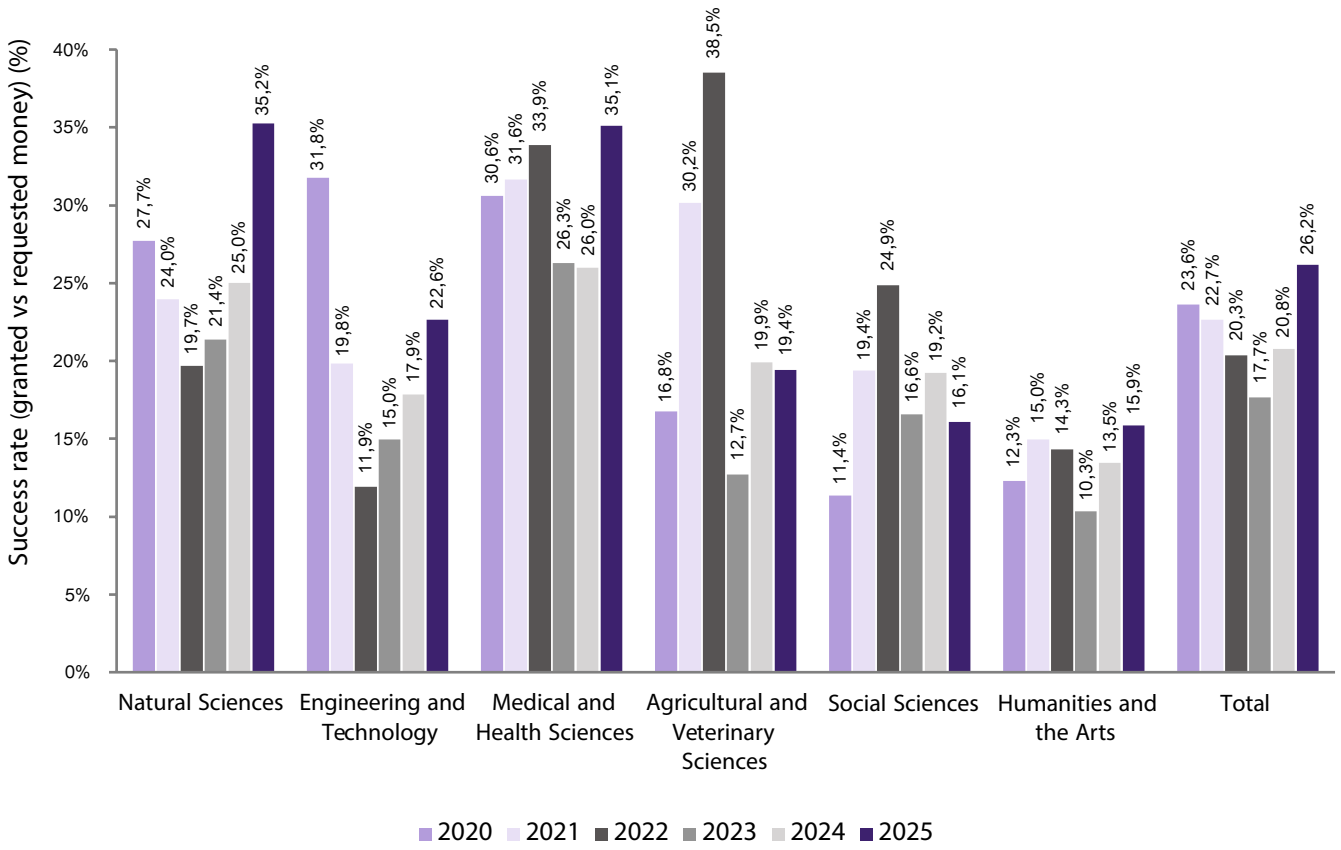


Figure 1.21. Granted by the Estonian Research Council versus requested money in 2020–2025 application rounds across research fields. The year marked indicates the start year of the grant project.

Source: Estonian Research Council.

It is clear that ensuring a precise annual distribution is not possible, as funding is allocated in units. In smaller fields, the allocation of even a single large grant in some years can significantly skew the overall picture. Therefore, in the assessment of the Estonian Research Council, the current proportions in funding are at a point where further substantial changes are no longer advisable and the focus should instead be on ensuring stability.

However, based on the research conducted, which employed different methodologies and interviews,[40] it can be concluded that **Estonian research is diverse**. However, when it comes to the diversity of research fields, clear goal-setting is crucial: what is to be achieved, why, for whom and what is the end goal. One of the sub-objectives of Estonian Research and Development, Innovation and Entrepreneurship Strategy 2021–2035 is to ensure that Estonian research is of high-quality, effective and diverse. However, no appropriate metric has been defined to assess the diversity of research across fields and the concept of field-specific diversity remains undefined. This is essential for both defining and measuring as well as for monitoring diversity. In addition to measuring research diversity through indices, the interdisciplinarity of research and its relevance to societal needs also require more detailed attention.

Since 2019, the Estonian Research Council has been piloting the funding of experimental development through **proof-of-concept (PoC)** grants to enhance the commercialisation of research results (including the creation of new products, introduction of new processes, improving existing products and processes), thereby promoting technology transfer, the application of research results in business and society at large, and increasing the social and economic impact of research.

Although there has been strong interest from applicants, three calls for proposals were organised (2019, 2021, 2023), resulting in 8 grants (totalling €0.76 million), 12 grants (totalling €1.2 million) and 14 grants (totalling €2.03 million), respectively.[41] In the last round, priority was given to promoting key areas of Estonian green policy. The concept of PoC grants was also adopted by several universities in their funding schemes. Starting in 2025, instruments with objectives similar to those of PoC grants were transferred to different Structural Funds measures (ASTRA+, the Centre of Excellence, and Infrastructure Service Measures) and are no longer managed by the Estonian Research Council.

[38] Eerma, D., Chebotareva, M., Espenberg, S., Hirv, T., Pavlov, D., Urmann, H., Remmik, M. (2022). Teaduse valdkondliku mitmekesisuse määratlemine, selle seire metoodika ja mõõdiku väljatöötamine. Tartu: University of Tartu. Online: https://etag.ee/wp-content/uploads/2022/07/RITA-4-024-Teaduse-valdkondliku-mitmekesisuse-mootmine_Lopparuanne_II.pdf (05.09. 2024).
[39] Estonian Research Council. Summary of the proof-of-concept grant calls in ETAG. Online: https://etag.ee/wp-content/uploads/2024/02/Arendusgrandi-taotlusvoorude-kokkuvote.pdf (05.09. 2024).

SUPPORT FOR UKRAINIAN RESEARCHERS[40]

Unusual times require unusual and swift measures. For example, in 2020, a round of necessary support related to the COVID-19 pandemic was quickly launched.[41] Shortly after, a new crisis emerged – in 2022, full-scale war broke out between Russia and Ukraine. As an organisation in a country receiving refugees, the Estonian Research Council also started to launch supporting measures. First, we supported the **short-term traineeships of Ukrainian researchers** in Estonian universities (up to three months). The purpose of the traineeships was to familiarise Ukrainian researchers with the research and teaching environment of Estonian universities and expand their professional development opportunities. A total of €450,000 was allocated to recruit 50 trainees for three months across all universities. However, the actual demand was lower than expected and only 28 trainees were recruited (with a total volume of €243,000).

A few months later, we provided the opportunity to directly involve Ukrainian researchers in research teams for ongoing starting grant, team grant and PoC grant projects. A total of 25 Ukrainian researchers were involved for a period of 6 to 12 months, with a total grant amount of €626,000. The researchers were distributed across different fields and universities: 12 at the University of Tartu, three at Tallinn University, four at Tallinn University of Technology, three at the National Institute of Chemical Physics and Biophysics, one at the Estonian University of Life Sciences and two at the Estonian Literary Museum.

In 2023, an international co-operation measure was also launched, in the framework of which and at the initiative of the US National Science Foundation (NSF), the research agencies of Ukraine, Estonia, Latvia, Lithuania and Poland jointly established the IMPRESS-U R&D support measure ('Towards Resilient International Collaborations. Integration of Ukrainian Researchers into Global Research Community') in the spring of the same year. The aim of this initiative is to support high-level international research and facilitate the integration of Ukrainian researchers and research institutions into global research co-operation. As of the end of 2024, six projects with Estonian participation have been approved in the evaluation. Hopefully, this scheme will also continue in the future.

CENTRES OF EXCELLENCE

The Estonian research system is built on a focus on quality, which is determined through intense competition. One of the largest and most stable research funding instruments since 2001 has been the Centres of Excellence. In 2023, the current last round of centres completed their activities.[42] The conditions and procedure for the naming and financing of new centres of excellence are outlined in Regulation No 13 of the Minister of Education and Research of 2023 'Conditions and Procedure for the Naming and Financing of Centres of Excellence'.[43] The main objective is to foster co-operation and joint activities among Estonian research teams of outstanding excellence. A centre of excellence focuses on addressing high-risk, high-potential research problems based on the needs of Estonia, with the goal of producing transformative research results that will contribute significantly to advancing existing knowledge in multiple fields. The Centres of Excellence grant was awarded in 2023 to ten consortia (see Table 1.2) for a seven-year period, with each centre receiving a maximum of €7 million, with eligible expenditure fully covered and no own contribution required.

[40] Support for Ukrainian researchers. Estonian Research Council. Online: https://etag.ee/rahastamine/toetused-ukraina-teadlastele/ (07.10.2024).
[41] Rutiku, S. (2022). 'Competitive research and development funding instruments'. – Estonian Research 2022 (ed K. Raudvere), pp 25–33, Estonian Research Council, Tartu. Online: https://doi.org/10.23673/tead/002.
[42] Estonian Research Council. Estonian Centres of Excellence. Online: https://doi.org/10.58009/aere-perennius0072.
[43] Teaduse tippkeskuste nimetamise ja finantseerimise tingimused ja kord (Conditions and Procedure for the Naming and Financing of Centres of Excellence). Approved by Regulation of the Minister of Education and Research of 11 May 2023. – Riigi Teataja I, 2023, No 13. Online: https://www.riigiteataja.ee/akt/113052023005 (06.09.2024).

Table 1.2. Centres of excellence that started in 2024.

Centres of excellence	Beneficiary (coordinator)	Partners
Centre of Excellence for Personalised Medicine	University of Tartu	Tallinn University Protobios OÜ Celvia CC AS
Foundations of the Universe	National Institute of Chemical Physics and Biophysics	University of Tartu Tallinn University of Technology
Estonian Center of Excellence of Well-Being Sciences	University of Tartu	Tallinn University of Technology Tallinn University
Estonian Centre of Excellence in Artificial Intelligence	University of Tartu	Cybernetica AS Tallinn University of Technology
Estonian Roots: Centre of Excellence for transdisciplinary studies on ethnogenesis and cultural diversity	University of Tartu	Tallinn University of Technology Estonian Literary Museum
Centre of Excellence for Sustainable Land Use	University of Tartu	Estonian University of Life Sciences Centre of Estonian Rural Research and Knowledge
Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources	Tallinn University of Technology	University of Tartu National Institute of Chemical Physics and Biophysics
Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources	University of Tartu	Tallinn University of Technology
Agroecology and new crops in future climates	Estonian University of Life Sciences	University of Tartu Centre of Estonian Rural Research and Knowledge
Centre of Excellence in Energy Efficiency	Tallinn University of Technology	Tallinn University University of Tartu

Source: Estonian Research Information System.

RESEARCH INFRASTRUCTURES

In order to invest in research infrastructures, Estonia has been preparing the Estonian Research Infrastructures Roadmap since 2010.[44] According to the Regulation 'Support for Research Infrastructures of National Importance'[45], the roadmap must be updated every five years, so the preparation of a new roadmap was planned for 2024.

The purpose of compiling the roadmap is to create a comprehensive overview of existing and future research infrastructures that are of key importance to the state. Inclusion in the roadmap is a prerequisite for applying for state support. The aim of supporting research infrastructures of national importance is to enhance the quality of evidence-based services provided by such infrastructures, improve their sustainability and expand the availability of these services to the public, private and third sectors.

To prepare the Estonian Research Infrastructures Roadmap for 2024, the Estonian Research Council conducted a comprehensive analysis of the objects from previous roadmaps and their funding[46] and prepared an overview of user experiences and recommendations for future action.[47]

Research infrastructures of national importance have been funded through different measures with approximately €135.5 million between 2010 and 2024 (Table 1.3). Approximately half of the funding for the roadmaps has been covered by the state through Structural Funds, with a significant portion (37%) allocated to membership fees.

[44] Estonian Research Infrastructures Roadmap. Estonian Research Council. Online: https://etag.ee/rahastamine/infrastruktuuritoetused/teadustaristu-teekaart/ (06.09.2024).
[45] Riikliku tähtsusega teadustaristu toetamine (Support for Research Infrastructures of National Importance). Approved by Regulation of the Minister of Education and Research of 28 September 2023. – Riigi Teataja, I, No 36. Online: https://www.riigiteataja.ee/akt/104102023006 (06.09.2024).
[46] Sillaste, M. (2024). Riikliku tähtsusega teadustaristute analüüs (Analysis of Research Infrastructures of National Importance). Estonian Research Council. Online: https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (07.10.2024).
[47] Kivistik, K., Toomik, K., Kaldur, K., Jurkov, K., ja Järvela, S. (2024). Teadustaristu kasutuskogemuse uuring (Research Infrastructure User Experience Study). Tartu: Institute of Baltic Studies. Online: https://doi.org/10.58009/aere-perennius0144.

Table 1.3. Funding of the objects of research infrastructures roadmaps by funding measure in 2010–2024.

Funding measure	Number of objects	Financial amount (million EUR)
Modernising the research infrastructures of national importance (SF 2007- 2013 and SF 2014-2020)	21	57,6
Programme „Internationalisation of Research" (SF 2007-2013)	6	5,9
Modernising the research equipment of R&D institutions (SF 2007-2013)	9	10,2
Funding of the Core Facilities (2014-2024, state budget)	17	9,2
Funding of the international collaboration between research infrastructures (2023-2024, state budget)	4	1,9
Membership fees (2012-2024, SF 2007-2013 and state budget)	9	50,7
Total	**66**	**135,5**

Source: Estonian Research Council.[48]
*The total number of financed objects is 27 (out of the 28 objects listed on the roadmap – one object was not financed through any of the measures, while some objects received funding through multiple measures).

Membership fees for participation in research infrastructures are covered through three ministries: Ministry of Education and Research (including through the Estonian Research Council) €5.0 million, Ministry of Social Affairs €0.2 million and Ministry of Economic Affairs and Communications €45 million. In the latter case, it is important to note that Estonia's accession to the European Space Agency in 2015 and to the European Organisation for Nuclear Research (CERN) in 2024 occurred under the leadership of the Ministry of Education and Research. These accessions were driven primarily by the interests of Estonian companies[49] but serve as excellent examples of synergy between business and research. As a whole, they support the ambitions of Estonia as a research-intensive country. In a separate article in this collection, Tarmo Soomere, Chairman of the Research Infrastructures Committee, provides an overview of the creation of the 2024 Estonian Research Infrastructures Roadmap.

The 2024 Estonian Research Infrastructures Roadmap was approved by Directive[50] of the Minister of Education and Research, including 28 objects across a variety of research fields (Table 1.4).

Table 1.4. The number of objects on the Infrastructures Roadmap according to the 2024 renewal proposal of the Estonian Research Infrastructures Roadmap by ESFRI field.

EFRI field	Number of objects on the roadmap
Health and Food	4
Environment	9
Physical Sciences & Engineering	8
Social & Cultural Innovation	4
Data, Computing & Digital Research Infrastructures	2
Energy	1
Total	**28**

Source: Estonian Research Council.[51]

[48] Sillaste, M. (2024). Riikliku tähtsusega teadustaristute analüüs (Analysis of Research Infrastructures of National Importance). Estonian Research Council. Online: https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (07.10.2024).
[49] Government ratifies Estonian membership of CERN. Government of the Republic. Online: https://valitsus.ee/uudised/valitsus-otsustas-eesti-taisliikmesuse-cernis (07.10.2024).
[50] Ministry of Education and Research. Directive of the Minister No 1.1-2/24/325, approved on 22 November 2024. Eesti teadustaristu teekaardi objektide loetelu kinnitamine (Approval of the list of objects in the Estonian Research Infrastructures Roadmap). https://dok.hm.ee/et/document.html?id=4d4b20c5-2a1e-4367-b6b1-2c0f2e0b6016 (25.11.2024).
[51] Sillaste, M. (2024). Riikliku tähtsusega teadustaristute analüüs (Analysis of Research Infrastructures of National Importance). Estonian Research Council. Online: https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (07.10.2024).

NEW PROGRAMMES FOR THE USE OF EU STRUCTURAL FUNDS

The Estonian Research Council will continue to implement certain programmes during the new Structural Funds period together with the State Shared Service Centre.

The new measure, TemTA[52] (Thematic R&D Programmes) supports research projects driven by the needs of companies and public sector institutions in areas such as digital solutions, health, valorisation of local resources and energy. It also fosters co-operation between researchers, companies and public sector institutions through cross-sectoral mobility activities.

Mobilitas 3.0[53] will continue to support the continuous functioning of the Estonian research system, enhancing its excellence, competitiveness and the internationalisation of research. Thanks to this programme, we can foster greater participation of Estonian researchers in Horizon Europe's excellent research calls, including the European Research Council (ERC) grants and Marie Skłodowska-Curie Actions (MSCA). An in-depth analysis of the impact of the different measures supporting the external co-operation of the Estonian Research Council has been completed.[54]

The main objectives of RITA+[55] include building public sector capacity in areas of smart specialisation, integrating R&D results into policy-making and addressing societal problems. The aim is also to increase the role of the public sector in guiding Estonian R&D, support the development of key R&D directions and improve the competence of public sector staff in scientific advice and policy-making, promoting both national and international co-operation.

TeaMe 3.0[56] implements activities that popularise natural and exact sciences, along with technology and engineering. According to the Science Communication Strategy 2020–2035 'Estonia knows'[57], the Estonian Research Council has a mainly co-ordinating role.

Table 1.5. Programs funded by the European Union Structural Funds in 2023–2029 and implemented by the Estonian Research Council and their financial volumes (million EUR).

Abbreviation	Programme	Budget (million EUR)	Including self-financing of grant recipients	Including cofinancing of the state	EU Structural Funds
Mobilitas 3.0	Internationalisation of research, supporting mobility and sustainability	**36,4**	2,9	8,1	25,5
RITA+	Support for sectoral R&D	**19,1**	3,1	2,7	13,4
TeaMe 3.0	Science popularization and communication	**7,0**	0,0	0,1	4,9
TemTA	Thematic R&D projects	**102,0**	14,8	15,8	71,4

Source: Estonian Research Council.

CONDUCTING CALLS FOR SECTORAL MINISTRIES AT THE ESTONIAN RESEARCH COUNCIL

In the research system, both in terms of funding and the strategic direction of research, the Ministry of Economic Affairs and Communications is playing an increasingly prominent role alongside the Ministry of Education and Research, with other ministries playing a lesser but still significant part (see also Figure 1.8 in article by K. Jaanson). The different research and development and innovation (R&D&I) instruments funded from the state budget have somewhat different foci. The main objective of R&D funding under the area of government of the Ministry of Education and Research is to maintain and develop the well-established R&D system of Estonia, which is primarily university-based, while preserving and advancing research excellence. The R&D&I funds under the area of government of the Ministry of Economic Affairs and Communications are primarily aimed at making entrepreneurship more evidence-based to foster economic growth through the increased volume and quality of private R&D&I. The primary goal of sectoral R&D is to support evidence-based decision-making in state governance and contribute to the implementation of key national strategies, particularly 'Estonia 2035'.

From the perspective of the state, sectoral R&D activities should be those with the highest demands and the most strategic planning, as their results are a direct input for state governance.

[52] TemTA – Thematic R&D Programmes. Estonian Research Council. Online: https://etag.ee/en/funding/programmes/temta-thematic-rd-programmes/ (08.10.2024).
[53] Mobilitas 3.0. Estonian Research Council. Online: https://etag.ee/rahastamine/programmid/mobilitas-3-0/ (08.10.2024).
[54] Estonian Research Council (2024). Impact of the measures supporting the external cooperation of the Estonian Research Council on the participation of Estonian applicants in the Framework Programmes. Online: https://etag.ee/teadusagentuur/publikatsioonid/ (08.10.2024).
[55] Rita+. Estonian Research Council. Online: https://etag.ee/en/funding/programmes/rita/ (08.10.2024).
[56] TeaMe 3.0. Estonian Research Council. Online: https://etag.ee/rahastamine/programmid/teame-3-0/ (08.10.2024).
[57] Science Communication Strategy 2020–2035 'Estonia knows'. Estonian Research Council. Online: https://www.etag.ee/wp-content/uploads/2019/12/ETAG_Eesti-teab_strateegia-ENG-web_dets19.pdf (06.01.2025).

In 2023 the following proposals were submitted by Estonian Research Council for organising sectoral R&D:
1. Use the single national platform (ETIS) to manage sectoral R&D;
2. Where appropriate, use the Estonian Research Council as a service provider in managing the R&D of sectoral ministries;
3. In collaboration with the Estonian Research Council, create synergies between sectoral R&D funding instruments and those managed by the Estonian Research Council;
4. Introduce an analysis map for sectoral R&D themes;
5. Develop a quality assurance system for sectoral R&D.

Already in the same year, funding rounds for the focus area 'Viable Estonia' were launched through the Estonian Research Council. The Ministry of Culture implemented the Estonian Culture Research and Development Programme and the Artistic Research Programme, while the Ministry of Education and Research carried out the programme 'Estonian Language and Culture in the Digital Age'. In 2024, when the measure of the Estonian Research Council was piloted, seven more ministries joined and in total more than €10 million was provided to researchers (Table 1.6).

Table 1.6. Supporting the R&D activities of sectoral ministries through competitive rounds in ETAG in 2023 and 2024 and their financial volumes (million EUR).

Subject	Ministry	Budget (million EUR)
Estonian Culture Research and Development Programme of the Ministry of Culture (2023)	Ministry of Culture	0,91
Programme 'Estonian Language and Culture in the Digital Age' of the Ministry of Education and Research (2023)	Ministry of Education and Research	1,08
Estonian Culture Research and Development Programme of the Ministry of Culture (2024)	Ministry of Culture	1,06
Artistic Research programme of the Ministry of Culture (2024)	Ministry of Culture	0,41
Programme 'Estonian Language and Culture in the Digital Age' of the Ministry of Education and Research (2024)	Ministry of Education and Research	0,42
Russian Studies grant (2024)	Ministry of Foreign Affairs	0,05
Land and soil management system for efficient and sustainable use of soil services, protection of biodiversity and reduction of climate impact (2024)	Ministry of Climate	1,20
Financial literacy starting grant (2024)	Ministry of Finance	0,30
Macro model development target grant (2024)	Ministry of Finance	0,30
Own sustainable varieties for smart food security (2024)	Ministry of Regional Affairs and Argiculture	1,98
Developments and opportunities for non-governmental organisations and volunteering. Analysis and proposals for policy making or interventions (2024)	Ministry of the Interior, Ministry of Social Affairs	0,15
Ministry of Economic Affairs and Communications R&D round: smart, digital and responsible economy (2024)	Ministry of Economic Affairs and Communications	1,00

Source: Estonian Research Council.

In co-operation with the ministries, solutions will continue to be explored to ensure that public research funding is allocated to researchers in the most effective way and contributes to the development of the country.

SUMMARY

Between 2022 and 2024, the Estonian Research Council awarded more than €230 million in grants to researchers, accounting for approximately a quarter of public R&D expenditure, with a consistent increase in the volume of research grants awarded each year. However, the world is not standing still and alongside funding, research policy challenges have intensified, particularly in areas such as sustainability, security and accountability. Public expectations of the research community have grown – they want to know more about what is being done and how public research funding contributes to human well-being. The expectations of researchers have also changed: they are increasingly speaking out to address society's challenges and are ready to contribute their knowledge and expertise to policymaking. It is crucial that their input is heard at the right time!

A significant development during the statistical period under review has been the amendment of the new fundamental law on research, initiated by the Ministry of Education and Research. In June 2024, the Ministry of Education and Research sent a draft of the new Organisation of Research and Development and Innovation Act to partners for an opinion. The draft outlines the roles and responsibilities of different parties, simplifies funding mechanisms and addresses research ethics issues.

Therefore, a number of changes are ahead that could significantly transform the organisation of work and funding instruments, both for the Estonian Research Council and other parties in the research system.



In 2023, students from the University of Tartu won the grand prize at the global synthetic biology competition iGEM, competing against hundreds of other teams. Pictured with their supervisor, Associate Professor Ilona Faustova, after the victorious final in Paris. • Ilona Faustova

HUMAN RESOURCES IN ESTONIAN RESEARCH

TOOMAS VAIMANN **Leading Researcher, Tallinn University of Technology**
President, The Estonian Young Academy of Sciences

INTRODUCTION

The development and sustainability of Estonian research depend heavily on human resources, with researchers, doctoral students and research staff at its core. While infrastructure, funding and technological innovation form the foundation of research, true success and quality are ultimately driven by people – their knowledge, skills and dedication. The power and impact of research stem from creativity, problem-solving abilities and the pursuit of discovery. Creating opportunities for researchers to grow and work in an environment that fosters open thinking and collaboration is essential to positioning Estonian research at a world-class level.

This article examines the current state of human resources in Estonian research, with a focus on the emerging generation of researchers, their field- and gender-specific distribution, and the working conditions affecting their motivation and career sustainability. It also examines the challenges facing the Estonian research community and considers strategies to ensure future competitiveness and sustainability of research by strengthening the connection between research and the development of the economy and society.

ESTONIAN RESEARCH AND RESEARCH COMMUNITY

In 2023, Estonian public universities employed a total of 4,039 academic staff members. The largest group among them comprised doctoral students/junior researchers, totalling 918. The number of employees in this position has grown significantly in recent years (Figure 2.1). This increase is largely attributed to the change in the status of doctoral students and the establishment of the doctoral student/junior researcher position, which has driven a clear upward trend in the number of academic staff members. The proportion of senior lecturers and lecturers (both with and without doctoral degrees) has been decreasing, while the share of teachers has seen a gradual rise. However, in reality, there has been a decline in the overall share of teaching staff in higher education, which is cause for concern in terms of the provision of higher education and the next generation of researchers, engineers and professionals. University rectors have repeatedly highlighted this issue. Low wages, insufficient funding for higher education and, in particular, a lack of incoming Estonian-speaking teaching staff are key factors contributing to these challenges. The occupancy of other positions has remained relatively stable in recent years. It should be noted that the current system of official positions was introduced in 2020, which complicates long-term statistical comparisons due to the lack of a unified system across universities before then.

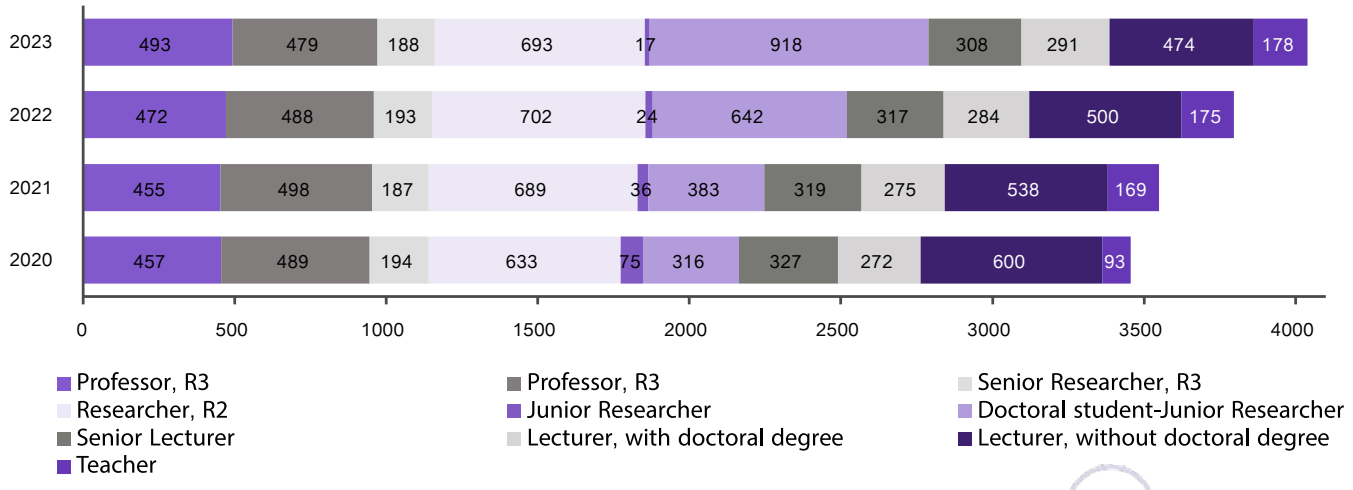


Figure 2.1. Changes in the number of filled positions (full-time equivalents) in six Estonian public universities in 2020–2023

Source: Universities Estonia.

In addition to the academic sector, researchers are also employed in other areas of the public sector as well as in the private sector. In 2023, a total of 6,566 researchers worked in the public sector and 3,797 in the private sector (63% and 37%, respectively) (Figure 2.2). Over the long term, the proportion of researchers employed in the public and private sectors has changed significantly. For example, in 1998, there were 3,975 researchers in the public sector (89%) and 483 in the private sector (11%)[58]. Public discussions have often pointed out that research is conducted in an 'ivory tower' and that collaboration with companies has been suboptimal. However, the data here shows noticeable improvement over the years, both in the total number of researchers and in the percentage distribution between the sectors, particularly in the private sector.

