Estonian Research Council

Co-funded by the European Union

Investing in your future

ESTONIAN RESEARCH LANDSCAPE ACROSS DIFFERENT FIELDS OF RESEARCH

Estonian Research Council
Department of Strategic Analysis

AUTHORS

Kadri Raudvere
Maarja Sillaste

TARTU 2024

The present analysis has been prepared to support the experts conducting the regular evaluation of Estonian research institutions in 2024, providing them with context on the Estonian research system.

When using this document, please refer to the Estonian Research Council.

DOI:

Table of Contents

Introduction

This overview of Estonian research is intended to support R&D evaluation experts with a broader context of the Estonian research landscape while conducting the scheduled regular R&D evaluation in 2024. Deeper understanding enables experts to provide more accurate assessments and adaptable recommendations.

The overview discusses the main characteristics of Estonian research on the basis of facts and figures and where possible, provides background information. The first part of the overview explains the functioning of the Estonian research system. The second part discusses financial resources available for Estonian researchers (mostly) during the current regular evaluation period (2018-2023). The third part focuses on the composition of human resources in research and the fourth part looks into the sustainability of Estonian research and higher education, i.e. doctoral studies. The fifth chapter provides an overview of the results of Estonian science primarily through bibliometric indicators.

Methodology

The overview uses the most recent data available at the time of its compilation and mostly relies on data reported by the Estonian Research Council (including the Estonian Research Information System – ETIS), the Estonian Ministry of Education and Research, Statistics Estonia, External Common Research Data Warehouse (eCORDA), OECD, Eurostat and inCites.

The terminology and presentation of statistics are generally based on the methodology set forth in the Frascati Manual.[1] The same methodology is also used by national statistical offices including Statistics Estonia and Eurostat. As regular evaluation is also conducted across the six Frascati research fields, the majority of the domain-specific data in this overview is presented according to this classifier.

For the purpose of this overview, when presenting statistics on economic sectors, the following aggregation has been done:

Public sector – the higher education sector and government sector.

Private sector – 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 enterprise 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 services and which are not part of 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.

[1] OECD. Frascati Manual 2015. http://oe.cd/frascati (27.02.2024).

Research and development (R&D) – creative and systematic work undertaken to increase the stock of knowledge – including knowledge of humankind, culture, and society – and to devise new applications of available knowledge. Research and development cover three types of activity: basic research, applied research and experimental development.[2]

When providing international context in the following analysis, Estonia is often compared to European Union countries, using abbreviations such as:

EU27 are all European Union member states.

EU14 are countries who were members of the EU prior to 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Republic of Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and Sweden.

EU13 are countries that have joined since 2004: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

1. Overview of the Estonian Research System

The legal basis for the organisation of Estonian research relies on the Organisation of Research and Development Act.[3] The general objectives for Estonian research, development, innovation, and entrepreneurship for the period 2021-2035 are stated in the Estonian Research and Development, Innovation and Entrepreneurship Strategy 2021-2035.[4] Once a year, the Prime Minister provides the Parliament with an overview of the execution of the strategy.

The following scheme (Scheme 1) illustrates the various components of the Estonian research system and their relationships. The different parts of the system serve the following functions:

The **Government of the Republic**, together with the **Parliament** (*Riigikogu*), shapes the policies. The Parliament has eleven standing committees and three select investigation and study committees of special issues[5]. However, there is no standing or special committee that would focuse solely on research and development matters. All the committees may commission research and often invite researchers to their meetings. The Government Office employs an **innovation team and science adviser**. The Parliament hosts the **Foresight Centre** which analyses and outlines future scenarios and presents them to the wider public[6].

The Research and Development Council (TAN) comprising of the Prime Minister, four other ministers and ten members appointed by the Government (mostly researchers) advises the Government on matters concerning research, development, and innovation strategy.[7]

The Ministry of Education and Research (HTM) is responsible for research and education policy and the distribution of public funds to higher education institutions and other public research institutions. **The Estonian Research Council** (ETAG) within the area of responsibility of the Estonian Ministry of Education and Research (HTM) is the principal state foundation implementing research policy. It

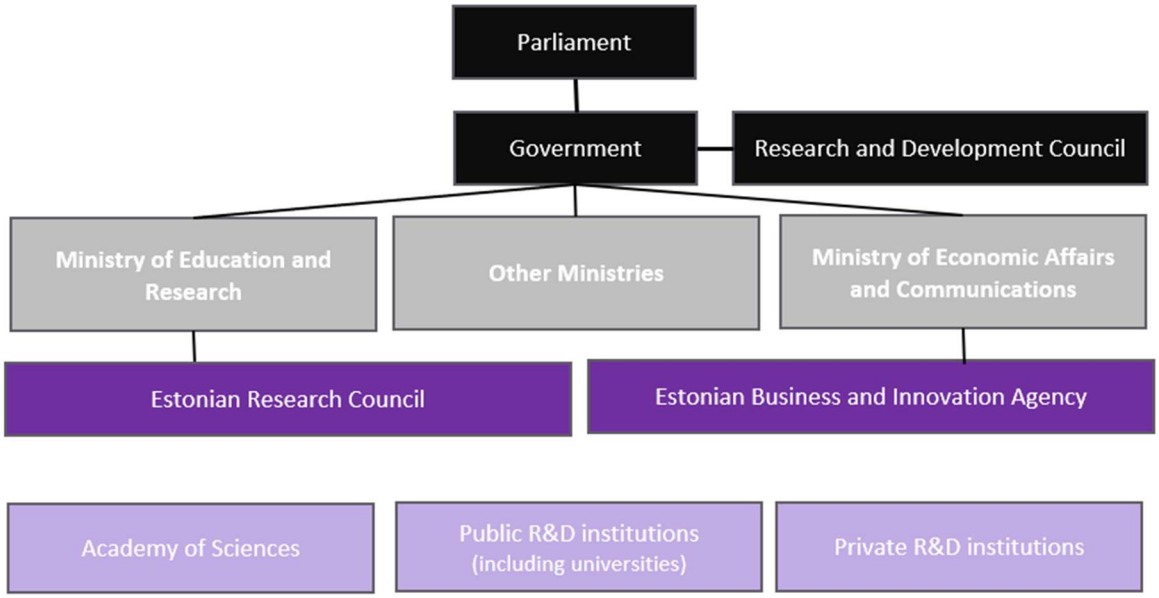
[2] Research and development. Statistical presentation. 3.4. Statistical concepts and definitions. Statistics Estonia. https://www.stat.ee/en/find-statistics/methodology-and-quality/esms-metadata/21701#4-Unit-of-measure-3 (27.02.2024).
[3] Organisation of Research and Development Act. Passed by Riigikogu on 26 March 1997. – Riigi Teataja I 1997, 30, 471. Translation published 03.06.2019. https://www.riigiteataja.ee/en/eli/524032014005/consolide/current (27.02.2024).
[4] Estonian Research and Development, Innovation and Entrepreneurship Development Plan 2021–2035. Estonian Ministry of Education and Research. https://www.hm.ee/en/ministry/ministry/strategic-planning-2021-2035#documents--2
[5] Committees. Parliament of Estonia. https://www.riigikogu.ee/en/parliament-of-estonia/committees/ (27.02.2024).
[6] Foresight Centre. https://arenguseire.ee/en/about/ (27.02.2024).
[7] Research and Development Council. Government of the Republic. https://www.valitsus.ee/valitsuse-eesmargid-ja-tegevused/teadus-ja-arendusnoukogu-tan (27.02.2024).

organises national calls for (competition-based) research funding, supports international research cooperation, promotes science communication, organises regular and targeted research evaluations and supports shaping the national research policies.

The Ministry of Economic Affairs and Communication (MKM) is a central player in business and innovation-related R&D. Within the area of responsibility of MKM, the **Estonian Business and Innovation Agency** is the principal institution that promotes research-intensive solutions and organises innovation funding in business enterprises.

Other ministries prepare and implement sectoral policies. In most ministries scientific advisors have been employed.

The Estonian Academy of Sciences is an independent association of top-level researchers and acts on the basis of its own law. It promotes scientific thinking, development, and representation of Estonian research on a national and international level.



Scheme 1. The research and development organisation structure in Estonia.
Source: Estonian Research Council.

At the time of compiling this overview, **there were 22 public or private research institutions in Estonia** holding positive regular evaluation status. Upon regular evaluation, i.e. external evaluation,[8] research of a specific field of the research institution is assessed, comparing it with the internationally recognised criteria. Successfully passing the regular evaluation allows to apply for national research grants and baseline funding and also enables higher education institutions to conduct doctoral studies.

Among the institutions that have successfully passed regular evaluation in at least one field are **six public universities, one private university, seven public R&D institutions and eight business enterprises.** A list of currently positively evaluated R&D institutions together with the evaluated research field is given in the following Table 1.

[8] R&D Evaluation. Estonian Research Council. https://www.etag.ee/en/activities/rd-evaluation/ (27.06.2024).

Table 1. Estonian research organisations holding positive regular evaluation in 2024.

	Research performing organisation	Field of research evaluated	Legal type
1	BioCC OÜ	Life and Environmental Sciences[9]	Business enterprise
2	Center of Food and Fermentation Technologies	Natural Sciences	Business enterprise
3	Competence Centre on Health Technologies	Health Sciences[10]	Business enterprise
4	Cybernetica AS	Natural Sciences	Business enterprise
5	Icosagen Cell Factory OÜ	Medical and Health Sciences	Business enterprise
6	Institute of the Estonian Language	Humanities and the Arts	Public R&D institution
7	Estonian Literary Museum	Humanities and the Arts	Public R&D institution
8	Estonian Academy of Arts	Humanities and the Arts	Public university
		Engineering and Technology	
9	Estonian University of Life Sciences	Natural Sciences	Public university
		Engineering and Technology	
		Agricultural and Veterinary Sciences	
10	Central Office of Metrology in Estonia Metrosert AS	Engineering and Technology	Business enterprise
11	Estonian Academy of Music and Theatre	Humanities and the Arts	Public university
12	Estonian National Museum	Humanities and the Arts	Public R&D institution
13	Centre of Estonian Rural Research and Knowledge	Agricultural and Veterinary Sciences	Public R&D institution
14	Under and Tuglas Literature Centre of the Estonian Academy of Sciences	Humanities and the Arts	Public R&D institution
15	Estonian Business School	Social Sciences	Private university
16	National Institute of Chemical Physics and Biophysics	Natural Sciences	Public R&D institution
		Engineering and Technology	
		Medical and Health Sciences	
17	Protobios OÜ	Medical and Health Sciences	Business enterprise
18	Tallinn University of Technology	Natural Sciences	Public university
		Engineering and Technology	
		Medical and Health Sciences	
		Agricultural and Veterinary Sciences	
		Social Sciences	
		Humanities and the Arts	
19	Tallinn University	Natural Sciences	Public university
		Social Sciences	
		Humanities and the Arts	
20	STACC OÜ	Natural Sciences	Business enterprise
21	University of Tartu	Natural Sciences	Public university
		Engineering and Technology	

[9] The institution was evaluated in 2015, when the evaluation was conducted based on the classification of the Estonian Research Information System fields of research. For more details, please refer to https://www.etis.ee/Portal/Classifiers/Index/25? (20.03.2024).
[10] The institution was evaluated in 2015, when the evaluation was conducted based on the classification of the Estonian Research Information System fields of research. For more details, please refer to https://www.etis.ee/Portal/Classifiers/Index/25? (20.03.2024).

		Medical and Health Sciences	
		Agricultural and Veterinary Sciences	
		Social Sciences	
		Humanities and the Arts	
22	National Institute for Health Development	Medical and Health Sciences	Public R&D institution

Source: Ministry of Education and Research.

2. Funding of research in Estonia

2.1. The components of research funding

The primary R&D funding instruments financed from the state budget are baseline funding and research grants. Structural Funds financed by the European Union also contribute a substantial share of the public R&D funding, these are considered part of the state budget in Estonia. Baseline funding means the financing of research and development for the purpose of attaining the development objectives of a research and development institution, including funding allocated for co-financing national and foreign projects, opening new fields of research, and for investing in infrastructure. The Estonian Ministry of Education and Research organises baseline funding. Research grants are aimed at funding high-level research and development projects of a researcher or a group of researchers. Calls for research grants are organised by the Estonian Research Council.

National R&D development target used worldwide is the R&D expenditure as a percentage of gross domestic product (GDP) that provides indication of the state's research intensity and level of development. As most countries, Estonia set an objective of increasing its total R&D expenditure to 3% of GDP by 2014 already in the R&D strategy "Knowledge-based Estonia "(2007-2013).[11] The goal for public sector R&D expenditure was set 1% and for private sector 2% of GDP. On 19 December **2018 significant agreement was reached while the chairpersons of Estonian political parties, representatives of Estonian research institutions, the academia and the largest business organisations signed the Estonian Research Agreement**, a social agreement to ensure fixing the public R&D spending at the minimum level of 1% to secure the further development of Estonian research.

However, the gap between the target and the actual level is still considerable (figure 2.1). The public sector funding goal (1% of GDP) has remained 0.26-0.23 percentage points below the target during 2019-2022 due to different reasons: the GDP during the COVID crisis in 2019-2020 exceeded forecasts, thereby influencing the ratio; it was followed by a subsequent economic downturn triggered by the war in Ukraine putting the state budget under extra pressure in the recent years. Similarly, the gradual decrease in the share of European Union Structural Funds, which is logical in the context of Estonia's economic development, also affects the amount of public sector R&D expenditures (we remind that in Estonia, European Structural Funds are counted within the national budget).

While the target of 1% of GDP for public sector R&D expenditure remains unachieved, Estonia is not particularly outstanding among European Union countries in this regard but even exceeds the average. As of 2022, the **average share of GDP allocated to public sector R&D expenditure among European Union countries was 0.72%, while in Estonia it was 0.77%**, including the average of old member states (joined before 2004, hereafter referred to as EU14), which stood at 0.75%. **The significant difference between Estonia and EU14 countries arises from the private sector's share of R&D expenditure as a**

[11] Knowledge-based Estonia: Estonian research and development and innovation strategy 2007–2013. https://cs.ioc.ee/excs/policy/teadm-pohine-eesti2-en.pdf (27.02.2024).

percentage of GDP: in 2022, Estonia's indicator was 1.01%, whereas the average for EU14 countries was 1.59% (EU27 being 1.51%). The average share of GDP allocated to private sector R&D expenditure among European Union's new member states (joined after 2004, hereafter referred to as EU13) was 0.83% in 2022 (see Annex 1).

Although private sector R&D expenditure in Estonia has significantly increased since 2019, it remains below the 2% target. Since 2019, private sector R&D expenditure has also exceeded those of the public sector (figure 2.1). A previous study carried out by the Estonian Research Council in 2022[12] pointed out that regardless of a larger jump in recent years, there were only 370 companies investing in R&D in 2021, of which 39 enterprises made 75% of all the R&D investments. Between 2015 and 2021, 40–50% of the businesses that had R&D expenditures were in the manufacturing sector and 16–22% of enterprises were ICT companies. Although the proportion of ICT companies out of all Estonian businesses reporting R&D expenditures in 2021 was 18%, the financial contribution of the ICT sector into business R&D was 151.4 million euros, which is approximately half of the total Estonian business sector R&D expenditure (307.7 million euros).

Therefore, the ICT sector could be considered one of the main sources of Estonian business R&D and has been the main driver of Estonian business R&D growth during the past years. Unfortunately, there is a limit to the further growth of the ICT sector at some point, as there is a shortage of ICT specialists in higher education. Simply creating more student positions is not enough to solve the problems related to IT education, as the main issue lies in the lack of qualified (Estonian-speaking) faculty members.[13] There are also various other socio-economic and political factors why research and development in Estonian companies is not progressing at the desired pace, and the path to reaching the target for R&D expenditures is still long.

