

# State of scientific research in Finland

Statistics on research funding, research personnel and scientific publishing



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# Finnish research and innovation system



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# Finnish research and innovation system 1/2

- The Finnish higher education system consists of 13 universities and 24 universities of applied sciences that operate under the Ministry of Education and Culture.
- There are 12 public research institutes operating under relevant ministries.
- Higher education and research institutes work closely with private business partners. Private business accounts for 67% of total Finnish RDI expenditure.
- The major research funding agencies are the Academy of Finland, Business Finland and various foundations.



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# Finnish research and innovation system 2/2

- Higher education and science policy comes under the Ministry of Education and Culture, which drafts legislation, budget proposals and government decisions relating to education.
- Innovation policy is the responsibility of the Ministry of Economic Affairs and Employment.
- Development of the innovation system is coordinated by the Research and Innovation Council, which is chaired by the Prime Minister.



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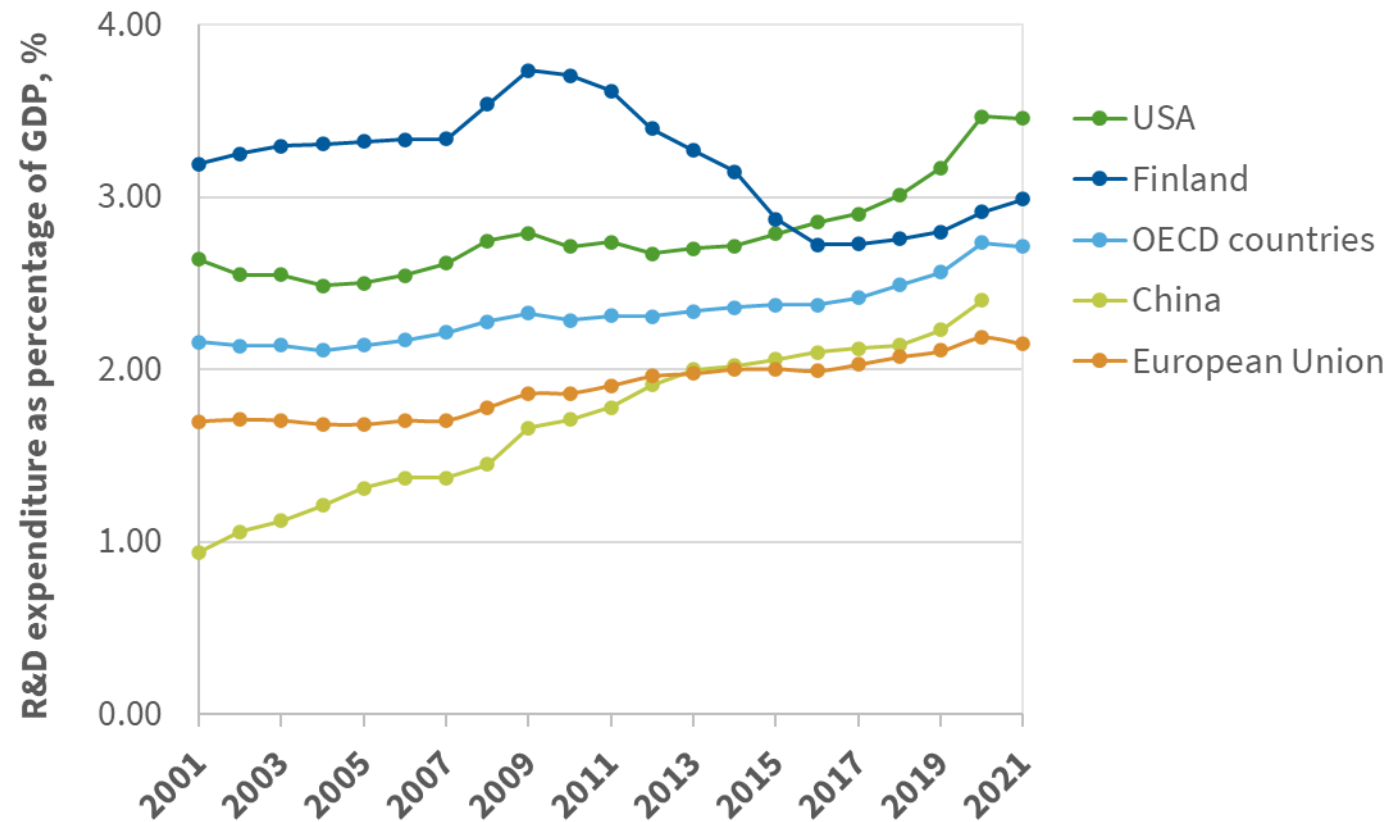
# Research funding



Figure 1.1a

# Finnish R&D intensity in international comparison

Finland and European Union, USA, China and OECD countries.



## R&D expenditure in 2021 (billion 2015 PPP US dollars)

	Billion USD
USA	709.7
Finland	7.6
OECD countries	1609.2
China	563.3
European Union	397.5

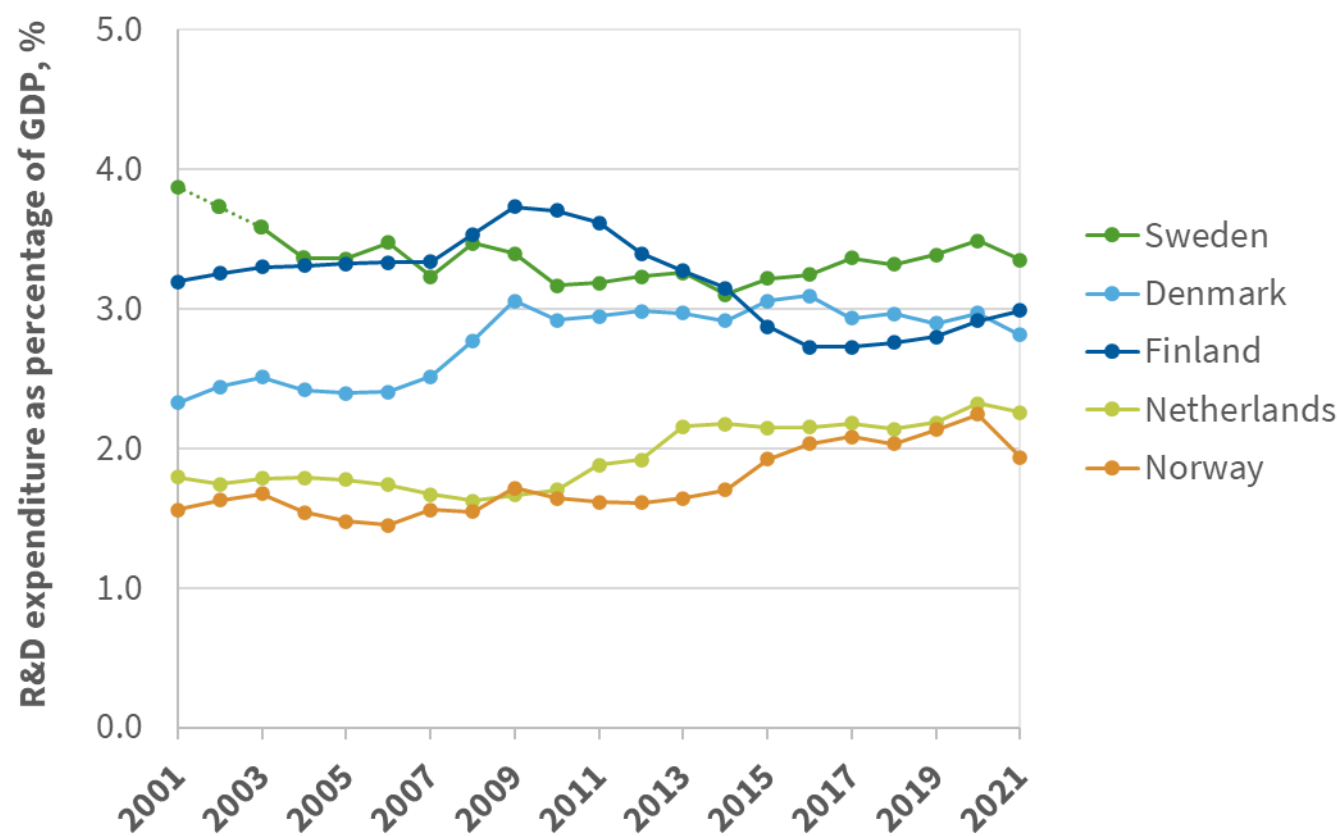
- United Kingdom included in EU figures up to 1 February 2020.
- Data for China missing for 2021, China's R&D expenditure id from 2020.