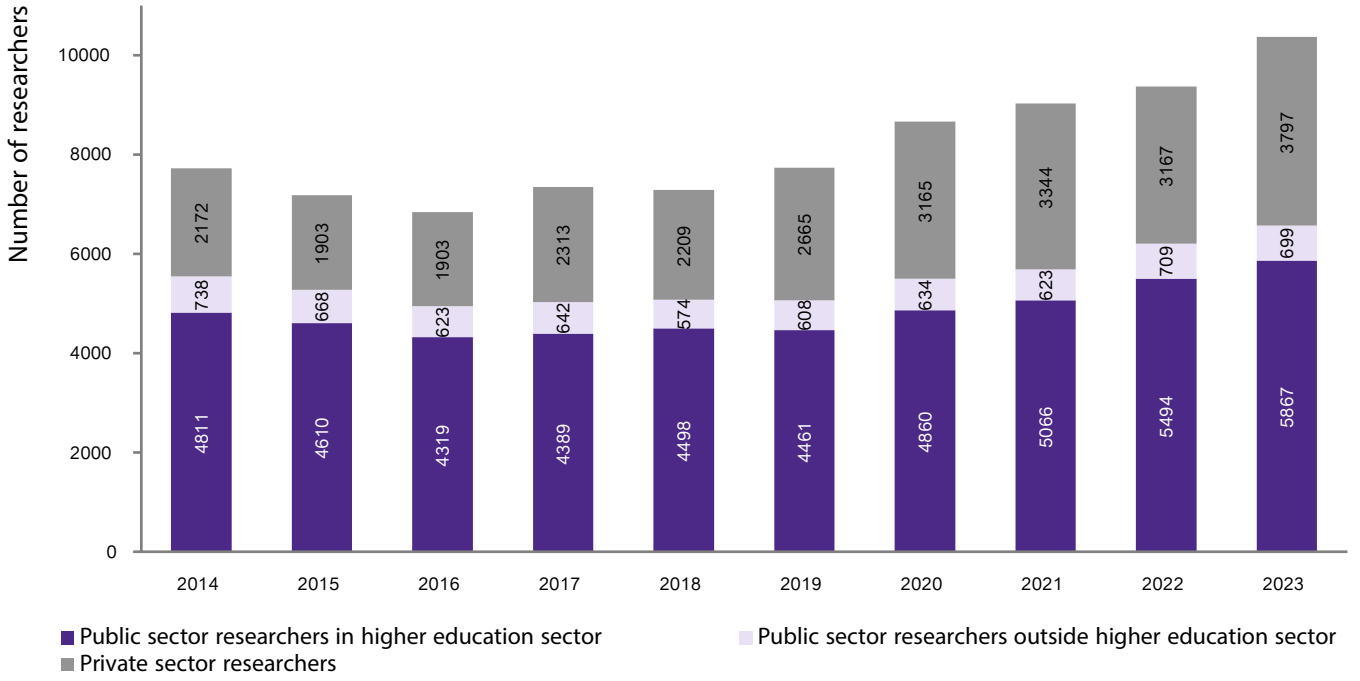


Figure 2.2. Distribution of researchers between the private and public sectors (including academic staff members in higher education sector) in 2014–2023.

Source: Statistics Estonia.

One key indicator of the research sector and the research community is the number of researchers per thousand inhabitants in a country. As we like to compare ourselves with our Nordic neighbours, it is worth noting that we lag behind the Scandinavian countries in this regard (Figure 2.3). Looking at the dynamics of this ratio in Estonia over the past few years, the trend is clearly positive (Figure 2.4). However, other developed countries also show positive trends, with the Nordic countries generally experiencing a faster increase than Estonia.

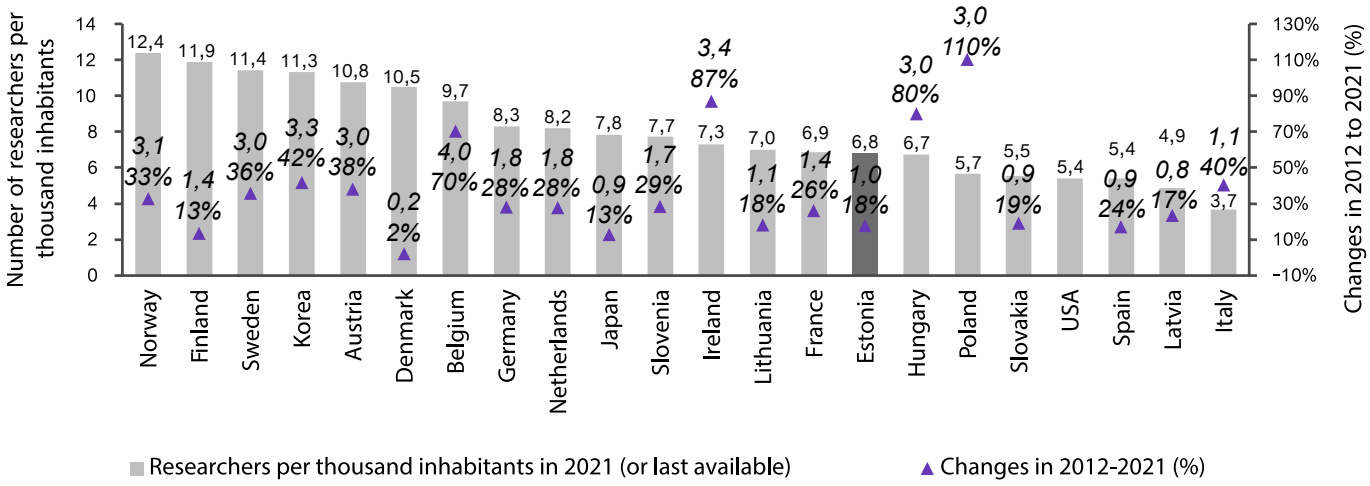


Figure 2.3. Number of researchers per thousand inhabitants in 2021 (or last available year) and its change in the period 2012–2021.

Source: Statistics Estonia, calculations by Estonian Research Council.

[58] Statistics Estonia.

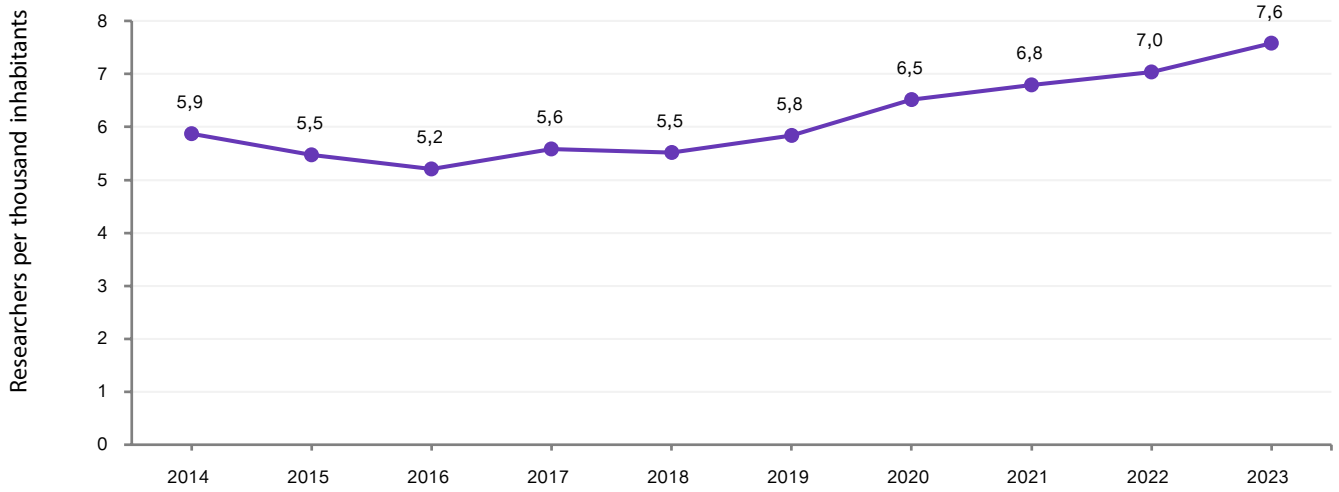


Figure 2.4. Number of researchers per thousand inhabitants in Estonia in 2014–2023.

Source: OECD, calculations by Estonian Research Council.

There have been no major changes in the distribution of researchers across different fields. Natural sciences continue to have the highest number of researchers, whereas agriculture and veterinary sciences employ the fewest (Figure 2.5). While there is a strong emphasis on technological development elsewhere in the world, in Estonia, the number of researchers in engineering and technology has remained relatively stable.

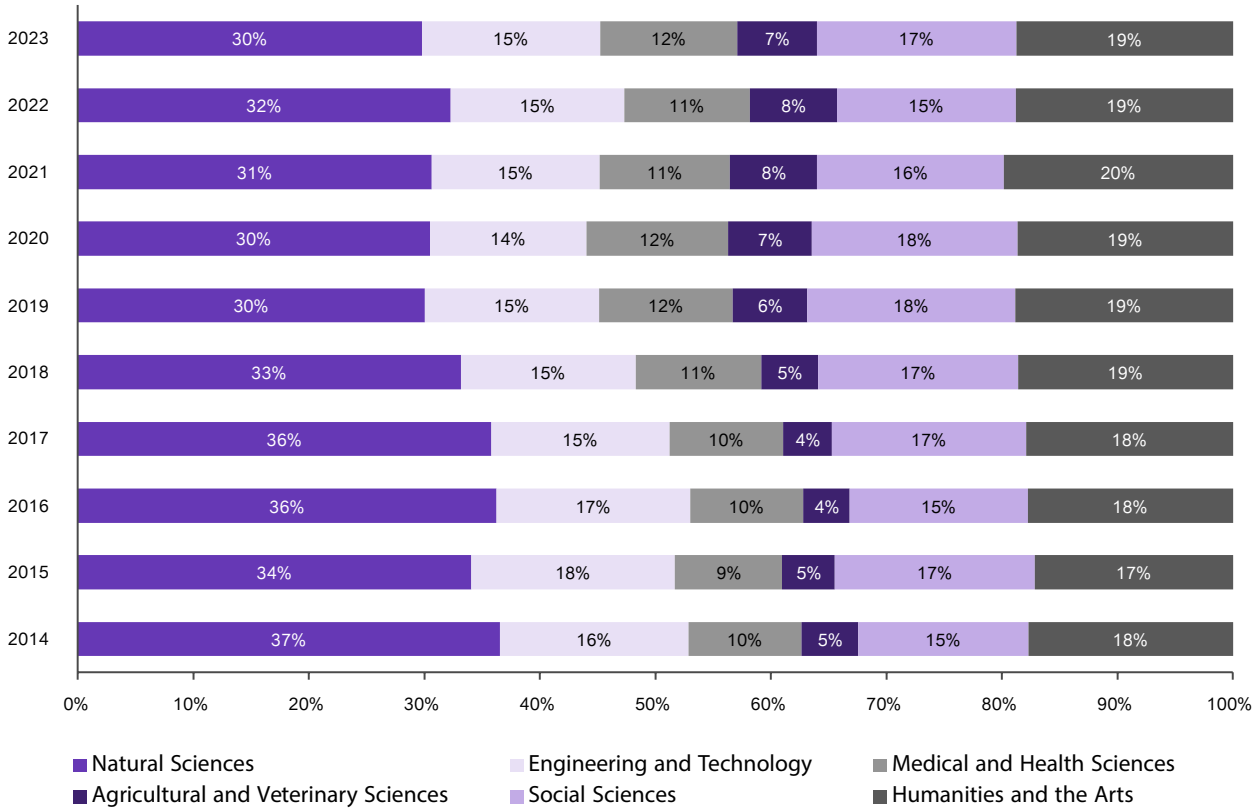


Figure 2.5. Researchers (full-time equivalents) employed in public sector in Estonia by research fields in 2014–2023.

Source: Statistics Estonia, calculations by Estonian Research Council.

One aspect of the composition of the Estonian research community that is clearly changing is the involvement of foreign researchers. For instance, in 2014, there were 426 foreign researchers in the non-profit institutional sectors (7.5% of the total), but by 2023, this figure had nearly tripled to 1,211 researchers (18.1%, Figure 2.6). This shows that we are living in a globalising world, with the quality of research in Estonia playing a crucial role in attracting these researchers. High-quality research is conducted in Estonia, which has been internationally recognised. The involvement of foreign researchers in our research community is vital for the future of research here, as it enhances visibility, fosters networking opportunities, and attracts potential external funding.

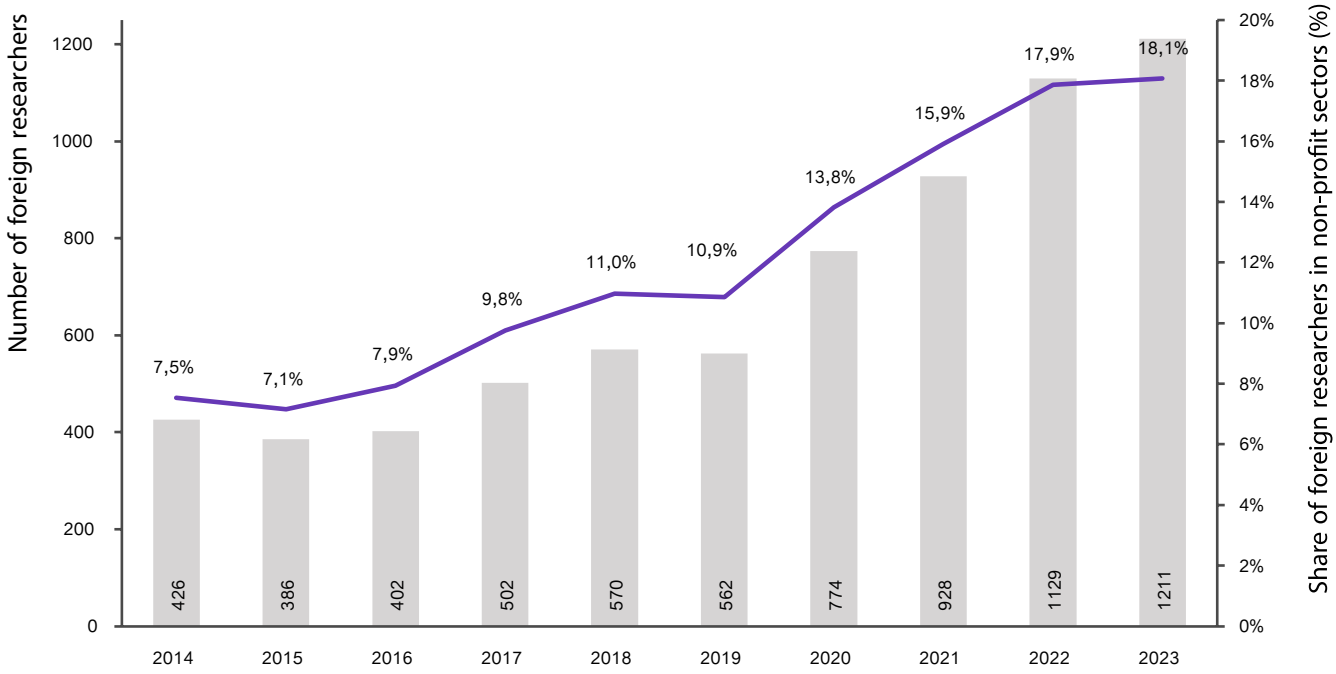


Figure 2.6. Number and share of foreign researchers in non-profit institutional sectors in 2014–2023.

Source: Statistics Estonia.

The age distribution of the research community has remained relatively stable over the years. The timeline shows a slight decline in the number of researchers over 55 years old and a slight increase among those aged 35 to 44 (Figure 2.7). Despite this, it cannot be said that our research community has become significantly younger. In fact, our research community is aging and, unfortunately, the same trend also applies to the next generation of researchers, as illustrated in the following section.

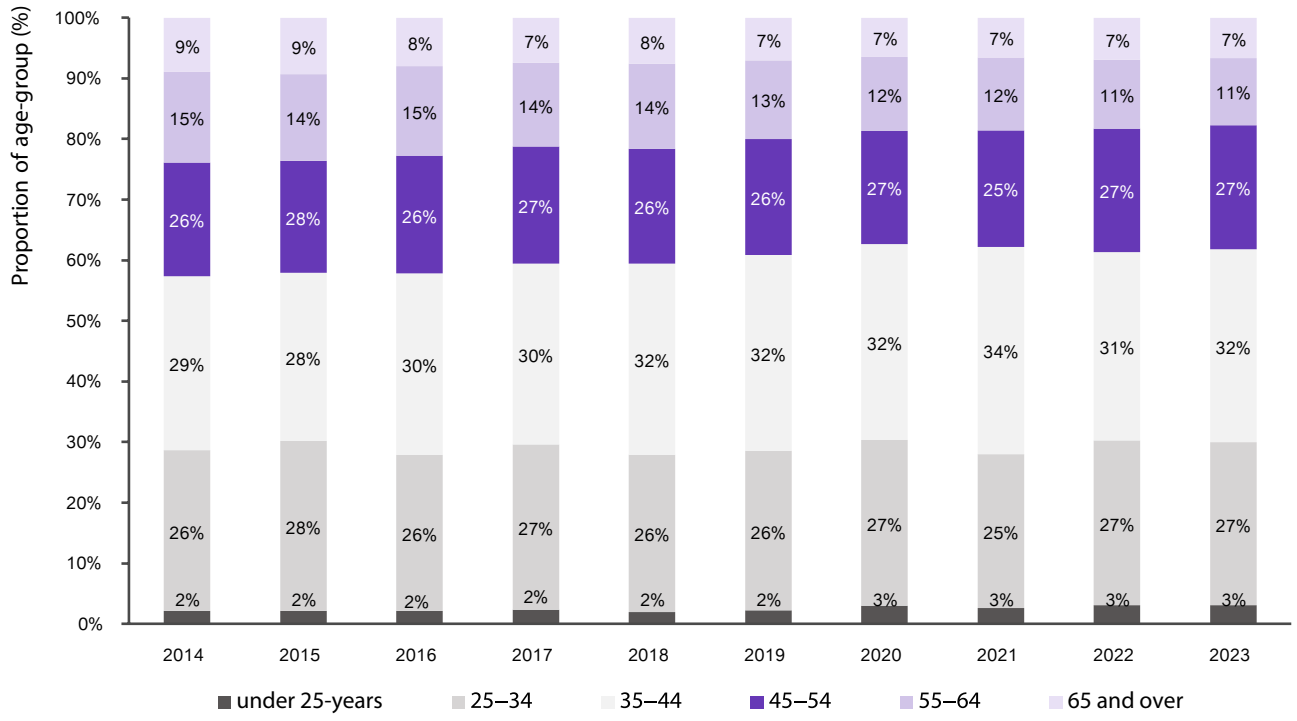


Figure 2.7. Changes in the age distribution of the Estonian research community in 2014–2023 (all sectors).

Source: Statistics Estonia.

NEW GENERATION OF RESEARCHERS

A new generation of researchers is crucial for the future of research. The education system of Estonia offers opportunities for young people to engage with research from an early age, such as through research projects, competitions and olympiads. However, the attractiveness of higher education, doctoral studies, and the prospect of a future research career is also important and depends on both the working conditions and society's attitude towards research.

The number of doctoral students and the success rate of their thesis defences are direct indicators of the next generation of researchers, though not the only ones. Doctoral students play a crucial role in the vitality of research, as they conduct a large part of it. Let us examine the situation of doctoral students in Estonia.

In the academic year 2023/24, there were 2,283 doctoral students in the Estonian higher education system, including 393 new doctoral students (Figure 2.8). This figure highlights a concerning downward trend in the overall number of doctoral students over the past decade. Additionally, there have been no significant positive changes in the number of doctoral graduates or dropouts. The doctoral studies reform, implemented in 2022, could, in theory, revitalise and provide hope for a better future. However, these changes are still too recent to be reflected in the current statistics.

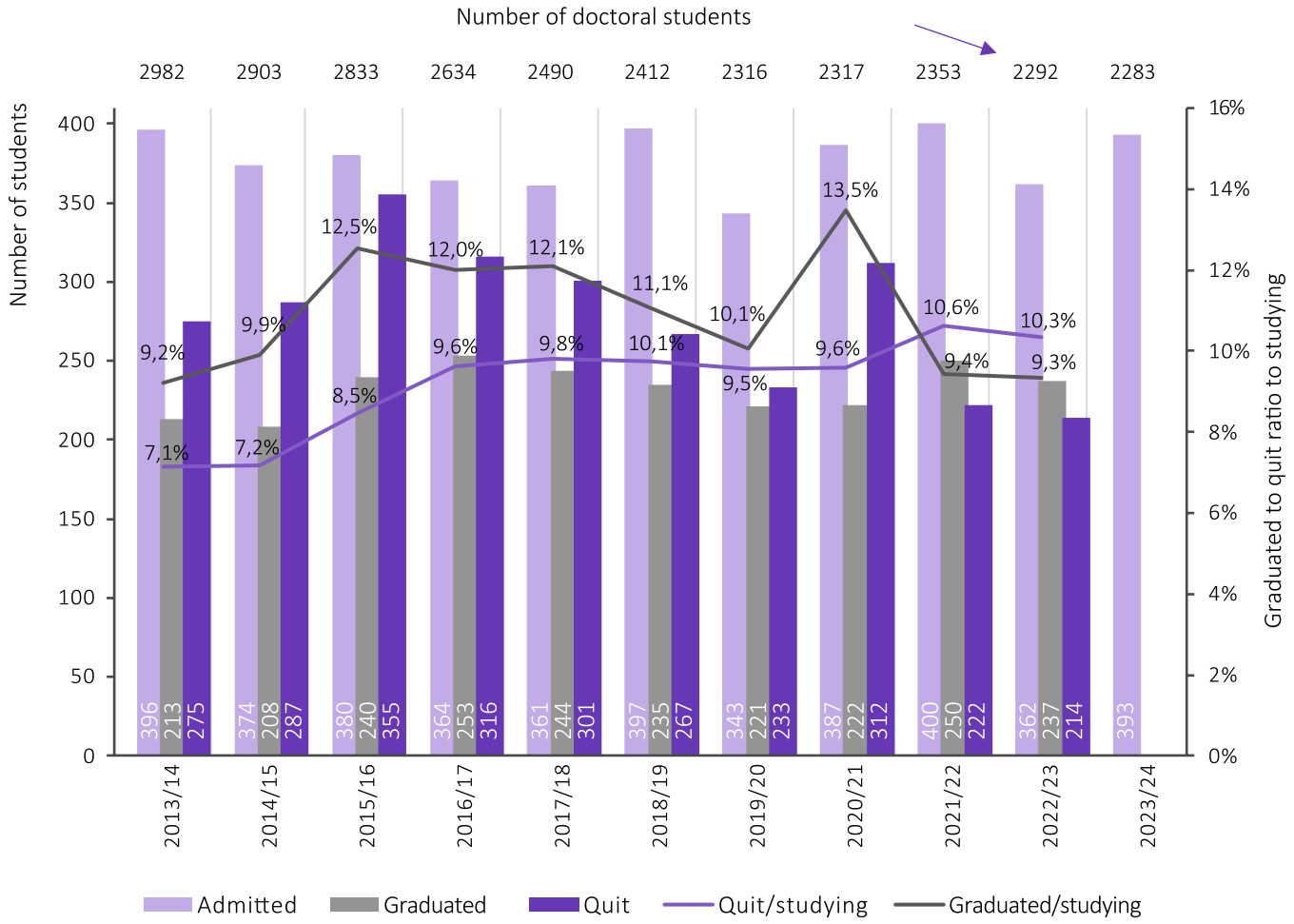


Figure 2.8. Number of doctoral students admitted, graduates and drop-outs in the academic years from 2013/14 to 2023/24.

Sources: Haridussilm and Statistics Estonia.

The number of doctoral students is also linked to the number of first and second level graduates in the Estonian higher education system and the students at these levels. As shown in Figure 2.9, there have been no significant changes in the number of bachelor's or master's degree students in recent years. Compared to 10–12 years ago, the number of bachelor's degree students has decreased by a quarter, which is directly related to reforms in higher education, the consolidation of study programmes and demographic factors. However, the number of master's degree students has seen a slight increase during the same period. The distribution across different fields over the long term reveals a decline in the number of master's students in business, administration and law. Conversely, the field of education has experienced a significant growth.

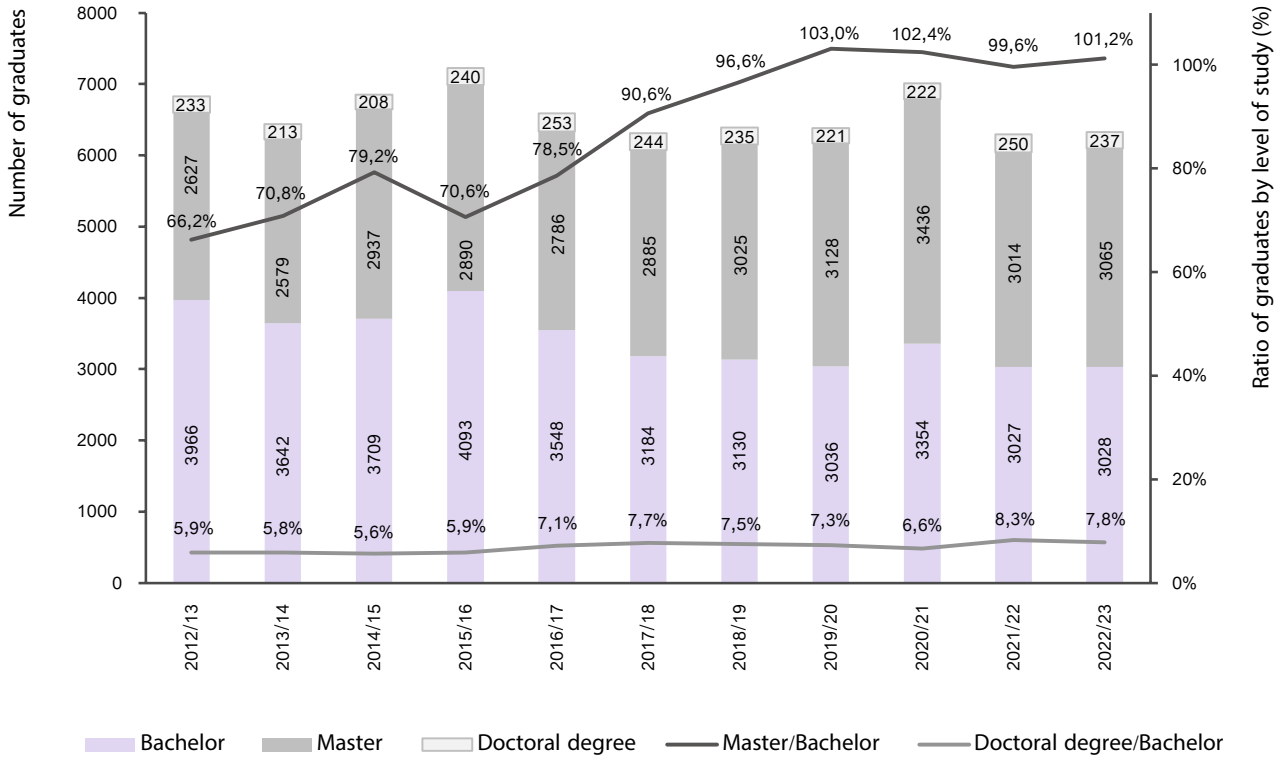


Figure 2.9. Number of graduates by level of education in the academic years from 2012/13 to 2022/23.

Source: Haridussilm.

The average age of Estonian doctoral students is increasing. According to the Estonian Education Information System (EHIS), the average age of a doctoral student with Estonian background in 2023 was 34.8 years, which is approximately five and a half years more than a decade ago. Several factors likely contribute to this trend. Although foreign doctoral students are, on average, about four and a half years younger than their Estonian counterparts when starting their doctoral studies, their presence has not significantly lowered the overall average age.

Table 2.1. Average age of persons starting doctoral studies in 2013–2023.

Academic year	Average age in total	Average age (foreign students)	Average age (Estonians)
2013	29,69	30,26	29,58
2014	29,75	30,80	29,44
2015	29,64	29,37	29,71
2016	29,93	29,44	30,09
2017	30,00	30,48	29,76
2018	30,85	30,15	31,31
2019	29,98	28,31	31,19
2020	30,75	29,44	31,78
2021	31,12	29,12	32,90
2022	32,01	29,72	33,48
2023	33,10	30,45	34,82

Source: EHIS.

Statistics on doctoral graduates reveal that the majority of those under the age of 29 come from the fields of education such as natural sciences, mathematics and statistics (Figure 2.10). This is unsurprising, as these fields typically have the largest number of doctoral students and researchers. The second-highest number of doctoral graduates in the youngest age group is found in engineering, manufacturing and construction. In contrast, the oldest doctoral students and those defending their theses are in the field of education, where doctoral studies are typically pursued after gaining professional experience.

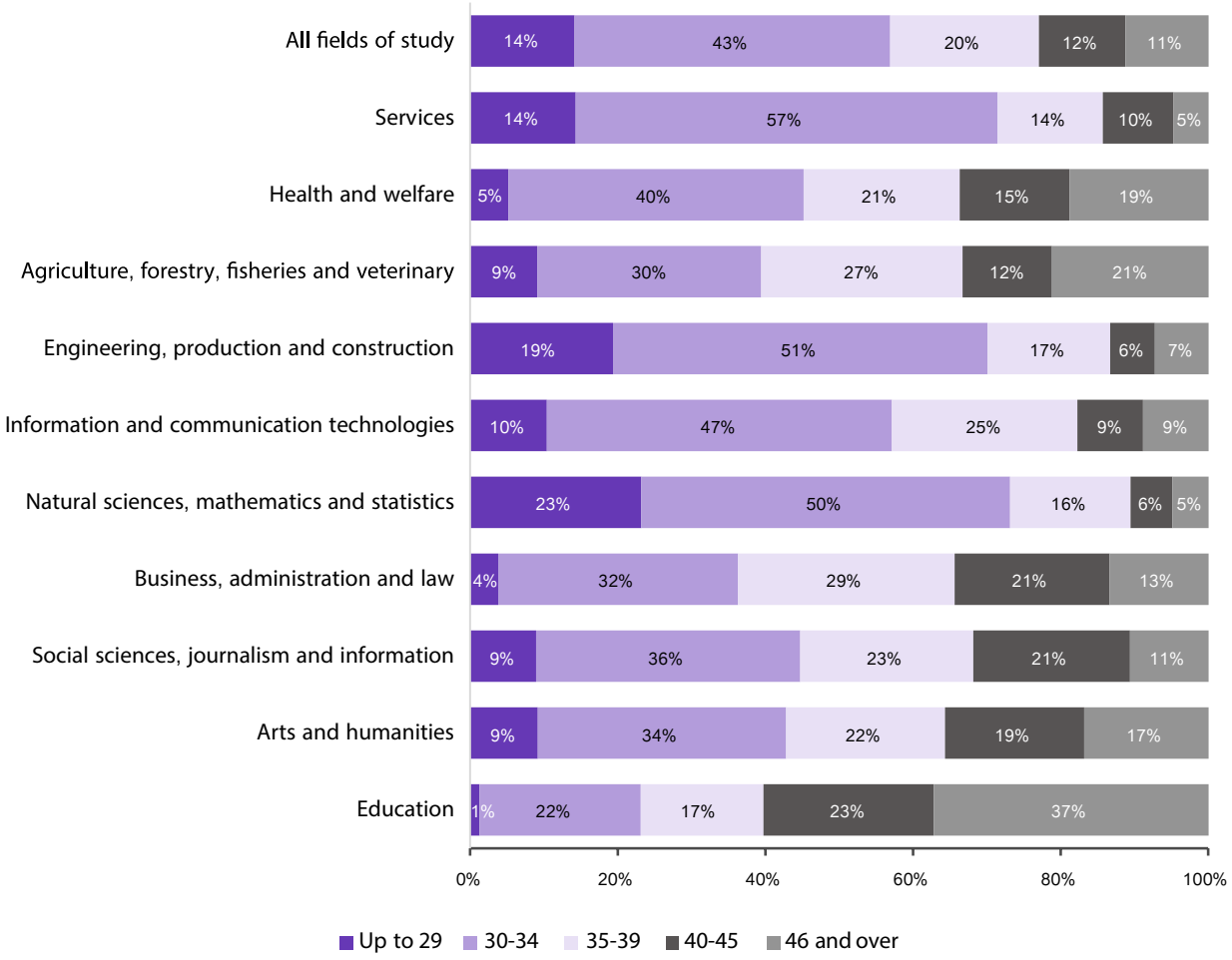


Figure 2.10. Breakdown of doctoral graduates by age in the academic years from 2013/14 to 2022/23.