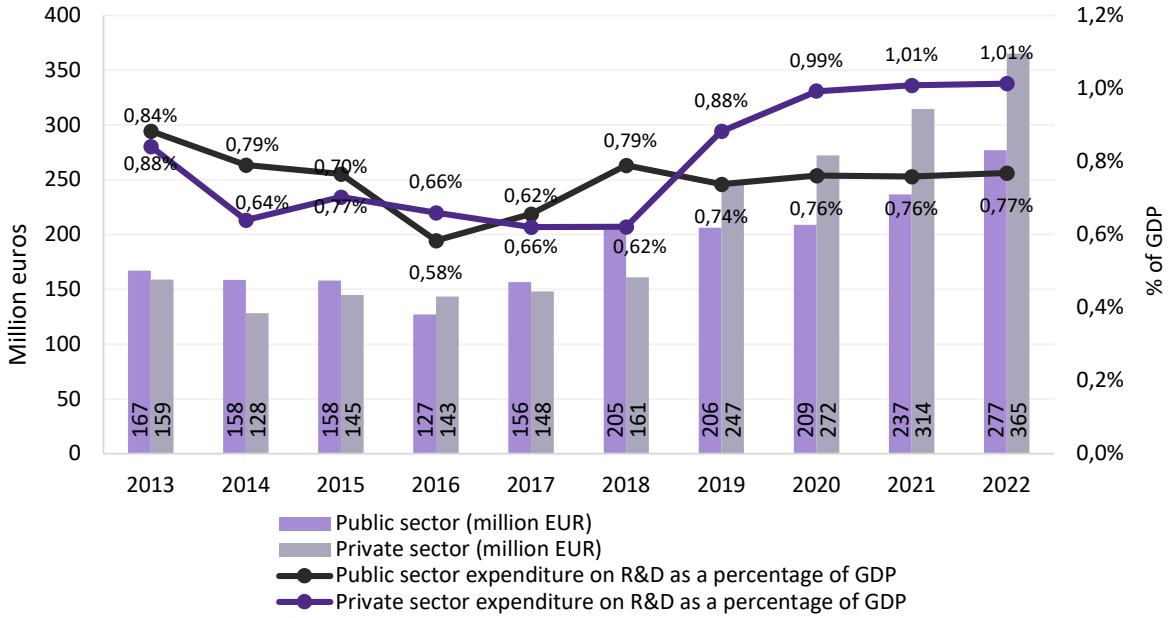


Figure 2.1. Gross domestic expenditure on R&D in Estonia (million EUR and as a percentage of GDP) from 2013 to 2022.
Source: Statistics Estonia (data last updated 01.12.2022), calculations by Estonian Research Council.

[12] Raudvere, K. (2023). Overview of the Estonian ICT sector. https://etag.ee/wp-content/uploads/2022/07/Overview-of-the-Estonian-ICT-sector-_2023.pdf (28.02.2024).
[13] Varblane, U., Eamets, R., Anger-Kraavi, A., Eerma, D. (2024). Eesti majanduse arengut toetavate ettepanekute analüüs. Uuring. Tallinn: Arenguseire Keskus https://arenguseire.ee/wp-content/uploads/2024/02/2024_eesti-majanduse-arengut-toetavate-ettepanekute-analuus_uuring.pdf (01.03.2024).

Figure 2.2 explains the relations between R&D funders and expenditures made by those who conduct R&D. It is also important to examine the relations between the flows of funding between sectors. R&D funders could be divided into three: the public sector (mainly government), private sector, and foreign sources. R&D performers are public sector institutions (mainly universities and governmental research institutions) and private sector institutions (enterprises performing research and private research institutions). For Estonia, foreign sources primarily consist of funding from framework programs. The EU Structural Funds are considered public sources.

As seen in Figure 2.2, in the case of Estonia, the public sector primarily funds public sector research, and likewise, private sector R&D financing tends to stay in the private sector. Only 6.2% (20.0 million euros) of private sector R&D financing in 2022 was allocated for research by universities and research institutes and there have been no significant changes in the past decade (in 2014 the respective ratio was 6.0%[14]). Similarly, the share of public sector contribution to private sector R&D funding has changed little during the period from 2014 to 2022. In 2022, public sector R&D funding accounted for 12.3% of private sector R&D funding (30.1 million euros), while in 2014, it was 10.3%.

The share of foreign funding in R&D financing is approximately 0.2% of GDP, and it is distributed almost equally between the public and private sectors. While Estonia has been successful in framework programs (as detailed below), the proportion of foreign sources in total funding has not noticeably changed over time. In 2022, external funding accounted for 11.4% (73.0 million euros) of Estonia's R&D funding sources, compared to 12.5% in 2014[15].

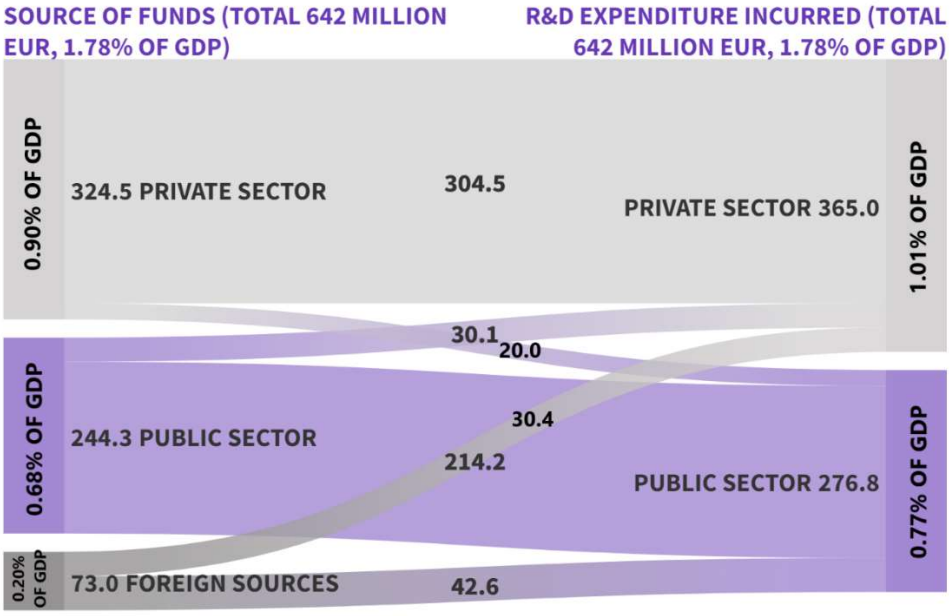


Figure 2.2. Flows of funding and incurred expenditures on R&D between sectors in Estonia in 2022 (million EUR and percentage of GDP).
Source: Statistics Estonia,[16] calculations by Estonian Research Council.

[14] Koppel. A. (2017). Research and development expenditure: an investment in the future. – Estonian Research 2016 (ed. K. Raudvere), pp. 11–18. Estonian Research Council, Tartu. https://www.etag.ee/wp-content/uploads/2015/12/TA_teaduskogumik_ENG_veeb.pdf (01.03.2024).

[15] Koppel. A. (2017). Research and development expenditure: an investment in the future. – Estonian Research 2016 (ed. K. Raudvere), pp. 11–18. Estonian Research Council, Tartu. https://www.etag.ee/wp-content/uploads/2015/12/TA_teaduskogumik_ENG_veeb.pdf (01.03.2024).

[16] Statistics Estonia, calculations by Estonian Research Council. (01.12.2023).

The abovementioned Estonian Research Agreement[17] that was signed in 2018 and aimed to increase the public funding of R&D to 1% of the GDP and maintain at least this level from 2021 onwards also laid the foundation of sectoral R&D within ministries. Additionally, at a meeting of Research and Development Council on 13 February 2019, it was decided that 20% of additional resources will be allocated to fund R&D and innovation supporting evidence-based sectoral policy measures and the implementation of sectoral objectives.[18] From the following Figure 2.3 it could be seen that around 55% of the government research budget in 2024 goes to research through the budget of Ministry of Education and Research, but also other ministries have obtained a notable (and growing) part from the state's R&D budget in order to promote sectoral R&D. Sectoral R&D mostly carries two types of purposes: firstly, it involves R&D for knowledge-based policy formulation (e.g. *ex-post* and *ex-ante* analysis for laws and regulations, political measures etc) and secondly, R&D is needed to ensure the development of area-based needs of the state (e.g. cybersecurity, e-governance, competences for green transition etc). The Ministry of Economic Affairs and Communications is also engaged in funding entrepreneurship support measures related to various focus areas development.

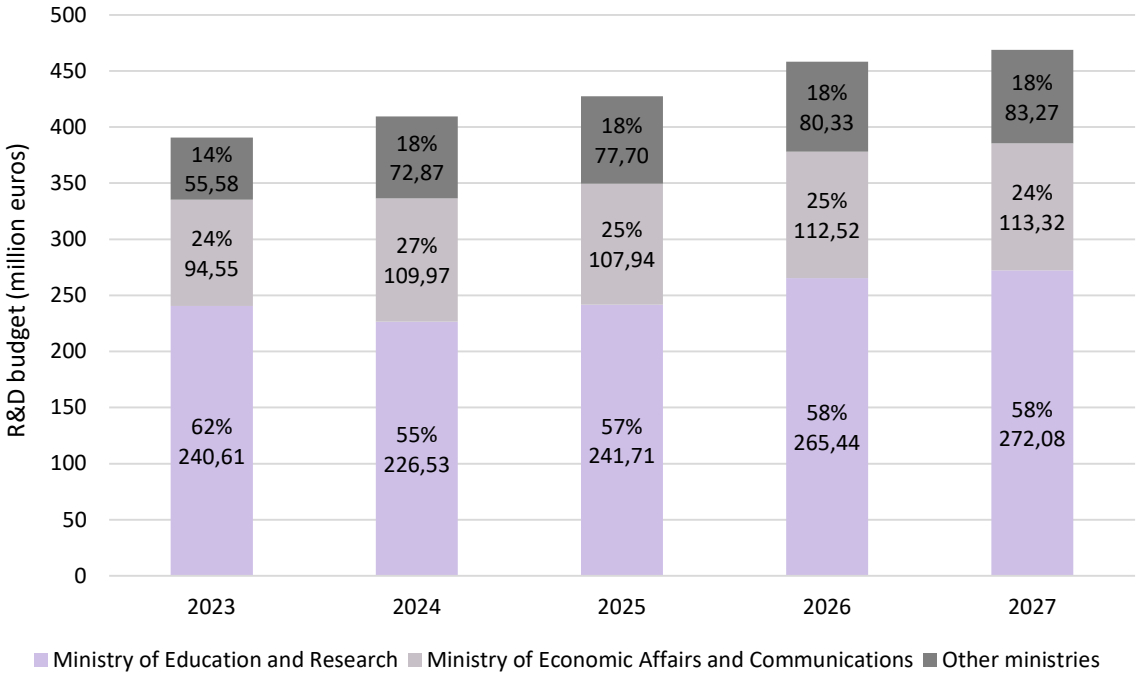


Figure 2.3. Distribution of ministries' research budgets in 2023-2027 (million euros).
Source: Ministry of Education and Research.

To better understand the development of Estonian business R&D (including the creation of new research-intensive companies and attracting foreign investment into research-based entrepreneurship), it must be noted that Estonia's significant difference from many other countries is the absence of tax incentives for corporate R&D. As of 2022, 33 of the 38 OECD countries, 22 of 27 EU member states and several other major economies offer tax relief for R&D expenditure at a central or subnational government level.[19] Besides, the direct government funding for business R&D as a percentage of GDP is amongst the lowest in OECD countries.[20] Since a more comprehensive analysis of corporate R&D would deviate from the objectives of this report, it will not be further explored here, but the absence of tax incentives certainly has an impact on the development of Estonian R&D.

[17] Estonian Research Agreement. A Social agreement to ensure the further development of Estonian research and innovation. https://www.etag.ee/wp-content/uploads/2019/05/Teaduslepe.pdf (01.03.2024).
[18] Minutes of the Research and Development Council. Government Office. https://pilv.riigikantselei.ee/index.php/s/45zBo6p2HbYfJsD#pdfviewer (01.03.2024).
[19] Mapping Business Innovation Support (MABIS). OECD. (2023). https://one.oecd.org/document/DSTI/STP/NESTI(2023)2/FINAL/en/pdf (06.03.2024).
[20] Tax incentives for R&D and innovation. OECD. https://www.oecd.org/innovation/tax-incentives-RD-innovation/ (06.03.2024).

In order to stabilize the research system and make it less reliant on competitive research grants, an important change took place in accordance with the Framework of Research Grants and Baseline Funding developed by the Estonian Research Council in 2016 that set an objective to increase the share of institutions' baseline funding and equalize the proportion of baseline funding and competition-based research grants by 2020. Baseline funding is aimed at supporting the achievement of institutional and strategic national objectives, including the aim to guarantee high-quality research in the areas of responsibility of higher education and to support research careers.[21] Figure 2.4 illustrates the increase in the volume of baseline funding and the convergence of the proportions of competitive research grants (managed by the Estonian Research Council) and baseline funding by the year 2020. In the years since last regular evaluation until 2024 (2018-2024), the amount of funding of competitive grants has risen 48% and baseline funding 120%.

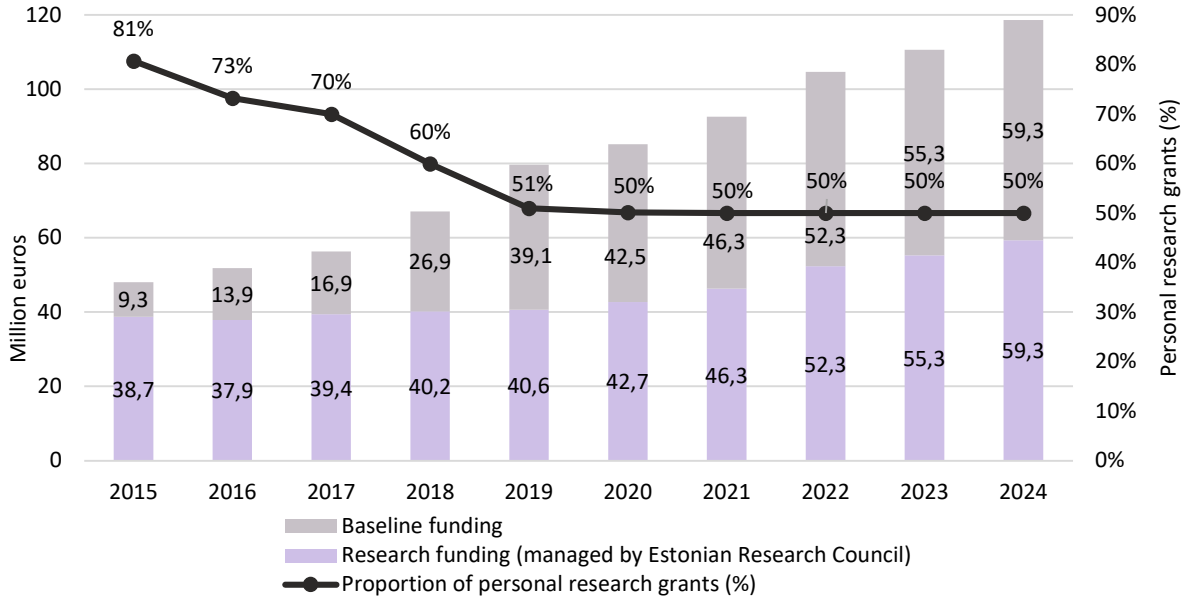


Figure 2.4. The volume of research funding managed by the Estonian Research Council (Estonian Science Foundation's grants, until 2017; institutional research funding, until 2020; personal research funding, from 2013, including postdoctoral grants, from 2014; a proof-of-concept grants, from 2019) and baseline funding from the budget of the Estonian Ministry of Education and Research in 2015-2024.
Source: Ministry of Education and Research.

In 2024, 22 positively evaluated research institutions received baseline funding (see Table 1) in total of 59.3 million euros. The largest baseline funding was allocated to the University of Tartu (25.7 million euros) and Tallinn University of Technology (12.7 million euros) that accounted for 10.3%[22] and 8.6%[23] of the respective institutions' budget revenues in 2024.

Despite the cyclical nature of the programming, the overall growth trend in obtaining funding from European Union framework programs by Estonian applicants over the years is significant (Figure 2.5). The yearly amounts of signed contracts of European framework programme projects exceeded the financial amount of competitive research grants awarded by the Estonian Research Council from 2018 (the only exception was in 2021, probably due to the delays at the beginning of a new framework

[21] A New Framework of Research Grants and Baseline Funding in the Estonian Research and Development Funding System. (2016). Estonian Research Council. https://www.etag.ee/wp-content/uploads/2018/03/New-Framework-of-Grants-and-Baseline-Funding_2016_short-version.pdf (05.03.2024).
[22] Eelarve 2024. University of Tartu. https://ut.ee/et/sisu/eelarve-2024 (05.03.2024).
[23] Eelarvestrateegia 2024-2028. Tallinn University of Technology. https://oigusaktid.taltech.ee/eelarvestrateegia/ (05.03.2024).

programme). In 2021-2023, participants from Estonia received a total of 160.5 million euros from the European Horizon (Figure 2.5) while the total amount of research grants awarded by ETAG during the same period was 153.9 million euros (Figure 2.4).