Sources: OECD Main Science and Technology Indicators (data published in March 2023); OECD: Science, Technology and R&D Statistics.

Figure 1.1b

# Finnish R&D intensity in international comparison

Finland, the Nordic countries except Iceland, and Netherlands.



R&D expenditure in 2021  
(billion 2015 PPP US dollars)

	Billion USD
Sweden	18.1
Denmark	8.9
Finland	7.6
Netherlands	21.3
Norway	7.0

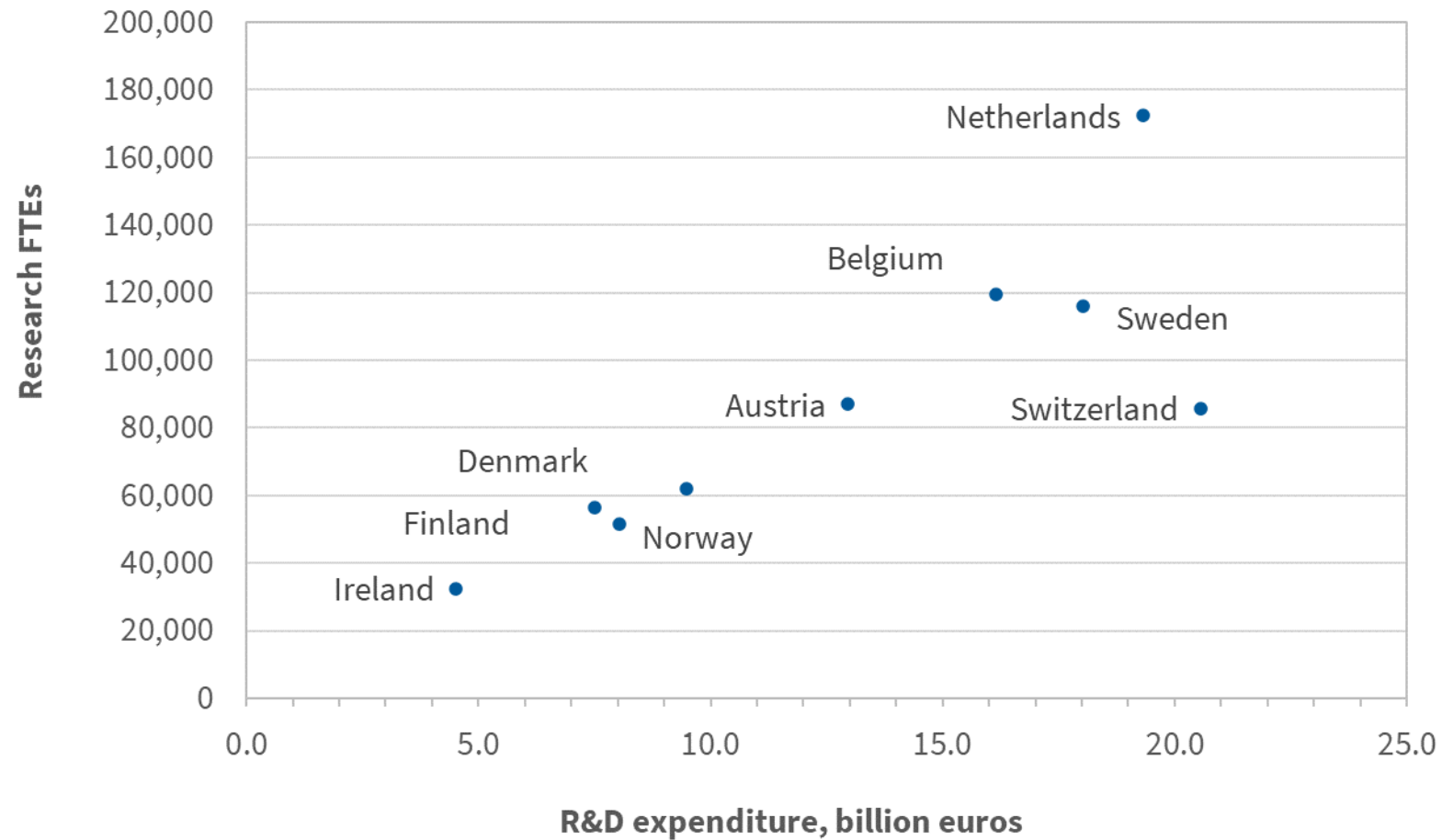
- Gap in Swedish data for year 2002 indicated by broken line, assuming constant change.

Sources: OECD Main Science and Technology Indicators (data published in March 2023); OECD: Science, Technology and R&D Statistics.



Figure 1.2

## Research FTEs in Finland and in peer countries relative to R&D expenditure in 2021



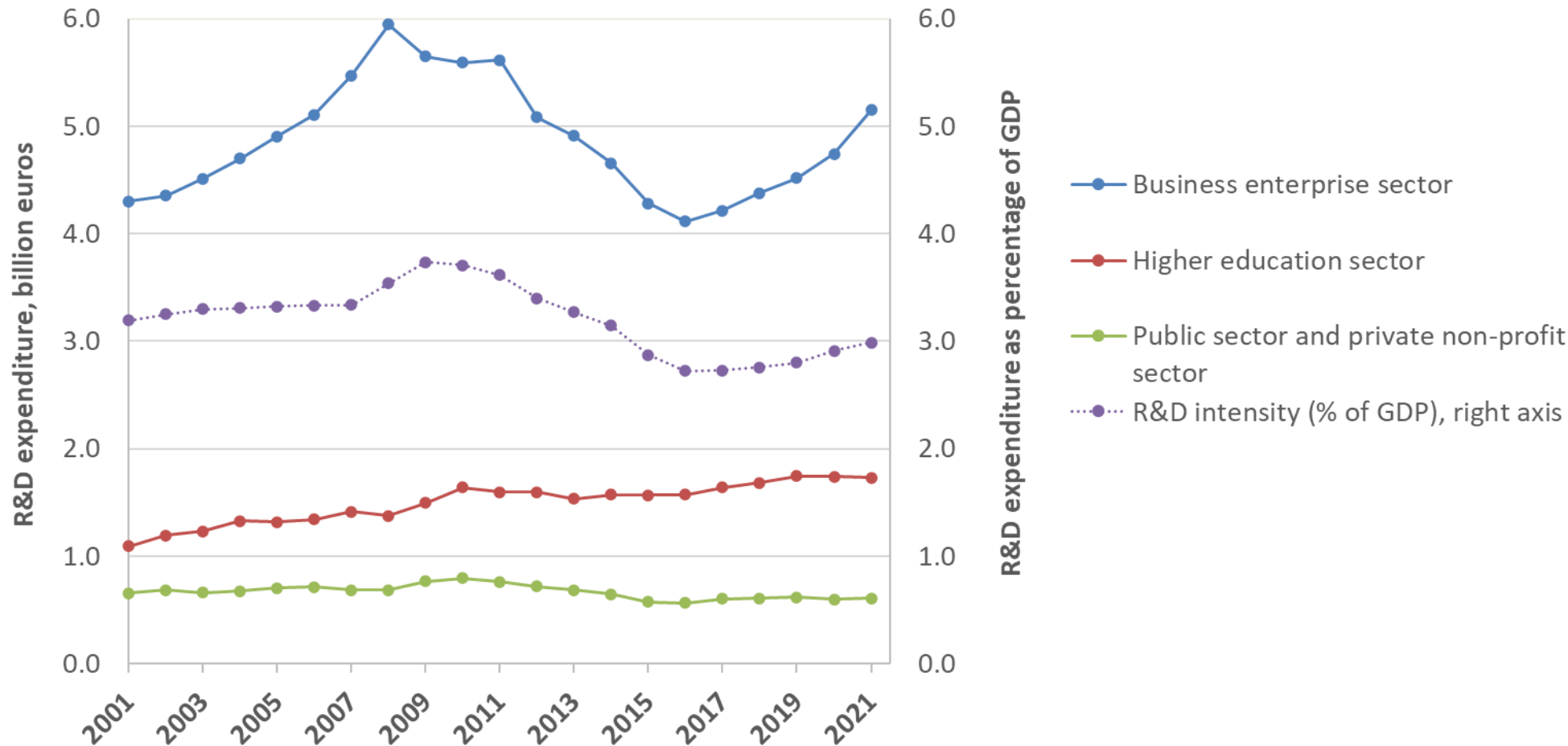
• Swiss data is for 2019.