Source: EHIS.

The previous Estonian Research collection[62] also highlighted the significant increase in the number of students with foreign background obtaining a doctoral degree in Estonia over the years. This trend continues, underscoring the need for universities, the government and society as a whole to contribute to a more effective integration of both foreign doctoral students and graduates. Given the shortage of specialists in the academic sphere and the public and private sectors as a whole, people with a foreign background who have obtained a doctoral degree in Estonia are a very valuable resource to us that must not be overlooked.

Compared to previous years, the growth in the total number of foreign doctoral students has slowed slightly. While no definitive conclusions should be drawn from short-term changes, discussions with those more closely involved in international student admissions suggest that the Russian war of aggression in Ukraine, and the perception of its relative proximity to Estonia by students from farther abroad, is a significant factor contributing to the slowdown. Another notable change increasingly observed in the case of doctoral candidates from abroad (particularly those from third countries) is the refusal to grant them Estonian visas.

The majority of foreign doctoral students study at the University of Tartu, with slightly fewer enrolled at the Tallinn University of Technology. This is quite understandable, considering the size and position of these institutions in Estonia, as well as the specialties they offer and their popularity among foreign doctoral students (Figure 2.11). The highest proportion of foreign doctoral students is in engineering, manufacturing and construction (49%), while the lowest is in education (14%) as of the 2023/24 academic year.[63]

[59] Tamm, M. (2022). 'Estonian research community and its future'. – Estonian Research 2022 (ed K. Raudvere), pp 35–59. Estonian Research Council. Tartu. Online: https://doi.org/10.23673/tead/002.
[60] Haridussilm.

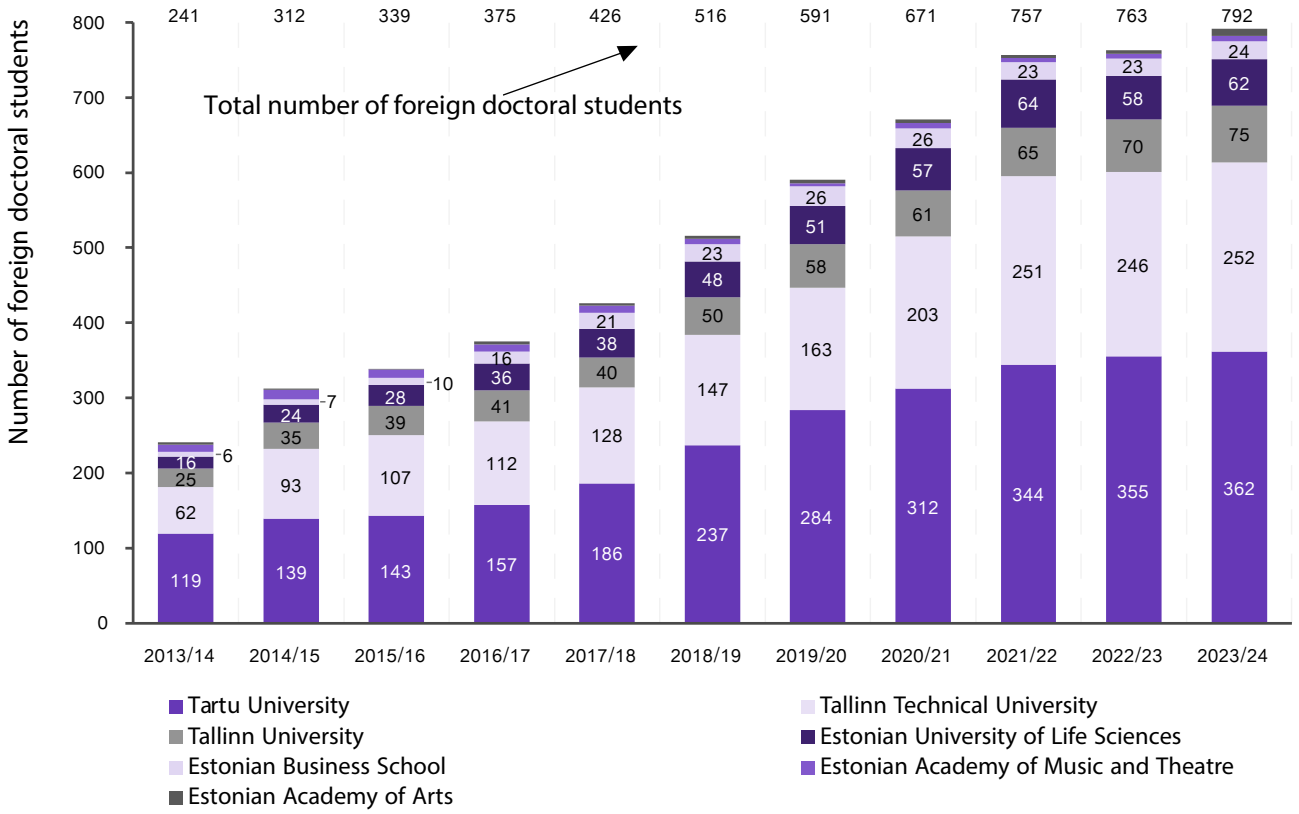


Figure 2.11. Changes in the total number foreign doctoral students in Estonian universities in the academic years from 2013/14 to 2023/24.

Source: Haridussilm.

From the perspective of the new generation of researchers, it is also important to consider the average time it takes to complete a doctoral degree in Estonia. While the nominal period of doctoral studies is four years, the average doctoral student does not complete their studies within this period. As of 2022, it took an average of 5.6 years to obtain a doctoral degree. The long-term trend has shown an increase in the time spent pursuing a doctoral degree, although this indicator has been declining since 2019 (Figure 2.12).

There are also notable differences between fields in this regard. While a doctoral student in the ICT field completes their studies in an average of 4.9 years, it takes two years longer for a doctoral student in agriculture, forestry, fisheries and veterinary to defend their thesis[61].

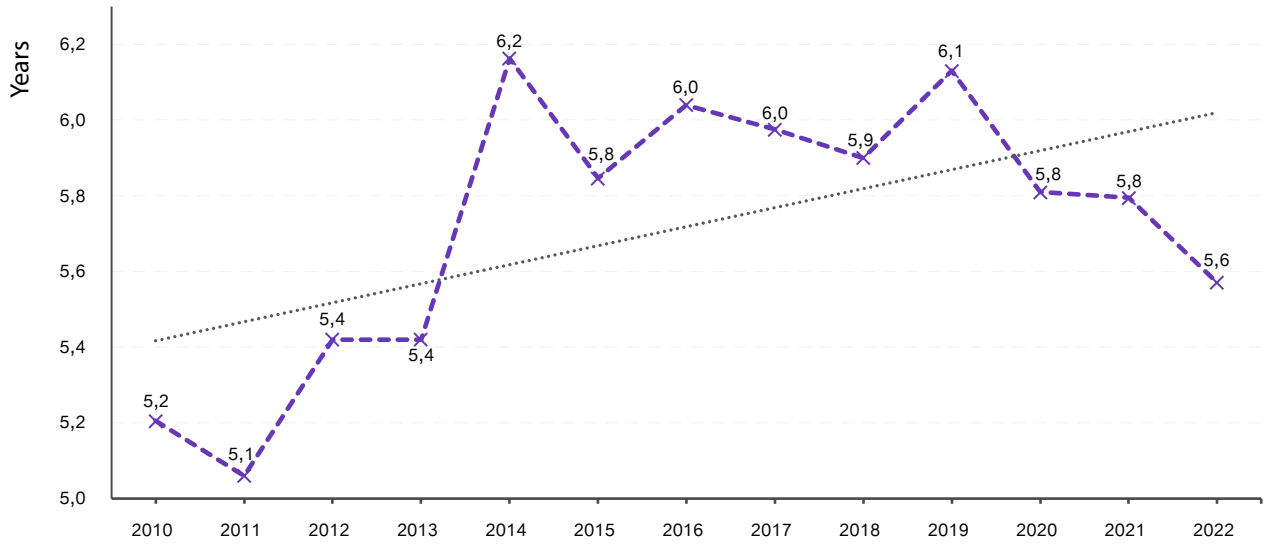


Figure 2.12. Average time to obtain a doctoral degree in 2010–2022.

Source: EHIS.

[61] EHIS.

A very important point emerges when comparing the average time it takes for Estonian and foreign doctoral students to complete their studies (Figure 2.13). It can be seen that foreign doctoral students complete their studies in an average of 3.8 years, ie, faster than the nominal period, whereas Estonian doctoral students require approximately 1.5 years more. Why is this the case?

There is no simple or single answer – several factors likely contribute to this difference. One of the key motivators for foreign doctoral students is the limited duration of their residence permit. Additionally, it is well known that Estonian doctoral students are often more burdened by different responsibilities. In particular, they are frequently tasked with duties that require proficiency in the official language, from teaching to popularising research.

However, a concerning trend is evident in relation to the above. Since we have committed to maintaining higher education in Estonian, there appears to be no immediate solution to change the current situation. Given the limited local human resources, we must remain open to involving foreign doctoral students and researchers in our research and higher education system. After all, we are striving for broader international coherence in our research, so there should be no doubt about this approach. However, if the system requires those working within it to perform tasks that are outside their usual skill set, local doctoral students and researchers may face a significantly greater burden, both physically and morally, simply because they are more familiar with the local language and conditions. However, this is detrimental in the long term, as surveys and studies to date have clearly shown that, particularly for young researchers, their work in the academic sector is fragmented, unstable and prone to overload. Therefore, we urgently need to find ways to integrate foreign doctoral students and researchers more effectively into both our research and higher education systems. This inevitably requires justified and calculated investments, along with a much more systematic approach than haphazard and enthusiasm-driven language learning.

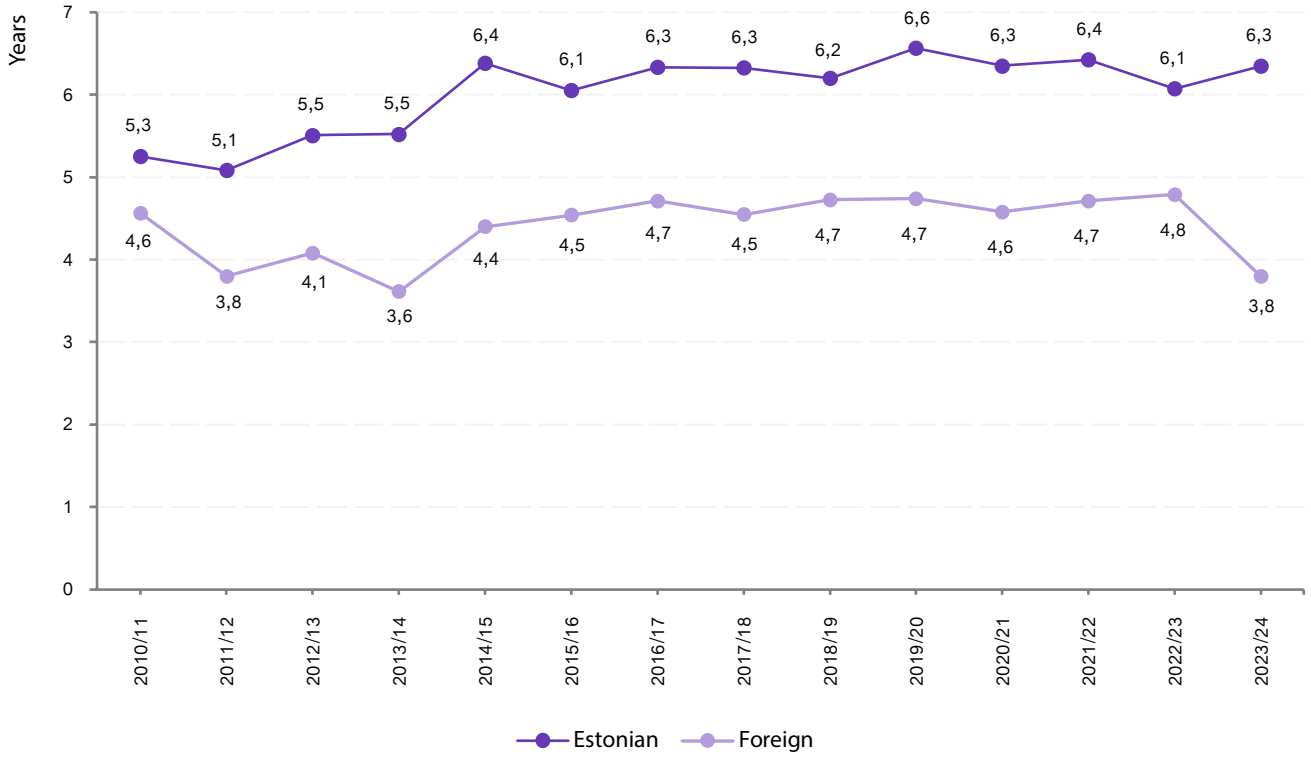


Figure 2.13. Average time to obtain a doctoral degree: Estonian vs foreign doctoral students in the academic years from 2010/11 to 2023/24.

Source: EHIS.

GENDER DISTRIBUTION

The proportion of women in the Estonian research community has increased over time, with women holding 52% of academic positions in 2023 (Figure 2.14). However, the distribution of men and women varies across fields, universities and research institutions.

In 2023, the highest proportion of female researchers by field was in medical science, where women accounted for 71% of all researchers. This represents an increase over the past 12 years, up from 65% in 2011. In contrast, the field with the lowest representation of women is engineering, where women make up 31% of the research community. These statistics are based on data from the non-profit sectors of Estonia.

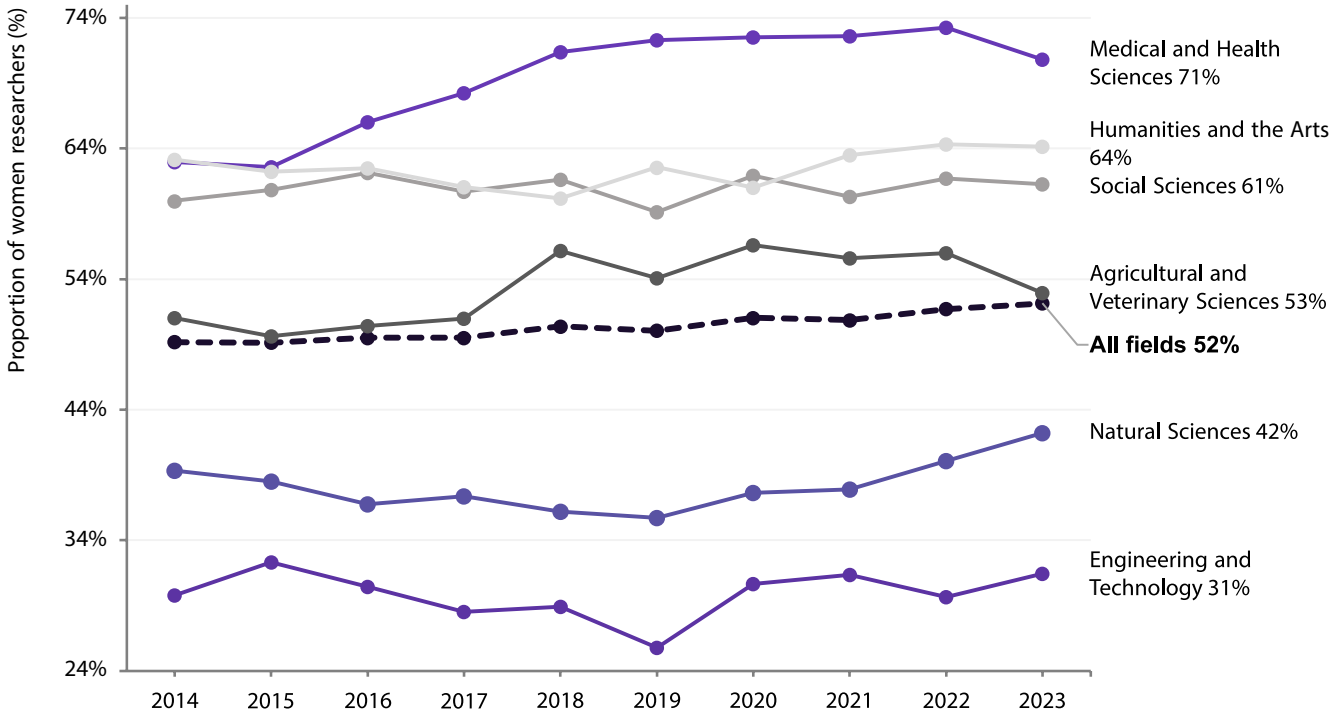


Figure 2.14. Proportion of women by field of research in 2014–2023.

Source: Statistics Estonia.

Although the overall numerical distribution of women and men in academic positions is relatively balanced, a closer examination of the occupational distribution tells a different story. Statistics indicate that the proportion of women decreases as academic positions become more senior (Figure 2.15). For instance, women account for only 31% of higher-category professors, compared to 70% of teachers. An anomaly in the figure is the 88% female representation among junior researcher. For statistical clarity, this group consists of 16 individuals who have held this position since before the doctoral studies reform. No additional junior researchers without doctoral student status are being appointed, as junior researchers are now typically doctoral students with employment contracts.

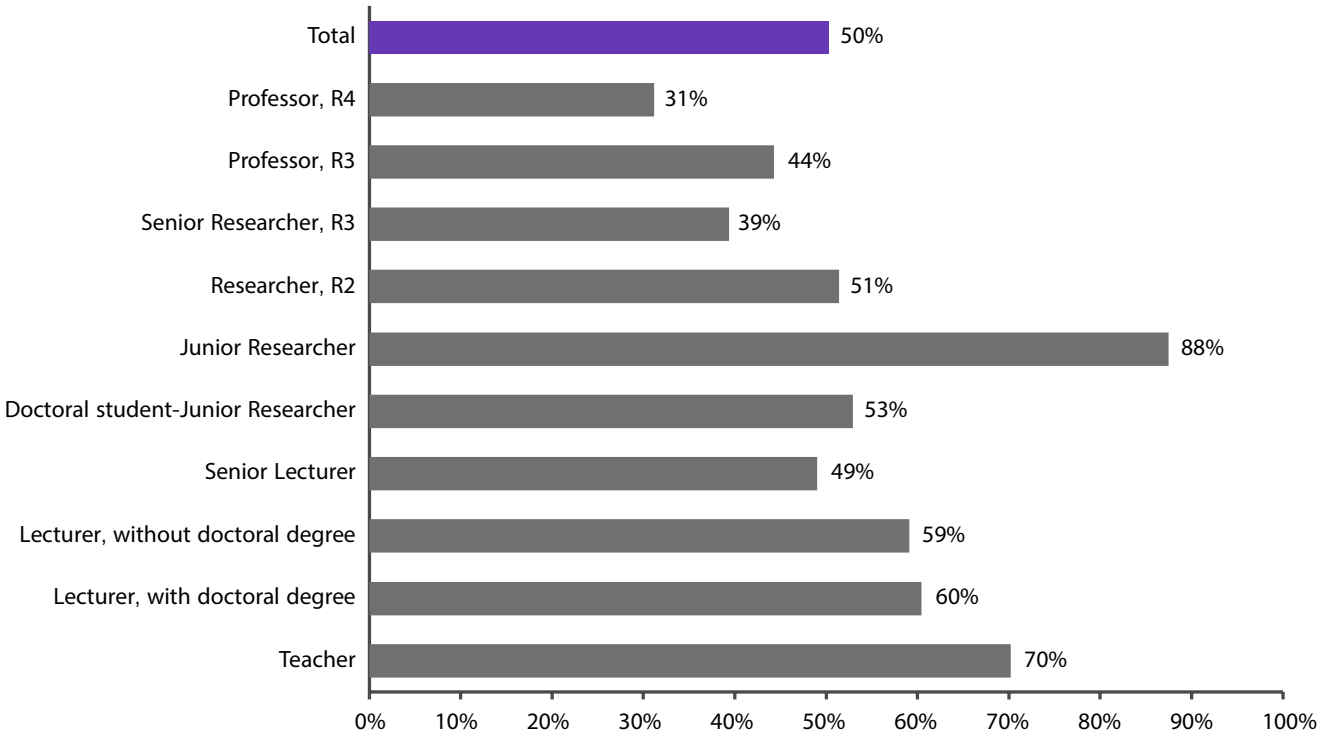


Figure 2.15. Proportion of women by position in public universities in 2023.

Source: Universities Estonia, calculations by Estonian Research Council.

Over the past decade, the gender distribution of those admitted to doctoral studies has shown no significant fluctuations (Figure 2.16). Somewhat surprisingly, the proportion of women has risen by ten percentage points in the past two academic years. It remains to be seen whether this represents the start of a new trend or if the situation will balance out again in the coming years.

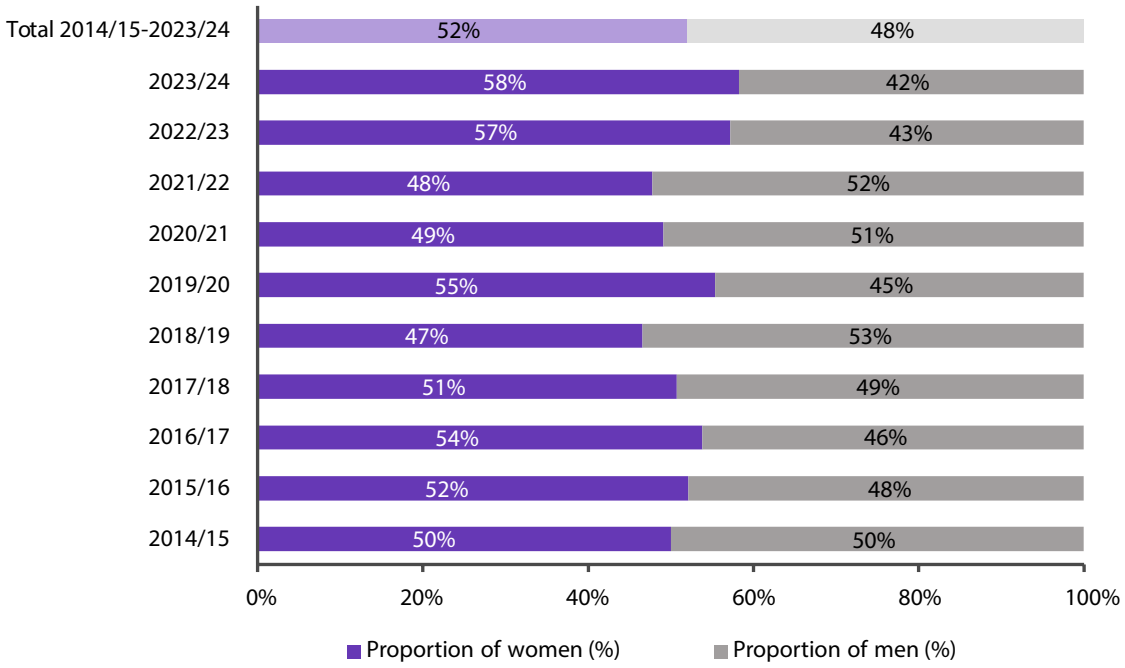


Figure 2.16. Gender distribution of those admitted to doctoral studies in the academic years from 2014/15 to 2023/24.

Source: Haridussilm.

A closer examination of the numbers reveals that over the last decade, the statistics still reflect a stereotypical distribution (Figure 2.17). The highest percentages of women pursuing doctoral degrees are in the fields of education, followed by health and well-being, and humanities and arts. The lowest number of female doctoral students can be found in the fields of agriculture, forestry, fisheries and veterinary, followed by engineering, manufacturing and construction. It can be assumed that these numbers and proportions will converge in the future and the gender distribution across fields will likely become more balanced over time.

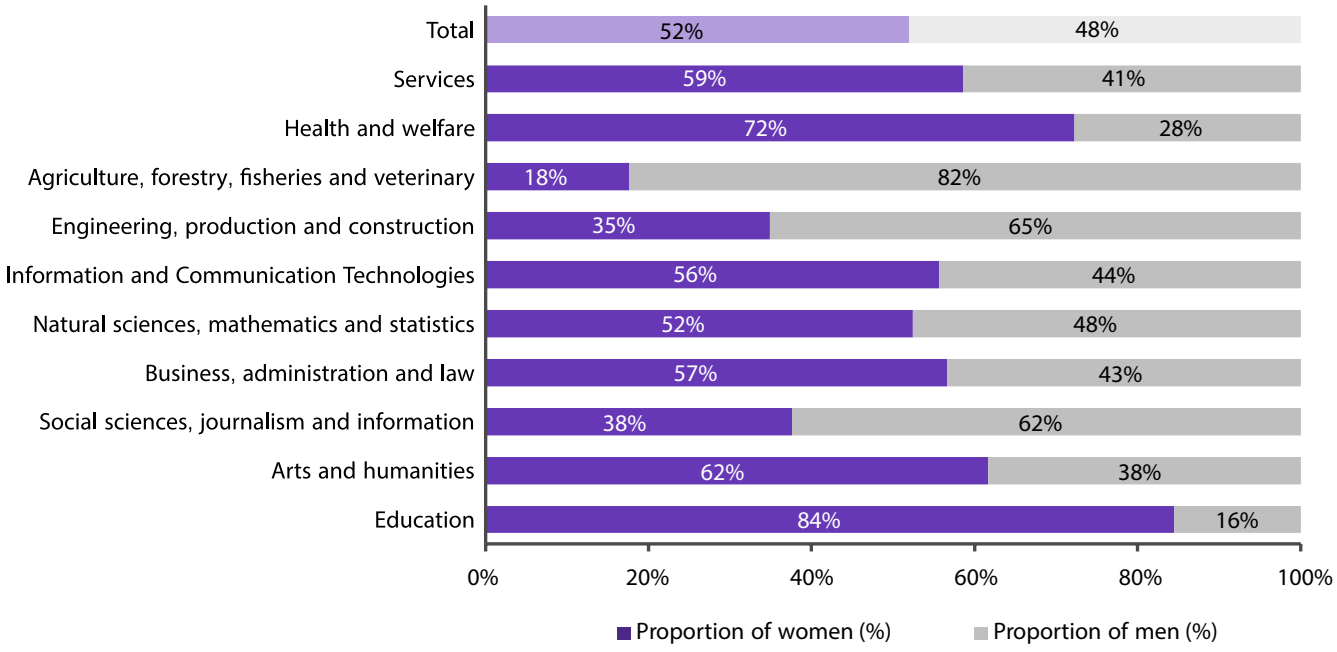


Figure 2.17. Gender distribution of those admitted to doctoral studies by field of study in the academic years from 2014/15 to 2023/24 (summary statistics).

Source: Haridussilm.

FINANCIAL OUTLOOK

It is no secret that the motivation of researchers and the quality of the workforce are closely tied to the stability of research funding. In Estonia, there are several research funding schemes available, but competition for these funds is intense. Unfortunately, research has largely been project-based for a long time, meaning that the success in securing funding is directly linked to the income of researchers.

Young researchers often experience insecurity regarding the sustainability of their careers, which not only impacts the quality of their research but, in some cases, raises existential concerns. These concerns may lead them to question their career choices and result in them withdrawing from the research field altogether. Therefore, it is crucial that both research funding and the profession of a researcher are stable and offer security and opportunities for long-term projects. To gain a deeper understanding of the perspectives of young researchers on their careers, the challenges they face and the reasons behind their decisions to either remain in academia or leave, the Estonian Young Academy of Sciences, in co-operation with the Estonian Research Council, has commissioned a large-scale survey of young researchers. The results of this survey are expected to be released in 2025.

Job stability, security, workload and career opportunities during doctoral studies have also been highlighted as important factors in previous editions of *Estonian Research*[62]. To improve the situation of doctoral students and create more favourable conditions, a reform of doctoral studies was implemented in 2022. The main goal of the reform was to ensure that doctoral students receive a fair wage that would enable them to focus on their research. It was also important to create opportunities for doctoral students to join the university staff on an equal footing with other academic staff. However, three years is too short a period to draw any definitive conclusions about the success of the reform, as not even one full nominal cycle of doctoral studies has passed.

On a positive note, it should be noted that, compared to the previous doctoral allowance rate, the wages of a doctoral student/junior researcher are now linked to the average Estonian wages. As a result, the position of a doctoral student/junior researcher has somewhat improved the sense of social security among doctoral students and the income from this position has increased compared to the past (Figure 2.18). However, in many fields, there are still significant wage disparities between the private sector and the research system, which often makes the private sector very attractive to doctoral students/junior researchers. Given the rising cost of living and the fact that many doctoral students are at an age where they have families and children, it is understandable that they may prefer the private sector.