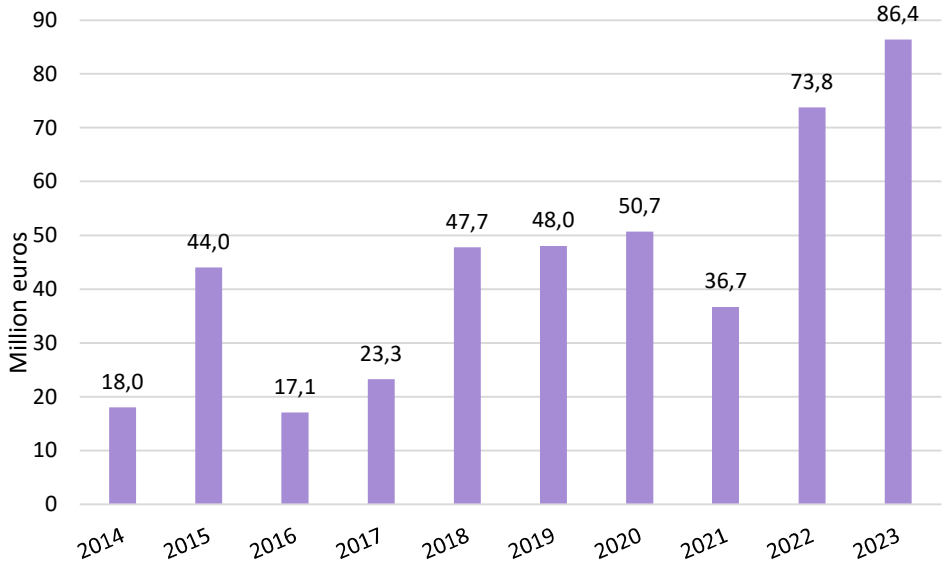


Figure 2.5. Financial contribution from the EU Framework Programmes to Estonia from 2014 to 2023 (amounts of signed contracts, million euros). In 2021, European Horizon amounted to 0.360 million euros and Horizon 2020 amounted to 36.4 million euros. The table contains amounts of signed contracts; together with all positive funding decisions (not signed yet) the financial contribution would be somewhat larger.
Source: eCORDA.[24]

During the period of European Horizon starting from 2021, Estonian participants have participated in 2188 applications out of which 472 have received a positive funding decision (success rate 21.6%) (Figure 2.6). With this, Estonia is close to the European Union average (21.8%) and ranks ninth among European Union countries. At this point, the measures for widening participation in so-called widening countries, including Estonia, must be considered. A previous study conducted by the Estonian Research Council[25] found that participating in widening measures accounted for 9.1% of all Estonian participations in the European Horizon as of 2023. The success rate of participation in widening measures was notably higher than the average − 29.0%. Funding obtained from widening measures accounted for 30.5% of all funding won in Estonia.

During the period 2014−2023, enterprises had the highest share of participation in framework programme applications (42.5% of all applications) and successful funding decisions (32.5% of all positive decisions). They were followed by higher education institutions, with their participation in applications accounting for 37.2% and successful applications receiving 36.3% of all positive decisions. During the period 2014−2023, higher education institutions attracted the most funding from framework programs, receiving approximately half (48.4%) of all funding allocated to Estonia. The share of funding for businesses has been approximately one-third (32.6%). The funding share for research institutions, public sector organizations, and other institutions combined was 19.0%. Of the

[24] External Common Research Datawarehouse (eCORDA). https://webgate.ec.europa.eu (07.02.2024).
[25] K. Raudvere. (2023). Estonian Research Council. Eesti Teadusagentuuri toetusmeetmete mõju Eesti taotlejate osalusele raamprogrammis „Horisont 2020" ja „Euroopa horisont". Kvantitatiivne ülevaade. https://etag.ee/wp-content/uploads/2022/07/Valisteaduskoostood-toetavate-meetmete-moju_kvantitatiivne-ulevaade_LOPLIK_01032024.pdf (30.04.2024).

funding allocated to higher education institutions, approximately 60% went to the University of Tartu and 25% to Tallinn University of Technology.[26]

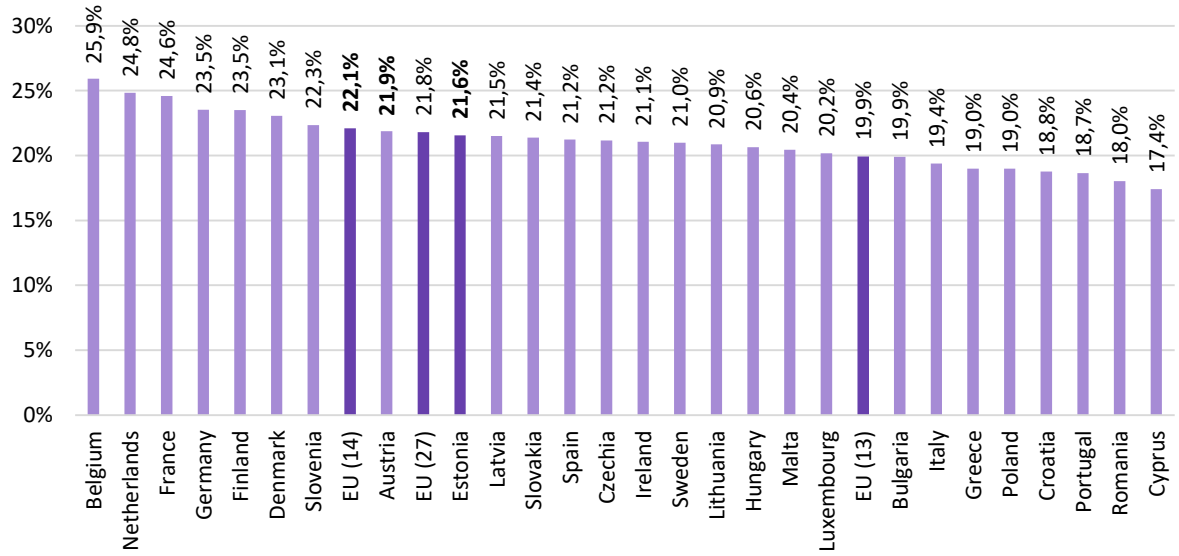


Figure 2.6. Success rates in applications by country in European Horizon (data frozen on 22 February 2024).
Source: eCORDA.[27]

Within the European Union, Estonia is holding a good position. If we compare the proportion of the EU contribution to each country to their GDP, Estonia exceeds the European Union average (EU27=100%) by almost 2.7 times and ranks third (Figure 2.7). However, it must be noted that countries with lower GDP have an advantage when using this indicator. In relation to the financial contribution per citizen, six countries are ahead of Estonia, but Estonia still continues to exceed the European Union average approximately two times.

[26] K. Raudvere. (2023). Estonian Research Council. Eesti Teadusagentuuri toetusmeetmete mõju Eesti taotlejate osalusele raamprogrammis „Horisont 2020" ja „Euroopa horisont". Kvantitatiivne ülevaade. https://etag.ee/wp-content/uploads/2022/07/Valisteaduskoostood-toetavate-meetmete-moju_kvantitatiivne-ulevaade_LOPLIK_03052024.pdf (30.04.2024).
[27] External Common Research Datawarehouse (eCORDA). https://webgate.ec.europa.eu (05.03.2024).

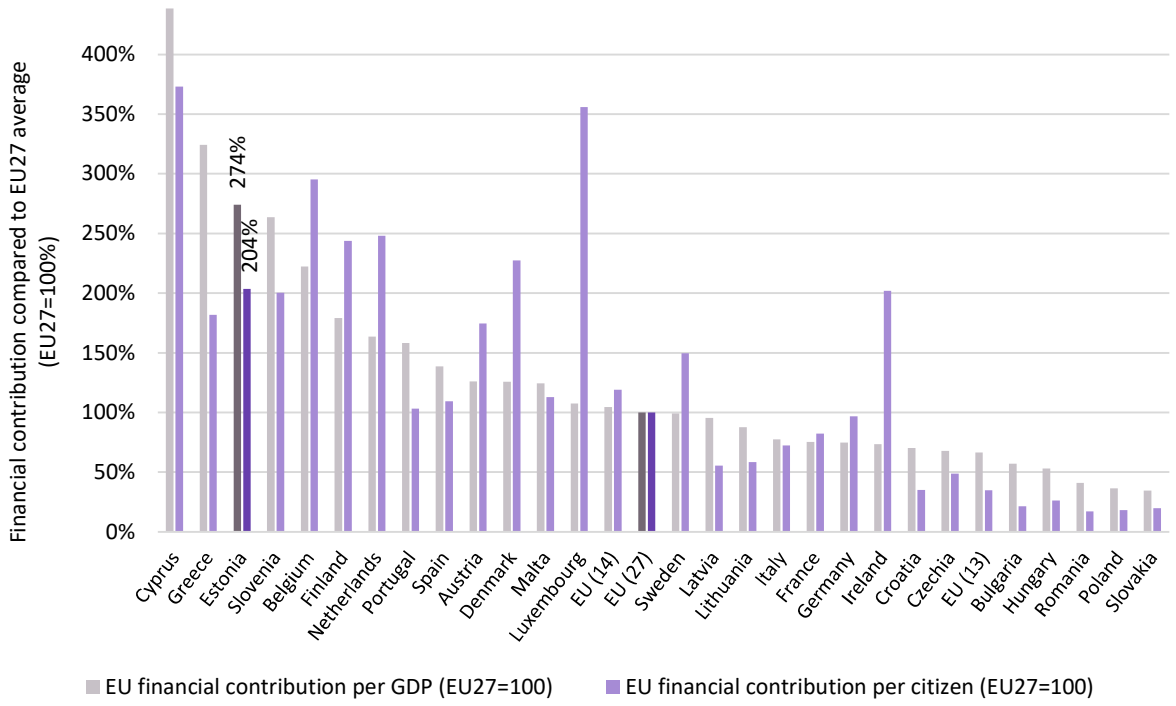


Figure 2.7. EU financial contribution from European Horizon compared to participating EU27 countries per GDP and per citizen compared to EU27 average (EU27=100) (data frozen on 22 February 2024).
Sources: Eurostat[28] and eCORDA,[29] calculations by the Estonian Research Council.

2.2. Financing of research fields

The proportions of funding between research fields (according to Frascati main classifier) have generally remained stable in recent years (Figure 2.8). Figure 2.8 describes the annual funding of all ongoing projects in 2018-2023 entered into the Estonian Research Information System (ETIS) by the institutions. ETIS compiles the most complete data on research projects in Estonia. Its advantage is that besides public sector projects it includes business sector research projects across Frascati fields, which are missing from national statistics (collected by Statistics Estonia), as business sector R&D funding is not collected across Frascati fields. However, not all business sector organisations enter their projects into ETIS. Annual project funding takes into account the research fields assigned to the project. However, project funding does not describe various non-project-based funding instruments (e.g. baseline funding) that also finance research in different fields, and its completeness depends on the institution's willingness to update its project data in the database.

As seen in Figure 2.8, **almost half of the funding of research projects ongoing in 2018-2023 has been allocated to Natural Sciences and one fifth to Engineering and Technology**. **The share of Agricultural and Veterinary Sciences is the lowest.** A closer look shows that there has been a slight increase in the proportion of Agricultural and Veterinary Sciences and Humanities and Arts, with a minor decrease in Natural Sciences.

[28] Eurostat. https://ec.europa.eu/eurostat/data/database (08.02.2024).
[29] External Common Research Datawarehouse (eCORDA). https://webgate.ec.europa.eu (05.03.2024).

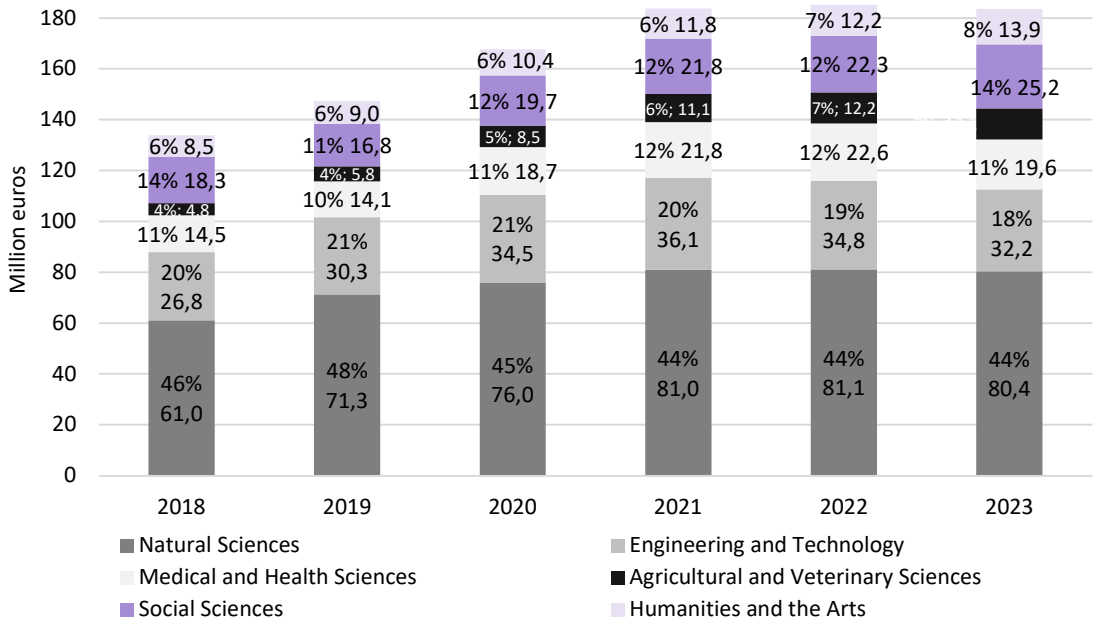


Figure 2.8. Funding of R&D projects by Frascati main fields in the years 2018−2023.
Source: Estonian Information System.[30]

Comparing national statistics (collected by Statistics Estonia) based on the allocation of R&D expenses by public sector research institutions to research fields, Natural Sciences and Engineering and Technology continue to be the two main areas, accounting for approximately 35−37% and 15−16% of R&D expenditures respectively (see Appendix 2). However, national statistics indicate a higher proportion of Medical and Health Sciences (18−19%) and a higher proportion of Humanities and the Arts (10−13%) compared to ETIS project statistics. Besides the differences in data collection methodologies, it might suggest that in these fields there are fewer projects and financing is more based on other sources. The advantage of national statistics is that it also includes expenditures not related to project-based funding (e.g. baseline funding), which is why the annual sums are significantly larger than the funding for ETIS projects. However, this does not provide comparable information about the research fields of R&D of the companies involved.

Comparing the distribution of competitive (blue-sky) research funding in Estonia (presented in Figure 2.8) to the blue-sky research funding in Finland and Norway, it can be concluded that in Finland and Norway roughly half of the research grants funded by national research councils goes to the Natural Sciences and Engineering and Technology fields (Figure 2.9). The proportions of Humanities and the Arts, along with Social Sciences, receive a combined total of approximately 20-30% of the funding. The share allocated to Agricultural and Veterinary Sciences in the countries studied is even lower than in Estonia.

[30] Estonian Research Information System (ETIS). www.etis.ee (06.02.2024).

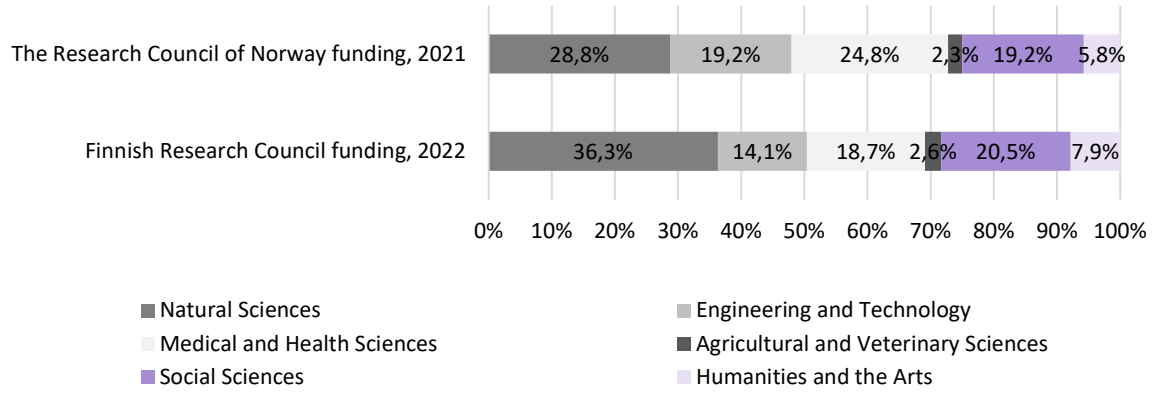


Figure 2.9. Distribution of competitive research funding across research fields: grants funded by the Research Council of Norway and Finnish Research Council according to the last data available.
Sources: Statistics Norway,[31] Statistics Finland,[32] calculations by the Estonian Research Council.