Source: Eurostat, science and technology, total researchers by sectors of performance - full time equivalent and GERD by sector of performance (data published in March 2023).

Figure 1.3

## Finnish R&D expenditure (billion euros) and R&D intensity (R&D expenditure as percentage of GDP) by sector of performance

Sectors as defined in Statistics Finland's R&D statistics.



- The higher education sector comprises universities, university hospitals and universities of applied sciences. In addition to universities operating under the Ministry of Education and Culture, the sector includes the National Defence University (from 2016) and the Police University College and the Åland University of Applied Sciences (from 2013); the latter three were previously classified in the public sector.
- The public sector comprises central government branches and state research institutes, municipalities (since 2007) and other public institutions.
- R&D expenditure figures are adjusted for inflation.

Sources: Statistics Finland, Research and development; R&D intensity data drawn from OECD Main Science and Technology Indicators (data published in March 20223).

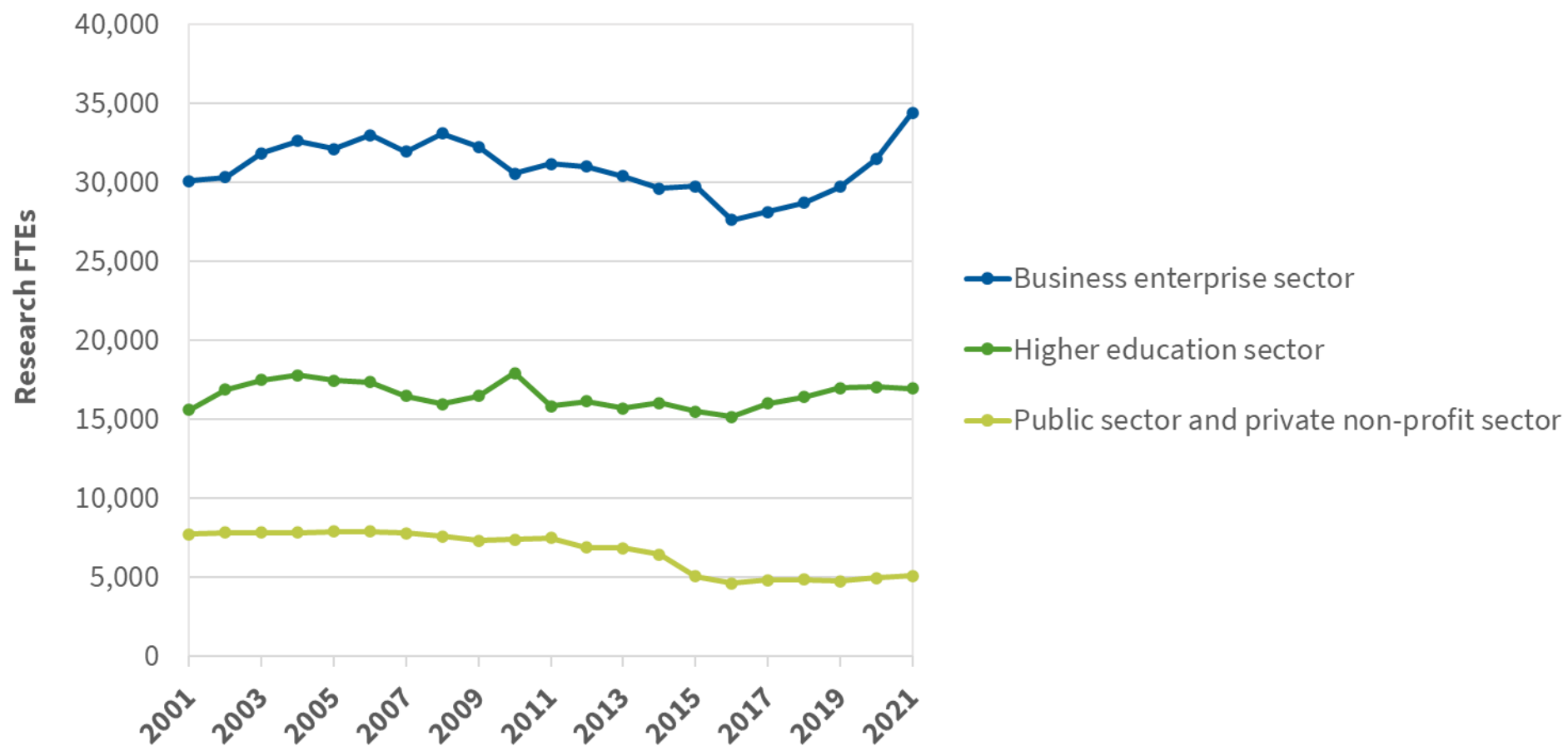
# Research personnel



Figure 2.1

## Research FTEs by sector of performance

Sectors as defined in Statistics Finland's R&D statistics.



- The higher education sector comprises universities, university hospitals and universities of applied sciences. In addition to universities operating under the Ministry of Education and Culture, the sector includes the National Defence University (from 2016) and the Police University College and the Åland University of Applied Sciences (from 2013); the latter three were previously classified in the public sector.
- The public sector comprises central government administrative branches and state research institutes, municipalities (since 2007) and other public institutions

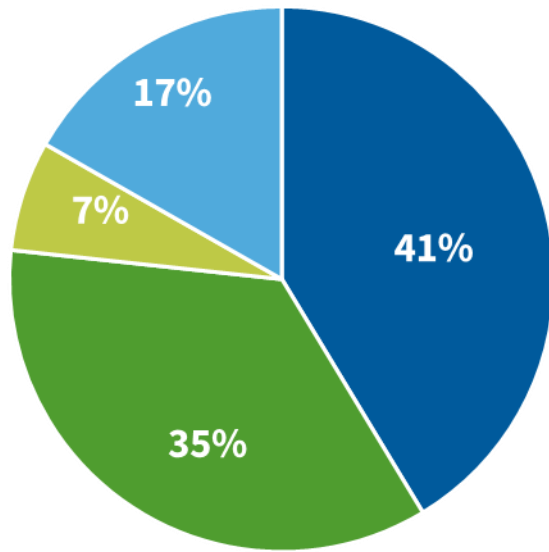
Source: Statistics Finland, Research and development.