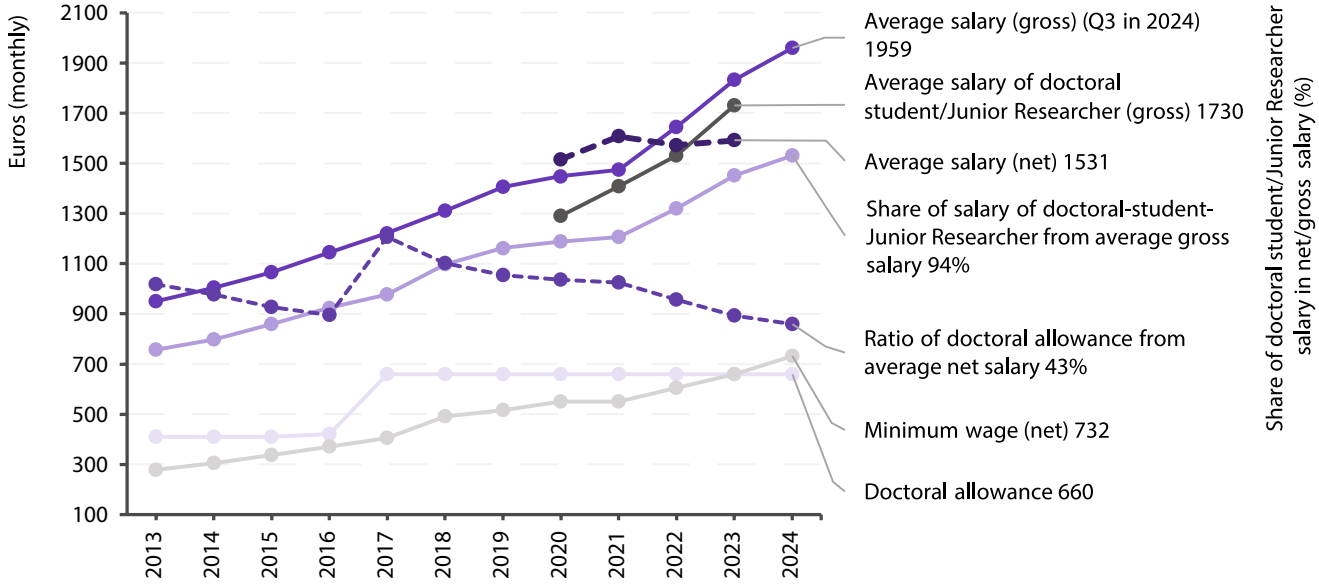


Figure 2.18. Dynamics of average Estonian wages compared to doctoral allowance in 2013–2024 (Q3).

Sources: Statistics Estonia, Estonian Tax and Customs Board, Universities Estonia, calculations by Estonian Research Council.

The question of how to enhance competitiveness in academic careers, so that future doctors and young researchers are more inclined to choose academic positions, remains a challenge. This is a key issue in terms of both research and the next generation of the research community. Supporting young researchers is crucial. Attention must also be given to the work-life balance of researchers and improving their working conditions to reduce emigration and encourage their return to Estonia. To ensure the next generation of Estonian researchers, it is essential that young people view research not just as a career opportunity, but as a means to contribute to society and change the world.

[62] Avaliable at the webpage of Estonian Research Council: https://etag.ee/en/estonian-research-council/publications/

CLOSING REMARKS

The success of Estonian research is closely tied to the availability and quality of skilled human resources. The best results are achieved when researchers are motivated, have access to the necessary infrastructure and feel that their work is valued. To ensure that Estonian research remains competitive and continues to generate new knowledge, it is essential to continue investing in both research infrastructure and human resources. It is important to ensure that young people have both the interest and the opportunity to contribute to research and that they perceive research not only from a personal but also from a societal perspective. The human resources in Estonian research represent the greatest asset of our society, the appreciation and development of which will determine the future of our research, the success of our research and how our research achievements reach the economy and the wider public.

Recent developments in the European Union and the wider world must also be taken into account. The innovation gap between Europe, on the one hand, and the United States and China, on the other, is putting Europe's competitiveness in the global economy at risk. A report[63] by former Italian Prime Minister and President of the European Central Bank, Mario Draghi, highlighted that the link between research and the economy is key to bridging this gap. The European Union needs to figure out how to turn cutting-edge research into economic success to support sustainable growth and social well-being. Draghi's recommendations include accelerating technological and evidence-based innovation, simplifying the path to commercialisation of innovation and removing barriers to business growth. These measures should create an environment conducive to Europe's competitiveness where research can reach its economic potential and also help address skills shortages.

Bridging the innovation gap is crucial for Estonia, as the connection between research and the economy is becoming increasingly vital for ensuring the country's competitiveness in a rapidly evolving global economy. Estonia has a strong research base and significant potential for conducting top-level research, but faces challenges in commercialising innovation and supporting companies to grow in global markets. To foster the next generation of Estonian researchers and develop their skills, it is essential to focus on accelerating scientific and technological innovation and establishing a strong funding system. Supporting young researchers and promoting international co-operation also play a key role in enhancing Estonia's ability to increase the impact of research on the economy and strengthen Europe's competitiveness in the global innovation landscape.

In Estonia, this means businesses and the public sector working more closely with research institutions to tailor research and development efforts to the needs of society and the economy. Research should focus on addressing specific challenges, such as those related to digitisation, green technologies, health care and educational innovation. The role of smart contracting is to create platforms that facilitate the transfer of knowledge and skills from research to the economy, supporting commercialisation and the growth of innovation-driven businesses. It is also important that research funding and support mechanisms remain flexible and focus on the rapid application of results, transforming research ideas into smart products and services that enhance both economic and social well-being.

To sum up, we are at a point where there is much to be gained, but achieving this requires a clear direction and well-defined objectives. While some aspects of our human resources in research have improved or are improving, if Estonia truly aspires to be a progressive, evidence-based country with capable researchers, innovative companies and a strong economy, the right decisions must be made. Generally speaking, success is not achieved by accident or without effort.

[63] The future of European competetiveness. A competetiveness strategy for Europe. September, 2024. Online: https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en#paragraph_47059 (01.11.2024).



Goddess of Wisdom. From the University of Tartu Museum (reproduction) • Marko Piirsoo

RESEARCH IN ESTONIA

KRISTA FISCHER **Member of the Estonian Academy of Sciences**
Professor of Mathematical Statistics, University of Tartu

Research and the research community are vital to the functioning of society. First, research is deeply integrated with the education system: the research community is directly responsible for the quality of higher education and, through this, helps to ensure a solid general education and the next generation of teachers. Second, research is strongly tied to the innovative economy. Historical trends and data show that the economic success of a country is directly linked to the extent of its investment in research and development. It is essential to recognise that prioritising the development of (applied) research, the results of which can be immediately channelled into innovative products or profit-generating businesses, is not sufficient. However, applied research with useful outputs grows out of basic research, which must also constantly evolve and generate new knowledge to form the foundation of education and other disciplines.

Today, no country's research exists in isolation – research is characterised by its global scope and close co-operation between countries. Alongside international research, there is, of course, national research that focuses on local languages and cultures.

Assessing the state of research in a country on a scale ranging from good to poor is no simple task. The current state of research can be described using different metrics, yet finding a clear standard against which to compare them is challenging. Similarly, just as there is no single answer to how many researchers a country needs, it is also impossible to determine the optimal number of research articles a country should produce or the number of doctoral degrees it should award in a year. Instead, the focus should be on observing trends over time. The number of significant publications reflects the standing of our research within the global research community – indicating whether we are regarded as a respected partner in international research and innovation.

In this article, I provide a data-driven overview of Estonian research as of the end of 2023, focusing on two key indicators: research publications and the success of doctoral studies.

RESEARCHERS

The number of researchers in Estonia has been continuously increasing. According to the Estonian Research Information System (ETIS), there were 8,811 people involved in research and development who had published research papers in 2022. OECD data (source: Teadussilm[64]) indicates that in 2021, there were 8.3 persons engaged in research and development per 1,000 working-age residents in Estonia. In Finland, the figure was nearly twice as high (16.16), while in the case of our southern neighbour Latvia, it was slightly lower (5.3). The share of researchers in Estonia increased until 2011, but there have been no significant changes since then.

Another indicator is the number of people with a doctoral degree as a percentage of the total population. According to the World Population Review[65], Slovenia ranks first in the world in this regard, with one in twenty adults aged 25–64, or 5%, holding a doctoral degree, accounting for 3.6% of the total population. In Estonia, only 0.6% of the population holds a doctoral degree, while our northern neighbours surpass us more than twofold in this regard – 1.2% of Finland's population holds a doctoral degree. In Germany the figure is 1.4% and in Sweden 1.6%, while in Latvia, it is only 0.3%.

Eurostat[66] databases provide data on the proportion of the population aged 25–34 with a doctoral degree, in comparison to other European countries. In Estonia, this proportion is relatively low (0.8%), compared to the European average of 1.3%. All Western European countries, as well as a large number of Eastern European countries, outperform us in this regard.

[64] Teadussilm. https://www.etis.ee/Teadussilm
[65] World Population Review (2024). PhD Percentage by Country / Number of Doctorate Degrees per Country 2024. Online: https://worldpopulationreview.com/country-rankings/phd-percentage-by-country (26.09.2024).
[66] Eurostat. Online: DOI:10.2908/educ_uoe_grad06 (26.10.2021).

RESEARCH ARTICLES

The history of scientific publishing spans more than 350 years.[67] At the end of the 17th century, ten scientific journals were being published worldwide; by the close of the 20th century, some estimates suggested that number had grown to 100,000. However, the actual figure is somewhat lower. In 2006, it was estimated that there were around 21,000 active peer-reviewed scientific journals.[68] Regardless of how scientific journals are accounted for, their number has steadily increased in the first two decades of the 21st century. The number of published articles has grown even faster, primarily thanks to the rise of online publishing.

When considering the increase in the number of research articles published, one might wonder if this can be partly explained by changes in the global population. After all, if the population is growing, it is logical that the number of researchers and their publications would also rise. However, it is important to note that the majority of research articles are published in countries where population growth has slowed significantly or plateaued in recent decades. Nevertheless, Estonia's position in the global research community is also worth considering when looking at the number of publications per million inhabitants. According to data from *Science Magazine*[69], combined with national population data,[70] approximately 4.8 million cited publications were published worldwide in 2023. In relation to the global population, this amounts to about 5.9 publications per 10,000 people. However, there are significant regional differences. For instance, in all Western European countries (Estonia is not one of them), a total of 26.3 articles per 10,000 inhabitants were published, which is more than four times the global average. When looking at this indicator by country, Switzerland ranks first, with 56.6 publications per 10,000 inhabitants, which is approximately ten times the global average. According to the same sources, a total of 30.5 citable research publications per 10,000 inhabitants were published in Estonia, placing us 21st out of 214 countries and autonomous regions worldwide and 17th out of 45 countries in Europe. Among Eastern European countries, only Slovenia (34.3) ranks ahead of Estonia in this regard, while several large Western European countries, such as the United Kingdom (29.1), Germany (21.3), and France (16.5), fall below Estonia. Among our neighbours, Finland is slightly ahead of us with 40.9 publications, while the other Baltic countries are significantly behind – Lithuania at 18.0 and Latvia at 17.0. In numerical terms, China had the highest number of publications (just over 1 million), but in terms of population, China's article output in 2023 was only 7.2 per 10,000 inhabitants, slightly above the world average and well below the Western European average.

Therefore, it cannot be said that Estonian research is doing poorly in a global context, but rather that we are one of the top countries in terms of research output.

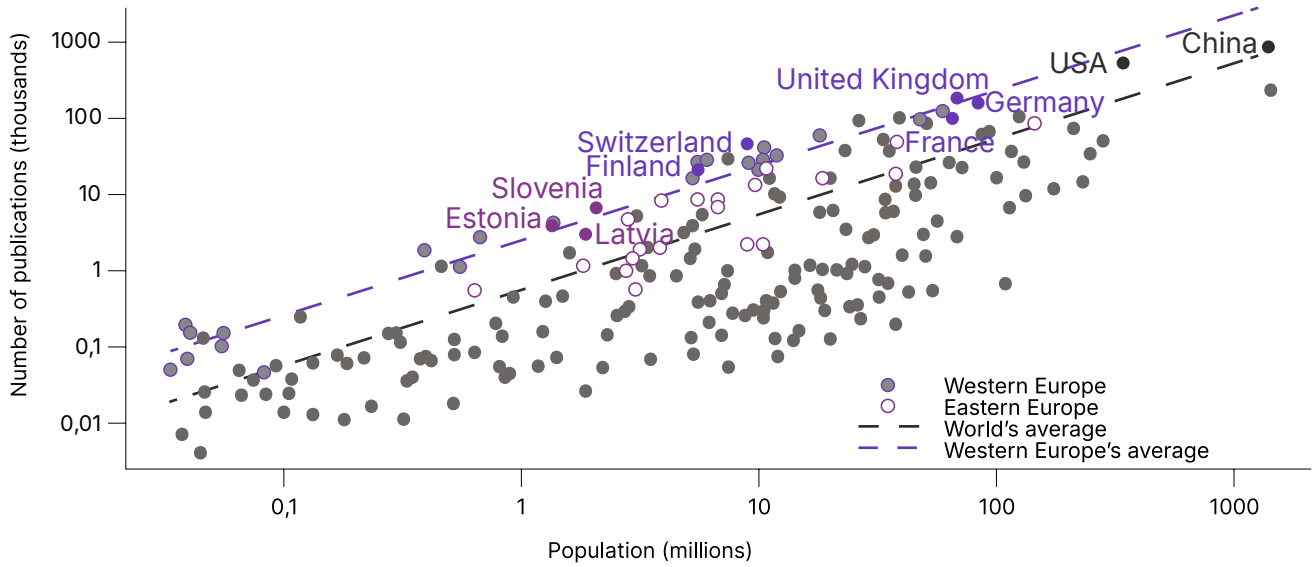


Figure 3.1. Number of scientific publications published in 214 countries and autonomous regions of the world in 2023 and the population of the corresponding country or region. The dashed lines correspond to the average ratio of the number of publications to the population of the world and Western European countries.

Sources: Scimago Journal & Country Rank[71] and Worldometers,[72] calculations by the author.

[67] Ghasemi, A., Mirmiran, P., Kashfi, K., Bahadoran, Z. (2022). Scientific Publishing in Biomedicine: A Brief History of Scientific Journals. Int J Endocrinol Metab, 2022 Dec 31;21(1):e131812. doi: 10.5812/ijem-131812. PMID: 36945344; PMCID: PMC10024814.
[68] Tenopir, C., King, D. W. (2014). The growth of journals publishing. – (eds Cope, B., Phillips, A.) The Future of the Academic Journal. Witney, United Kingdom: Chandos Publishing, pp 159–178.
[69] Scimago Journal & Country Rank. Online: https://www.scimagojr.com/countryrank.php?year=2023 (20.09.2024).
[70] Worldometers. Countries in the world by population (2024). Online: https://www.worldometers.info/world-population/population-by-country/ (10.09.2024).
[71] Scimago Journal & Country Rank. Online: https://www.scimagojr.com/countryrank.php?year=2023 (20.09.2024).
[72] Worldometers. Countries in the world by population (2024). Online: https://www.worldometers.info/world-population/population-by-country/ (10.10.2024).

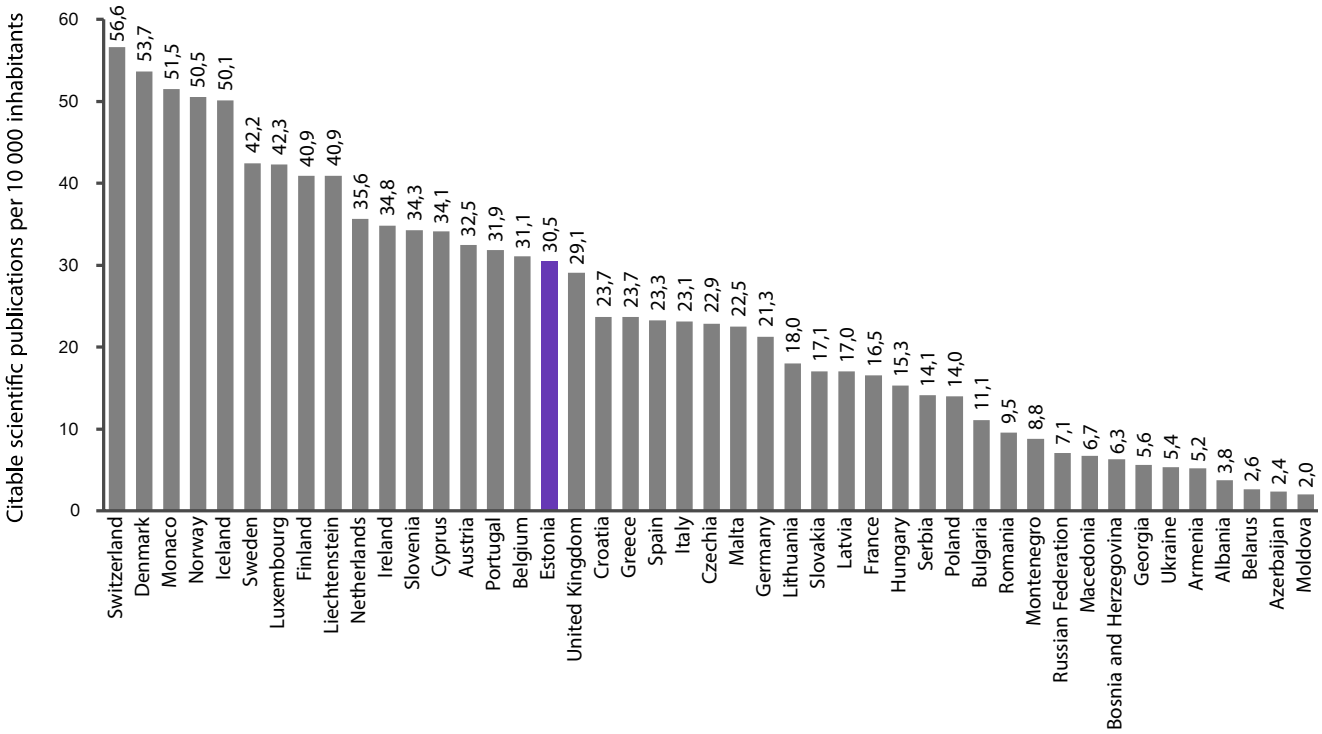


Figure 3.2. Number of citable scientific publications per 10,000 inhabitants in 35 European countries in 2023.

Sources: Scimago Journal & Country Rank[73] and Worldometers,[74] calculations by the author.

Looking at the trends over time in Estonia, research publishing has been on an upward trend, as in the rest of the world. The total number of peer-reviewed research articles increased steadily until 2014, with a significant increase in the number of top-tier category 1.1 articles continuing until 2021. However, between 2022 and 2023, there was a slight decline in the number of publications. In 2023, the total number of research publications across different categories was 5.6% lower than in 2021, while the number of top-tier category 1.1 publications declined by 7.5% (Table 3.1). This decrease may be a lingering effect of the coronavirus pandemic, as similar trends have been observed in other developed countries, with the exception of China.

As expected, the majority of research publications originate from the University of Tartu. In 2023, a total of 6,158 research publications were published with the participation of Estonian authors (in the categories presented in Table 3.1). Of these 2,985, or 48%, were authored by researchers from the University of Tartu (Tallinn University of Technology 1,259, Tallinn University 844, Estonian University of Life Sciences 401, National Institute of Chemical Physics and Biophysics 186). Among these, 3,449 publications fell into category 1.1, of which 1,783 (43%) were authored by researchers from the University of Tartu (Tallinn University of Technology with 727, Tallinn University with 337, the Estonian University of Life Sciences with 331, and the National Institute of Chemical Physics and Biophysics with 177).

Table 3.1. Total number of publications by Estonian researchers from 2009 to 2023 according to the classification[75] of the Estonian Research Information System.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1.1.	1638	1927	2017	2071	2455	2525	2612	2738	2735	2736	3227	3470	3733	3576	3450
1.2.-1.3.	1178	1248	1253	1353	1352	1160	980	877	748	689	673	650	637	618	544
2.1.-2.5.	185	205	242	231	247	377	416	405	365	426	424	441	425	474	409
3.1.-3.3.	2130	2267	2215	2242	2125	2206	1906	1762	1777	1661	2008	1825	1628	1616	1624
5.1.	120	116	108	104	117	122	137	103	104	103	133	85	98	129	131
Total	5251	5763	5835	6001	6296	6390	6051	5885	5729	5615	6465	6471	6521	6413	6158

Source: Estonian Research Information System (ETIS).

[73] Scimago Journal & Country Rank. Online: https://www.scimagojr.com/countryrank.php?year=2023 (20.09.2024).
[74] Worldometers. Countries in the world by population (2024). Online: https://www.worldometers.info/world-population/population-by-country/ (10.10.2024).
[75] Publication classification of the Estonian Research Information System. Estonian Research Information System. Online: https://www.etis.ee/Portal/Classifiers/Index/28? (11.10. 2024). Classifier numbers indicate the following: 1 – articles in journals; 2 – a book or monograph; 3 – articles in proceedings, a chapter in a book or in a collection, specific research publications; 4 – editing scientific publications; 5 – published meeting abstracts. Further details on the classification can be found at the link referenced.

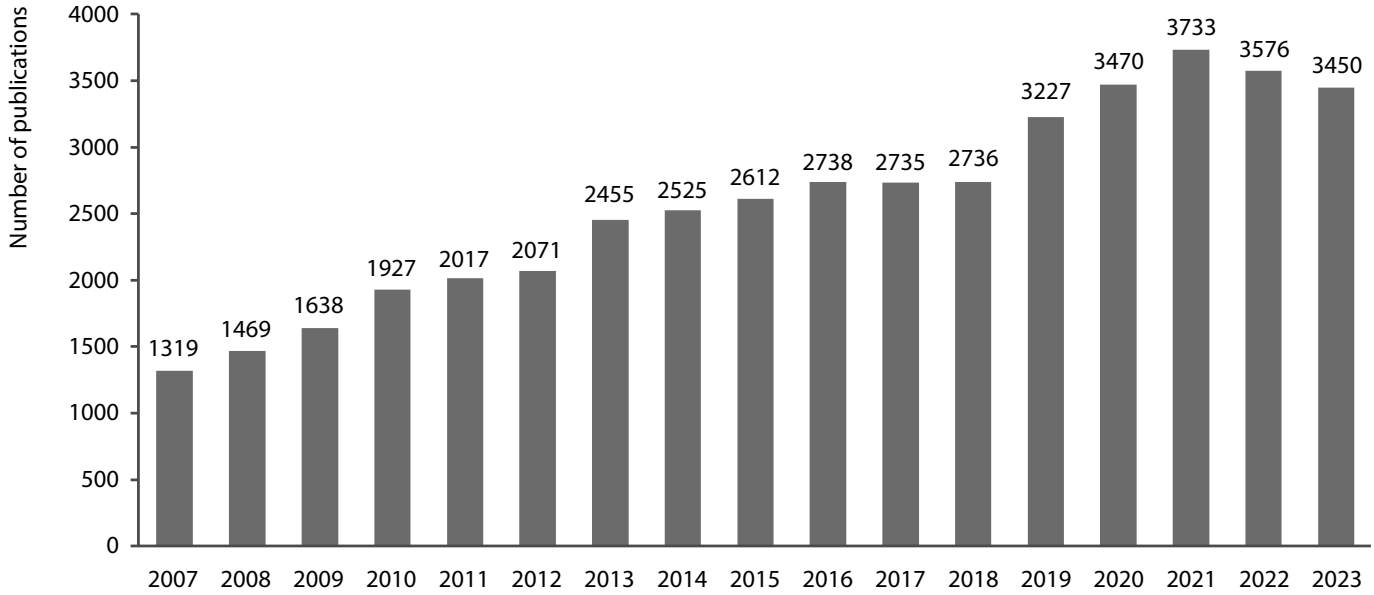


Figure 3.3. Total number of publications in category 1.1 (classification of the Estonian Research Information System) in 2007–2023.

Source: Estonian Research Information System (ETIS).

DOCTORAL STUDIES

As previously mentioned, the proportion of people with a doctoral degree in Estonia is lower than in many other European countries. For example, in Germany, 1.4% of the population holds a doctoral degree and 28,000 doctoral degrees are awarded there annually.[76] To achieve a proportionally similar level in Estonia, considering the population difference, an additional 400–450 doctoral degrees would need to be awarded each year. In reality, a total of 256 doctoral theses were defended in Estonia in 2023. It should be noted that more than one-third of doctoral students in Estonian universities are foreign students (according to Haridussilm, foreign students made up 39% of those admitted to doctoral studies in 2023), a significant proportion of whom leave the country after earning their degrees. The number of foreign doctoral students has also increased in our neighbouring countries (Figure 3.4). While the exact number of individuals with doctoral degrees earned abroad who move to Estonia each year is unclear, it is likely lower than the number of those who leave.

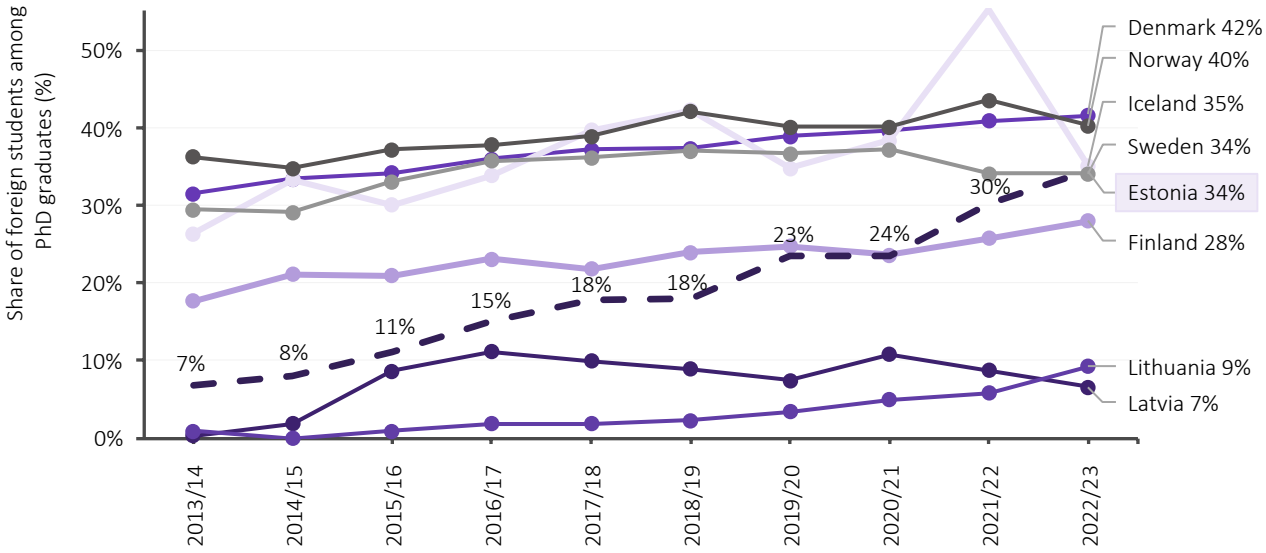


Figure 3.4. Share of foreign students among PhD graduates in the academic years from 2013/14 to 2022/23.

Source: Statistics Norway.[77]

[76] Federal Ministry of Education and Research. Research in Germany. Online: https://www.research-in-germany.org/en.html (11.10.2024).
[77] Statistics Norway. Age at the time of doctoral dissertation in the Nordic and Baltic countries, by field of R&D and sex 1990–2022. Online: https://www.ssb.no/en/statbank/table/13613/tableViewLayout1/ (11.10.2024).

The high drop-out rate from doctoral studies is also a major problem. Between 2016 and 2023, the annual number of students admitted to doctoral studies ranged from 343 to 400 (Figure 2.8, see also T. Vaimann's article in this collection), but the maximum number of graduates was 253. This means that fewer than two-thirds of those who begin doctoral studies complete them. Hopefully, the recent reform of doctoral studies will prove beneficial by ensuring that doctoral students can financially support themselves without having to take on other (often unrelated) jobs, allowing them to fully dedicate themselves to their studies. However, even if drop-out rates were significantly reduced, it would still be necessary to increase admissions to doctoral studies in order to reach a level closer to the European average.

The high age of our doctoral students is also notable: 37.2% of those admitted in the 2023/24 academic year were 35 years of age or older, while only 41% were under 30 (Figure 3.5). In total, 40% of those currently in doctoral studies are at least 35 years old (916 out of 2,283 doctoral students). The age of doctoral students appears to be rising: for example, in 2016, doctoral students aged 35 and older composed only 20% of those admitted, while the proportion of those admitted under 30 is clearly declining.[78]

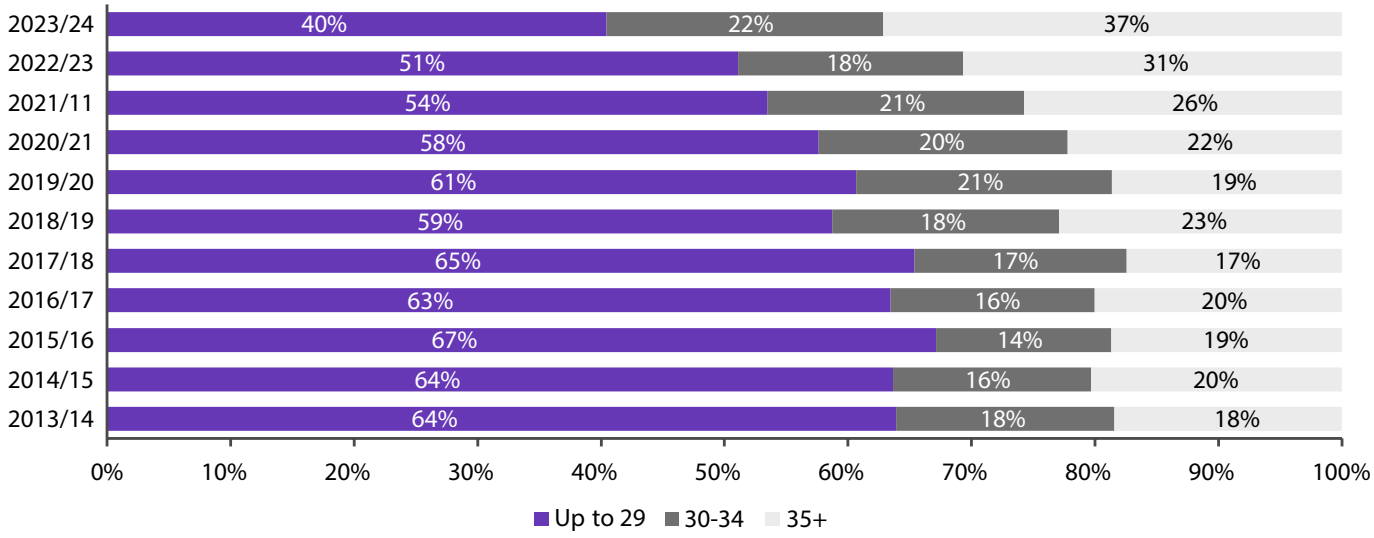


Figure 3.5. Persons admitted to doctoral studies by age group in the academic years from 2013/14 to 2023/24.

Source: Haridussilm.

However, it cannot be said that Estonian doctoral students are significantly older than those in neighbouring countries. The average and median age of Estonian doctoral students at the time of their thesis defence (36.6 and 34.0 years, respectively) is similar to that of Swedish doctoral students and is lower than that of Finnish doctoral students (Figure 3.6).