Research grants can be applied by researchers who work at positively evaluated Estonian R&D institutions. During the evaluation period 2018−2023, there have been some changes in the evaluation of research grant applications. Grants are applied for and applications evaluated based on the research fields of the Frascati Manual (previously based on ETIS classification). Applications for grants starting 2018−2022 were evaluated first by foreign reviewers (at least two reviewers for each application), then by the Expert Committees of Estonian experts, and finally ranked and decided by the Evaluation Committee of the Estonian Research Council. Since 2023, the applications are evaluated by the expert panels consisting of international experts (except for the postdoctoral applications), then processed by the Panel on Research Ethics and Data Management, and then the final ranking and the decision is made by the Evaluation Committee of the Estonian Research Council.

Since 2018 the following types of grants can be applied for: postdoctoral, starting and team grants. The funding for research grants is allocated to the Estonian Research Council from the state budget through the Ministry of Education and Research. As seen in Figure 2.4. the budget for research grants has increased 48% between 2018−2024. The fixed grant amounts (per one grant per one year) have also risen, the average postdoctoral grant being 37 000 euros in 2018, 56 000 euros in 2023 (rise 51%) and 76 000 euros in 2024 (rise 105%); the average starting grant being 63 000 euros in 2018, 94 000 euros in 2023 (rise 49%) and 97 000 euros in 2024 (rise 54%); the average team grant being 165 000 euros in 2018, 222 000 euros in 2023 (rise 35%) and 231 000 euros in 2024 (rise 40%). Funding of research grants by Frascati main fields in the years 2018−2023 can be seen in Figure 2.10.

[31] Statistics Norway. https://www.ssb.no/en/statbank (26.03.2024).
[32] Statistics Finland. https://stat.fi/ (25.03.2024).

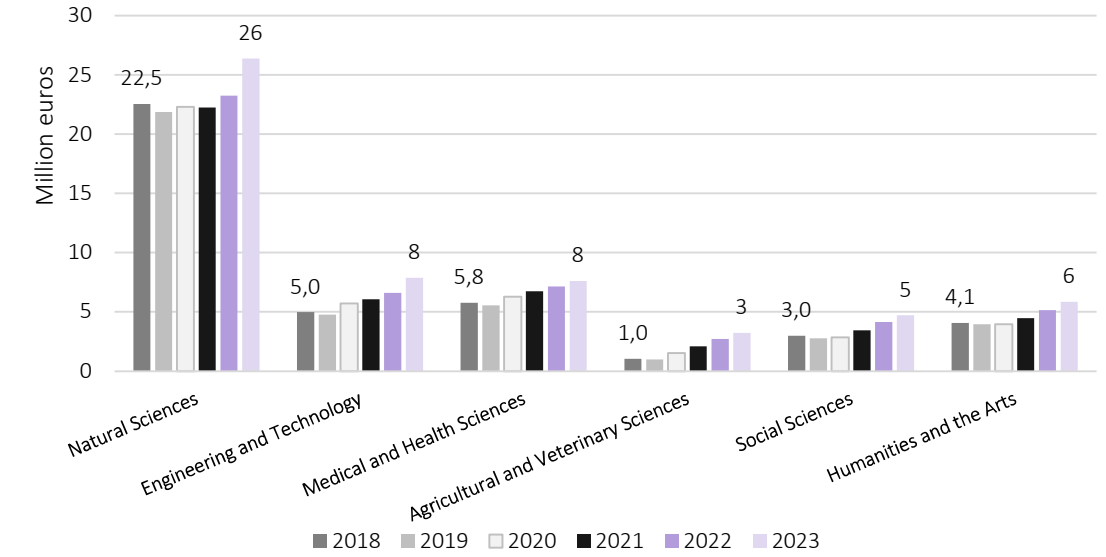


Figure 2.10. Funding of competitive research funding (based on real payout) across research fields: grants funded by the Estonian Research Council.
Source: Estonian Information System.[33]

Figure 2.11. shows the proportions of funding of Estonian Research Council`s grants across research fields.

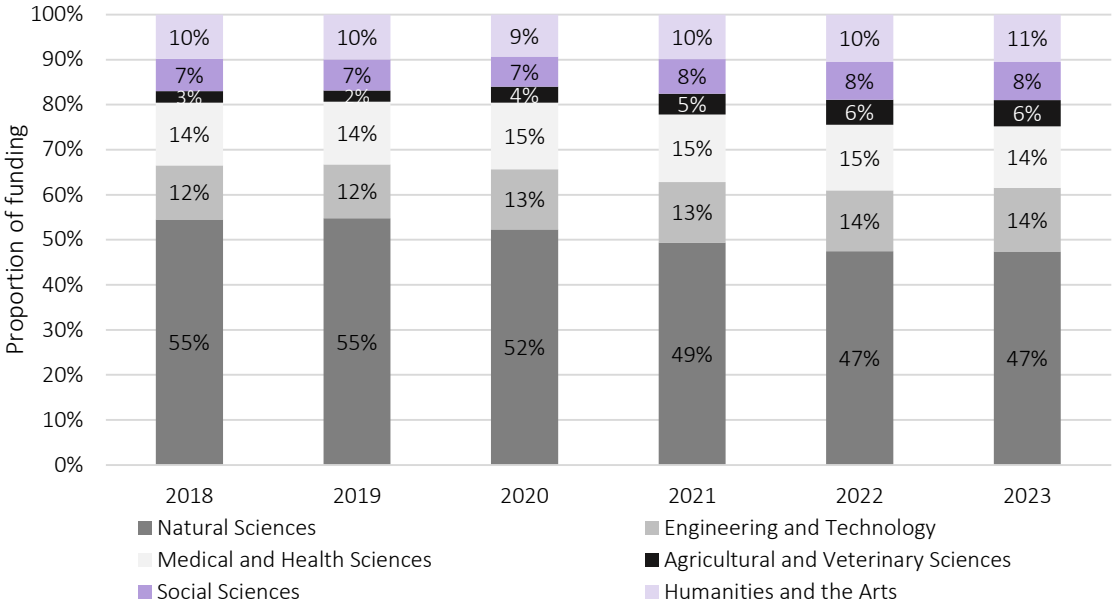


Figure 2.11. Distribution of competitive research funding (based on real payout) across research fields: grants funded by the Estonian Research Council.
Source: Estonian Information System.[34]

The proportions of funding of research grants by research fields were formed long ago and for a long time no changes had been made. In 2019, processing the applications in six fields of research showed that in smaller fields the budget was too small to finance all three types of new grants. At the same time, the diversity and good balance of research fields of national research grants were also seen somewhat threatened. So, the topic was discussed by the Research and Development Council of the

[33] Estonian Research Information System (ETIS). www.etis.ee (18.04.2024).
[34] Estonian Research Information System (ETIS). www.etis.ee (18.04.2024).

Government. In 2020, additionally to the regular budget of the grants, 2.1 million euros were appointed to Engineering and Technology (50%), Medical and Health Sciences (30%) and Agricultural and Veterinary Sciences (20%). It was also advised that the Estonian Research Council would find the means to move to a better balance. By 2023, the proportions had changed, and the Research and Development Council found in its discussion on 6 March 2024 that overall, the objective has been met, but constant analysis is needed in the future. The average success rate (proportion of the number of grants out of the number of applications) for research grants 2018-2023 is 23%, being a little higher for postdoctoral grants (32%) and a little lower for team grants (18%). See Annex 4 for numbers of applications and grants.

In the Estonian research landscape, centres of excellence also play a significant role, both in terms of financial contribution and influence. This is a competitive-based measure aimed at bringing together high-level research groups working on closely related research topics to conduct internationally high-quality research. During the period of 2015−2022, nine centres of excellence were operating (table 2) with the total budget of 41.2 million euros that was mostly financed from the EU Structural Funds. **Seven centres of excellence out of nine in the period of 2015−2022 brought together research groups from the fields of Natural Sciences and Engineering and Technology.** During the next funding period (2024−2030), ten new centres of excellence will be funded, with a total sum of 70.0 million euros.

Table 2. Centres of excellence in the period from 2015 to 2022 and the funding volumes (million euros) for the entire funding period.

Centres of excellence	Total budget (million euros)	Beneficiary	Area of research*
Ecology of global change: Natural and managed ecosystems	4.4	Estonian University of Life Sciences	Natural Sciences
The Dark Side of the Universe	4.0	National Institute of Chemical Physics and Biophysics	Natural Sciences
Emerging orders in quantum and nanomaterials	3.9	National Institute of Chemical Physics and Biophysics	Engineering and Technology, Natural Sciences
Advanced materials and high-technology devices for sustainable energetics, sensorics and nanoelectronics	4.7	University of Tartu	Engineering and Technology, Natural Sciences
Centre of Excellence for Genomics and Translational Medicine	5.1	University of Tartu	Medical and Health Sciences
Centre of Excellence in Molecular Cell Engineering	4.8	University of Tartu	Natural Sciences
Centre of Excellence in Estonian Studies	4.8	Estonian Literary Museum	Humanities and the Arts
Zero energy and resource efficient buildings and districts	4.4	Tallinn University of Technology	Engineering and Technology, Natural Sciences
Estonian ICT Centre of Excellence in research (EXCITE)	5.1	Tallinn University of Technology	Natural Sciences
Total	**41.2**		

*Authors' distribution.
Source: The State Shared Service Centre.[35]

[35] The State Shared Service Center. Meede: teaduse tippkeskused. https://vana.rtk.ee/meede-teaduse-tippkeskused#toetatud-projektid (06.03.2024).

3. Composition and distribution of researchers across research fields

This chapter offers insight into the situation of Estonian research community paying attention to the number and dynamics of researchers, ageing, gender stratification and internationalisation.

In international comparison, Estonia ranks relatively low in terms of the number of researchers[36] per capita among developed countries (figure 3.1). However, there is a slight growth trend in the statistics starting from 2019: in 2021 there were 6.8 researchers per thousand inhabitants (9033 researchers altogether) and in 2022 the ratio was 7.4 (9797 researchers) (Figure 3.2). Most researchers were employed in the public sector (67.3%), the proportion of researchers working in the private sector in 2022 was 36.7%. The gap between private and public sector researchers (head count) has been narrowing since 2018 when the share of private sector researchers was 30.3%.

The growth in the number of researchers (head count) over the last five years (2018-2022), according to available statistics, is approximately 34.6%. It is worth noting that the number of researchers has increased in all sectors except for the non-profit private sector. The largest increase during this period was observed in the business sector, with a growth of 66.3% (from 2089 to 3474 researchers). The number of researchers in the higher education sector and the government sector increased by 22.1% and 23.5% respectively.[37]

Part of the recent rise in the number of researchers employed in the public sector could be explained by a fundamental change regarding researchers working in the higher education sector introduced in 2022, when a legal amendment came into force. According to this amendment, a doctoral student enrolled in a doctoral program enters an employment contract with the university or another positively evaluated research and development institution, where at least 75% of the activities are related to the doctoral thesis. As a result, in 2021−2022, the number of researchers working in the higher education sector increased more than usual by 8.4%.

[36] Statistics Estonia as well as most other authorities collect statistics on research on the basis of the methodology presented in the Frascati Manual. This ensures that the data are collected on a uniform basis and the results are comparable. According to Statistics Estonia's interpretation of the Frascati Manual, researchers include: all persons with a scientific degree or higher education diploma who perform basic and applied research or experimental development of new knowledge, products, processes, methods and systems; all lecturers involved in research and development; heads of research institutions and their subdivisions who plan or organise scientific and technical projects; doctoral and master's students involved in original research. Researchers do not include individuals who are employed in the position of a researcher or engineer but who do not have a higher education, as well as routine analysts, bibliographers or programmers, for they are considered technicians. When technicians and support staff (working under the guidance of researchers and engineers, playing a supportive role in R&D projects) are included in the group of researchers, they are referred to as R&D personnel. An employee is involved in research and development if they spend at least 10% of their working time on respective activities.

[37] Statistics Estonia. www.stat.ee (06.03.2024).

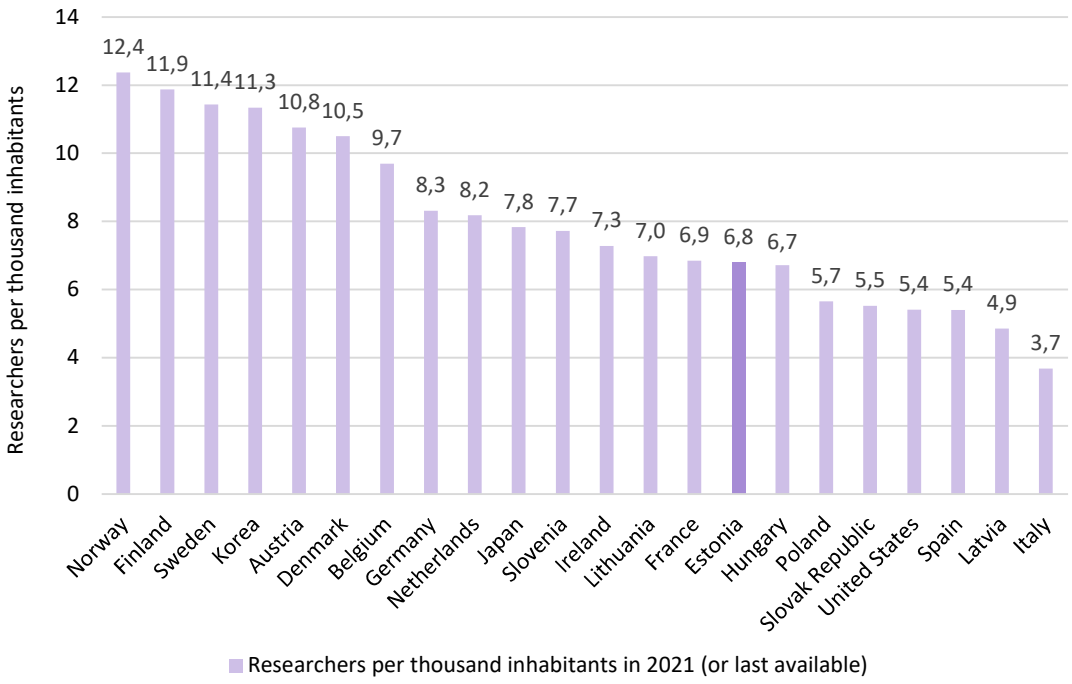


Figure 3.1. Researchers per thousand inhabitants in 2021 (or last available).
Source: OECD.[38]

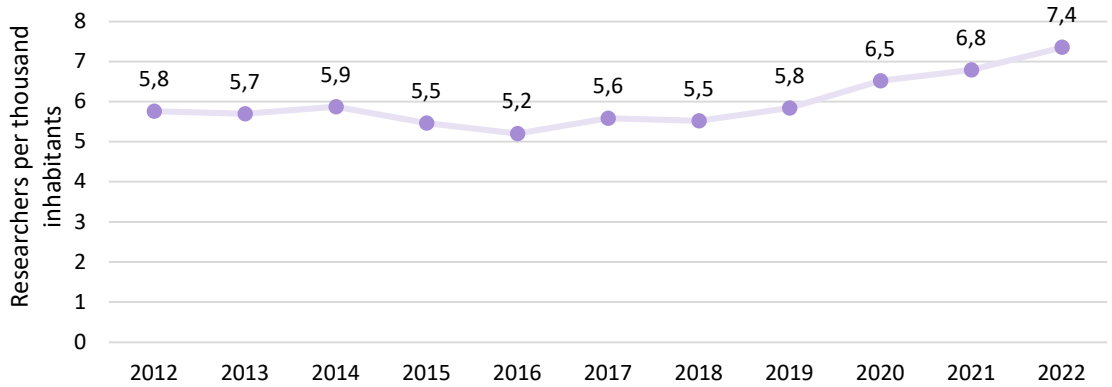


Figure 3.2. Researchers per thousand inhabitants in Estonia in the period 2009–2022.
Source: OECD[39] and Statistics Estonia[40] (2022).

Since sectoral statistics for R&D in the private sector are not collected according to the Frascati classification but according to the Estonian Classification of Economic Activities (EMTAK 2008) based on NACE Rev. 2, it is not possible to precisely determine which research fields have seen the highest influx of new researchers in the business enterprise sector. Within economic sectors, the largest increase in R&D-related labour costs between 2018-2022 was observed in various branches of manufacturing industries (e.g. production of wood and paper products, machinery, and equipment manufacturing). However, labour costs related to R&D also increased in many other economic sectors. Additionally, this period also witnessed a notable wage growth in Estonia in general. The highest R&D-related labour costs in 2022 were in the ICT sector.[41]

[38] OECD. Main Science and Technology Indicators Database. www.oecd.org/sti/msti.htm (12.02.2024).
[39] OECD. Main Science and Technology Indicators Database. www.oecd.org/sti/msti.htm (12.02.2024).
[40] Statistics Estonia. www.stat.ee (12.02.2024).
[41] Statistics Estonia. www.stat.ee (06.03.2024).