Figure 2.2

## Educational level of R&D personnel by sector in 2021

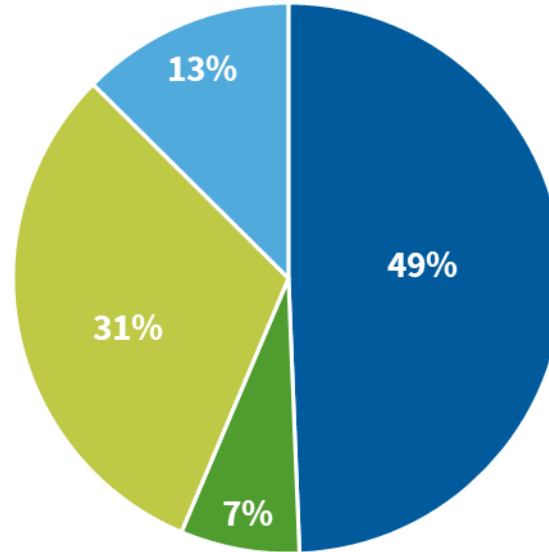
The graph shows the share of each educational level in total R&D personnel and total number of R&D personnel by sector.

### Higher education sector



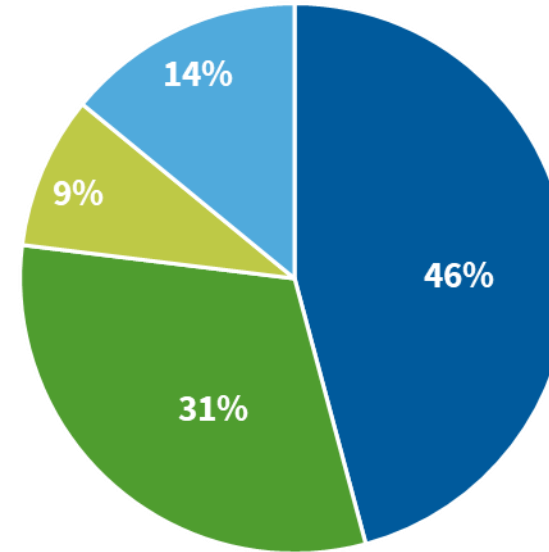
R&D personnel number:  
33,788

### Business enterprise sector



R&D personnel number:  
46,115

### Public and non-profit sector



R&D personnel number:  
7,461

■ University degree  
■ Doctoral degree  
■ University of applied sciences degree  
■ Other education

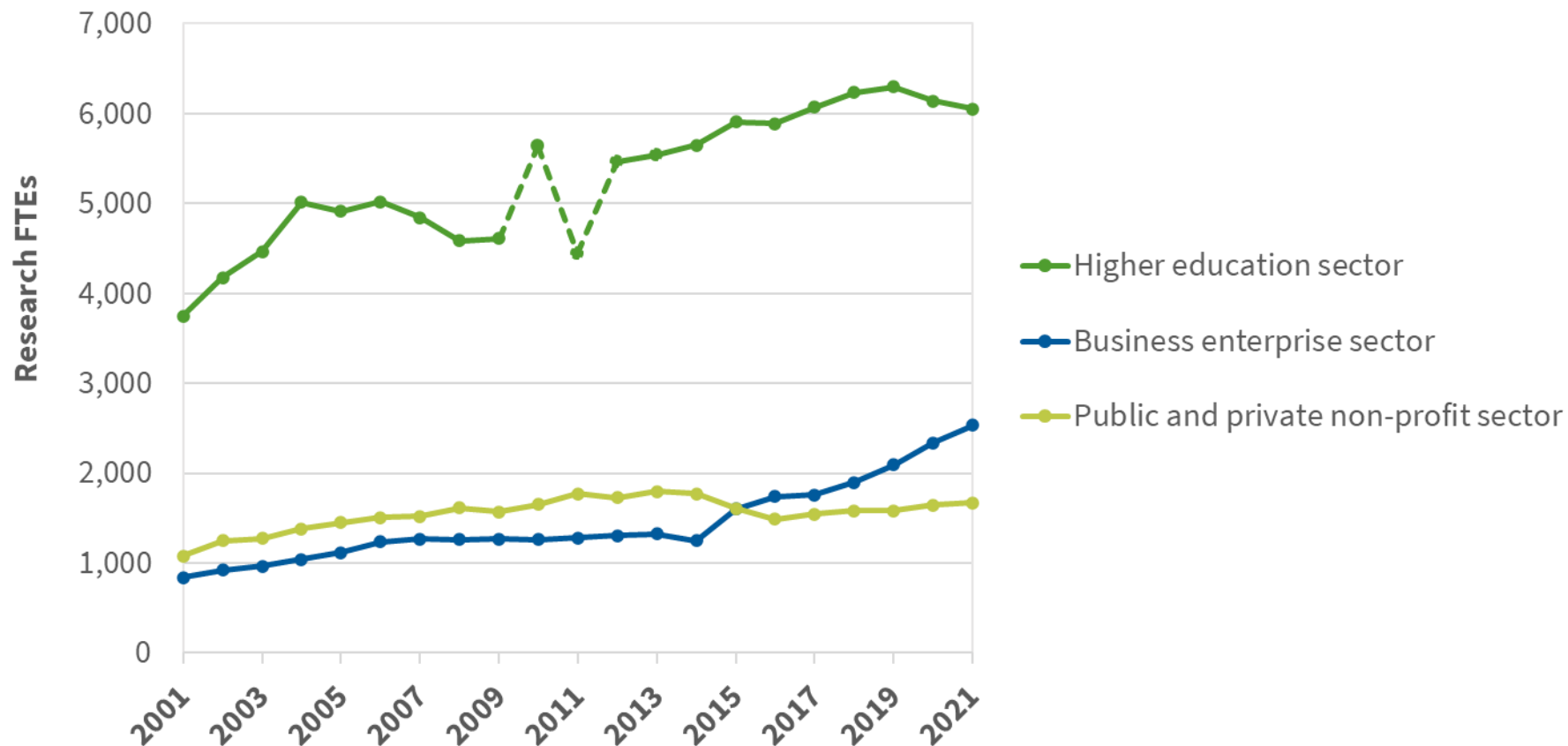
- The higher education sector comprises universities, university hospitals and universities of applied sciences. In addition to universities operating under the Ministry of Education and Culture, the sector includes the National Defence University (from 2016) and the Police University College and the Åland University of Applied Sciences (from 2013); the latter three were previously classified in the public sector. For the higher education sector, 'Other education' includes missing data for education.
- The public sector comprises central government administrative branches and state research institutes, municipalities (since 2007) and other public institutions.

Source: Statistics Finland, Research and development.

Figure 2.3a

## PhDs' research FTEs by sector

Sectors as defined in Statistics Finland's R&D statistics.