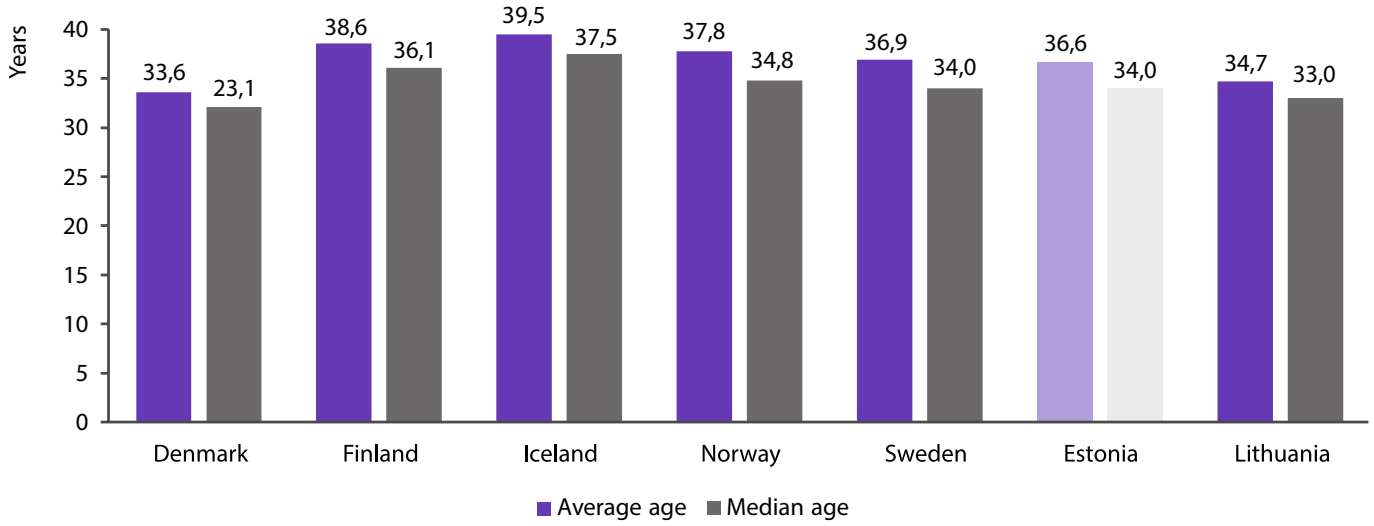


Figure 3.6. Average and median age at the time of PhD graduation in 2022.

Source: Statistics Norway.[79]

[78] Haridussilm.
[79] Statistics Norway. Age at the time of doctoral dissertation in the Nordic and Baltic countries, by field of R&D and sex in 1990–2022. Online: https://www.ssb.no/en/statbank/table/13613/tableViewLayout1/ (11.10.2024).

In most cases, doctoral studies are not completed within the standard duration. This is particularly evident among Estonian doctoral students, whose average duration of doctoral studies has been between 6.1 and 6.4 years since the 2014/2015 academic year. On the other hand, foreign doctoral students typically exceed the nominal four-year period of studies by less than a year. Notably, for foreign doctoral students who defended their theses in the 2023/2024 academic year, the average duration of their doctoral studies was even shorter than the nominal period, at 3.8 years (see also Figure 2.12 in T. Vaimann's article).

It would certainly be necessary for more young people to continue their doctoral studies immediately after completing their previous level of study and for doctoral studies to not take too long, as delaying graduation also postpones career opportunities that are only available upon obtaining the degree. Additionally, interest in postdoctoral fellowships abroad is often negatively correlated with the age of the graduate. For instance, families with school-age children are understandably not always able to move to another country for several years.

INNOVATION

One important measure of research success is the application of research results in the national economy and innovation. The World Intellectual Property Organization (WIPO), part of the United Nations, has developed the Global Innovation Index (GII), which includes about 80 indicators on a country's economy, education system, political system and other aspects, to assess the country's level of innovation. As of 2024, Switzerland ranks first among 133 countries based on this index, with a GII value of 67.5. It is followed by Sweden (64.5) and the United States (62.4). Our neighbouring country Finland holds the 7th place (59.4), while Estonia ranks 16th with a GII value of 52.3. Latvia, Lithuania, as well as Norway and Iceland, are ranked below Estonia in this ranking.

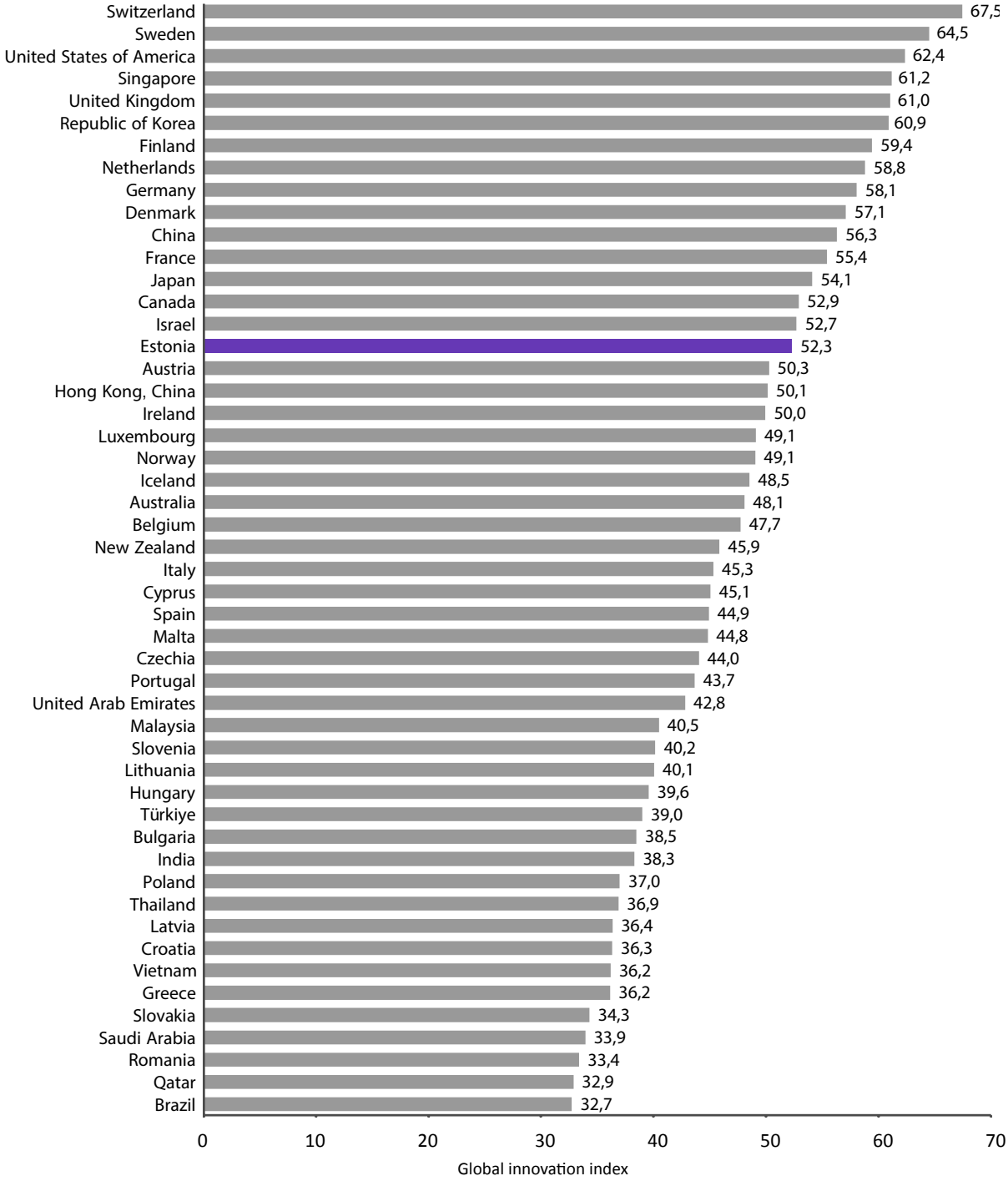


Figure 3.7. 2024 global innovation index, top 50 countries.

Source: World Intellectual Property Organization.[80]

SUMMARY

In conclusion, it can be said that the current state of Estonian research is quite good, particularly when considering the number of publications. In terms of our population, the research productivity of Estonia surpasses that of most countries globally and is close to the Western European average. Estonia is also well-positioned in terms of overall societal innovation. However, there are concerns about the shortage of a new generation of researchers and specialists with doctoral degrees. This could potentially impact both the quality of our education and the development of a research- and innovation-driven economy in the near and distant future. Increasing the volume of doctoral studies may incur higher short-term costs for the state, but in the long run, it would likely be more economically beneficial. Additionally, greater attention should be given to improving the success rate of doctoral studies, as a full third of those who start doctoral studies do not complete them for different reasons. A systematic survey is likely needed to identify the main causes of drop-outs from doctoral studies and to explore measures that could help reduce the likelihood of drop-outs.

[80] World Intellectual Property Organization. Global Innovation Index 2024. Online: https://www.wipo.int/web-publications/global-innovation-index-2024/en/ (12.10.2024).



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SOCIETAL IMPACT OF ESTONIAN RESEARCH

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INTRODUCTION

In parallel with the broader social development, the debate on the impact of Estonian research is evolving. In the past, the contribution of researchers to the economy and business was seen as sufficient, but today, the question of their wider contribution to social debates and addressing grand challenges has become equally, if not more, important.

The social impact of research is most clearly reflected in how society addresses grand challenges. What matters is the extent to which the public debate that accompanies problem-solving is informed enough. Is it based on facts, knowledge and analysis or on emotions and impressions? The importance of the role of researchers in the media was clearly highlighted during the coronavirus pandemic[82], but it is equally important in other areas, such as the environment and security. Therefore, it can be said that the quality of decisions affecting society directly depends on the quality of public debate, which is why researchers' engagement in discussions on important social issues is of key importance.

In light of the above, this article broadens the discussion on the societal impact of research and, for the first time, focuses on the participation of researchers in public debate. It explores the extent to which, where and on what topics researchers' voices are heard in the public sphere.

Respecting existing practices, a look has also been taken at the economic and business-related aspects of the societal impact of research. Among other things, topics such as co-operation between companies and research and development institutions, as well as the involvement of researchers in the private sector, have been examined.

THE PARTICIPATION OF RESEARCHERS IN SOCIETAL DEBATE: HOW LOUD IS THEIR VOICE?

The contribution of researchers to public debate is analysed below in terms of how actively they[83] engage with the medi[84] and how frequently they are quoted. Specifically, the Estonian written press (including online publications) is examined, with an assessment of the distribution of coverage in relation to the total number of researchers, as well as by topic, research field and source. The data used in this analysis was collected for this article by Balti Meediamonitooringu Grupp OÜ through the use of web scraping techniques.

VISIBILITY OF RESEARCHERS IN WRITTEN PRESS

Visibility refers to both the articles authored by researchers themselves and the mentions of researchers or their work in articles written by others. The 1,868 researchers included in the dataset authored a total of 13,338 articles between 2019 and 2024 (up to 16 April). During the same period, researchers or their work were mentioned 94,602 times (see Figure 4.1).

A growing trend is observed in the authorship of researchers: during the observed period, the number of articles written by researchers increased from 2,273 to 2,615 per year. However, mentions of researchers in the written press have decreased over the same period, dropping from 18,315 mentions to 14,827 (with 20,268 mentions in 2021, as shown in Figure 4.1). This reflects, on the one hand, the

[81] I would like to thank Kadri Raudvere, analyst at the Estonian Research Council, for her reflections and excellent co-operation in data collection and analysis.
[82] See also Soomere, T. (2020). 'Tarmo Soomere: teadusnõustamise tuleproov koroonakriisis'. ERR. Opinion piece, 9 August. Online: https://www.err.ee/1122061/tarmo-soomere-teadusnoustamise-tuleproov-koroonakriisis (24.09.2024).
[83] This article analyses engagement with the media based on a sample of researchers who, according to the Estonian Research Information System (ETIS), authored at least one publication between 2019 and 2024 (as of 20 March 2024) corresponding to category 6 of the ETIS publication classification, and who, according to ETIS data, held an academic staff position and a doctoral degree during that period. According to ETIS, there were a total of 1,890 of such individuals. The journalists with same names identified during data analysis and the researchers who worked as journalists during the period under review were excluded from the final analysis, as their inclusion would have significantly skewed the results. This left a total of 1,868 researchers in the sample.
[84] Due to the technical and economic specifics of web scraping, the analysis is limited to Estonian-language written press, including online publications, newspapers and magazines. Social media, radio, television and other channels have not been included. Both authorship and mentions are considered separately.

growing activism of researchers in contributing to social debates, and on the other hand, a fluctuating interest from the written press in researchers as sources. However, the interest of the press likely depends significantly on the topical issues and their relative complexity (eg COVID-19). A more detailed analysis would require a longer data series in the future.

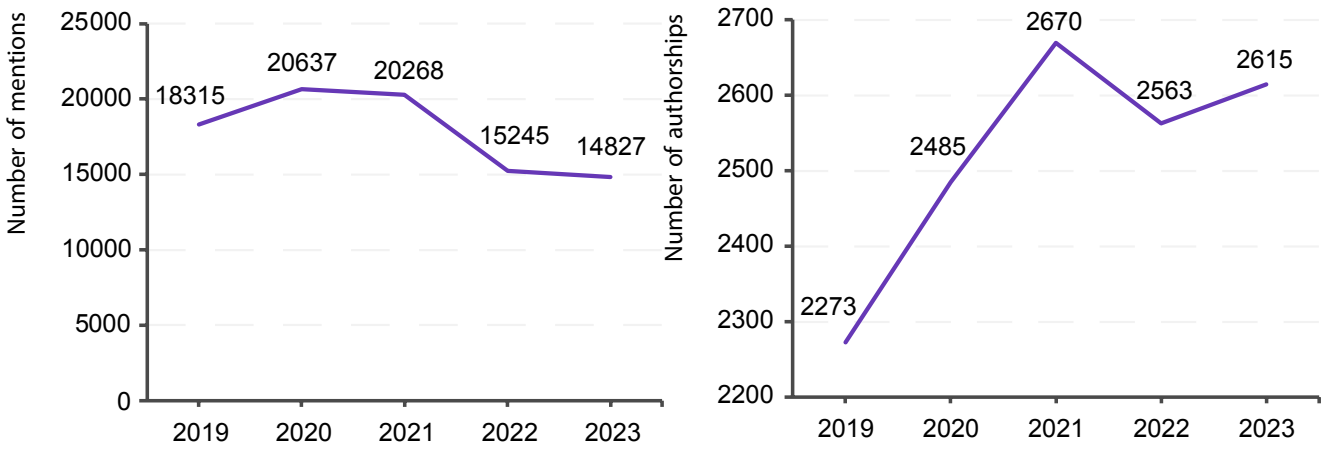


Figure 4.1. The trend of authorship and mentions of Estonian scientists in Estonian written media in the period 2019–2023.
Source: Balti Meediamonitooringu Grupp OÜ, calculations by Estonian Research Council.

Among written media sources, *Postimees* ranks first, hosting 35% of the articles authored by researchers in the sample, followed by the ERR web portal (14%) and *Sirp* (10%). The remaining publications account for smaller shares. Half of the articles were published in online media, while a third appeared in national print newspapers (with some articles published in both formats).

Looking at the distribution of media coverage (total number of articles written by researchers and total number of mentions) among the research community (Figure 4.2), a strongly concentrated pattern is evident: approximately 1% of researchers (20 persons) accounted for 20% of all coverage, and 7% of researchers accounted for 50% of coverage. Despite the high concentration of results, it is somewhat encouraging that 87% of the researchers in the sample received press coverage during the period under review, either with their full article or by being mentioned at least once.

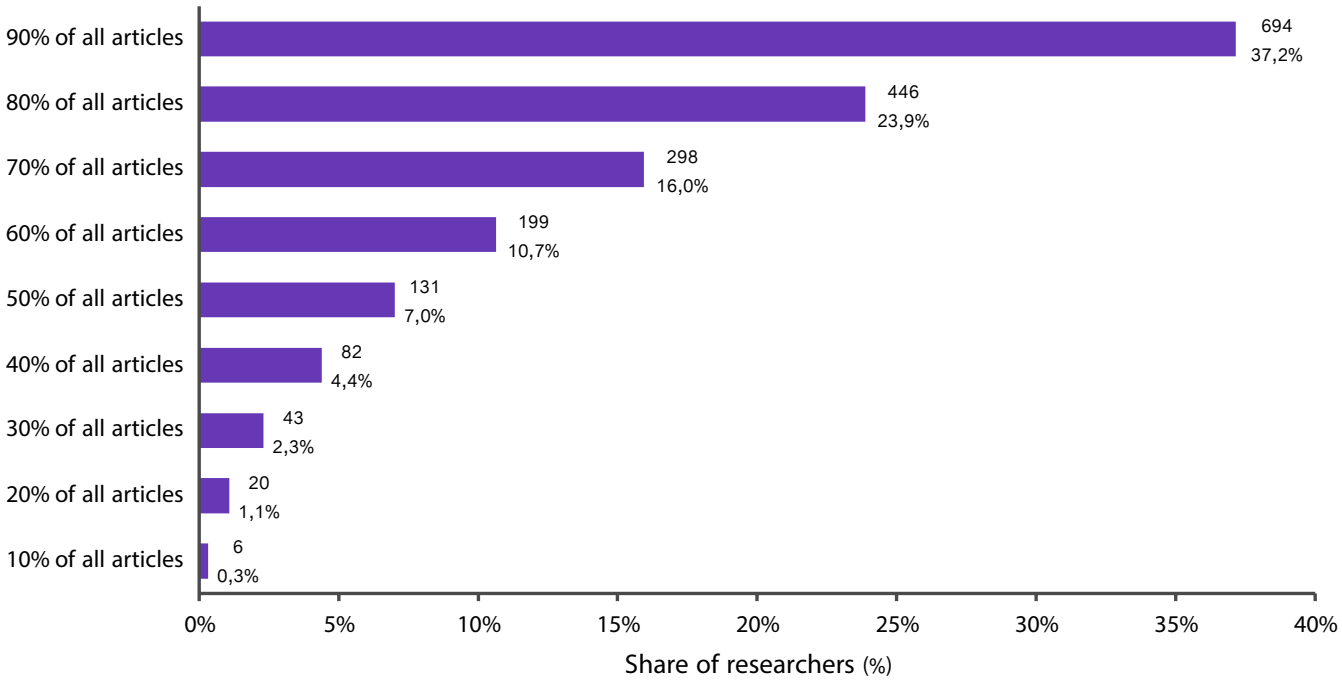


Figure 4.2. Breakdown of media coverage (total number of articles authored by researchers and the total number of mentions) within the research community from 2019 to 2024 (up to 16 April).
Source: Balti Meediamonitooringu Grupp OÜ, calculations by Estonian Research Council.

VISIBILITY OF RESEARCHERS BY SUBJECT AREA AND FIELD OF RESEARCH

The following section explores which researchers from which fields of research are covered in the media, along with the subject areas associated with their media coverage.[85]

An analysis of data from 2019 to mid-April 2024 (Figures 4.3 and 4.4) shows that researchers working in the fields of culture and society (65% of articles written by researchers) are the most covered in terms of both authorship and mentions. Researchers in this field write more and more articles for publication in the media every year (the trend is increasing), while in other fields this indicator plateaued between 2021 and 2022.

It is worth highlighting that between 2020 and 2022, there was a noticeable increase in the number of articles written by researchers in the fields of biosciences and environment, health, and natural sciences and engineering, as well as in the number of mentions, which then declined again. This temporary increase can largely be explained by the impact of the coronavirus pandemic.

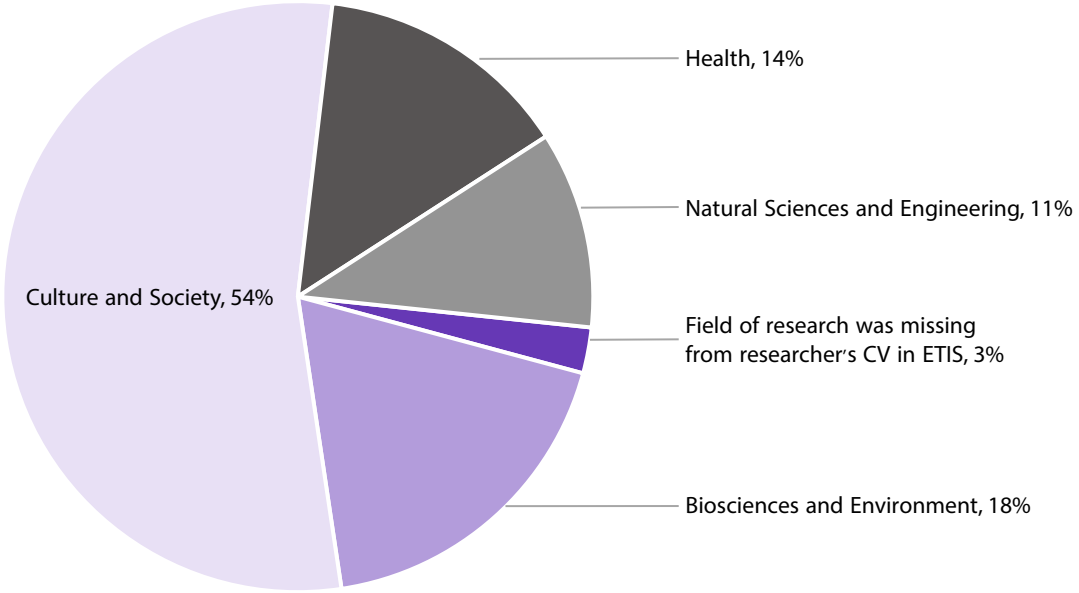


Figure 4.3. Share of articles authored by researchers and mentions by field of research of researchers between 2019 and 2024 (until 16 April).

Source: Balti Meediamonitooringu Grupp OÜ, calculations by Estonian Research Council.

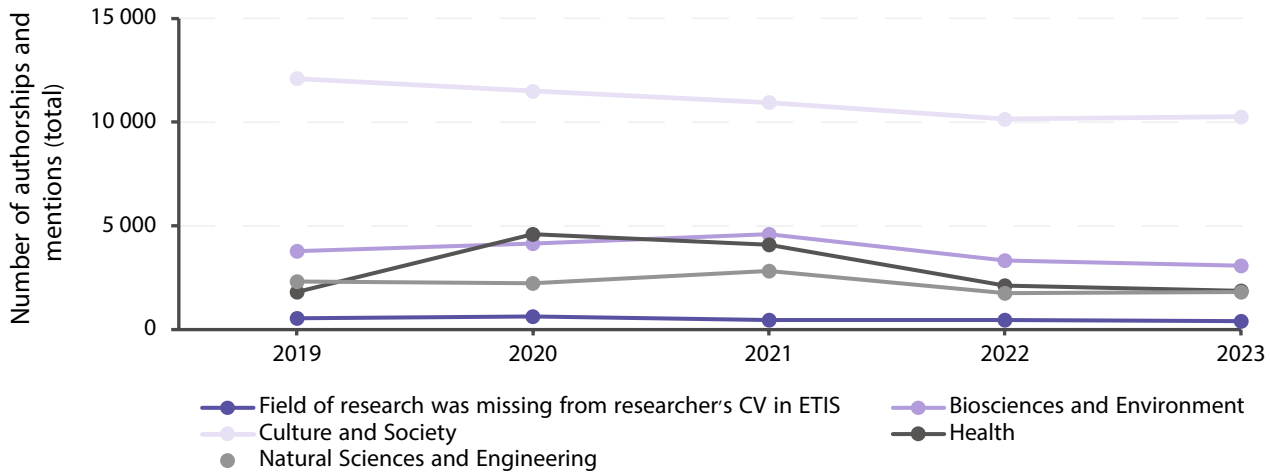


Figure 4.4. Change in the number of articles authored by researchers and the number of mentions by different fields of research between 2019 and 2023.

Source: Balti Meediamonitooringu Grupp OÜ, calculations by Estonian Research Council.

[85] For the analysis of fields, the researchers' self-defined fields of research (according to the ETIS classification of research fields) as listed in their ETIS CVs were used. In cases where multiple fields were indicated, the first-listed field was selected for the analysis.

On which topics do researchers primarily express themselves? An analysis of the words used in the titles of the 13,340 articles written by the researchers in the sample shows (Figure 4.5) that the most frequently used words (excluding conjunctions, interrogative words and pronouns) were as follows: 'Estonia' / 'Estonian', 'Russian', 'Russia', 'Ukraine', 'new', 'world'. In other words, researchers often write about current, social and security-related topics.



Figure 4.5. Top keywords used in the titles of articles published in the written press and written by researchers between 2019 and 2024 (until 16 April).

Source: Balti Meediamonitooringu Grupp OÜ, calculations by Estonian Research Council.

As mentioned in the introduction, the voice of researchers is particularly important when addressing major social issues, as the quality of the debate directly influences the quality of the social decisions. Therefore, the titles of articles written by researchers were analysed to identify keywords that characterise the challenges currently facing Estonia, such as those related to security, health and the environment. In addition, considering the topic of the article, keywords were searched that would characterise the research environment and the link between research and the economy. Approximately 11% of the articles written by researchers contained keywords[86] in the title related to three major areas of social importance: the environment, health care and security (Table 4.1). Understandably, health care dominated the dataset over the past five years (5.4% of articles), but topics related to research itself and the links between research and the economy (including innovation) were also relatively popular, accounting for 4.8% and 5.4% of articles, respectively.

Table 4.1. Societal challenges in the titles of articles written by researchers.

	Number of articles with keywords from the relevant field in the title	Share of articles with keywords from the relevant field in the title out of all articles
SECURITY	373	2,8%
SECURITY (only Ukraine and NATO)	181	1,4%
HEALTHCARE	720	5,4%
HEALTHCARE (without COVID-19-related keywords)	381	2,9%
ENVIRONMENT	409	3,1%
RESEARCH	637	4,8%
LINK BETWEEN RESEARCH AND ECONOMY (innovation, business, applied research)	720	5,4%
Total SECURITY, HEALTHCARE, ENVIRONMENT	1502	11,3%

Source: Balti Meediamonitooringu Grupp OÜ, calculations by Estonian Research Council.

[86] An algorithm was used to search for keywords reflecting specific topics in the titles of articles written by the selected researchers. The selection of topics and keywords was based on the author's personal knowledge.

RESEARCHERS' CONTRIBUTION TO THE DEVELOPMENT OF BUSINESS AND ECONOMY

The contribution of research to the development of business and the economy is reflected in two key aspects: the co-operation between companies and research and development institutions, and the involvement of researchers in the private sector. The following sections will discuss both aspects separately and outline some general trends in the financing and structure of Estonian research and development (R&D).

1. **Co-operation between companies and R&D institutions**

The extent of co-operation between companies and R&D institutions can be assessed through the following indicators: a) R&D expenditure in non-profit sectors financed by the business sector (Figure 4.6) and b) the share of the business sector in financing R&D within the national higher education sector.

When examining the R&D expenditure of the business sector in non-profit sectors (including the higher education sector, the government sector and the non-profit private sector), the main trend is that business sector R&D expenditure in the higher education sector has been steadily and rapidly growing over the past ten years. Compared to 2014, R&D expenditure from the business sector has nearly tripled, increasing from 5.6 million euros to 15.6 million euros. This highlights the growing role of universities as key partners for companies in developing new products and services, as well as in enhancing existing ones.

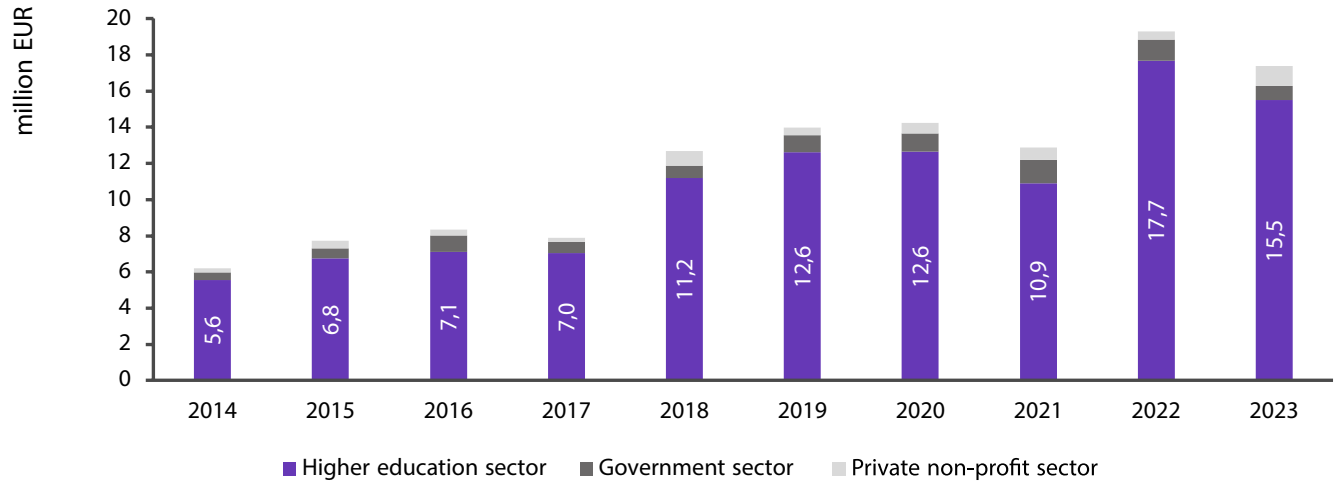


Figure 4.6. R&D expenditure in non-profit sectors financed by the business sector in 2014–2023 (million EUR).

Source: Statistics Estonia.

The above trend is further supported by data on the role of the business sector in financing R&D in the country's higher education sector (Figure 4.7). The share of R&D funding provided by the Estonian business sector has gradually increased since 2013, rising from 3.5% in 2012 to 6.7% in 2023, with a peak of 8.4% in 2022. Although the growth has not been uniform, with quite sharp jumps over the years, the overall share of the business sector in R&D funding in the higher education sector has increased significantly.