While the public sector continues to have a significant lead in terms of the number of researchers (head count), the distribution of full-time researcher positions (FTEs) between the private and public sectors was nearly equal by 2022. In 2022, Estonia had a total of 6205 full-time researcher positions, of which 51.5% (3194.6 FTEs) were in the public sector and 48.5% (3010.7 FTEs) in the private sector.

The following Figure 3.3 illustrates the distribution of full-time researchers in the public sector across Frascati fields. The business sector is not included in the figure due to abovementioned differences in classification systems. Similarly to research funding across research fields, the distribution of public sector researchers into research fields has remained largely unchanged in recent years. **The highest number of public sector researcher positions is in the field of Natural Sciences (approximately one-third), although the proportion of Natural Sciences has decreased in recent years. The second most common field is Humanities and Arts, accounting for about one-fifth of researcher positions. This is followed by Social Sciences and Engineering and Technology. The fewest researcher positions are in Medical and Health Sciences (approximately one-tenth) and Agriculture and Veterinary Sciences (less than 10%).**

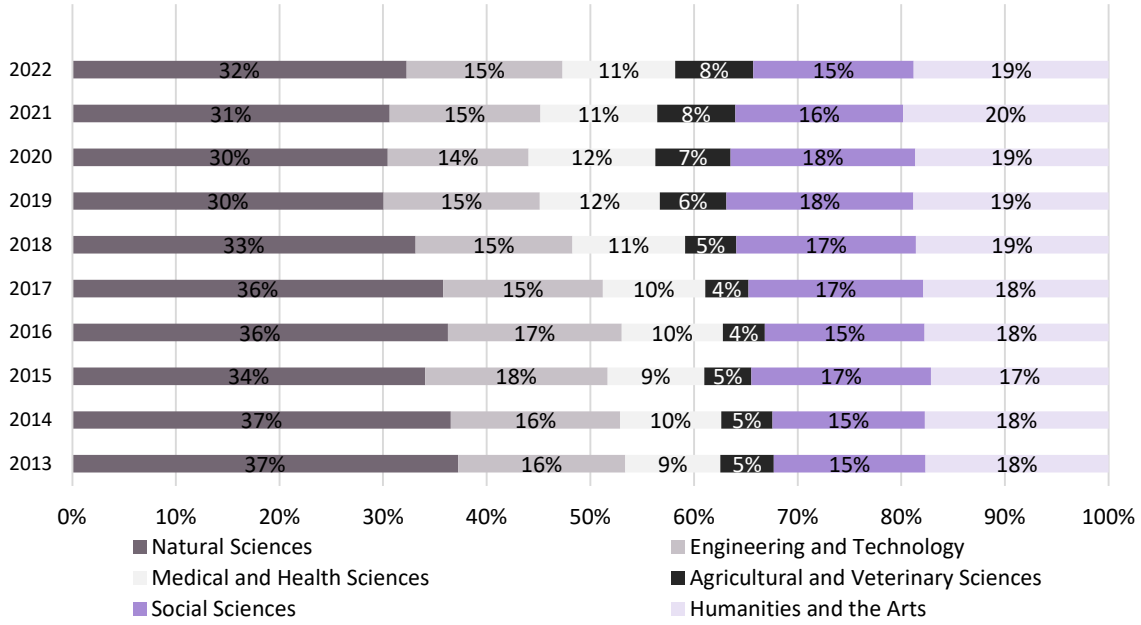


Figure 3.3. The distribution of public sector researchers (full-time equivalents) in Estonia by research fields from 2013 to 2022.
Source: Statistics Estonia,[42] calculations by the Estonian Research Council.

While the number of Estonian researchers has increased in recent years, the proportion of those under 35 has not changed notably (Figure 3.4). From 2013 to 2022, the share of researchers under 35 in Estonia ranged from 27.9% to 30.4%, including 28.9% in 2022. The private sector employs slightly more researchers under 35: as of 2022, it was 40.0%, while the share of those under 35 in the public sector was 22.5%. Unfortunately, there is no comprehensive statistics available regarding the age distribution within the Frascati fields.

[42] Statistics Estonia. www.stat.ee (06.03.2024).

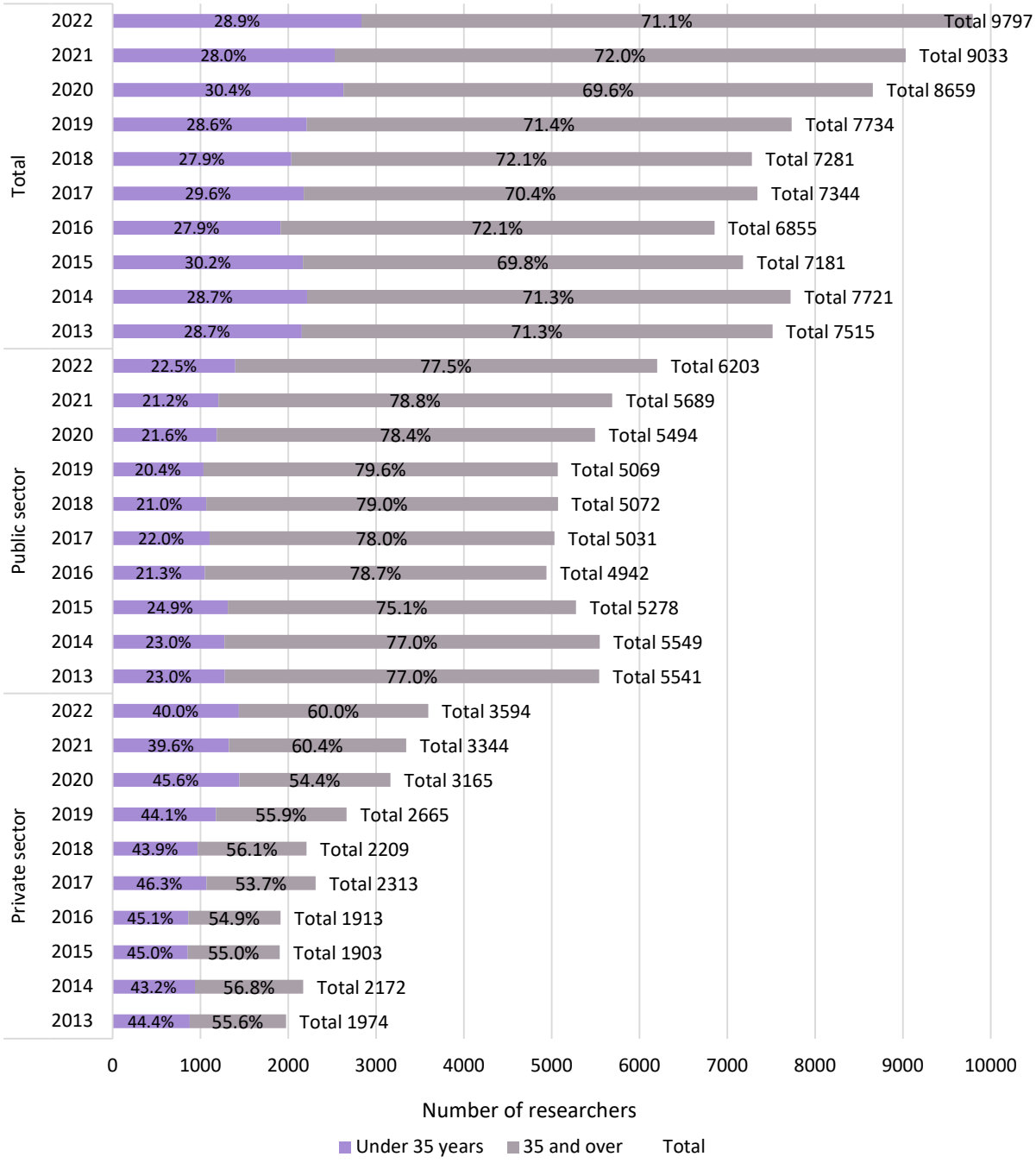


Figure 3.4. Distribution of Estonian researchers by age groups (under 35 years old and 35 years old and older) from 2013 to 2022.
Source: Statistics Estonia,[43] calculations by Estonian Research Council.

The gender stratification within the research community is a global issue that is also prevalent in Estonia. Gender equality and equal treatment is about fairness in society. The gender dimension in R&D content improves the overall research quality and makes use of the full potential of human capital and its various other benefits, thus gender equality in research does not need further justification in the context of this report. Since the beginning of data collection by Statistics Estonia in 1995, women have generally outnumbered men among both admitted and graduated students at the bachelor's and

[43] Statistics Estonia. www.stat.ee (13.02.2024).

master's levels. The numbers for doctoral admissions and completions have fluctuated over the years, but overall, there have been roughly equal numbers of women and men.[44]

Among researchers in Estonia, the gender ratio is generally equal, and the percentage of women has slightly increased during the last decade (by 2.6 percentage points)**, but there are notable differences across fields** (Figure 3.5). The proportion of women is considerably lower in Natural Sciences and Engineering and Technology (40% and 30% respectively), while women dominate in Medical and Health Sciences and Humanities and the Arts (with proportions of 73% and 64% respectively). The proportion of women also varies across universities, which can be logically explained by research fields dominant in each university. In 2022 the share of women among academic staff is highest at Tallinn University (61.7% were women). The share of women is also high in the Estonian Academy of Arts (55.2%). At the University of Tartu and Estonian University of Life Sciences women accounted almost half of the researchers (50.8% and 49.4% respectively) and the proportion is the lowest at Tallinn University of Technology (37.4%).[45]

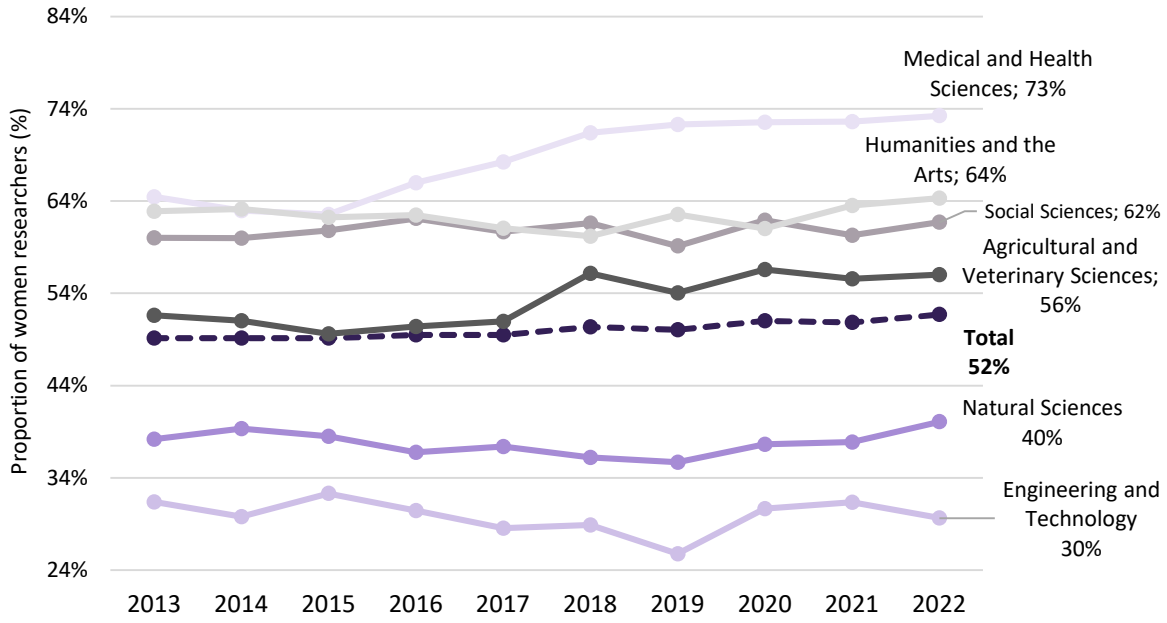


Figure 3.5. Proportion of women researchers by research fields from 2013 to 2023 (non-profit institutional sectors).
Source: Statistics Estonia,[46] calculations by the Estonian Research Council.

While men and women are roughly equal among academic staff, differences arise in positions. According to the data collected by Universities Estonia (collecting data about academic staff at universities), in 2022 the proportion of women among professors (R4) was 30.0% and associate professors (R3) 41.5%, whereas 59.6% lecturers (with doctoral degree) were women and 67.7% of teachers were women.[47] In 2020, a study commissioned by the Estonian Research Council identified several possible reasons for the differential progression of women and men in academic careers. These included entrenched assumptions that academic careers are continuous, prevailing attitudes and stereotypes related to progression to next career stages, the absence of consequences for activities associated with gender-based inequality, imbalance in the composition of decision-making bodies, and the perception that the world of science is already gender-neutral (as advancement is based on

[44] Statistics Estonia. www.stat.ee (08.03.2024).
[45] Universities Estonia. https://statistika.ern.ee/tootajad/ (08.03.2024).
[46] Statistics Estonia. www.stat.ee (12.02.2024).
[47] Universities Estonia. https://statistika.ern.ee/tootajad/ (08.03.2024).

scientific results), leading to resistance against gender-sensitive measures in the belief that competence should be the sole basis for advancement.[48]

As internationalisation has become a focus area for research institutions, the same trend has emerged in Estonia throughout the past decade (Figure 3.6). It is important to look at where researchers come from when coming to Estonia because each researcher brings along their own scientific traditions. **The researchers who have come to Estonia are primarily of European origin, however, growth from Asian countries has been the most remarkable.** During the academic years 2013/14 to 2022/23, the number of foreign researchers in Estonia (non-profit institutional sectors) increased by 187%, from 393 to 1129 researchers (while the total number of Estonian researchers grew by 30.4%). As a result, the proportion of foreign researchers has risen from 7.1% in 2013/14 to 18.2% in 2022/23. Over the past decade, the proportion of foreign researchers of Asian origin has experienced the most significant growth, with an increase of over 246 researchers from Asia (a growth of 534.8%). In the academic year 2022/23, out of the 292 researchers of Asian origin working in Estonia, 205 were from India, Iran, or Pakistan. It is worth noting that the number of researchers of Ukrainian origin working in Estonia almost doubled from 38 to 72 between the academic years 2021/22 and 2022/23. Among European Union countries, researchers have predominantly come to Estonia from Germany, Italy, and Finland.

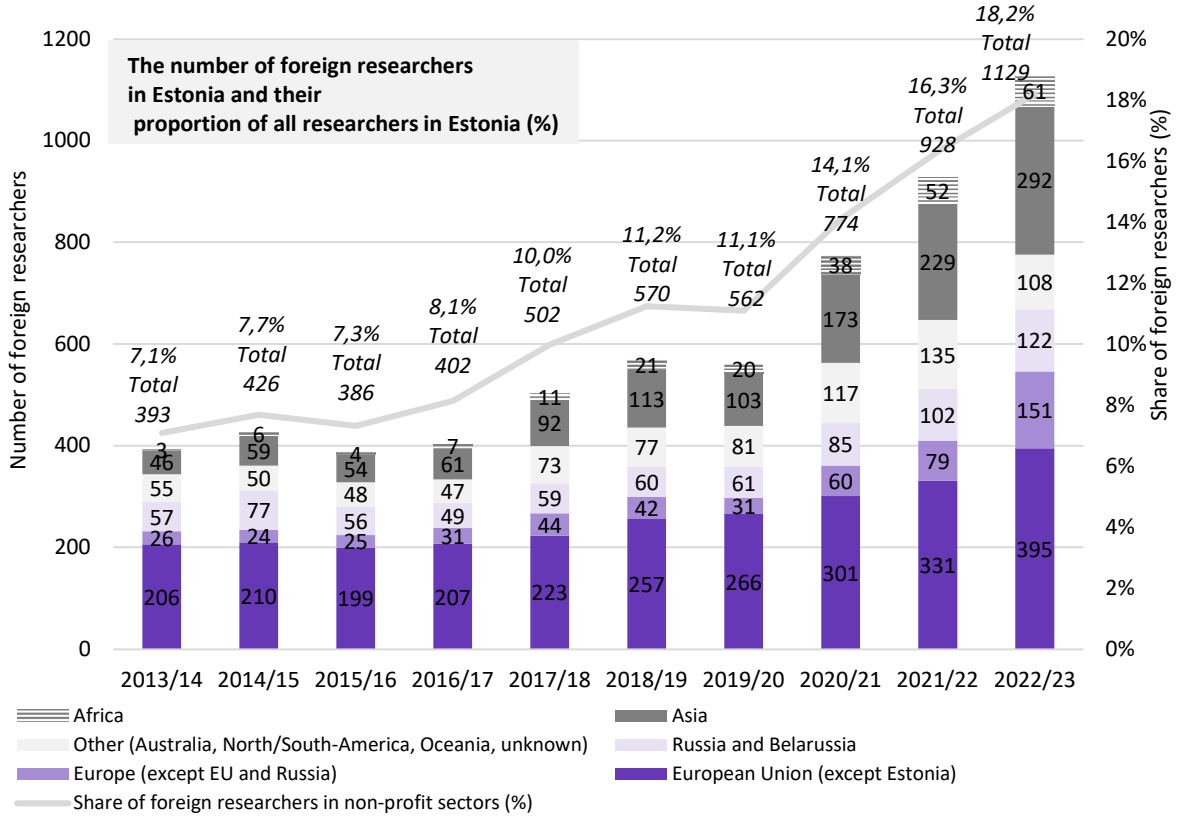


Figure 3.6. Foreign researchers in non-profit institutional sectors (higher education sector, government sector and private non-profit sector) in 2013 to 2022.
Source: Statistics Estonia,[49] calculations by the Estonian Research Council.