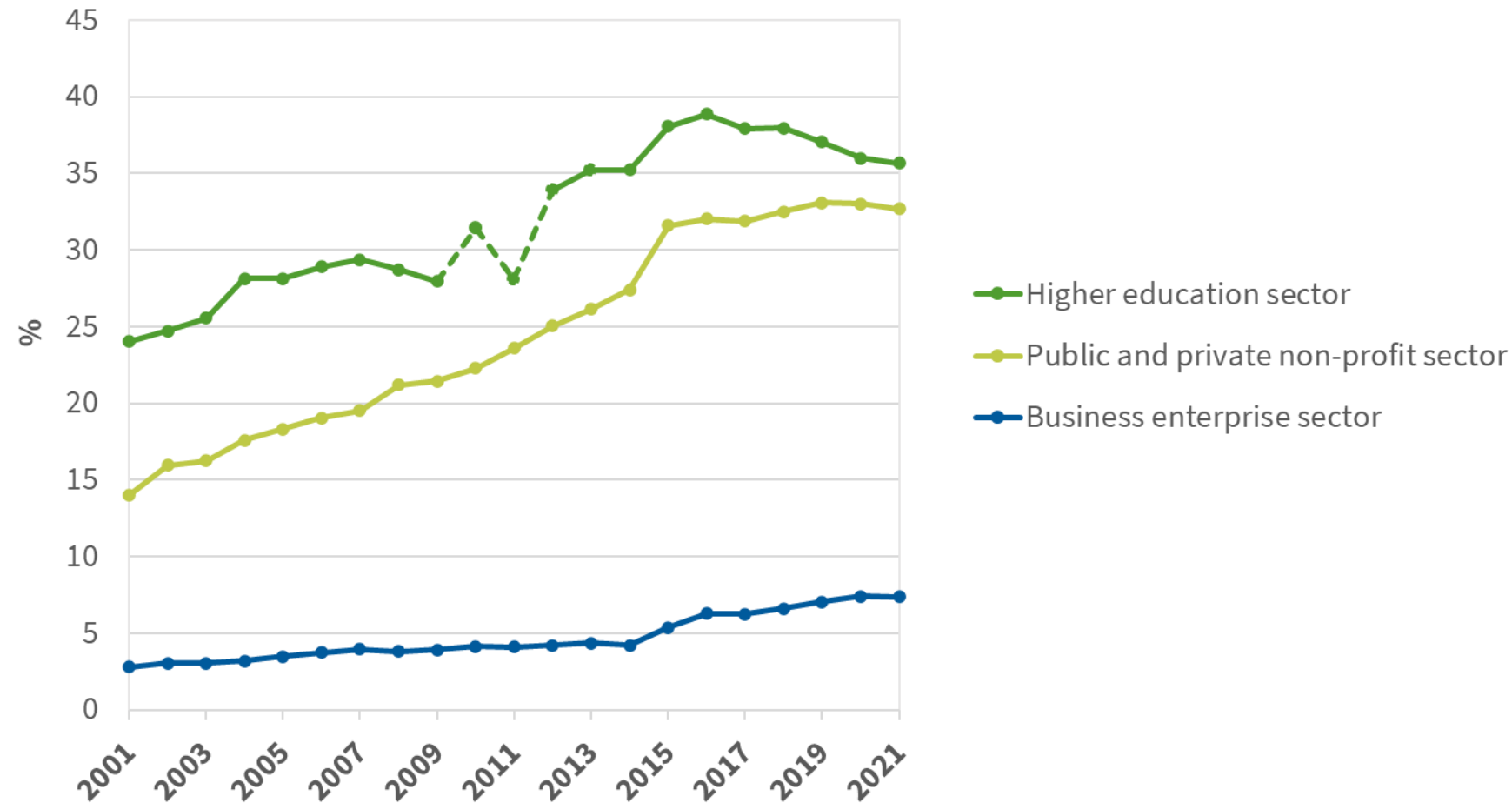
- The higher education sector comprises universities, university hospitals, universities of applied sciences and public or private research institutes closely integrated with university research activities. In addition to universities operating under the Ministry of Education and Culture, the sector includes the National Defence University (from 2016) and the Police University College and the Åland University of Applied Sciences (from 2013); the latter three were previously classified in the public sector.
- The public sector comprises central government administrative branches and state research institutes, municipalities (since 2007) and other public institutions.

Source: Statistics Finland, Research and development.

Figure 2.3b

## PhDs' research FTEs as proportion of total research FTEs

Sectors as defined in Statistics Finland's R&D statistics.

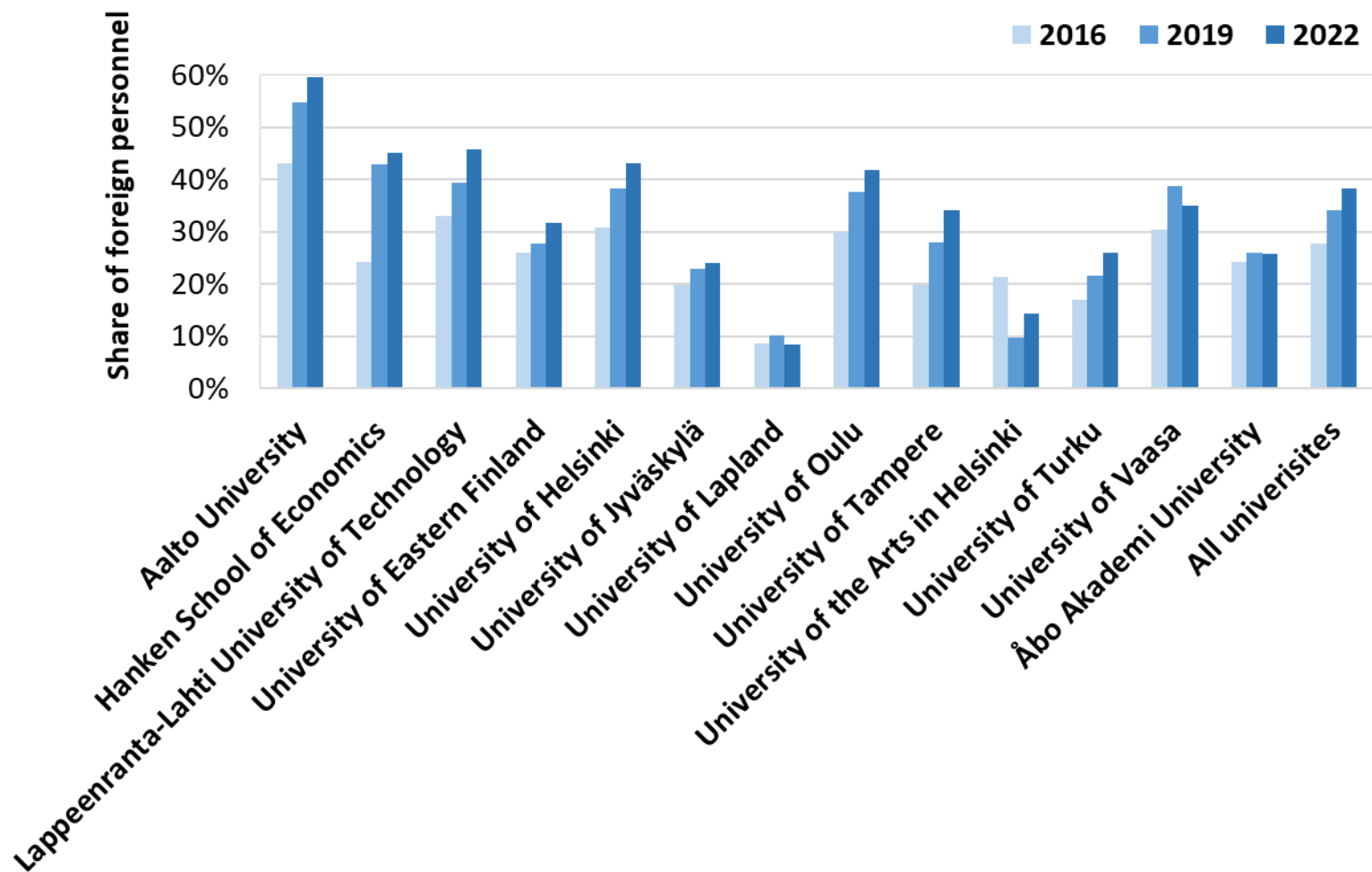


- The higher education sector comprises universities, university hospitals, universities of applied sciences and public or private research institutes closely integrated with university research activities. In addition to universities operating under the Ministry of Education and Culture, the sector includes the National Defence University (from 2016) and the Police University College and the Åland University of Applied Sciences (from 2013); the latter three were previously classified in the public sector.
- The public sector comprises central government administrative branches and state research institutes, municipalities (since 2007) and other public institutions.