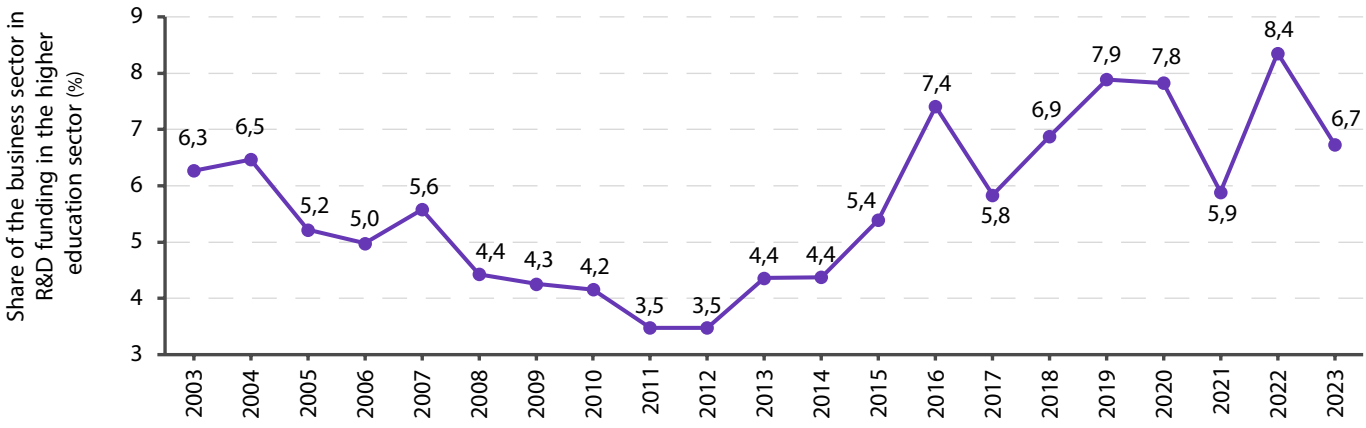


Figure 4.7. Share of the business sector in financing R&D in the country's higher education sector (share of the R&D expenditure of the higher education, %) in Estonia between 2003 and 2023.

Sources: OECD and Statistics Estonia.

However, it is important to compare these data with those from other countries (Figure 4.8). In 2021, when 5.9% of Estonian higher education R&D was funded by the business sector, Estonia was close to the OECD and European Union averages, but lagged behind the Nordic countries that serve as role models for us: Finland (3.3%), Sweden (2.8%) and Denmark (2.5%). Considering the 2022 level of 8.4%, we are moving significantly away from the national average and towards one extreme.

On the one hand, this is a positive development – it reflects the excellent work of universities in providing R&D services and the increasing capacity and willingness of companies to engage in R&D co-operation. This has been a priority of Estonia's innovation and R&D strategies for years, with significant resources invested to achieve it.

However, it is also evident that an excessive focus on the needs of the business sector may limit the ability of universities to concentrate on strategic, long-term research. While there is no optimal level for business sector funding of R&D in universities, it is crucial to maintain a balance between the different funding components.

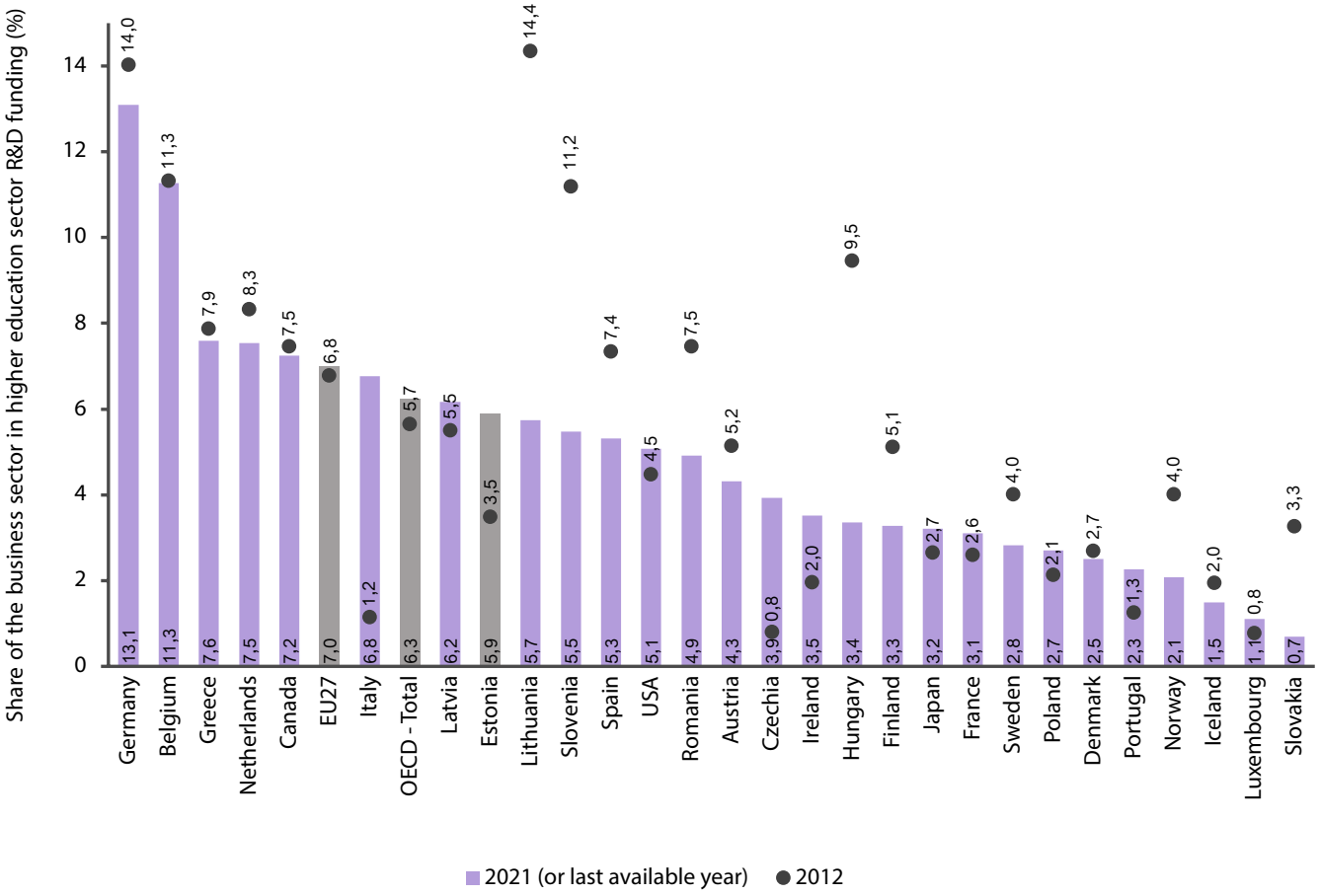


Figure 4.8. Share of the business sector in the country's higher education sector R&D funding (share of the R&D expenditure of the higher education, %) in 2021 compared to 2012.

Source: OECD.

2. Involvement of researchers in the private sector

The number of researchers in Estonia has been growing steadily (Figure 4.9). In 2013, there were 7.3 researchers per thousand employees, but by 2022, this number had increased to 9.4. However, in an international comparison (Figure 4.10), Estonia still lags behind in this indicator, with figures comparable to those of Poland and Lithuania.

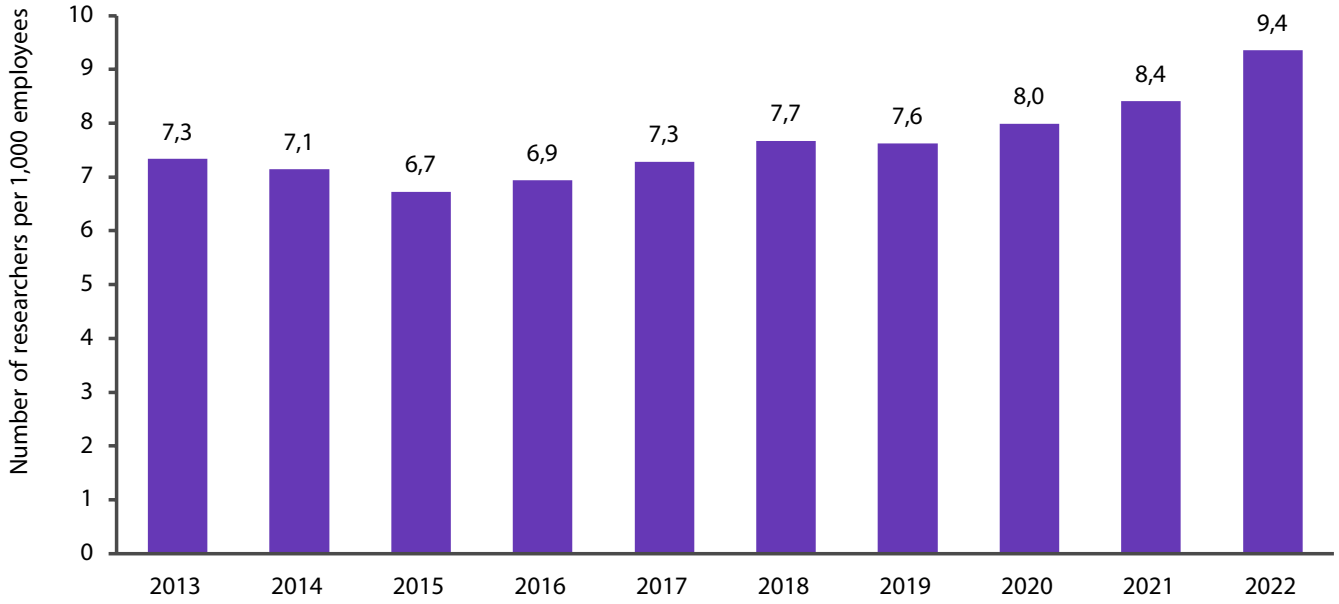


Figure 4.9. Number of researchers per 1,000 employees in Estonia between 2013 and 2022.

Source: OECD.

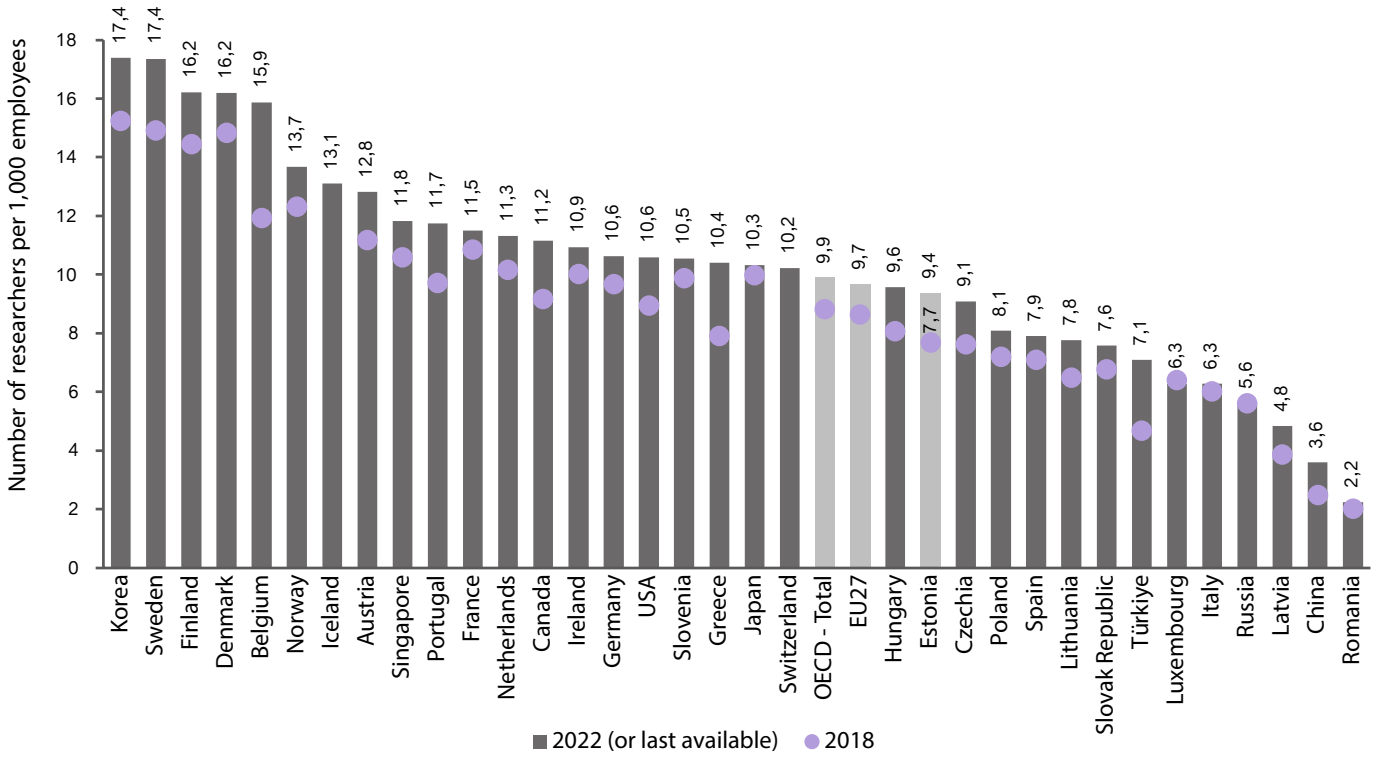


Figure 4.10. Number of researchers per 1,000 employees in 2022 (or last available year) compared to 2018.

Source: OECD, calculations by Estonian Research Council.

In addition to the total number of researchers, it is crucial to consider where these researchers are applied. It is said that knowledge moves with people. Therefore, both the number of researchers in the industry (per thousand employees) and the number of researchers with a doctoral degree in different fields of the Estonian business sector are crucial indicators of the innovation and knowledge intensity of the economy.

The number of researchers per thousand employees in industry has increased from 3.2 in 2012 to 4.8 in 2021 (Figure 4.11). This indicator has grown significantly faster than the total number of researchers, offering a degree of hope that the industry will become more knowledge-intensive and, therefore, more competitive. However, compared to other countries, Estonia still has room for improvement, as it lags behind both the European Union average (7.2) and the OECD average (8.7) (Figure 4.12). In part, this may be explained by the smaller share of industry in the structure of our economy, but at the same time, it reflects the continuing challenges in enhancing the competitiveness of the industry.

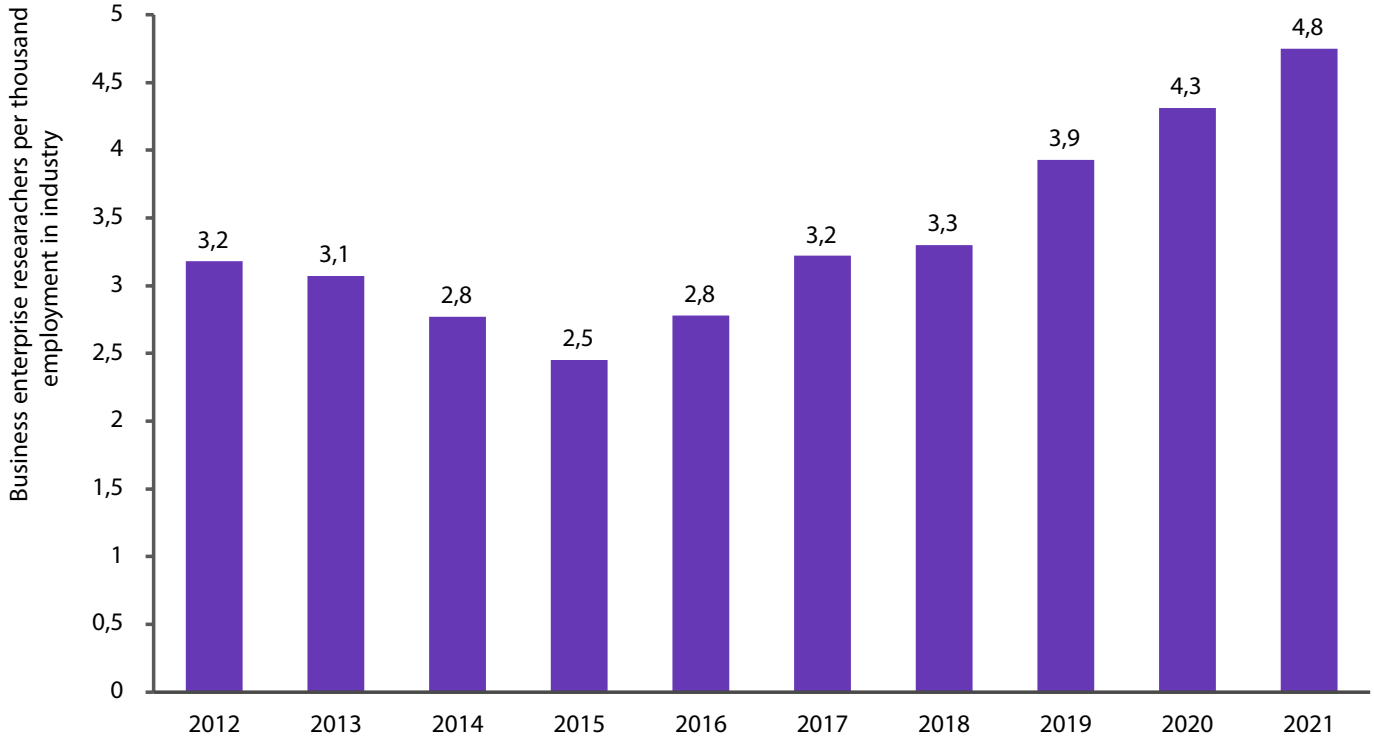


Figure 4.11. Business enterprise researchers per 1,000 employment in the industry in Estonia between 2012 and 2021.

Source: OECD.

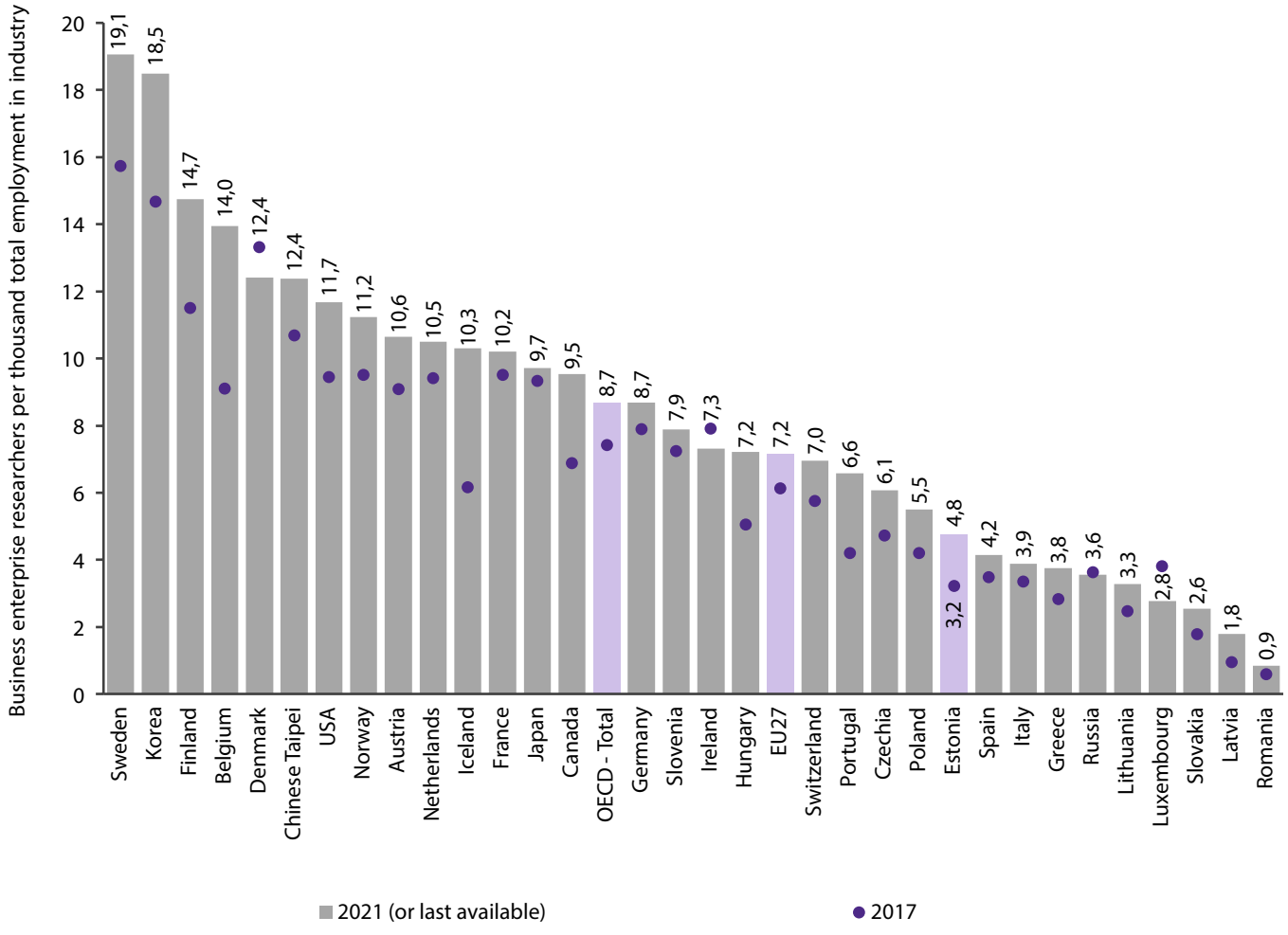


Figure 4.12. Business enterprise researchers per 1,000 total employment in industry in 2021 compared to 2017.

Source: OECD.

The sectoral distribution of researchers with a doctoral degree in the Estonian business sector (Figure 4.13) further illustrates this point. It is evident that the number of researchers with a doctoral degree has been growing most consistently in the manufacturing, while in the information and communications sector, which has otherwise seen rapid growth, this growth has stagnated in recent years.

This suggests that making the economy more knowledge-intensive requires continued attention to the share of researchers with a doctoral degree in different economic sectors. On the one hand, attention must be given to demand: the profiles and ambitions of companies must allow for the use of researchers. On the other hand, efforts to strengthen supply must continue. To ensure there are enough people with a doctoral degree to meet the needs of both the private and public sectors, investment is needed to make doctoral studies more attractive. In this regard, the highly successful industrial doctorate study programmes in the Nordic countries, where doctoral degrees are earned through close co-operation between companies (or the public sector) and universities, can serve as a model.

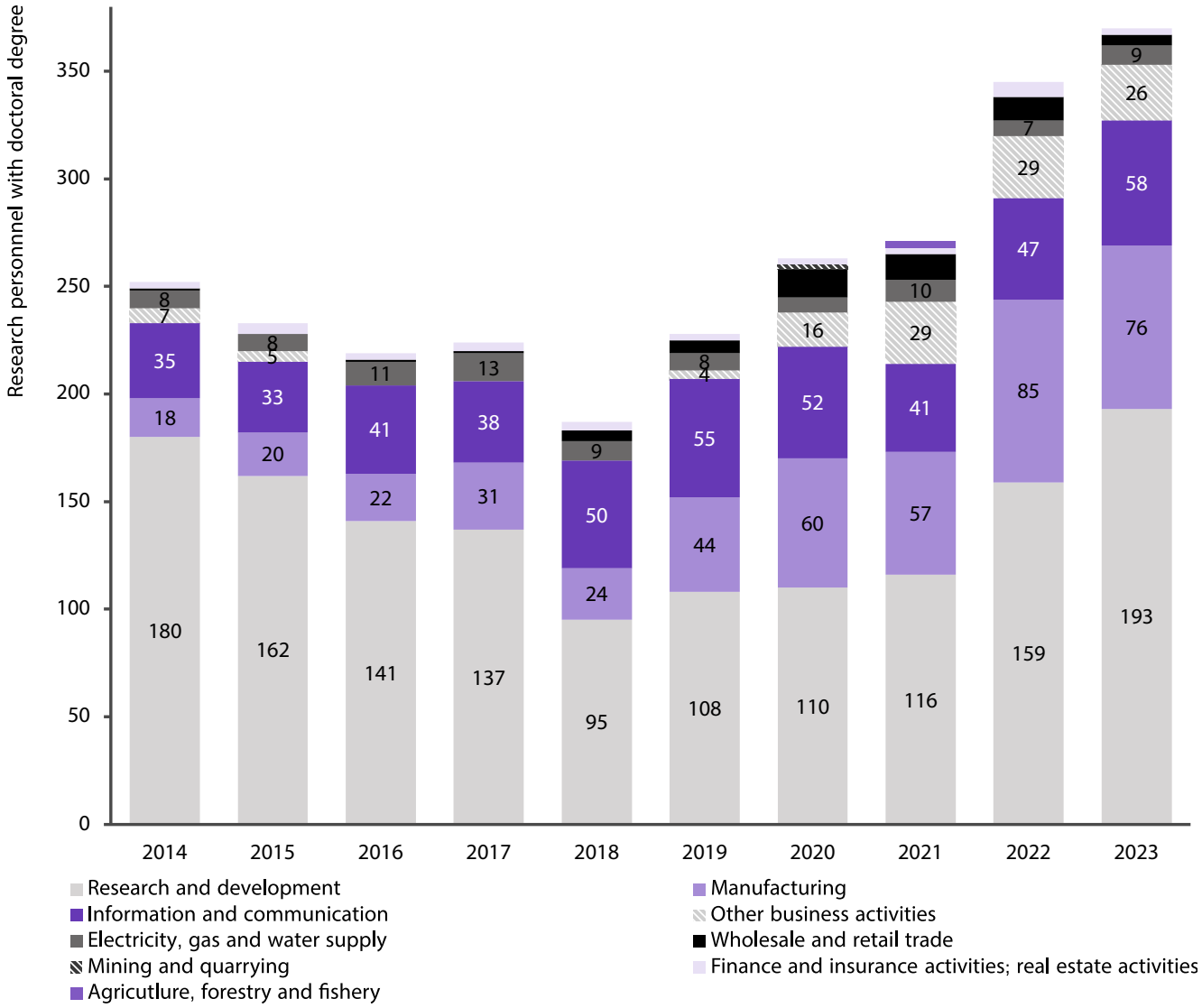


Figure 4.13. Number of research personnel with doctoral degrees in the business sector of Estonia by different fields of economic activity between 2014 and 2023.

Source: Statistics Estonia.

GENERAL TRENDS IN THE FUNDING AND STRUCTURE OF R&D IN ESTONIA

This section follows the practice of the Estonian Research Council of highlighting the main indicators that characterise R&D funding and its structure in statistical collections.

First, it can be observed that Estonia is close to the EU average in terms of GDP (Table 4.2) and, in terms of R&D expenditure as a percentage of GDP, being close to countries like the Czech Republic, Portugal and Norway (Figure 4.14).

Table 4.2. GDP level compared to EU 27 average in 2015–2023, where EU = 100.

	2015	2016	2017	2018	2019	2020	2021	2022	2023
European Union (27)	100	100	100	100	100	100	100	100	100
Czechia	89	89	91	92	93	93	92	90	91
Denmark	128	128	130	129	126	133	135	136	128
Germany	124	125	124	124	121	123	119	117	115
Estonia	76	77	79	82	83	85	86	85	81
Ireland	181	176	183	190	189	207	221	235	212
Latvia	65	66	67	69	69	72	71	73	71
Lithuania	75	76	79	81	84	88	89	89	87
Poland	69	69	69	71	73	76	77	79	80
Slovenia	83	84	86	87	89	89	90	90	91
Slovakia	79	73	71	70	71	74	73	71	73
Finland	111	111	111	111	109	114	112	110	108
Sweden	128	124	122	120	119	123	122	119	117

Source: Eurostat.

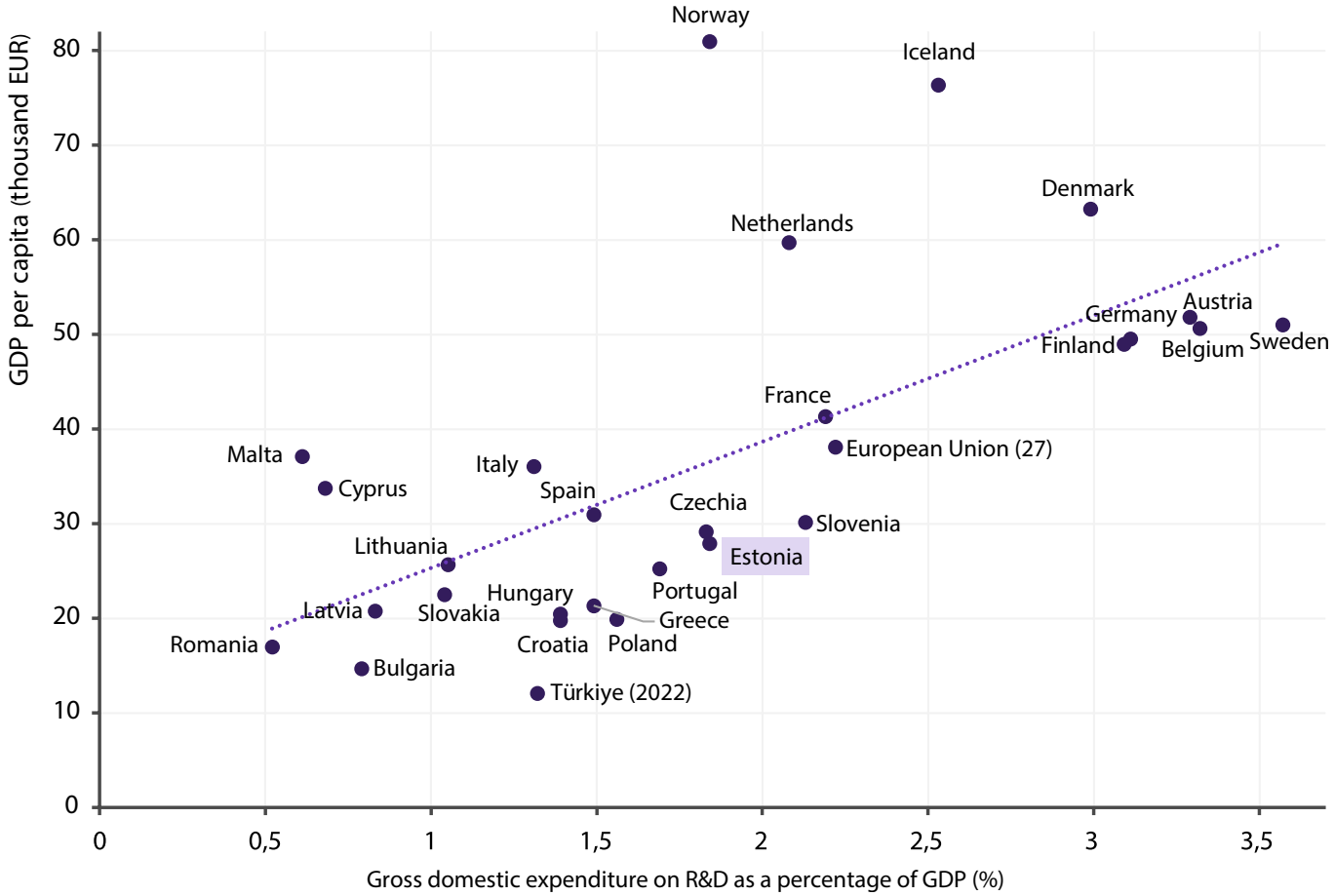


Figure 4.14. R&D expenditure (% of GDP) and GDP per capita (thousand euros) in 2023.

Source: Eurostat.