[48] Urmann, H., Lees, K., Remmik, M., Tubelt, E., Roos, L., Vilson, M., Puur, S. M., Aksen, M., Espenberg, S. (2020). Soolise võrdõiguslikkuse hetkeolukord ja parandamise viisid Eesti teaduses (Gender equality in Estonian science – current situation and ways of improving). University of Tartu's Centre for Applied Social Sciences (CASS), Tartu. https://www.etag.ee/wp-content/uploads/2021/03/Sooline_vordoiguslikkus_Eesti_teaduses.pdf (08.03.2024).
[49] Statistics Estonia. www.stat.ee (12.02.2024).

4. The future of Estonian researchers – doctoral students

Doctoral studies represent the main prerequisite for supporting the growth of research community and ensuring the sustainability of Estonian research and higher education. Unfortunately, **there has been no significant growth in the numbers of doctoral students admitted and graduating in Estonia over the past evaluation period** (figure 4.1).

During the academic years from 2016/17 to 2023/24, the number of **doctoral students admitted to doctoral programs has ranged from 400 to 342**, while the total number of doctoral students has decreased by approximately 351 individuals over the same period (from 2634 to 2283 students). **The number of doctoral graduates has fluctuated between 221 and 253** during the academic years 2016/17 to 2022/23 (data for the academic year 2023/24 were not yet complete at the time of reporting).

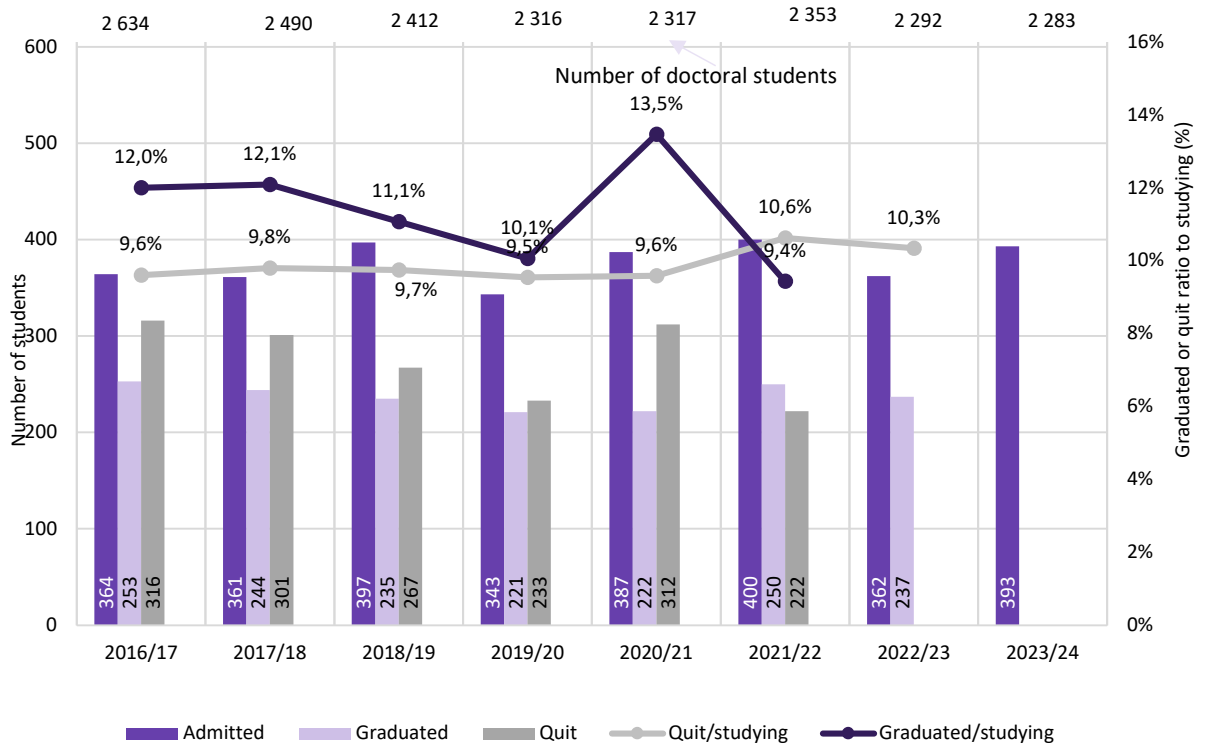


Figure 4.1. The number of students admitted to, graduated from, quitting and continuing studies in doctoral programs during the academic years 2016/17–2023/24.
Sources: Haridussilm[50] and Statistics Estonia.[51]

The following Figure 4.2 examines the distribution of doctoral degrees across the Frascati research fields. In educational statistics, the ISCED classifier is typically used for categorization into study fields. However, for better comparison with Frascati research fields, the authors have aggregated ISCED study fields under Frascati research fields, based on the closest substantive relationship between the field of study and the research field. The same categorization method is used also later in the report.[52]

[50] Haridussilm.ee (21.02.2024).
[51] Statistics Estonia. www.stat.ee (13.02.2024).
[52] More specifically, the following categorization was made: according to the Frascati classification, the field of Natural Sciences includes ISCED study fields Natural Sciences, Mathematics and Statistics; Information and Communication Technologies. The Frascati field of Engineering and Technology includes ISCED study field Engineering, Production and Construction. The Frascati field of Humanities and the Arts includes ISCED study field Arts and Humanities. The Frascati field of Social Science includes ISCED study fields Social Sciences, Journalism and Information; Business, Administration and Law; Education; Services. The Frascati field of Agriculture, Forestry, Fisheries and Veterinary includes ISCED

Between the academic years 2016/17 and 2022/23, a total of 3645 doctoral degrees were awarded in Estonian universities. Utilizing the transition to Frascati research fields, **the largest proportion of doctoral degrees during this period was conferred in the field of Natural Sciences** (**37.6%**, totalling 1370 doctoral degrees). **The share of doctoral degrees awarded in other fields remained below 20%**: 19.0% in Social Sciences, 16.7% in Engineering and Technology, and 15.0% in Humanities and Arts. The smallest proportions of doctoral degrees were conferred in the fields of Medical and Health Sciences (7.7%) and Agricultural and Veterinary Sciences (4.0%). **Over the observed period, there have been no significant changes in the distribution across fields.**

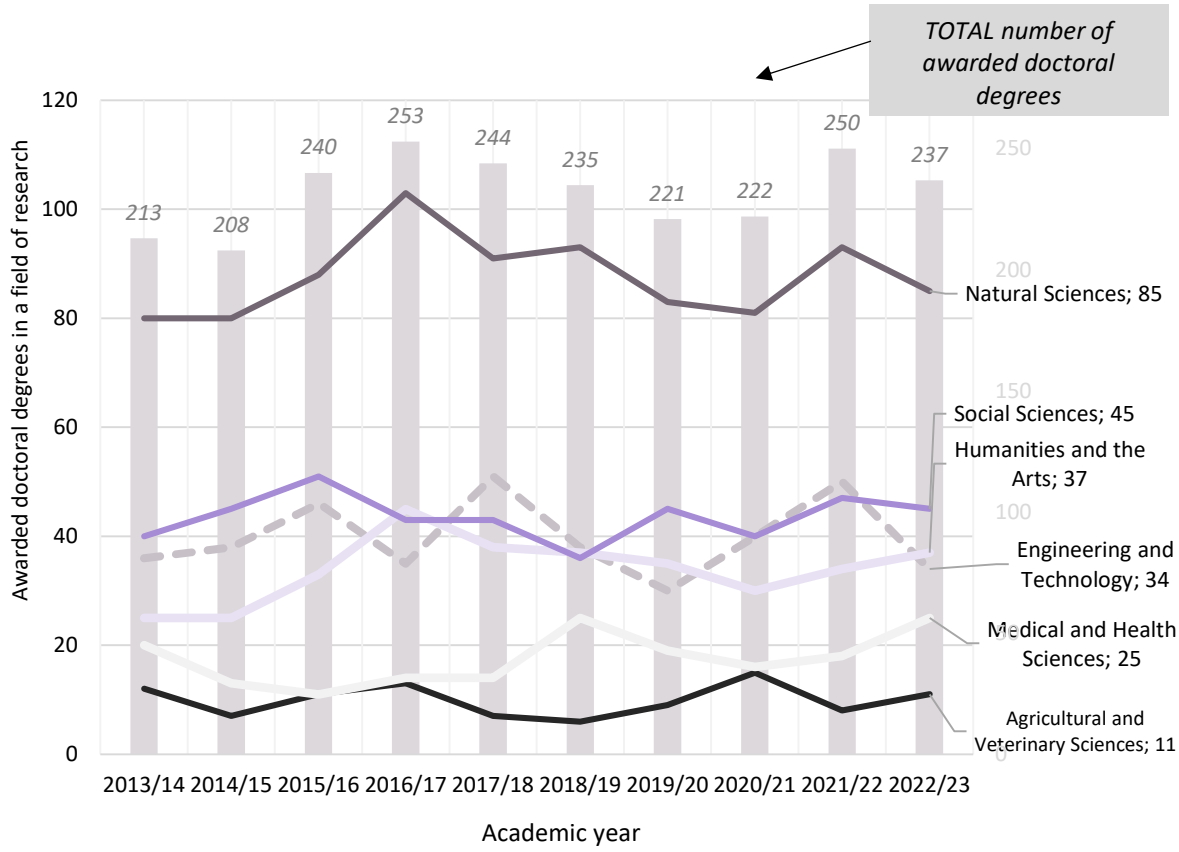


Figure 4.2. The number of doctoral degrees granted by field of study in the Estonian education system in academic years 2013/14–2022/23.
Source: Haridussilm.[53]

And even in a situation where the absolute yearly numbers have remained relatively unchanged throughout the years and no visible trend in total numbers could be identified (figures 4.1 and 4.2), the proportion of admitted doctoral students of Estonian nationality has seen a decline while the **proportion of admitted foreign doctoral students[54] has seen a remarkable growth from 16% a decade ago in 2013/14 to 39% in 2023/24** (Figures 4.3 and 4.4). Figure 4.3 indicates that **the total number of admitted doctoral students comparing academic years from 2013/14 to 2023/24 has declined only 0.8%** (from 396 to 393). However, the **number of Estonians admitted has declined by 28.7% and**

study field Agriculture, Forestry, Fisheries and Veterinary. The Frascati field of Medical and Health Sciences includes ISCED study field Health and Welfare.

[53] Haridussilm. Haridussilm.ee (14.02.2024).

[54] In this analysis, we use the term "foreign student" in the sense of the definition "mobile degree student" provided by Statistics Estonia, which means a student who is not a resident or citizen of Estonia, has not finished upper secondary education in Estonia and does not have the right of permanent residence/a long-term residence permit. Excluded are persons who are studying or training in Estonia only for a limited time period. Source: Statistics Estonia, www.stat.ee (https://www.stat.ee/en/find-statistics/methodology-and-quality/esms-metadata/40310#3-Statistical-presentation-2) (18.03.2024).

foreign students increased by 150%. i.e. maintaining the level of doctoral education has been achieved through admitting a higher number of foreign doctoral students.

As seen in Figure 4.4, approximately one-third of the foreign doctoral students admitted during the academic years 2016/17−2020/21 (for longer time frames, such precise data were not available) were from the European Union countries (26.1−29.6%). During the same period, admitted doctoral students from Russia accounted for 10.4−14.9% and other European countries represented 10.1-11.8% of admissions. **Thus, the proportion of foreign doctoral students from Europe (including Russia) during the period 2016/17−2020/21 accounted for about half of admissions** (ranging between 48.3%−54.7%). However, **there is also a significant proportion of doctoral candidates originating from Asia: they constituted 34.9%−40.7% of admissions** during the period 2016/17−2022/23. The proportion of students from other parts of the world has not exceeded ten percent during the observed period.

The addition of foreigners to our universities is not problematic; it only enriches and brings new perspectives in research. Problematic is the decrease in doctoral students of Estonian nationality. Alongside high-level research, equally important is the sustainability of Estonian-language higher education and its long-term sustainability in order to maintain the high level of university education and a high-quality pool of teachers at other stages of education. Therefore, if Estonia wants to ensure comprehensive higher education and specialization diversity, the need for Estonian-speaking faculty does not diminish, and for this, a certain critical proportion of Estonian-speaking research staff must be maintained.

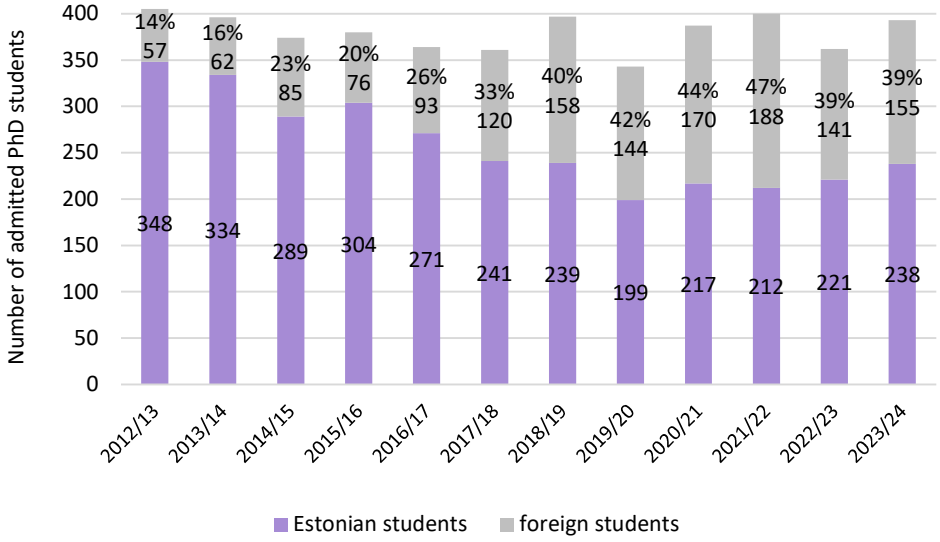


Figure 4.3. Admitted Estonian and foreign doctoral students in academic years 2013/13-2023/24. Source: Haridussilm.[55]

[55] Haridussilm. Haridussilm.ee (14.02.2024).

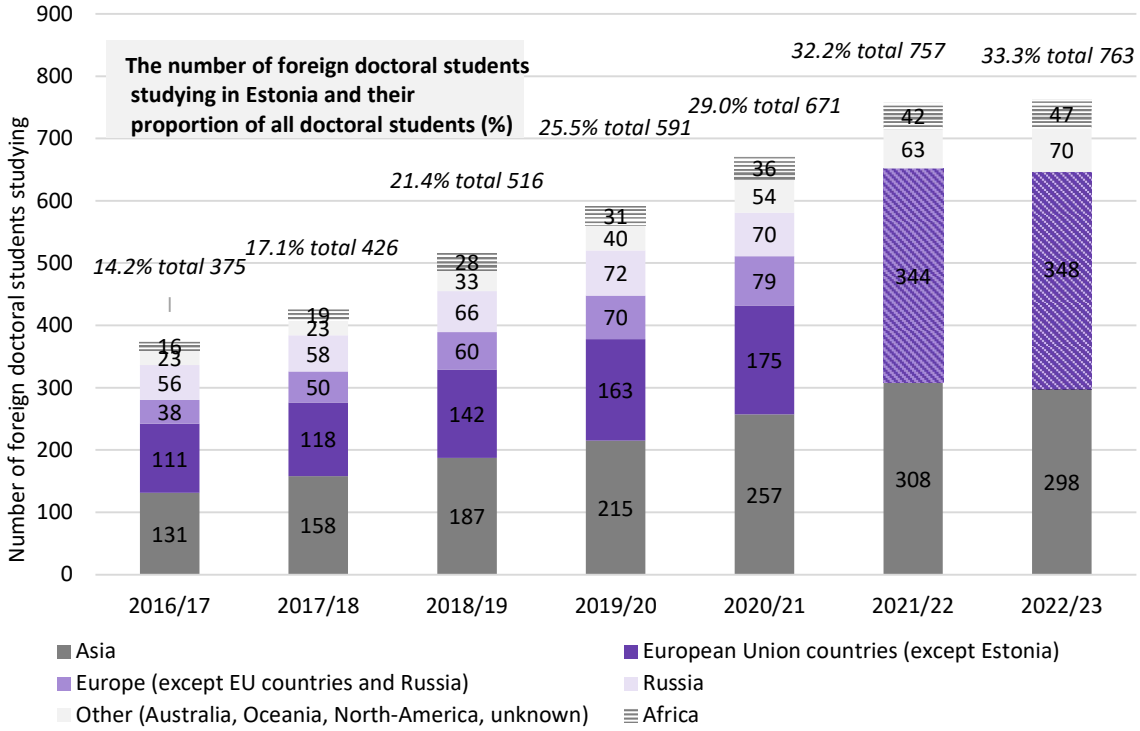


Figure 4.4. Foreign doctoral students in Estonia according to their country of origin in academic years 2016/17–2022/23. For years 2021 and 2022, country-level data (for European countries division) were not available.
Source: Statistics Estonia [56] and Eurostat (country-specific data).[57]

Similarly, just as doors are open to foreigners, an increasing number of Estonians have also pursued higher education, including doctoral degrees, abroad. According to OECD data, during the period 2013-2021, a total of 417 individuals with Estonian citizenship obtained a doctoral degree in various countries around the world (still excluding the USA, for which OECD lacks data) (see Appendix 3). The most common destinations where Estonians have obtained their doctoral degrees abroad are the United Kingdom and Finland, with 114 and 91 individuals, respectively. It is also noteworthy that the number of Estonians achieving a doctorate abroad has increased approximately by 50% during the observed period – in 2013, there were 34 Estonians who had obtained a doctorate abroad, and in 2021, this number increased to 54. However, the number of Estonians obtaining a doctorate abroad remains significantly lower than the decrease in the number of Estonians obtaining a doctorate in Estonian universities in recent years, as well as the number of foreign doctoral students admitted to Estonian universities (previous figure 4.3).