Source: Statistics Finland, Research and development.

Figure 2.8a

## Foreign teaching and research personnel FTEs as proportion of total university teaching and research personnel FTEs by university at career stages I–II in 2016, 2019 and 2022



University	FTEs
Aalto University	1,617
Hanken School of Economics	83
Lappeenranta-Lahti University of Technology	418
University of Eastern Finland	907
University of Helsinki	2,217
University of Jyväskylä	1,076
University of Lapland	185
University of Oulu	1,311
University of Tampere	1,430
University of the Arts in Helsinki	201
University of Turku	1,130
University of Vaasa	192
Åbo Akademi University	388
All universities	11,154

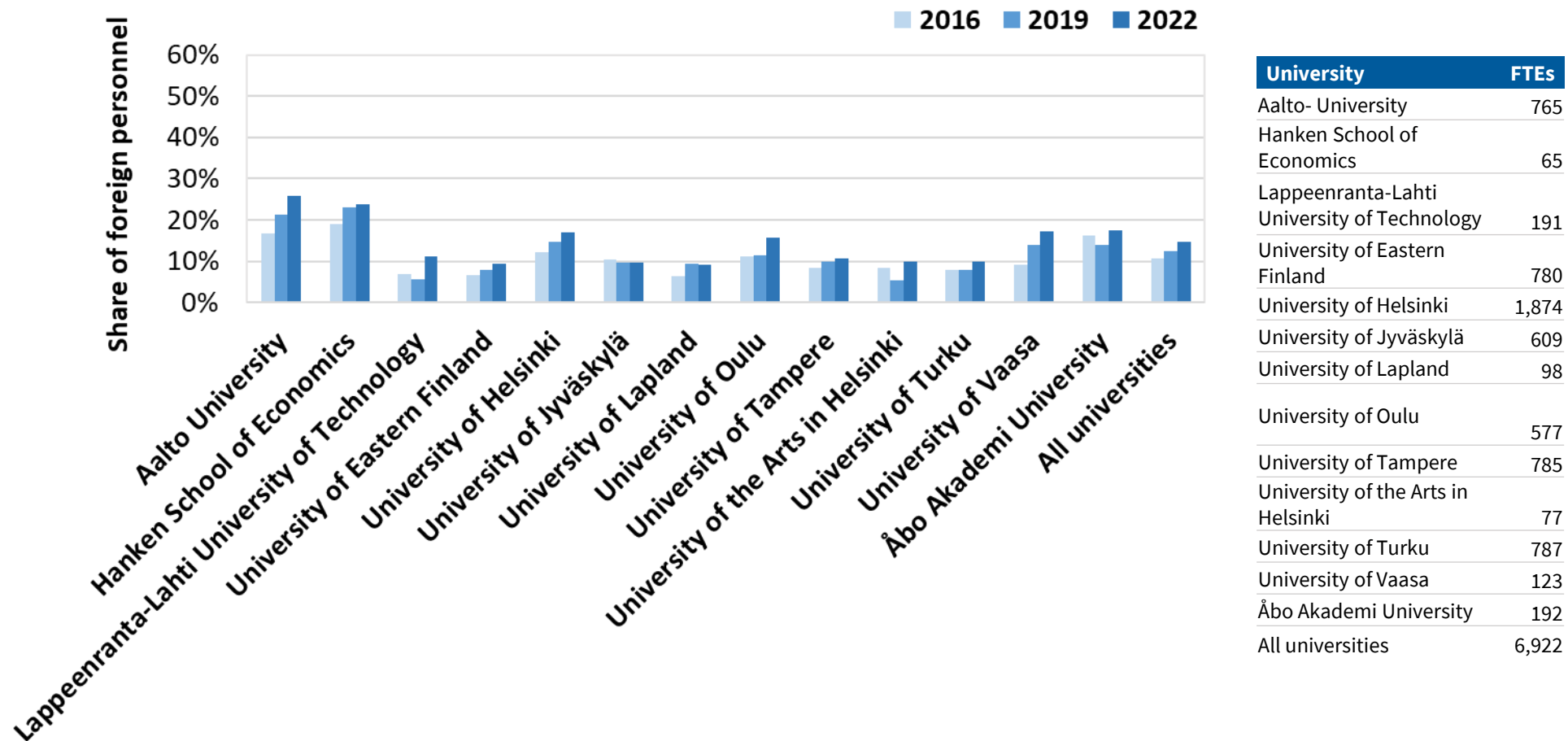
- The University of Helsinki aligned its statistical practices with other universities in 2017 and began to report data for teaching and research assistants under the category of support staff for teaching and research. This implied a transfer of some 250 FTEs from career stage I teaching and research personnel to support staff for teaching and research. Therefore, the data reported for 2016 do not accurately reflect the true situation at the University of Helsinki.
- FTE reporting practices at the University of the Arts in Helsinki were updated in 2019. FTEs for lecturers were previously allocated to career stage III, but since 2019 they have been reported under career stage II. Thus, the change in FTE figures for career stages I–II seen in the graph does not accurately reflect the true change at the University of the Arts in Helsinki or in the disciplinary group of arts and literature studies.
- FTE data do not include the category 'data on citizenship missing'.

Source: Vipunen -- Education Statistics Finland, University education, Personnel.



Figure 2.8b

## Foreign teaching and research personnel FTEs as proportion of total university teaching and research personnel FTEs by university at career stages III–IV in 2016, 2019 and 2022



University	FTEs
Aalto- University	765
Hanken School of Economics	65
Lappeenranta-Lahti University of Technology	191
University of Eastern Finland	780
University of Helsinki	1,874
University of Jyväskylä	609
University of Lapland	98
University of Oulu	577
University of Tampere	785
University of the Arts in Helsinki	77
University of Turku	787
University of Vaasa	123
Åbo Akademi University	192
All universities	6,922

- FTE figures for university teaching and research personnel do not include grant-funded personnel. Universities also differ in how they allocate positions to different career stages.
- FTE reporting practices at the University of the Arts in Helsinki were updated in 2019. FTEs for lecturers were previously allocated to career stage III, but since 2019 they have been reported under career stage II. Thus, the change in FTE figures for career stages III–IV seen in the graph does not accurately reflect the true change at the University of the Arts in Helsinki or in the disciplinary group of arts and literature studies.

Source: Vipunen -- Education Statistics Finland, University education, Personnel.