Looking at the structure of R&D expenditure, the breakdown by type of R&D (Figure 4.15) shows that experimental development dominates, accounting for almost half of the total expenditure, followed by applied research and basic research. Over the last decade, the share of basic research has decreased the most, dropping from 30% in 2014 to 20% in 2023. In contrast, the share of experimental development has increased, rising from 44% in 2014 to 57% in 2023. The share of applied research has remained more or less the same, despite occasional fluctuations. In an international comparison (Figure 4.16), Estonia is positioned in the middle of the scale regarding the share of applied research, roughly on par with Norway, Iceland and Slovenia.

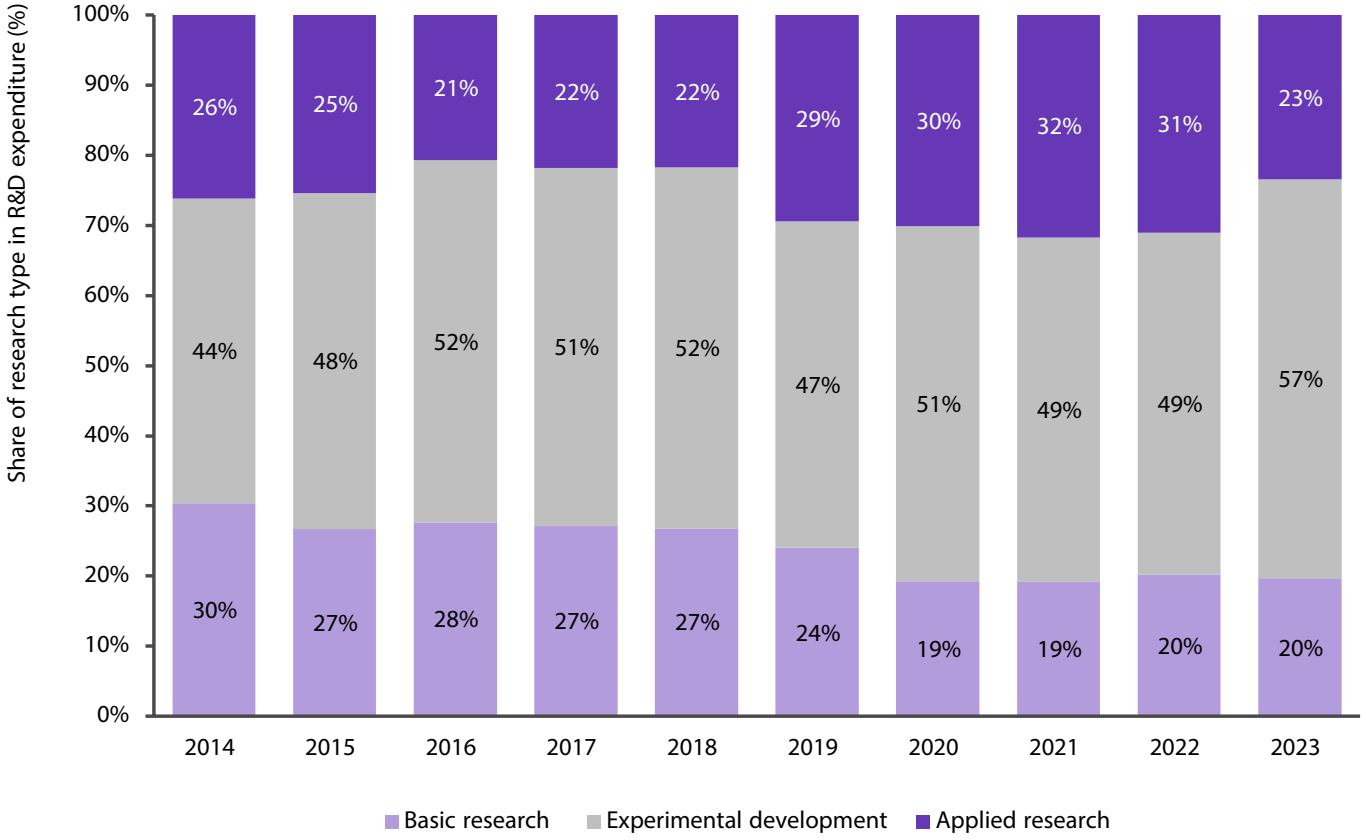


Figure 4.15. Breakdown of R&D expenditure by type of R&D in 2014–2023.

Source: Statistics Estonia.

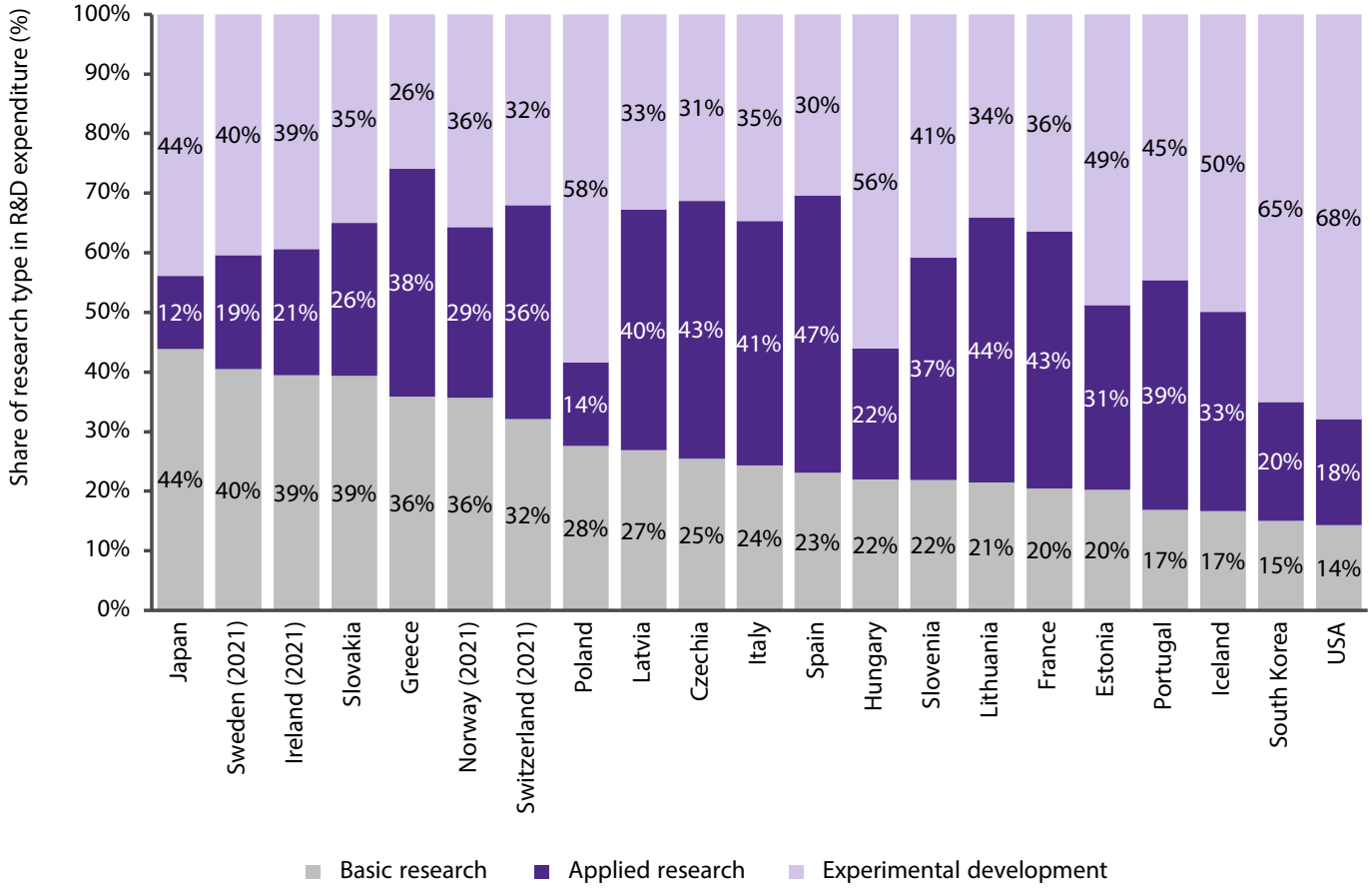


Figure 4.16. Breakdown of R&D expenditure by type of R&D by country in 2022 (or last available year).

Source: Eurostat.

A closer look at the breakdown of R&D expenditure of Estonian companies by economic activity (Figure 4.17) reveals that the information and communication industry (approximately 45% of all companies' R&D expenditure as of 2023) and the manufacturing (30%) clearly dominate. The share of the former has increased significantly over the decade, rising by around 13 percentage points, while the latter has seen a decrease of approximately 7,3 percentage points.

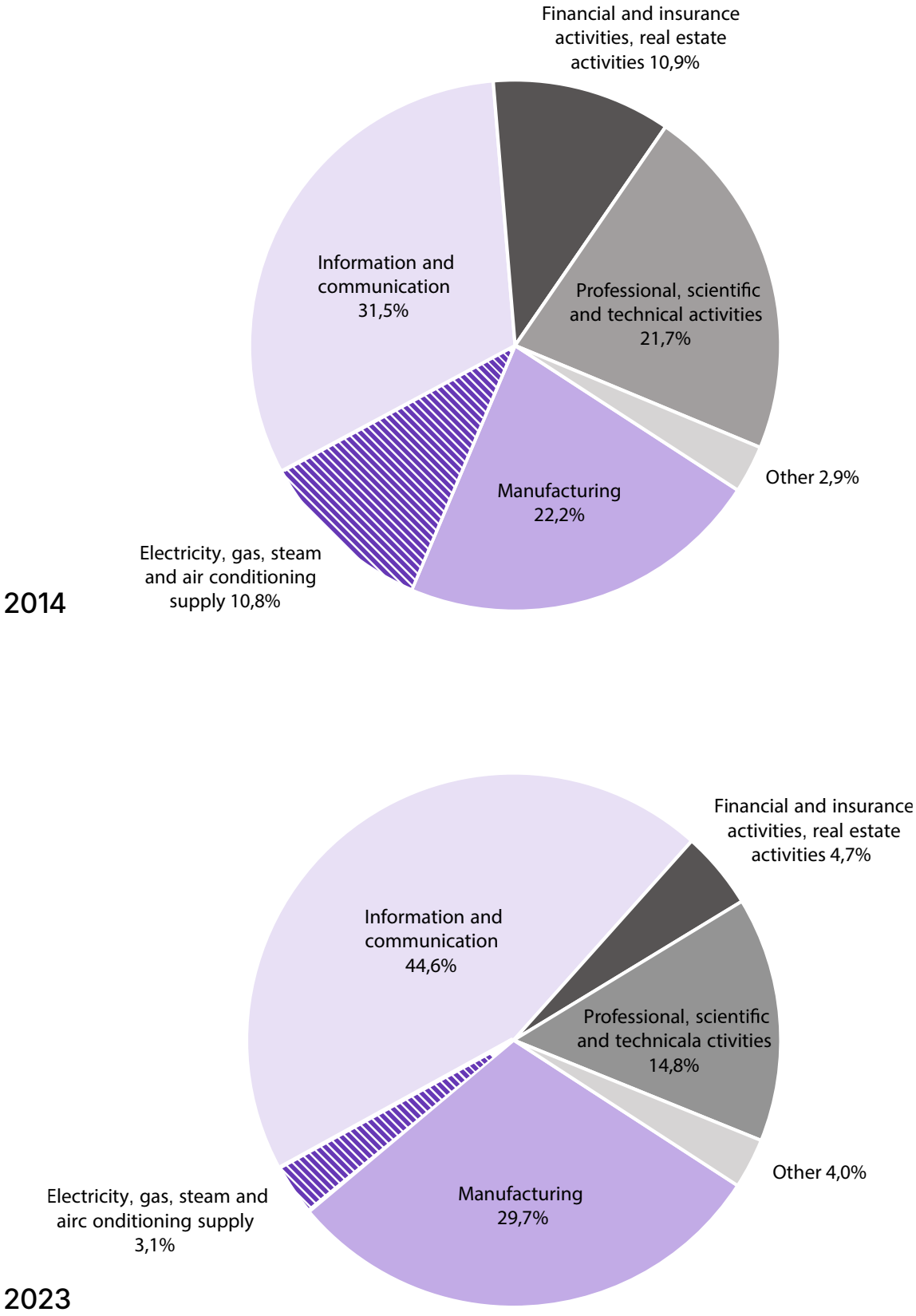


Figure 4.17. Percentages of R&D expenditure of Estonian companies by economic activity in 2014 and 2023.

Source: Statistics Estonia.

The government's share of business sector R&D funding (Figure 4.18) has been steadily increasing in recent years, reaching 10.1% of business sector R&D expenditure. However, it still remains below the 2014 level of 10.3%. On the positive side, despite the rapid increase in the absolute amount of government support, the growth of the share of government support has been slower. This suggests a potential leverage effect of state support, indicating that the rise in business sector expenditure on R&D is not solely driven by the increase in government funding.

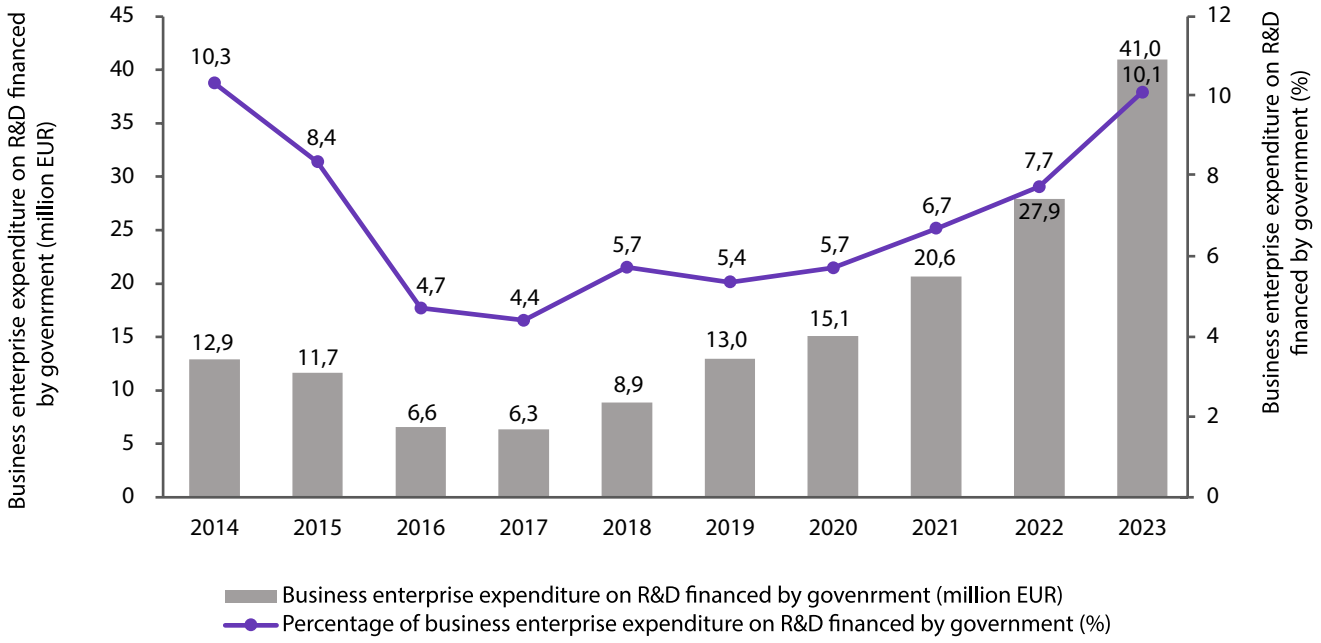


Figure 4.18. Business enterprise expenditure on R&D financed by government in 2014–2023 (million EUR).
Source: Statistics Estonia.

SUMMARY

In conclusion, it can be said that the influence of Estonian research in society is steadily increasing. On the one hand, researchers are becoming more active in social debates, while on the other, the contributions to different business-related indicators are also growing.

However, there is still significant room for further development. The participation of researchers in public debates is highly concentrated, with a small number of researchers providing the majority of coverage. Researchers in the fields of society and culture dominate this space. Therefore, it is important to increase both the overall and sector-specific participation in public debates.

There is also room for development in the analysis of indicators related to societal impact. This article is the first to analyse the broader societal impact of research. However, it is a research topic that requires continuous development, both in terms of methodology and data. It is hoped that, in the coming years, the analysis of social debates can be deepened (for example, through longer time series and international comparisons) and expanded to include other topics that offer a broader perspective on social impact (eg the direct involvement of researchers in policymaking).



A chest full of Kihnu skirts (Heimtali Museum). • Anu Ansu.

STRATEGIC SUPPORT OF EXCELLENT SCIENCE AND INFLUENTIAL INNOVATION

TARMO SOOMERE **Member of Estonian Academy of Sciences**
Chariman of the national research infrastructure committee

Contemporary science is much more than simply creating new and essential knowledge and communicating this knowledge to others. It is an intricate and fragile ecosystem that functions in the complex landscape of interrelations between academia and society. It is fed by energy via financing and benefits from cooperation that serves as its blood circulation system. Universities are like muscles and single scientists contribute like cells.

It is virtually impossible to pursue excellent science with bare hands and pure reason. Various tools and resources are needed for organising thoughts and for the communication of results. Some kind of infrastructure is thus an intrinsic part of science, maintaining its structure and ensuring its necessary reach, like a skeleton.

The definition of contemporary research infrastructure embraces an extreme variety of devices, resources, structures and services that support the research process. It is thus natural that the list of such resources extends from unique large-scale facilities, such as colliders of the European Organization for Nuclear Research (CERN), to simple field tools and elementary office equipment. This spectrum naturally involves libraries, archives, databases of all kinds, and the means of protecting and retrieving information from these sources, as well as the relevant professional knowledge, methods, and services.[87]

NATIONAL RESEARCH INFRASTRUCTURE

Estonia has allocated substantial funds for developing national research infrastructure since 2010. This category is defined as (sets of) items of any kind or structure that support excellent science so that they (i) are essential for the entire science landscape, society and economy in Estonia, (ii) have large enough scale and coverage, and (iii) it makes sense to plan such (infra)structure on the country level and to additionally provide finance from the state budget.[88]

These investments are framed via the so-called national research infrastructure roadmap (simply roadmap in the following). Technically, it is a list of sets (called objects in the relevant jargon) of specific assets with greatly varying kinds of support they provide to research. The traditional roadmap items are single devices or sets of large-scale assets (e.g., Marine Technology and Hydrodynamics Research Infrastructure (MARTE) concentrated around a ship test basin), exclusive functional units (e.g., Estonian Centre for Genomics), and distributed sets of devices that are significantly needed for some field of science (e.g., Estonian Centre of Analytical Chemistry). National participation in international research units (such as CERN) and consortia (such European Molecular Biology Laboratory (EMBL)) are another traditional type of roadmap objects. Examples of non-traditional objects are e-infrastructures (such as Infotechnological Mobility Observatory (IMO)), the network of natural history archives and common data space (NATARC), or participation in the European Social Survey.[89]

The preparation of the first roadmap was launched in 2009. The roadmap, first signed and entered into force in 2010, and upgraded in 2014 and 2019, has been part of the national research, development and innovation strategies „Science-based Estonia“ 2007–2013 and 2014–2024.[90] It is thus a component of science policy in Estonia, framing a political decision about financing of this component of science from the national budget.

[87] Ministry of Education and Research (2023). Regulations of supporting national-scale research infrastructure. Decree of the Minister of Education and Science 28.09.2023 No 36. – RT I, 4.10.2023, 6 (in Estonian).
[88] Ministry of Education and Research (2023). Regulations of supporting national-scale research infrastructure. Decree of the Minister of Education and Science 28.09.2023 No 36. – RT I, 4.10.2023, 6 (in Estonian).
[89] Sillaste, M. (2024). Analysis of national-scale research infrastructure 2010–2024. Tartu: Estonian Research Council. https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (26.11.2024, in Estonian).
[90] Sillaste, M. (2024). Analysis of national-scale research infrastructure 2010–2024. Tartu: Estonian Research Council. https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (26.11.2024, in Estonian).

The three versions of the roadmap included 33 objects in total.[91] The path to being included on this list was thorny and convoluted. Only about a quarter of the proposals were clearly successful in the two first rounds. For about a third of the proposals the committee suggested that two or more consortia join forces. The success rate of new proposals rose to about 60% in the 2019 call. While the first two editions of the roadmap mostly consisted of physical (sets of) devices, in the 2019 call, participation in international infrastructure consortia (such as CERN or the Estonian beamline at MAX IV Synchrotron Radiation Source) comprises about half. This change is natural: it does not make sense for Estonia to own expensive devices, the resources of which are used only partially. It is important to grant access for our scientists to such assets in other countries and to ensure that we can jointly contribute to and benefit from large-scale data sets.

ESSENTIAL BENEFITS

Feedback from the users of roadmap objects is straightforward. The supported assets are a vitally important resource and tool for both scientists and for users from other fields, often providing the unique possibility to carry out necessary work within a reasonable budget.[92] The users also stress the importance of such infrastructure in addressing socio-economic issues and widening the cooperation with industry, alongside producing excellent science. This feedback supports the perception that the entire set of roadmap objects functions properly, while acknowledging that single objects are popular and much-needed for many, with possible alternative options are located at a large distance from Estonia.

The 2019 roadmap objects have generated 813 projects with a total funding of 408.4 M€, that is, by an order of magnitude more than the contribution from the state budget. They provide at least 228 different services and have published at least 2928 research papers.[93]

A GLIMPSE INTO THE FUTURE

The biggest concern of leaders of the roadmap consortia is how stable financing can be achieved. This is a reflection of one of the principles of this roadmap: being listed does not guarantee financing but first of all reflects that the proposed science is of high quality and confirms that the infrastructure has national importance. In essence, being listed provides confirmation of eligibility to participate in specific financing calls where only roadmap consortia and possibly national centres of excellence can participate.

The total investment into roadmap objects from national budget was about 135.5 M€ 2010–2024. Roughly half of these funds originated from the European Union (EU) budget. The situation has now changed. Such massive use of EU funds for research infrastructure is no longer possible. This change also means that it makes sense to consolidate pre-existing different channels of financing the roadmap into one arrangement with simple rules, so that all different kinds of costs, from investments into devices to participation in international consortia, will come from one source. More problematic is that the level of self-financing has increased several times and will be 30% of all costs, except for contribution to running international consortia that will be 5% as in the past.

28 RECOMMENDATIONS

The picture presented in the reports of the pre-existing roadmap objects was generally pleasant. Most players have done more than promised. There were some failures, mostly because of external factors. Such things always happen when stakes are high and possible rewards substantial. It was however distressing that reports from some honourable institutions and good scientists appeared arrogant and had almost no real content. Luckily for them, the committee had no mandate to reject such reports and exclude the relevant new proposals. It was requested that they provide substantially improved reports.

The set of 41 proposals to the new roadmap contained 14 proposals in natural sciences, 9 in physics and engineering, 7 in social sciences and the humanities, 6 in health and food sciences, and one in energetics. Additionally, four consortia proposed virtual infrastructure. The committee was instructed to take into account not only formal grades provided by referees but also the proportions of different fields of research and development in the country and how important the proposed actions

[91] Sillaste, M. (2024). Analysis of national-scale research infrastructure 2010–2024. Tartu: Estonian Research Council. https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (26.11.2024, in Estonian).
[92] Kivistik, K., Toomik, K., Kaldur, K., Jurkov, K., Järvela, S. (2024). Study of the use of national-scale research infrastructure. Tartu: Institute of Baltic Studies. https://www.ibs.ee/projektid/teadustaristu-kasutuskogemuse-uuring/ (26.11.2024, in Estonian).
[93] Sillaste, M. (2024). Analysis of national-scale research infrastructure 2010–2024. Tartu: Estonian Research Council. https://etag.ee/wp-content/uploads/2024/09/Riikliku-tahtsusega-teadustaristute-analuus.pdf (26.11.2024, in Estonian).

were at the national scale.[94] This instruction automatically put proposals into a proper context. Namely, the grades were used for a preliminary selection of proposals in three groups: very good proposals that definitely should be included into the roadmap, ineligible proposals (for example, reflecting too narrow fields), and proposals that needed more careful consideration.

The results were generally in accord with the composition of previous roadmaps. The committee found 26 proposals definitely worthy of listing in the roadmap. Five proposals were such that alone they were below the threshold but combined with others would be sufficiently valuable to be included. In this way, the inclusion of two more proposals was suggested. Ten proposals had different issues. They were not really weak; however, they were mostly either too local, or it remained unclear as to how they would generate excellent science. The success rate was thus over 75%. The final list from this call was signed by the Minister of Education and Science on 22 November 2024 and the call for financing was opened a few days later.

[94] Ministry of Education and Research (2023). Regulations of supporting national-scale research infrastructure. Decree of the Minister of Education and Science 28.09.2023 No 36. – RT I, 4.10.2023, 6 (in Estonian).



Common blue damselflies in a heart-shaped mating position, blue is male, brown is female. The male holds the female by the neck. • Tavo Romann (Estonian Science Foto Competition 2023).

WIDENING PARTICIPATION IN THE EXCELLENT SCIENCE OF THE EUROPEAN UNION

TOIVO MAIMETS **Professor, University of Tartu**

The European Union's (EU) Framework Programme for Research and Innovation for the years 2021–2027 Horizon Europe (HEU) contains as part of it the sub-programme 'Widening participation and spreading excellence'. Its aim is to bridge the gap between the leading research countries in the EU and those that are lagging behind. The HEU Work Programme 2023–2025 emphasises that excellence in research and innovation can only be achieved if all countries and regions in Europe advance together. Therefore the EU's research and development (R&D) system must adopt a more inclusive approach, ensuring that everyone can participate and benefit.[95]

A number of actions taken under the programme, the best-known of which are ERA Chairs, Teaming and Twinning, are aimed at enhancing the research and innovation capacity of countries, fostering networking and supporting reforms. Widening Participation actions have received significant political attention and resources in both the current and previous Framework Programmes. Of the €95.5 billion budget for HEU, the Widening Participation actions account for 3.3%, or approximately €3 billion (compared to less than €1 billion in the previous Framework Programme Horizon 2020).

Statistics show positive shifts in many areas.[96] More resources have been allocated to research, international co-operation has significantly improved and the share of private funding has increased. The latest European Innovation Scoreboard (2024) indicates that some Widening countries are nearing the European average, with Estonia, for example, classified in the strong innovator group (100–125% of the EU average). However, the gap between the so-called old (EU14) and new Member States (EU13) still exists and, in the case of some countries, is even widening, The group of emerging innovators (less than 70% of the EU average) – primarily Widening countries – has improved its position by 6% over the past eight years, but this progress is still below the EU average growth rate of 10%. Those lagging behind remain behind. Therefore, it is crucial to continue Widening Participation actions while reassessing the effectiveness and success of existing actions.

The continuation of Widening actions in the next Framework Programme is strongly endorsed by universities, research institutions and industry. However, there are differing views on the instruments, budget allocation and objectives, which need to be resolved in the ongoing consultations for the next Framework Programme. Denmark considers that Widening actions could continue, but outside the Framework Programme, with funding instead coming from the EU Structural Funds (which are specifically aimed at supporting lagging regions in the EU).[97] The position of Estonia on the next Framework Programme (so far only as a project) is also that Widening actions should continue, but with a clear focus on reducing the participation gap in other parts of the Framework Programme. In contrast, the European Association of Research and Technology Organisations (EARTO) has expressed strong criticism, suggesting that the Widening Participation programme either needs substantial improvements or should be discontinued.[98]

Latvia has proposed doubling the budget allocated for Widening Participation in the next Framework Programme.[99] Several universities and research organisations have advocated for the doubling of the budget for the entire next Framework Programme, which suggests that an increase in funding for Widening actions is also likely. There is also considerable disagreement on the position of these actions in the overall structure of the Framework Programme and the instruments required. For example, a significant portion of the Widening budget is allocated to activities organised through the Cooperation in Science and Technology (COST) network. Although the HEU work programmes require COST to spend 50% of this budget on Widening countries, this target has not yet been met.

[95] Horizon Europe – Work Programme 2023–2025. 11. Widening participation and strengthening the European Research Area. European Commission Decision C(2024) 2371 of 17 April 2024, p 9.
[96] Brent, T. (2024). Ten graphs show how the research landscape in EU 2004 members has changed. Science Business, 8 May. Online: https://sciencebusiness.net/news/research-and-innovation-gap/ten-graphs-show-how-research-landscape-eu-2004-members-has-changed?utm_source=ActiveCampaign&utm_medium=email&utm_content=Ten+graphs+show+how+the+research+landscape+in+EU+2004+members+has+changed&utm_campaign=The+Widening+No++33 (24.09.2024).
[97] Zubașcu, F. (2024). Axe the European Institute of Innovation & Technology and move missions and Widening out of Horizon Europe successor, Danish government says. Science Business, 25 January. Online: https://sciencebusiness.net/news/fp10/axe-european-institute-innovation-technology-and-move-missions-and-widening-out-horizon (24.09.2024).
[98] EARTO (2023). EARTO Inputs to ERAC on the next European Research & Innovation Framework Programme (FP10). Online: https://www.earto.eu/wp-content/uploads/EARTO-Inputs-to-ERAC-on-FP10-Final.pdf (24.09.2024).
[99] The Ministry of Education and Science of the Republic of Latvia (2024). The informal Latvian Position Paper on the Future EU Framework Programme for Research and Innovation (FP10) has been published. Online: https://www.izm.gov.lv/en/article/informal-latvian-position-paper-future-eu-framework-programme-research-and-innovation-fp10-has-been-published?utm_source=https%3A%2F%2Fsciencebusiness.net%2F (24.09.2024).

There are differing opinions on whether the Widening Participation policy should extend downwards from the level of Member States to harmonise the development of different geographical regions. However, several analyses (such as the recent one conducted by the ESIR expert group[100]) highlight the drawbacks of this approach and even suggest that the task has been incorrectly framed.

Therefore, preference should be given to Member States as the focus of Widening Participation, rather than the regions within them (as proposed, for example, by Belgium).

Alliance4Life, an association of leading biomedical universities in the EU13, found in its recent Policy Paper on the Efficiency of Widening Measures that these measures have led to significant positive developments: enhanced collaboration between participating institutions, improved grant-writing skills and administrative capacity, increased researcher mobility and better opportunities for institutions to attract top researchers from abroad.[101] However, institutions in the Widening countries still receive few European Research Council (ERC) and European Innovation Council (EIC) grants and rarely take on the leadership role. Alliance4Life argues that the new Framework Programme should shift its focus from importing scientific excellence from leading European research countries to empowering, supporting and nurturing the existing local excellence. This aligns with the principle outlined in the HEU work programme referred to above, which emphasises that true excellence in European research and innovation can only be achieved if every country progresses.