Indeed, when looking at the different fields of research, the **dynamics of doctoral admissions vary considerably both in terms of the number of entrants and in terms of internationalization** (Figure 4.5). In no field is there a direct downward trend, but in Engineering and Technology as well as in Humanities and Arts, the admissions of doctoral students have been more fluctuating over the years. Although admissions are relatively small, the field of Medical and Health Sciences has managed to maintain a stable intake during the observed period, both in terms of local and international doctoral student admissions. However, looking at the admission numbers in terms of international students and Estonians, a **notable decrease in the number and proportion of Estonians is observed in almost all fields except Medical and Health Sciences**. **The largest changes have occurred in the fields of Natural Sciences and Engineering and Technology**, where during the period of 2013/14–2023/24 the number of Estonians admitted to doctoral studies has decreased by 41.0% and 63.6%, respectively, while the

[56] Statistics Estonia. www.stat.ee (13.02.2024).
[57] Eurostat. https://ec.europa.eu/ (18.03.2024).

numbers of international students have increased by 385.7% and 155.6% respectively. Looking at current trends, it has been forecasted that by the year 2033, the share of foreign workers in several fields will exceed that of Estonian academic staff[58].

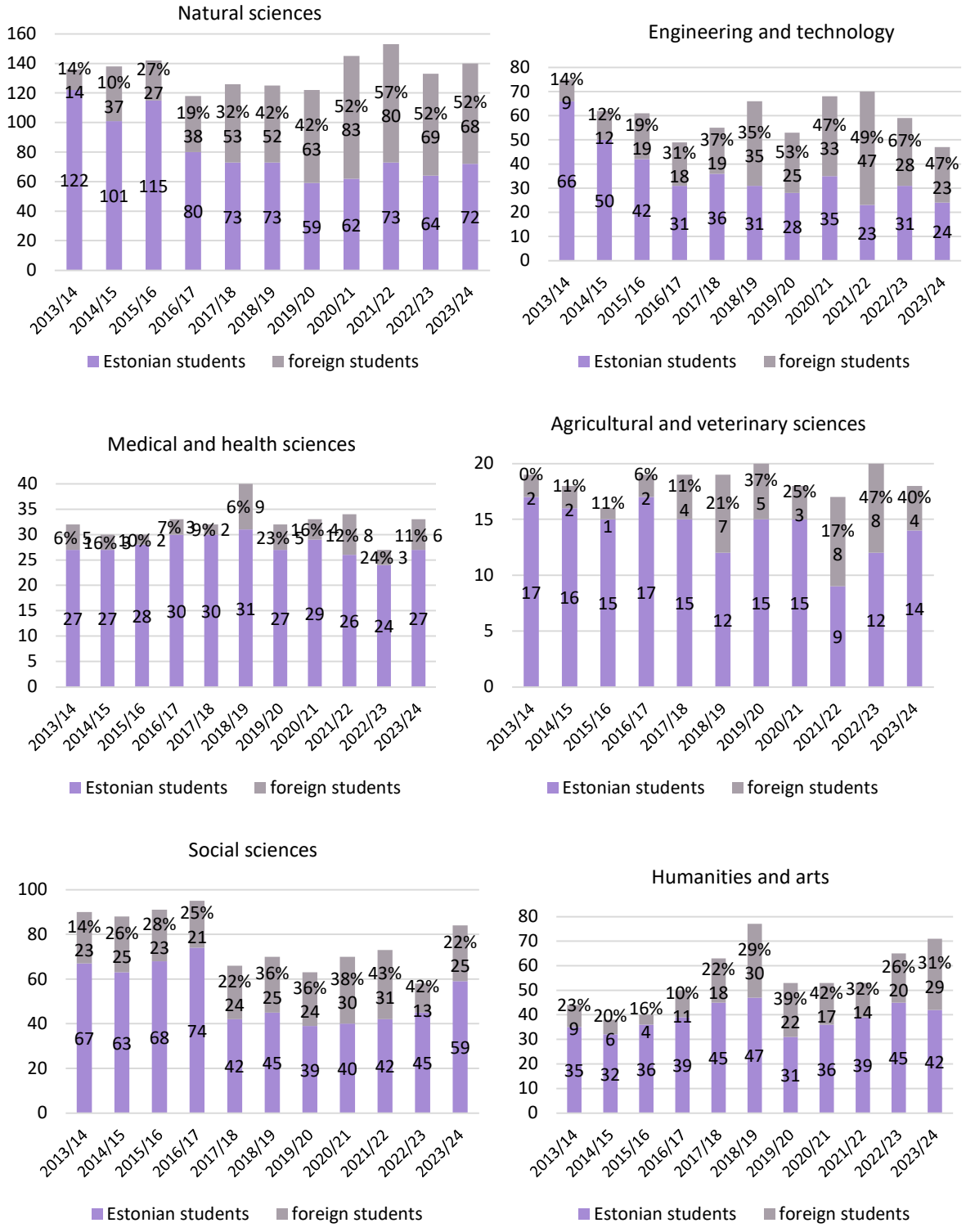


Figure 4.5. Admitted PhD students by fields of research.
Source: Haridussilm,[59] calculations by the Estonian Research Council.

[58] Kindsiko. E. Eestikeelne kõrgharidus on kümne aasta perspektiivis tõsises ohus. Postimees. https://arvamus.postimees.ee/7778326/ak-eestikeelne-korgharidus-on-kumne-aasta-perspektiivis-tosises-ohus (19.03.2024).
[59] Haridussilm. Haridussilm.ee (14.02.2024).

5. Publication activity and quality across research fields

Estonian researchers currently publish approximately 5000 research papers per year[60], the total number of publications in Web of Science database[61] in 2018–2023 being **3900 research papers per year**.

To see the impact of articles, we present the number and proportion of publications in top 10% most cited publications (Figure 5.1. and 5.2.), proportion of Open Access publications (Figure 5.3.) and Category Normalized Citation Impact by fields of research (5.4.).

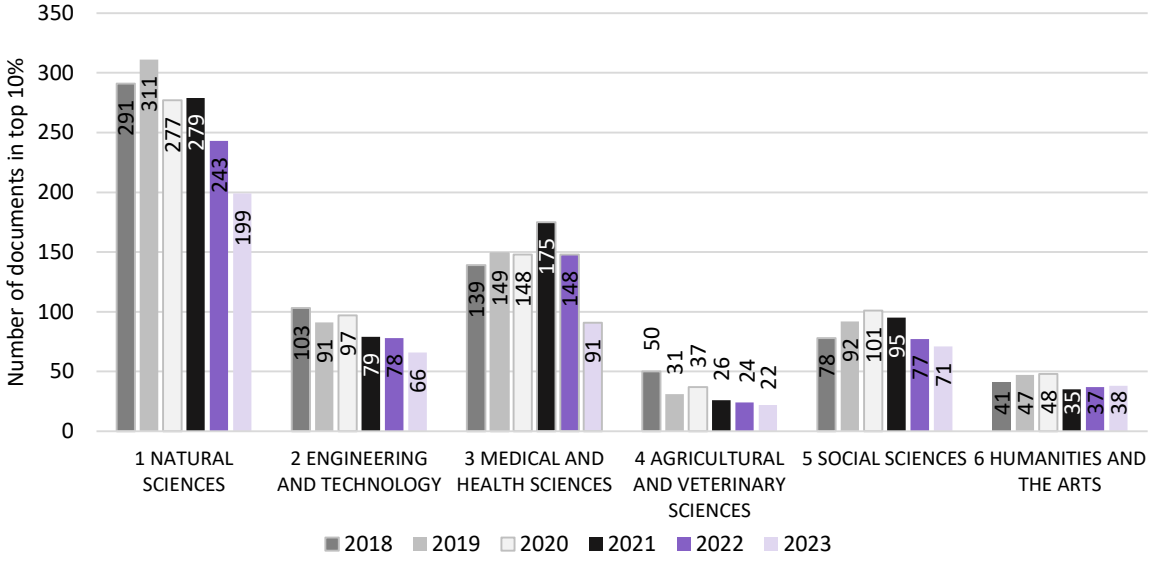


Figure 5.1. Number of documents in top 10% by fields of research 2018–2023.
Source: InCites[62]

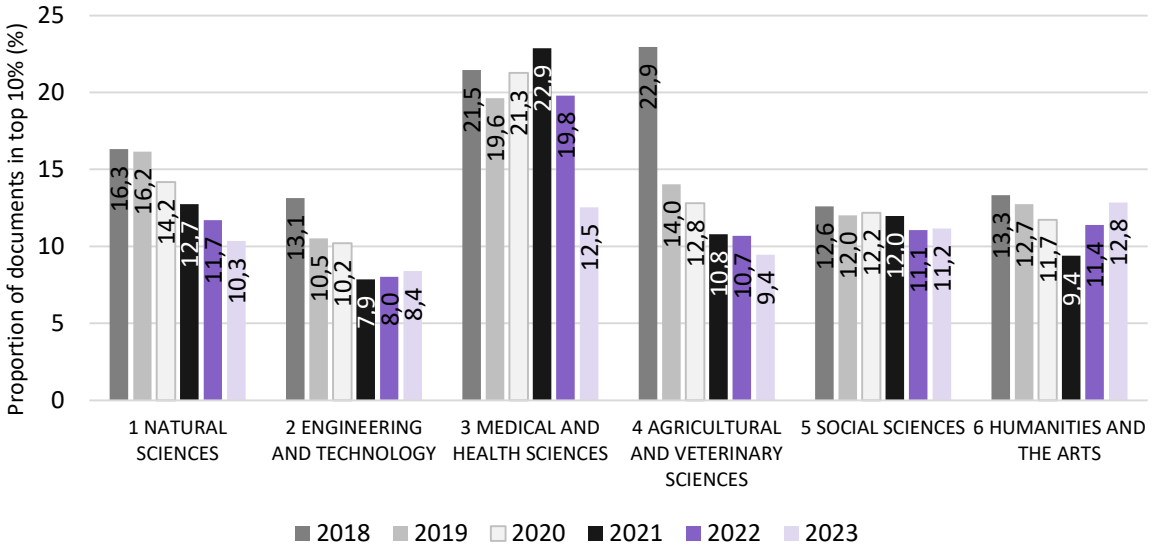


Figure 5.2. Proportion of documents in top 10% by fields of research 2018–2023.
Source: InCites[63]

[60] Vilo. J. (2012). A Look at the State of Estonian Research. – Estonian Research 2022 (ed. K. Raudvere), pp. 61–77. Estonian Research Council, Tartu. https://www.etag.ee/wp-content/uploads/2022/01/Estonian_Research_2022.pdf (30.04.2024).
[61] InCites. Incites.clarivate.com (30.04.2024).
[62] InCites. Incites.clarivate.com (28.04.2024).
[63] InCites. Incites.clarivate.com (28.04.2024).

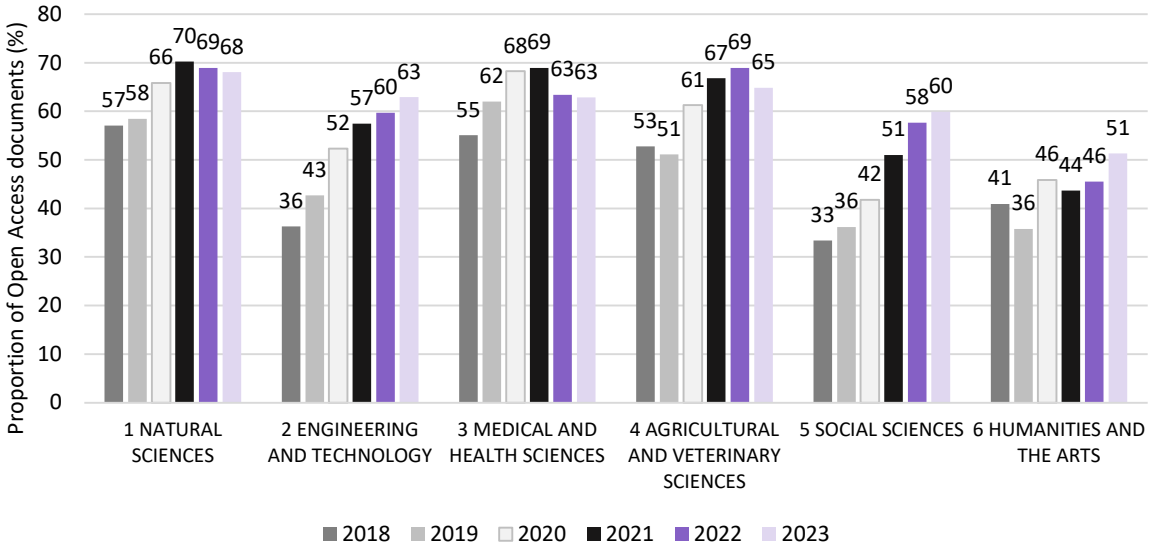


Figure 5.3. Proportion of Open Access documents by fields of research 2018–2023.
Source: InCites[64]

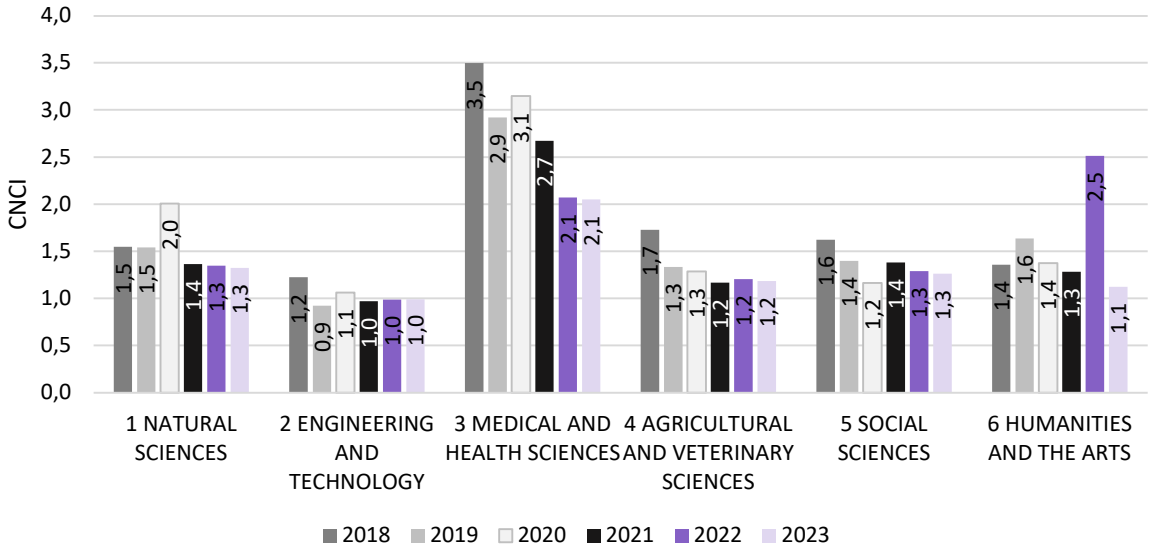


Figure 5.4. Category Normalized Citation Impact by fields of research 2018–2023
Source: InCites[65]

[64] InCites. Incites.clarivate.com (28.04.2024).
[65] InCites. Incites.clarivate.com (28.04.2024).