Table 2.12

## University teaching and research personnel FTEs at career stages III-IV by gender and disciplinary group in 2016, 2019 and 2022

Disciplinary group	2016		2019		2022	
	Share of women, %	FTEs total	Share of women, %	FTEs total	Share of women, %	FTEs total
Mathematics, statistics	12 %	195	16 %	181	16 %	193
Physics, geosciences, space science	15 %	365	15 %	372	19 %	426
Chemistry, chemical engineering	26 %	212	31 %	200	29 %	199
ICT and electrical engineering	14 %	489	12 %	495	15 %	581
Materials science, materials engineering	15 %	102	21 %	122	21 %	147
Engineering, other fields	22 %	307	23 %	278	27 %	287
Business studies and economics	34 %	440	34 %	502	35 %	550
Ecology, environmental science, plant biology	34 %	259	41 %	301	41 %	289
Agricultural and forest sciences	48 %	213	49 %	165	53 %	193
Biomedicine, biosciences	41 %	509	45 %	549	47 %	609
Clinical medicine	46 %	468	47 %	430	51 %	481
Health sciences	58 %	204	60 %	213	62 %	222
Behavioural sciences	62 %	569	63 %	573	65 %	598
Social sciences, other fields	43 %	649	48 %	714	53 %	782
Languages	61 %	379	64 %	425	65 %	381
Arts, literature studies	47 %	456	49 %	431	53 %	296
Humanities, other fields	40 %	349	40 %	340	45 %	386
<b>All disciplines</b>	<b>39 %</b>	<b>6,180</b>	<b>41 %</b>	<b>6,310</b>	<b>43 %</b>	<b>6,634</b>

- 'All disciplines' includes FTEs in the disciplinary group 'other natural sciences'.
- FTE figures for university teaching and research personnel do not include grant-funded personnel. Universities also differ in how they allocate positions to different career stages.
- FTE reporting practices at the University of the Arts in Helsinki were updated in 2019. FTEs for lecturers were previously allocated to career stage III, but since 2019 they have been reported under career stage II. Since 2019 career stage II has comprised postdoctoral researchers, lecturers and university teachers; and career stage III university lecturers, university researchers, Academy Research Fellows and assistant professors.

Source: Vipunen -- Education Statistics Finland, University education, Personnel.

Table 2.15

## Foreign RDI personnel FTEs as proportion of total FTEs at universities of applied sciences in 2016, 2019 and 2022

	2016	2019	2022
Share of foreign personnel, %	2 %	3 %	4 %
Foreign personnel, FTEs	22	39	82
Total RDI personnel, FTEs	984	1,348	1,933

- Citizenship is not a compulsory data collection item for universities of applied sciences. In 2016 data were missing for 6 FTEs, in 2019 for 144 FTEs and in 2022 for 74 FTEs. This introduces some uncertainty to the calculation of percentage shares.

Source: Vipunen -- Education Statistics Finland, University of applied sciences education, Personnel.

Table 2.16

## Universities of applied sciences teaching and RDI personnel FTEs by gender and disciplinary group in 2016, 2019 and 2022

Disciplinary group	2014		2017		2020	
	Share of women, %	FTEs total	Share of women, %	FTEs total	Share of women, %	FTEs total
Mathematics, statistics	38 %	99	39 %	79	35 %	91
Physics, geosciences and space science		46		45		52
Chemistry, chemical engineering	63 %	58	48 %	85	55 %	99
Natural sciences, other fields		14		13		26
ICT and electrical engineering	23 %	603	20 %	617	19 %	712
Materials science, materials engineering		32		26		29
Engineering, other fields	24 %	772	25 %	747	29 %	904
Business studies and economics	60 %	935	63 %	1,286	63 %	1,008
Ecology, environmental science, plant biology		10		9		11
Agricultural and forest sciences	52 %	178	56 %	198	55 %	173
Biomedicine, biosciences		12		12		10
Clinical medicine		20		15		13
Health sciences	90 %	1,129	89 %	1,036	87 %	1,374
Behavioural sciences	76 %	226	77 %	289	80 %	261
Social sciences, other fields	67 %	632	69 %	599	72 %	771
Languages	86 %	374	87 %	332	85 %	408
Arts, literature studies	52 %	310	52 %	252	55 %	314
Humanities, other fields	72 %	170	79 %	145	77 %	157
<b>All disciplines</b>	<b>59 %</b>	<b>5,621</b>	<b>59 %</b>	<b>5,785</b>	<b>60 %</b>	<b>6,414</b>

- FTEs for which data on discipline is missing are not included in the table.

Source: Vipunen -- Education Statistics Finland, University of applied sciences education, Personnel.

# Scientific publishing



Table 3.1

# Publication profile in Finland and in peer countries by disciplinary group 2017–2020

Data from Web of Science database. Publication share for discipline highlighted when it is at least 0.5 percentage points higher than the world average.