The new Framework Programme, currently under discussion, will significantly shape the future of the European Research Area. On the one hand, it could be argued that the best and most effective approach would be to concentrate research resources and talent in a few key locations across Europe, particularly in the old EU14 countries. Such arguments were previously made when the European Institute of Innovation and Technology was established. However, an important drawback to this approach – especially for smaller and historically less advantaged countries – is that excellence in higher education is a prerequisite for excellence in science. As a result, the level of universities in many regions of the EU would suffer, which, in turn, would also undermine the long-term capacity for innovation. The result could be a so-called two-speed Europe.

[100] Richardson, K., Renda, A., Balland, P., Castaño Marin, M. et al. (2024). Combining regional strengths to narrow the EU innovation divide. A policy brief by the Expert Group on the Economic and Societal Impact of Research and Innovation (ESIR). European Commission: Directorate-General for Research and Innovation. Publications Office of the European Union. Online: https://data.europa.eu/doi/10.2777/87992.
[101] Alliance4Life (2023). Policy Paper on Efficiency of Widening Measures. Online: https://alliance4life.ceitec.cz/policy-paper-on-efficienty-of-widening-measures/ (24.09.2024).

SMARTER POLICYMAKING THROUGH THE EUROPEAN COMMISSION'S PROJECT 'BUILDING CAPACITY FOR EVIDENCE-INFORMED POLICYMAKING IN GOVERNANCE AND PUBLIC ADMINISTRATION'[102]

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Governance in the 21st century has grown increasingly complex, as society faces a bundle of interconnected problems – a polycrisis – for which there are no simple solutions. Technologies are evolving, bringing not only new opportunities but also new challenges. At the same time, people's expectations of public services are increasing. All of this has made the life of policymakers exceptionally difficult. Decisions must be made about what to address (as a priority) and where to direct limited public resources. The recent global crisis in the form of the COVID-19 pandemic clearly highlighted the importance of the availability, accessibility and application of evidence-informed information[103] in political decision-making.

The recognition that a fundamentally new, evidence-informed approach to policymaking is essential in a crisis-ridden world has become widely accepted by policymakers in many developed countries. To help interested Member States improve the quality of their policymaking, the European Commission and the OECD launched an international evidence-informed policymaking project of unprecedented scale, which ran from 2023 to 2024.

The project was funded by the Directorate-General for Structural Reform Support (DG REFORM) and implemented by the Joint Research Centre (JRC). A total of seven countries participated in the project, including Estonia, Belgium, the Netherlands, Greece, Lithuania, Latvia and the Czech Republic. The Estonian Government Office, the Ministry of Education and Research, and the Estonian Research Council deserve commendation for expressing their interest in participating in the project. The most important outcome of this two-year project is country-specific policymaking analyses and the recommendations based on them.

[102] The full title of the project is 'Building capacity for evidence-informed policymaking in governance and public administration in a.post-pandemic Europe'. More information about the project: https://knowledge4policy.ec.europa.eu/projects-activities/introducing-multi-country-technical-support-project-building-capacity-evidence_en#{35864a9c-6775-43f6-a794-f8a3e297c5f4}{189} (22.10.2024).

[103] It should be noted that the term 'evidence-informed', which is used in the title of the project, carries a broader meaning than the term 'evidence-based' and is even broader than 'science-based'. The term 'evidence-informed' refers to the idea that evidence-informed information is a key factor in helping policymakers make sound decisions, but it is not the sole input. In fact, it is said that policymaking is based on the three Is – information, interests and institutions – with our focus here being on information. In the Estonian version of this article, we use the Estonian term teadmistepõhine poliitikakujundamine as the equivalent of the English term 'evidence-informed policymaking', which can be found in professional literature.

HOW WAS THE PROJECT CONDUCTED?

The project was based on the continuous cooperation between the project team – consisting of two JRC expert analysts, one OECD expert analyst and five Estonian experts – and Estonian state agencies (Government Office, ministries, Statistics Estonia), knowledge providers (universities, research institutions, Estonian Academy of Sciences, Estonian Young Academy of Sciences, Praxis, Centar, Foresight Centre) and policy enforcers (Estonian Research Council, Estonian Business and Innovation Agency).

The work comprised three main phases. First, based on an extensive survey, interviews, and a document analysis, a Diagnostic Report was prepared describing the current situation of evidence-informed policymaking in Estonia (as of July 2023).

The content of the first report was discussed with partners in thematic focus groups to formulate an ideal situation to ensure better policymaking. This process also involved identifying gaps, barriers and opportunities for system improvements. At the end of this phase, a second overview document, the Needs and Gaps Assessment Report, was produced.

In the third phase, policy recommendations were developed based on the previous reports. As in earlier phases, this work focused on co-creating knowledge, with the project team testing its expert-formulated proposals against partners' perspectives. A key source of feedback was a joint discussion forum with representatives from all stakeholders held in June 2024. The policy recommendations were finalised in the autumn 2024 report, which also took into account the written comments on the recommendations and interviews conducted.

The final outcome of the project is thus the result of the collective efforts of approximately one hundred people, with the project team serving as discussion moderators, proposal formulators and, where views diverged, consensus builders. The project team extends its gratitude to the Estonian Research Council for their assistance in organising the events in Estonia and addressing any issues that arose.

WHAT DID THE ANALYSIS OF THE CURRENT SITUATION REVEAL?

The analysis of evidence-informed policymaking in Estonia showed that while there are some good examples, there is still significant room for improvement.

It is positive that the public sector recognises the need for evidence-informed policymaking; however, this understanding is shared very unevenly. The scientific adviser posts established in the ministries have proven valuable and instrumental in changing attitudes towards scientific advice. The government is also supportive of innovative policymaking methods. Over the past five years, funding for research has also been a cross-party political priority, which has made it possible to strengthen sectoral research and development for ministries, including the commissioning of essential surveys and analyses for policymaking.

A negative aspect is that Estonia lacks a central coordination and governance mechanism for evidence-informed policymaking. It is not clear who the leader is and who takes responsibility. Unfortunately, the willingness and ability to heed scientific advice is weak among politicians and top-level civil servants. Although scientific advisers have proven their worth in ministries, their knowledge and skills are used unevenly, and their roles and duties need to be harmonised across ministries.

The current elements of the evidence-informed policymaking system have emerged and developed somewhat organically as individual initiatives and inspired by enthusiastic leaders. We hope this project will contribute to creating a more comprehensive system.

WHAT ARE THE KEY POLICY RECOMMENDATIONS?[104]

The policy recommendations are organised into four main areas.

- **Strengthen whole-of-government evidence-informed policymaking for cross-government coordination.** It is recommended to assign a clear leadership role to a central coordinating body, develop methods for identifying cross-ministerial research needs, prepare in good time a cross-cutting research programme for the period after the end of RITA+, create an easy-to-use central database of research and analysis results, and systematise discussions on evidence-informed policymaking, bringing them closer to the government.

[104] The limited scope of this article also prevents a comprehensive discussion of the project's results. Therefore, only general information about the project is provided in this article. However, by the time of publishing this collection, the final report had been confirmed and available at the webpage of Estonian Research Council: https://etag.ee/wp-content/uploads/2024/12/2024.11.30-TSI-EE-Final-report.pdf (02.01.2025).

- **Harmonising the role and elevating the status of scientific advisers.** The creation of the scientific adviser post has been one of Estonia's success stories. Recommendations for further development include increasing the status of advisers within ministries, better integrating them into the strategic decision-making processes of ministries, fostering stronger links with the scientific community, and enhancing networking within the system of advisers.

- **Increase the capacity of line ministries to absorb evidence-informed advice.** This area includes the most recommendations (8), ranging from increasing and recognising the qualifications of ministry staff to strengthening policymaking and strategic planning capacities, as well as enhancing connections between policymakers and the research community. It also involves practical recommendations related to commissioning research and analysis, improving data literacy and enhancing development monitoring capacity.

- **Increase the capacity and incentives of the scientific community to provide policy-relevant research .** The recommendations focus on three main themes: how research institutions can promote closer interaction with policymakers, how to recognise both research institutions and researchers for providing policy advice, and how to enhance the knowledge and skills of researchers and university heads in offering policy advice.

The final report of the project offers 20 recommendations on the necessary actions in each area to drive change, specifying which institutions should take the lead and who should be involved. It also outlines a logical sequence of activities, along with estimates of the time and resources required. The recommendations consider the likely limited financial capacity of the public sector, both now and in the near future.

GENERAL OBSERVATIONS

Firstly, the project revealed a clear understanding among the key actors in the Estonian policymaking 'ecosystem' (policymakers, knowledge brokers, researchers and research institution leadership) of the importance of incorporating more evidence in policymaking. This understanding is widespread among mid-level officials, but unfortunately, it is not as widely embraced by senior officials and politicians. Moving forward, developing a shared understanding and establishing common priorities among all actors in the evidence-informed policymaking system is essential.

Secondly, since the evidence-informed policymaking system involves many actors and is inherently complex, it requires a clear agreement on leadership and accountability to function effectively. Given the structure of the Estonian public sector, centralising leadership in the Government Office would be the most effective approach. While alternative solutions are possible, they have been found to have more drawbacks.

Thirdly, the implementation of this project coincided with a particularly challenging period where, in addition to (and partly due to) global crises, the Estonian government was compelled to enforce strict austerity measures and implement cuts in the public sector. In the project's final phase, many participants experienced a shift in mood. Several civil servants voiced concerns about the feasibility of the project's proposals because 'there is less money than before'. However, the crisis situation and the need to streamline governance actually make the recommendations developed during the project even more valuable. One of the outcomes of evidence-informed policymaking is promoting economic savings through more informed strategic decisions.

It is crucial that the initiators of this project (Government Office, Ministry of Education and Research, Estonian Research Council) keep the policy recommendations, resulting from the joint efforts of many people, at the forefront of the government's attention, both now and in the future, and work together to implement them. Repeating such a large-scale task in the coming years, or even in the next decade, is not feasible

RESEARCH AND DEVELOPMENT EVALUATION IN ESTONIA

MARKO PIIRSOO **Head of Department of Strategic Analysis, Estonian Research Council**

Along with the issue of research funding, the evaluation of research and development (R&D) is one of the most debated processes in the Estonian research system – and likely in those of other countries as well. The reason is clear: the burden on researchers and research institutions during the evaluation process is high, yet the tangible benefits are minimal. There is also no clear and globally agreed-upon methodology for such a process. Additionally, the criteria for the quality of research can vary significantly among researchers and other parties in the system. Given this, it is rather fortunate that in Estonia a regular evaluation of the entire research system is conducted only once every seven years. The most recent evaluation took place in 2024.

Ideally, R&D evaluation should be viewed as an objective and systematic process that evaluates, ex post, the quality of activities on an absolute or relative scale, as well as their societal impact. As a result, the contracting authority of the evaluation, ie the state, should get an answer to the following question: 'Were the efforts made to support Estonian R&D worthwhile?' Meanwhile, those subject to evaluation should receive constructive feedback on how to advance in the field of R&D.

In Estonia, the primary goal of R&D evaluation is to serve the interests of the contracting authority, ie the state, and the process yields three direct outcomes. Firstly, a positive decision in the regular evaluation ensures that the evaluated institution has access to baseline R&D funding, where the allocation is determined by the volume of R&D rather than its quality. Secondly, a positive decision grants the institution access to key R&D funding instruments, particularly research grants. Research grants are competitive funding instruments where the quality of the proposed R&D is rigorously evaluated before funds are awarded. Thirdly, a positive evaluation decision allows the institution to offer doctoral studies. This outcome is particularly relevant for universities and it partially also overlaps with the institutional accreditation process, which is also necessary for running doctoral programmes. Therefore, it could be said that there is no immediate need to assess the quality of R&D in Estonia through a comprehensive research evaluation, as the substantive and most valuable outcome of the evaluation – the descriptive feedback received from evaluators – is not reflected in the three direct outcomes of the process.

In Estonia, regular R&D evaluations are carried out in six research fields by research institutions, using the peer review method. The evaluated research fields include natural sciences, engineering and technology, medical and health sciences, agricultural and veterinary sciences, social sciences, and humanities and the arts. Institutions, including private companies, that fulfil the legal criteria for an R&D institution can apply for evaluation. In essence, the law defines an R&D institution as an institution whose statutes specify that one of its principal activities is basic research, applied research or experimental development. While the law includes several other restrictive criteria, to the best of this author's knowledge, these are not actively checked. A total of 25 institutions, operating in 41 areas, participated in the 2024 regular evaluation. The last regular evaluation was conducted by experts from nine countries.

One of the key outcomes of the 2024 regular evaluation is that experts generally regarded the level of Estonian research as very high in an international context, which serves as a significant recognition of the joint efforts of our country and the research community. Additionally, two features of the Estonian research system were highlighted, which most experts considered successful innovations to the traditional European research system. Firstly, it was found that considering private companies as part of the national research system is a very positive, albeit bold, step and that it could lead to more effective knowledge transfer from academic institutions to the for-profit sector. Another positive aspect highlighted was the treatment of doctoral students as researchers (junior research fellows). This is significant because it not only provides doctoral students with greater social guarantees but also helps make the research system more cohesive and will hopefully have a positive impact on the next generation of researchers.

In the course of the work, several bottlenecks were also identified. In particular, they concerned the design of evaluation in Estonia, which could be addressed in the future planning of such activities.

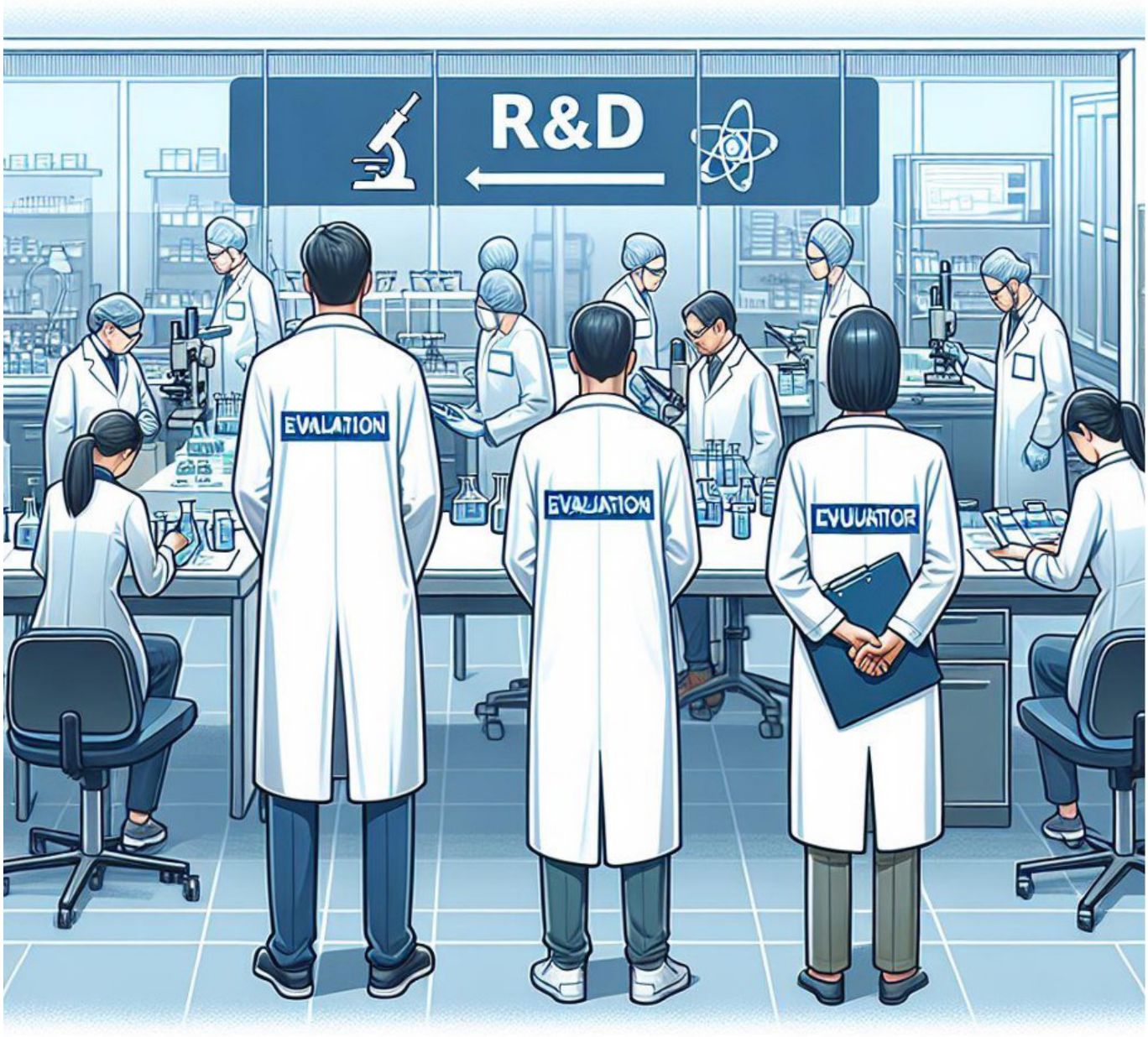
Firstly, it was noted that it is currently very difficult to categorise R&D and researchers strictly into specific research fields. This approach has led to situations where some researchers appear in multiple research fields simultaneously. There is nothing unusual about this if the researcher identifies as a multidisciplinary researcher. What is strange, however, is when an external entity, whether it is the institution being evaluated or an automated database, assumes it knows better than the researcher in which field the researcher belongs. Therefore, in the future, when designing the evaluation, it would be worthwhile to discuss how to categorise modern, predominantly multidisciplinary research.

Another important bottleneck identified was the use of the same criteria to evaluate different types of institutions and research fields. Universities, public research institutions, private companies and one professional higher education institution all participated in the 2024 evaluation. It is clear that the objectives and the rationale for setting up these institutions are very different. Unfortunately, this was not taken into account in this evaluation, which made it much more

difficult for the evaluators to provide to the different types of institutions meaningful feedback that could reasonably be taken into consideration.

A similar problem also exists with the research fields that are evaluated. One of the core principles of peer review evaluation is that R&D outputs serve as the most important evidence for evaluation. However, different types of outputs are important in different fields of research and their importance can vary across fields. In natural sciences, for example, one of the most important outputs is a peer-reviewed research article, while in the humanities, it may be a book published as a monograph instead. Additionally, when a researcher focuses on issues specific to Estonia, a book published in Estonian may carry more weight than one published in another language. In private companies, however, intellectual property is a key output and companies often avoid publishing articles to protect their potential intellectual property. Therefore, in the future, field-specific criteria could be introduced for different fields of research when planning evaluation.

The trends emerging from the development of artificial intelligence (AI) are likely to present a unique challenge for future R&D evaluations. Although the role that AI will play in the research system is still unclear, several countries have already started to experiment with the use of AI in R&D evaluation from different perspectives. It is highly likely that the next R&D evaluation in Estonia will be conducted entirely by AI. Nevertheless, for the time being, AI's understanding of R&D evaluation is primitive: for example, while reading this article, Microsoft Copilot was able to generate the following image about it.



Research evaluation from the perspective of artificial intelligence. • The illustration was created using artificial intelligence.

In conclusion, the evaluation of the research system through R&D evaluation is undoubtedly a necessary process for the state to gain an external perspective on the system's health. As such, evaluation is unlikely to disappear in the future. The key is to ensure that evaluation does not become an oppressive policymaking tool that tries to shape research according to the politics of the day, ignoring the potential long-term beneficial impacts of research results on society.

EXPECTATIONS FOR EUROPEAN UNION'S 10TH FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

MAARJA ADOJAAN **Head of Department of International Research Cooperation, Estonian Research Council**

The European Union's Framework Programmes for Research and Innovation play a central role for Estonia in international research co-operation. The current Framework Programme, the ninth in the series, called Horizon Europe, is the world's largest international research programme by budget, participating countries and number of research projects. The Framework Programme has a major impact as it funds all fields of research through a wide range of activities, such as support for top-level research projects, transnational research co-operation, training and conferences, researcher and student mobility, collaboration between businesses and research institutions, science communication, and research infrastructure development. Estonia joined the European Union's Framework Programmes even before its accession to the Union. Since its inception, the Estonian Research Council has been the central institution responsible for disseminating information about the Framework Programmes in Estonia.

The activities of the Framework Programmes are organised in seven-year cycles, with Horizon Europe set to run until 2027. Although the next programme, the 10th EU Framework Programme, is still several years away, countries are already actively preparing by collecting the wishes and preferences of researchers and businesses and formulating their positions. The formulation and publication of national positions serves multiple purposes. As the Framework Programme is prepared in co-operation between European institutions and the representatives of all Member States, research diplomats and other national representatives involved in research policy need clear guidance for negotiating different issues. In addition, making national positions public helps draw broader attention to issues important to the country, providing an opportunity to proactively share ideas and proposals and to seek potential allies. Importantly, preparing national positions forces us to analyse and agree on our national priorities for research, development and innovation, and to identify the problem areas in the functioning of the programme In Estonia, these discussions have been held over the past year, more broadly since the traditional conference of the Estonian Research Council (ETAG), TeadusEST, in December 2023, which this time focused on international co-operation[105].

Compared to other countries, Estonian applicants have performed very well in the competitive landscape of the Framework Programme: in terms of the amount of funding received under the current Horizon Europe programme, Estonia ranks third based on GDP and seventh based on population. As of December 2024, a total of 477 projects with Estonian participation have received positive financing decisions totalling €214.2 million, which accounts for 0.53% of the total EU contribution. What sets Estonia apart from the older EU Member States that joined before 2004 is the type of calls for proposals in which we have achieved success. In Estonia's case, as much as a quarter of the funding comes from Widening Participation actions, which account for only 3% of the Framework Programme budget. By contrast, the actions of the European Research Council (ERC) and the Marie Skłodowska-Curie Actions, which account for about a quarter of the Framework Programme budget, provide only 10% of Estonia's funding. One of Estonia's objectives is to strengthen its capacity to compete among the beneficiaries of actions supporting excellence, making our success in the Framework Programmes more sustainable and less reliant on Widening Participation actions.

The same concerns apply, to varying degrees, to all the new Member States that have joined the EU since 2004. One of the central issues for the next Framework Programme will be the future of Widening Participation actions – specifically, how to bridge the gap between the success rates of older and newer Member States while adhering to the principle of making funding decisions based on the scientific merit of proposals.

Estonia is in a challenging position. On one hand, the Widening Participation actions (Twinning, ERA Chairs, Teaming) have been beneficial, allowing Estonia to attract a number of important projects and significant funding, which undoubtedly help to enhance our capacity. On the other hand, Estonia ranks among the top countries in terms of success in Widening Participation in the Framework Programme and, for the sake of development, it would be time to advance to the next stage.

Discussions on the future of the Framework Programme in Estonia have concluded that Widening Participation actions should continue but must be designed to enhance

[105] Estonian Research Council. TeadusEST 2023. Online: https://etag.ee/tegevused/uritused/teadusest/teadusest-2023/ (11.10.2024).

the competitiveness of Widening Participation countries in other areas of the Framework Programme, including actions in support of excellence.

Supporting world-class excellence is one of the greatest strengths of the Framework Programme – the grants of the European Research Council (ERC) are prestigious and highly sought after by researchers. The Estonian Research Council and Estonian universities have made significant contributions to help Estonian researchers apply for ERC grants, resulting in an increasingly larger number of these grants being awarded to Estonia (ten under Horizon Europe). It is essential that ERC grants remain attractive in the next Framework Programme as well. This will require an increase in the volume of grants, but not by reducing the number of projects and success rates. This is one specific area where the possibilities offered by the Widening Participation actions or the transfer-of-funds could be considered to finance the activities of the Framework Programme.

In addition to the future of the Widening Participation actions, there are other issues that could lead to heated negotiations. Over the years, the budgets of the Framework Programmes have increased, along with the range of activities. The current Framework Programme has been supplemented by EU Missions with ambitious goals and the European Innovation Council. While there are few criticisms of the Innovation Council, there is considerable dissatisfaction with the missions: their launch has been slow, their impact is deemed insufficient, the management is multi-level and complex, and their activities are sometimes far removed from science. It is also the opinion of Estonia that, before proceeding with the missions, their impact as well as their suitability for inclusion in the Framework Programme should be assessed. Several countries have proposed excluding missions from the next Framework Programme.

Another instrument that, alongside the missions, has generated dissatisfaction, though for entirely different reasons, is European Partnerships. As in the case of missions, active contributions from Member States are expected in partnerships. For missions, national support primarily involves developing appropriate regulations and relevant policies, while partnerships require collective efforts to address common global challenges, with countries and other stakeholders also expected to provide financial support. However, there are many different types of partnerships and even those of the same type work slightly differently. All of this leads to the overlap of topics, heavy administrative burdens and complex national decision-making processes, placing particular pressure on smaller countries with fewer (human) resources. Ultimately, this leads to a situation where applicants from certain countries cannot compete on specific research topics because their country is unable to contribute to the associated partnership. The number of partnerships should be kept within reasonable limits to avoid overwhelming countries, administrative burden should be reduced and processes simplified – the latter applies to the entire programme, not just the partnerships. Partnerships should be used more than in the past to foster co-operation with third countries, as the format is appropriate and has proven effective for this purpose.

There is an increasing emphasis on the application of research results in funding decisions. The intensification of this trend can also be seen in the current Framework Programme. However, it is crucial to maintain a balance in funding for both basic and applied research and innovation projects, ensuring adequate support for research also at the lower technology readiness levels (TRLs 1 to 4). At the same time, it is essential to strengthen the link between basic research, applied research and experimental development in relevant areas to foster co-operation between R&D institutions and businesses, and accelerate the market uptake of research.

The COVID-19 pandemic and the war in Ukraine have highlighted issues that will undoubtedly shape the nature of the future Framework Programme: it is clear that thematic objectives must align with new challenges, including the changed geopolitical circumstances and the rapidly evolving global issues. Nevertheless, addressing unforeseen challenges should not come at the expense of other important activities.

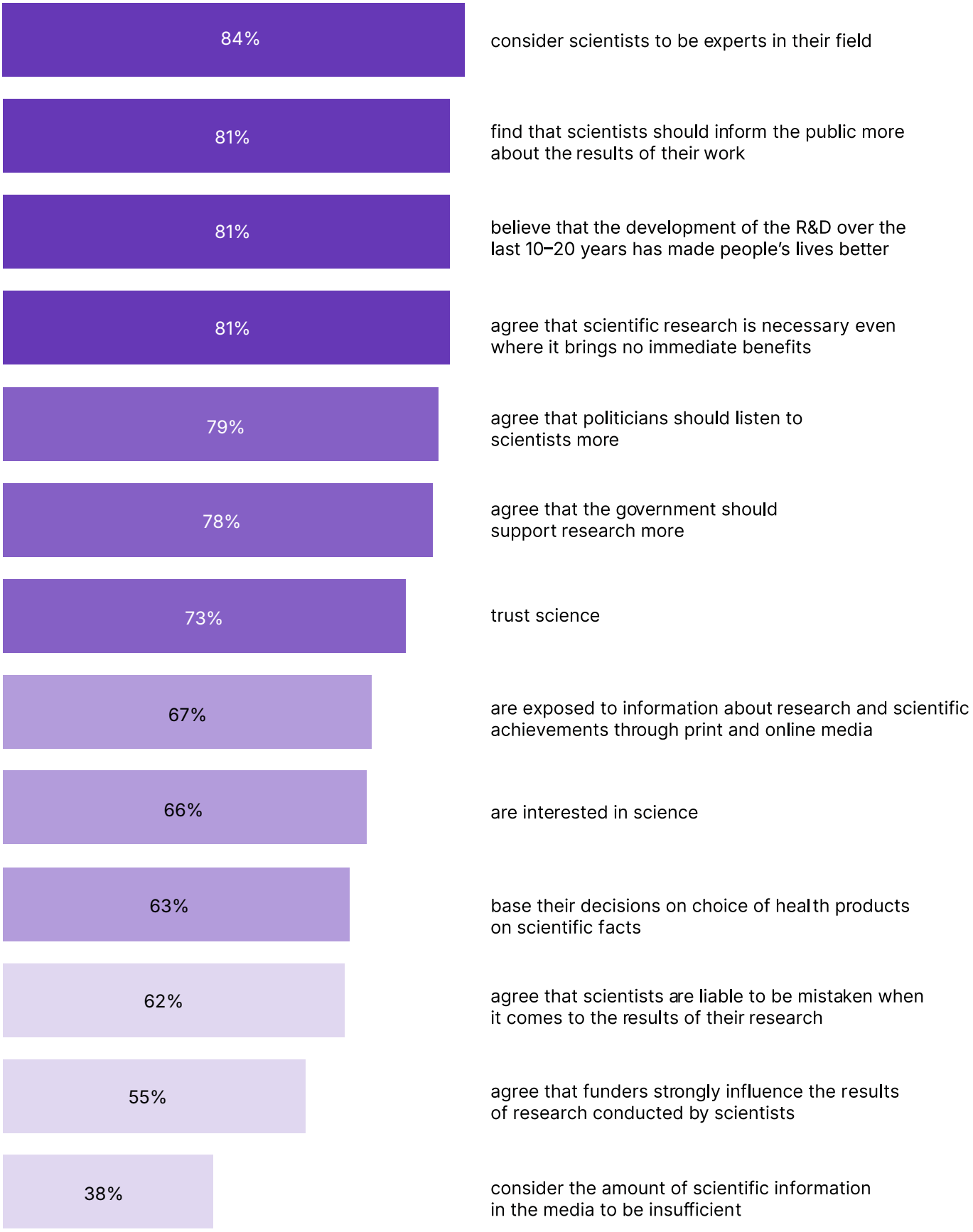
In conclusion, researchers play the most significant role in achieving the objectives of the research programme. If there are not enough young people choosing the path of a researcher or innovator, the structure and implementation of the programme will make little difference. It is, therefore, vital to ensure the next generation of researchers, which is just as relevant in Estonia as it is in the European Union as a whole. The involvement of young researchers, doctoral students and postdoctoral fellows should be mainstreamed across different activities in the next Framework Programme.

At the beginning of the Horizon Europe programme, we established the objectives we aimed to achieve and these objectives have guided us in developing the support measures of the Estonian Research Council. It is also important to set clear targets at the outset of the 10th Framework Programme and to monitor their progress, as this will help maintain focus and allow for timely responses.



Barometer from the University of Tartu Museum. • Marko Piirsoo

SCIENCE BAROMETER



*** Figures express the proportion of respondents who "completely agree" or "somewhat agree".**

Source: Estonian Science Barometer 2023 (report).

[106] Kree, H. (2024). Eesti Teadusbaromeetri 2023. aasta uuringu raport. Eesti Teadusagentuur, Tartu. https://etag.ee/wp-content/uploads/2024/03/Eesti-Teadusbaromeeter_raport.pdf (05.12.2024).

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