Summary

- At the time of compiling this overview, **there were 22 public or private research institutions in Estonia holding positive regular evaluation status**. Successfully passing the regular evaluation permits to apply for national research grants and baseline funding, and also enables higher education institutions to conduct doctoral studies.
- The primary R&D funding instruments financed from the state budget are **baseline funding and research grants**.
- As most (Western) countries worldwide, Estonia set the objective of increasing its total R&D expenditure to 3% of GDP by 2014 already in the R&D strategy "Knowledge-based Estonia" (2007-2013). The goal for public sector R&D expenditures was set 1% and for private sector 2% of GDP.
- On 19th December **2018, the Estonian Research Agreement was signed** by all the chairpersons of Estonian political parties. This social agreement aimed to increase the public funding of R&D at the minimum level of 1% of the GDP and maintaining at least this level from 2021 to secure the further development of Estonian research.
- **While the target of 1% of GDP for public sector R&D expenditures has still remained unachieved** (it was 0.77% in 2022), **Estonia still exceeds the European Union average** (0.72% in 2022).
- **Notable differences between EU14 countries and Estonia arise from the private sector's share of R&D expenditures as a percentage of GDP.** Private sector R&D expenditure of GDP in Estonia was 1.01%, the EU27 average 1.51%, EU14 average 1.59%.
- **ICT sector could be considered one of the main sources of Estonian business R&D:** approximately half of the private sector R&D expenditure is incurred by the ICT sector (2021).
- **Gross domestic expenditure on R&D expenditure as a percentage of GDP in Estonia was 1.78%** (2022), in the EU27 2.22% and the EU14 2.34%.
- In Estonia, the **public sector primarily funds public sector research, likewise the private sector R&D financing stays in the private sector**. Only 6.2% of private sector R&D financing in 2022 was allocated for research by universities and research institutes and there have been no significant changes in the last decade.
- In 2022, **foreign sources accounted for 11.4% of Estonia's R&D funding sources and were divided almost equally between public and private sectors**. Foreign sources primarily consist of funding from framework programs.
- Estonia's significant difference from many other countries is the absence of tax incentives for corporate R&D. Besides, the direct government funding for business R&D as a percentage of GDP is amongst the lowest in OECD countries.
- In 2019 the Research and Development Council (TAN) decided to allocate additional Resources to fund R&D and innovation supporting evidence-based sectoral policy measures and the implementation of sectoral objectives.
- Since the last regular evaluation (2018-2024**), the amount of funding of competitive grants has risen 48% and baseline funding 120% . As a result, the volumes of baseline funding and competition-based funding have become equal since 2020**.
- **Estonian applicants have been relatively successful in receiving funding from framework programs**. In recent years (with a few exceptions), the amounts obtained from framework programs have exceeded those obtained from competitive grants. However, Estonian applicants have been significantly aided in increasing funding through using widening measures, which are not open to all countries.

- **The proportions of funding between research fields (according to Frascati main classifier) have generally remained stable in recent years.** Approximately half of the funding of research projects ongoing in 2019-2023 has been allocated to **Natural Sciences and** one fifth to **Engineering and Technology.** The share of Agricultural and Veterinary Sciences is the lowest.
- **Estonia ranks relatively low in terms of the number of researchers per capita among developed countries**, but there is a slight growth trend in the statistics starting from 2019: in 2021 there were 6.8 researchers per thousand inhabitants (9033 researchers altogether) and in 2022 the ratio was 7.4 (9797 researchers).
- Part of the recent rise in the number of researchers employed in the public sector could be explained by a **fundamental change regarding researchers working in the higher education sector introduced in 2022** according to which a doctoral student enrolled in a doctoral program enters an employment contract with the university or other positively evaluated R&D institution.
- **Most researchers are employed in the public sector (67.3%),** the proportion of researchers working in the private sector is 36.7% (2022) and the gap between sectors has been narrowing throughout the years.
- The highest number of **public sector researcher positions is in the field of Natural Sciences** (approximately one-third) **and Humanities and Arts** (one-fifth of researcher positions).
- While the number of Estonian researchers has increased in the last decade (2013-2022), **the proportion of those under 35 has not changed notably**. The share of researchers under 35 in Estonia was 28.9% in 2022.
- **Among researchers in Estonia, the gender ratio is generally equal**, and the percentage of women has slightly increased during the last decade (by 2.6 percentage points), **but there are notable differences across fields** – the proportion of women is considerably lower in Natural Sciences and Engineering and Technology while women dominate in Medical and Health Sciences and Humanities and the Arts.
- **Gender differences, however, exist in the distribution of positions**: there are more men in higher academic positions (30.0% of professors (R4) were women in 2022).
- Between the academic years 2016/17 and 2022/23, a total of 3645 doctoral degrees were awarded in Estonian universities and over the years there have not been remarkable changes in the distribution across fields of research. **The largest proportion of doctoral degrees during this period was conferred in the field of Natural Sciences** (**37.6%**, totalling 1370 doctoral degrees). The share of doctoral degrees awarded in **other fields remained below 20%.**
- **The proportion of foreign researchers in non-profit institutional sector has increased from 5.2% to 11.5% during the academic years 2013/14–2022/23**. More than half of the foreign researchers are of European origin (including Russia), but the fastest growth has been seen in the number of foreign researchers from Asia.
- **Maintaining the level of doctoral education has been achieved through admitting a higher number of foreign students.** The total number of admitted doctoral students during the academic years 2013/14–2023/24 has declined only 0.8% (from 396 to 393). However, the number of Estonians admitted has declined by 28.7% and foreign students increased by 150%**.**
- **The largest changes in terms of admitted doctoral students have occurred in the fields of Natural Sciences and Engineering and Technology** where in the recent years (2020 and onwards) approximately half of the admitted doctoral students have been of foreign origin. However, there has been no visible downward trend in the total number of admitted doctoral students during the last decade.

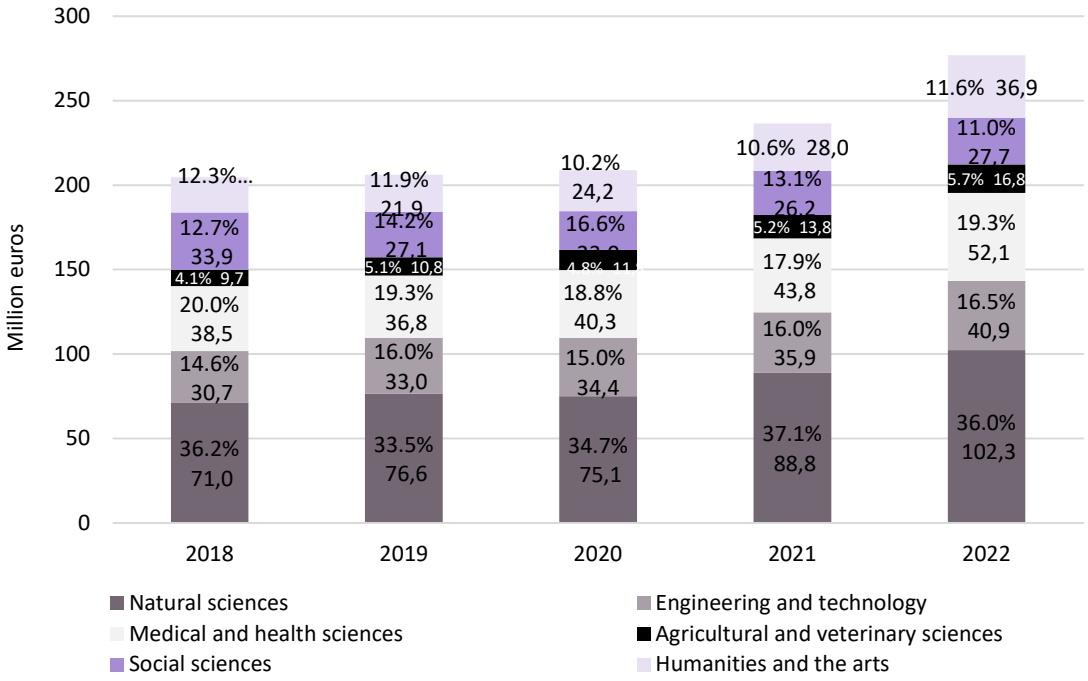
Annexes

Annex 1. Public sector and private sector R&D expenditures as a percentage of GDP in 2022 in European Union.

	Public sector	Private sector	Total
Belgium	0.88%	2.52%	3.41%
Sweden	0.89%	2.51%	3.40%
Austria	0.98%	2.22%	3.20%
Germany	0.94%	2.18%	3.13%
Finland	0.93%	2.03%	2.95%
EU14	**0.75%**	**1.59%**	**2.34%**
Netherlands	0.73%	1.56%	2.30%
Denmark	0.93%	1.56%	2.49%
EU27	**0.72%**	**1.51%**	**2.22%**
Slovenia	0.60%	1.51%	2.11%
France	0.70%	1.48%	2.18%
Czechia	0.70%	1.27%	1.96%
Portugal	0.60%	1.10%	1.71%
Estonia	**0.77%**	**1.01%**	**1.78%**
Hungary	0.38%	1.00%	1.38%
Poland	0.49%	0.96%	1.46%
EU13	**0.46%**	**0.83%**	**1.29%**
Spain	0.62%	0.81%	1.44%
Italy	0.53%	0.81%	1.33%
Croatia	0.64%	0.77%	1.41%
Ireland	0.19%	0.77%	0.96%
Greece	0.75%	0.74%	1.49%
Slovakia	0.42%	0.56%	0.98%
Bulgaria	0.24%	0.52%	0.75%
Lithuania	0.53%	0.50%	1.02%
Luxembourg	0.48%	0.50%	0.98%
Malta	0.22%	0.42%	0.64%
Cyprus	0.35%	0.41%	0.77%
Romania	0.17%	0.28%	0.46%
Latvia	0.48%	0.27%	0.75%

Source: Eurostat (data last updated 08.12.2023). Calculations by the Estonian Research Council.

Annex 2. R&D expenditures in the public sector by field of science in 2018-2022 (million euros, %).



Source: Statistics Estonia (28.06.2023), calculations by the Estonian Research Council.

Annex 3. Estonians who obtained their doctorate abroad during the period 2013-2021.

	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total 2013-2021
Australia	3	0	0	0	0	0	0	0	0	3
Austria	1	0	1	1	0	0	0	1	0	4
Belgium	0	1	1	0	0	0	0	1	1	4
Canada	0	0	0	0	3	3	3	3	3	15
Czechia	0	0	0	0	2	0	1	0	0	3
Denmark	0	1	1	3	2	3	3	5	1	19
Finland	7	7	9	9	15	17	13	11	3	91
France	..	..	..	..	2	4	2	2	4	14
Germany	5	1	4	5	1	3	8	2	10	39
Italy	1	1	1	1	1	2	1	0	0	8
Japan	..	..	..	..	1	1	1	3	1	7
Latvia	0	0	0	1	0	0	0	0	1	2
Luxembourg	0	0	1	0	0	0	0	0	1	2
Netherlands	2	0	5	3	3	3	3	3	3	25
Norway	0	0	2	0	0	0	1	1	3	7
Poland	..	..	..	..	..	0	1	0	0	1
Portugal	0	0	0	0	0	0	2	0	0	2
Spain	..	..	..	..	..	..	2	1	2	5
Sweden	5	3	4	3	5	1	8	3	2	34
Switzerland	2	1	1	2	2	1	4	2	2	17

Türkiye	..	0	0	1	0	0	0	0	0	1
United Kingdom	9	11	9	15	16	11	11	15	17	114
United States	..	..	..	..	..	..	..	..	..	..
Total	**35**	**26**	**39**	**44**	**53**	**49**	**64**	**53**	**54**	**417**

.. data missing.

Source: OECD. Education at Glance. (15.03.2024).

Annex 4. Number of applications and grants by fields of research 2018−2023.

		Natural Sciences	Engineering and Technology	Medical and Health Sciences	Agricultural and Veterinary Sciences	Social Sciences	Humanities and the Arts	Total
2018	Number of applications	142	52	38	7	41	37	**317**
	Number of grants	21	7	6	2	3	4	**43**
2019	Number of applications	146	60	47	23	42	48	**366**
	Number of grants	37	8	12	3	7	8	**75**
2020	Number of applications	205	67	45	21	66	76	**479**
	Number of grants	58	20	14	4	7	11	**114**
2021	Number of applications	162	69	43	21	47	71	**413**
	Number of grants	37	12	15	7	10	11	**92**
2022	Number of applications	128	60	30	19	39	59	**335**
	Number of grants	30	8	13	7	10	11	**79**
2023	Number of applications	121	62	30	27	36	59	**335**
	Number of grants	27	12	8	5	7	7	**66**

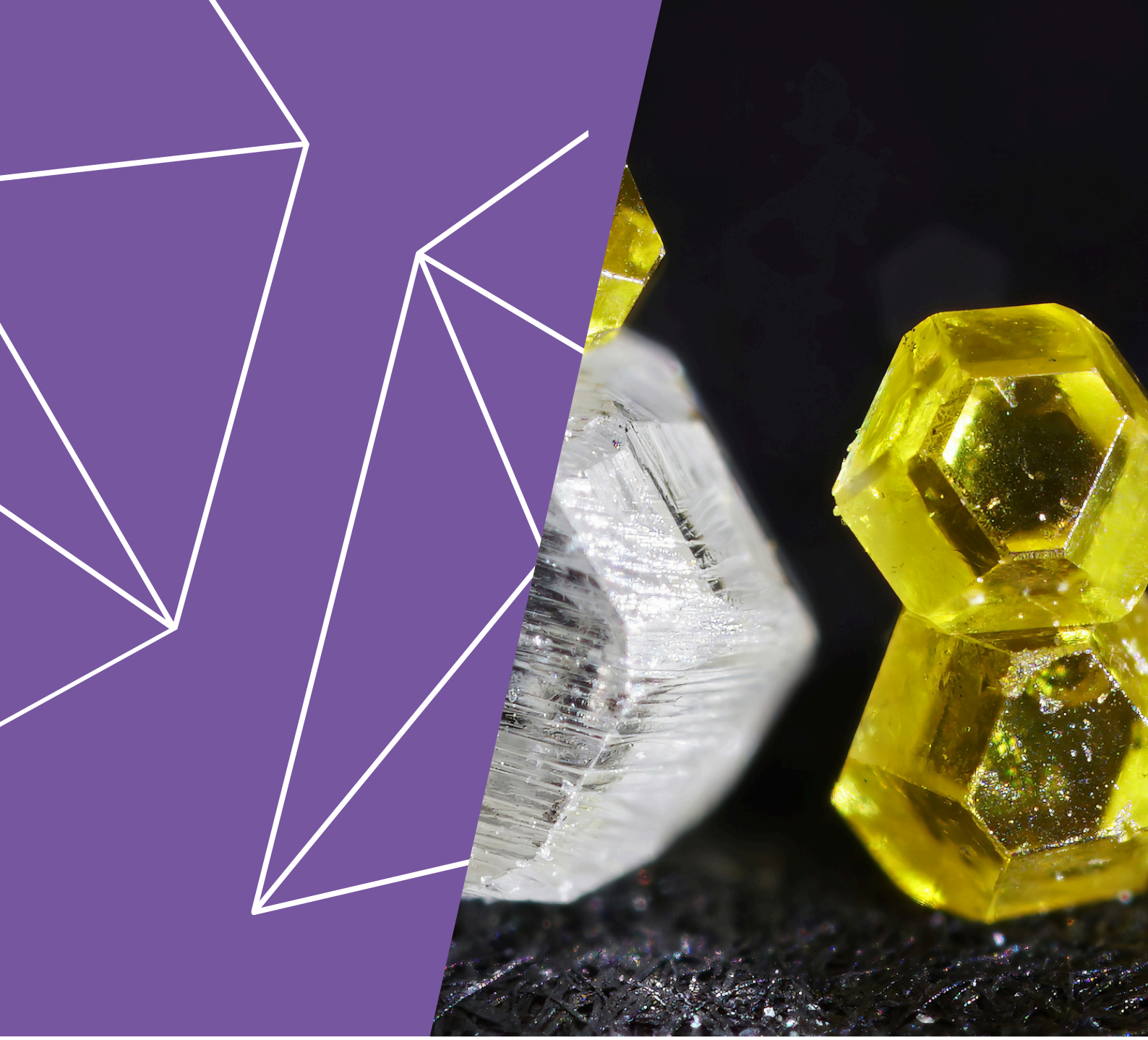


Photo: Diamonds. Maxim Bilovitskiy Estonian Science photo competition 2023

Contact:

Estonian Research Council
Soola 8
Tartu 51004
www.etag.ee