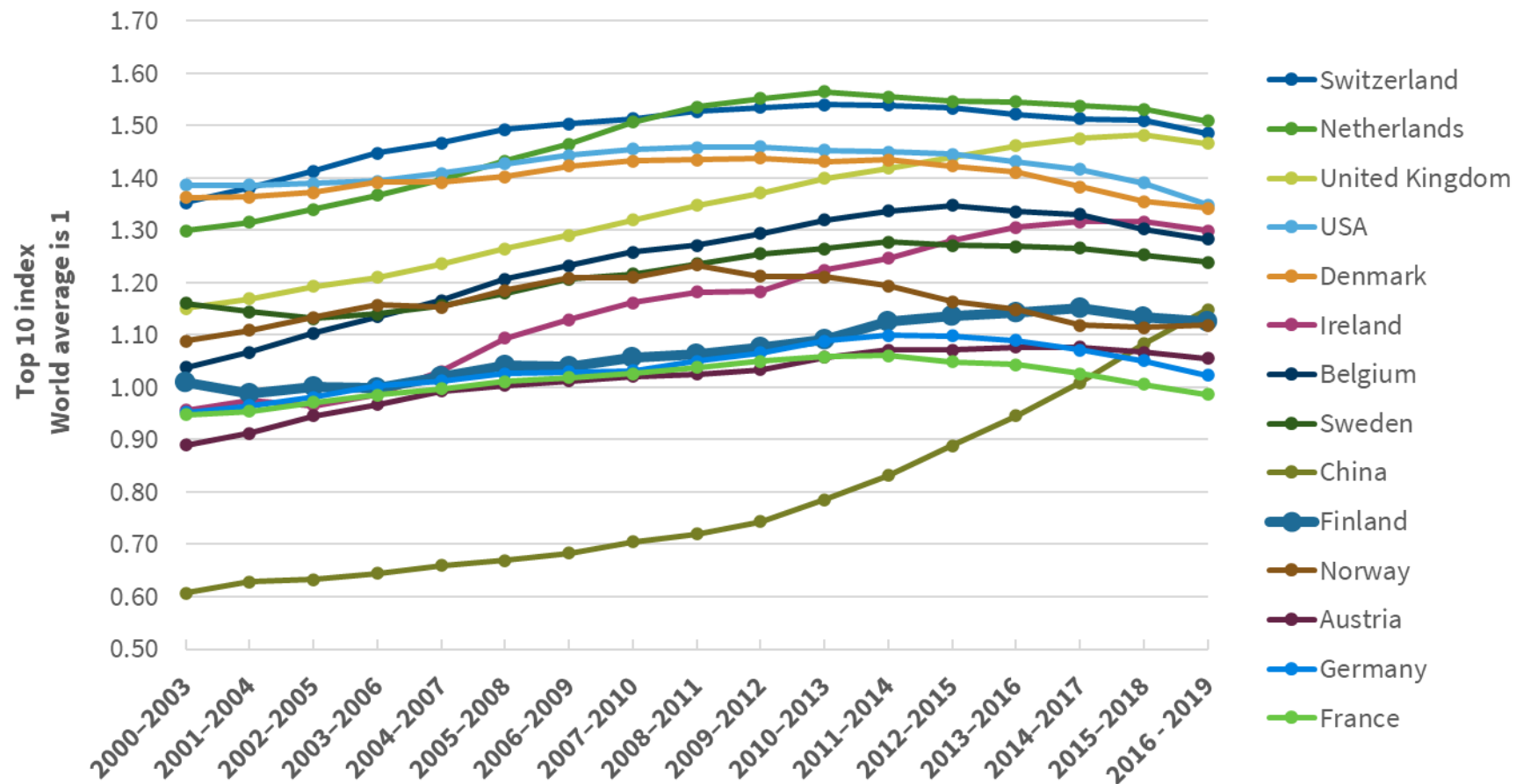
Number of publications (fractional)		Share of country's publications, %														
Disciplinary group	Finland	Finland	Nether lands	Belgium	Ireland	United Kingdom	Austria	China	Norway	France	Sweden	Switzer land	Germany	Denmark	USA	World
Mathematics and statistics	941	2.0	1.3	2.1	1.6	1.9	3.9	2.6	1.8	4.3	1.8	2.3	2.8	1.3	2.1	2.6
Physics, geosciences, space science	4,444	9.5	8.5	9.8	6.9	9.2	10.8	14.0	9.7	14.6	9.0	13.2	13.6	8.0	9.0	11.3
Chemistry, chemical engineering	2,257	4.8	4.0	5.9	4.7	4.1	5.9	12.9	3.3	6.9	5.0	6.0	7.8	4.4	4.2	7.6
ICT and electrical engineering	6,371	13.6	7.5	9.2	10.9	8.1	12.6	15.8	8.7	12.0	9.9	9.0	11.0	8.8	8.8	11.6
Materials science, materials engineering	1,501	3.2	2.4	3.3	3.2	2.7	3.6	7.9	1.9	4.0	3.2	3.5	4.2	2.2	3.1	4.8
Engineering, other fields	2,805	6.0	4.5	5.2	4.1	5.1	6.0	10.4	8.9	4.8	6.5	4.2	6.0	6.6	4.3	7.2
Business studies and economics	2,118	4.5	3.4	2.8	3.2	3.8	3.0	1.4	3.9	2.9	3.6	2.7	2.7	3.1	2.7	2.7
Ecology, environmental science and plant biology	3,122	6.7	4.8	5.9	4.2	4.5	5.7	6.1	6.3	5.4	5.7	5.6	5.1	6.0	5.3	5.9
Agricultural and forest sciences	1,356	2.9	1.8	3.1	4.5	1.7	2.5	2.1	2.6	2.0	1.7	2.3	1.9	2.9	2.0	2.8
Biomedicine, biosciences	3,653	7.8	11.2	11.4	9.3	9.2	10.4	11.5	7.4	11.0	10.2	12.0	10.6	12.1	12.0	10.3
Clinical medicine	6,234	13.3	24.2	18.3	18.0	17.5	17.9	9.1	14.5	17.8	18.4	20.2	17.3	22.6	21.2	15.5
Health sciences	2,379	5.1	5.7	3.7	6.7	5.3	2.5	0.9	7.5	2.4	6.6	3.8	2.6	6.0	6.1	3.6
Behavioural sciences	2,435	5.2	5.2	3.9	5.9	5.1	2.6	0.9	5.5	1.5	3.9	2.8	3.3	2.6	5.4	3.2
Social sciences, other fields	3,768	8.0	7.8	7.0	7.7	10.2	4.9	1.5	9.8	3.0	7.4	4.8	4.0	6.6	6.1	4.6
Humanities	2,118	4.5	4.1	5.5	6.9	8.5	4.4	0.6	4.7	4.5	3.4	3.4	3.7	3.4	4.7	3.5
General scientific journals	1,359	2.9	3.5	2.9	2.3	3.2	3.5	2.1	3.2	3.0	3.8	4.3	3.4	3.4	3.1	2.9
<b>All disciplines</b>	<b>46,860</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

- International co-publications and publications classified into more than one discipline are fractionalised.
- Publication counts for Finland vary depending on whether the figures are drawn from Education Statistics Finland's data for Finland and Finnish organisations or from international comparative data. The difference stems from the fact that in international comparative data, publications are fractionalised based on country data alone, whereas for Finnish publications this is done based on the publishing organisation.
- Publications in many social sciences and humanities fields in particular are inadequately represented in Web of Science data. Therefore the number of WoS publications does not accurately reflect the true extent of scientific publishing in these fields.

Figure 3.2

## Scientific impact in Finland and in peer countries as measured by top 10 index

Data from Web of Science database.



- The top 10 index describes the proportion of the 10% most cited publications in the discipline. The world average in each discipline is 1. A top 10 index greater than 1 means that more than 10% of a country's/organisation's publications rank among the 10% most cited publications. When calculating the top 10 index, the number of citations to a publication is only compared to the number of citations to publications appearing in the same discipline in the same year.

Source: Clarivate Analytics Web of Science based data, bibliometric computing by CSC Ltd, 2022.



Table 3.3b

# Scientific impact in Finland and in peer countries by disciplinary group 2016–2019

Data from Scopus database. Three highest-impact disciplines highlighted for each country.

Number of publications (fractional)		Top 10 index													
Tieteenalaryhmä	Finland	Finland	Netherlands	Belgium	Ireland	United Kingdom	Austria	China	Norway	France	Sweden	Germany	Switzerland	Denmark	USA
Mathematics, statistics	1,420	1.07	1.20	1.11	1.18	1.43	1.03	1.06	1.09	0.96	1.05	0.99	1.47	1.39	1.19
Physics, geosciences, space science	4,123	1.26	1.65	1.33	1.31	1.55	1.28	0.96	1.15	1.18	1.35	1.28	1.78	1.65	1.48
Chemistry, chemical engineering	1,842	0.99	1.50	1.11	1.24	1.28	0.93	1.21	0.84	0.87	1.19	1.04	1.48	1.18	1.40
ICT and electrical engineering	7,218	1.14	1.12	1.16	1.06	1.42	0.91	1.10	0.97	0.82	1.16	0.86	1.62	1.48	1.42
Materials science, materials engineering	2,454	1.00	1.25	1.15	1.11	1.25	0.78	1.26	0.80	0.79	1.09	0.85	1.31	1.09	1.25
Engineering, other fields	3,426	1.27	1.43	1.33	1.55	1.43	0.80	1.10	0.98	1.05	1.25	0.89	1.55	1.48	1.00
Business studies and economics	2,521	1.25	1.61	1.23	0.96	1.43	1.22	1.27	1.16	0.90	1.31	0.98	1.37	1.48	1.31
Ecology, environmental science, plant biology	2,865	1.31	1.87	1.53	1.55	1.66	1.39	1.00	1.32	1.31	1.61	1.36	1.77	1.68	1.27
Agricultural and forest sciences	1,474	1.49	1.74	1.34	1.93	1.54	1.30	1.09	1.41	1.28	1.49	1.16	1.51	1.59	1.23
Biomedicine, biosciences	4,422	1.14	1.44	1.33	1.59	1.50	1.26	0.90	1.04	1.07	1.24	1.14	1.54	1.24	1.39
Clinical medicine	5,981	1.26	1.56	1.46	1.21	1.42	1.20	0.80	1.22	0.99	1.4466	1.00	1.36	1.49	1.41
Health sciences	2,000	1.27	1.40	1.43	1.39	1.31	1.25	1.29	1.13	0.57	1.11	0.83	1.45	1.30	1.13
Behavioural sciences	1,837	1.37	1.77	1.47	0.97	1.24	0.94	1.00	1.07	0.46	1.08	1.09	1.19	1.25	1.18
Social sciences, other fields	3,000	1.18	1.77	1.23	0.99	1.34	1.28	1.19	1.33	0.56	1.4468	1.14	1.42	1.46	1.16
Humanities	2,095	1.17	1.66	1.03			1.05	1.36	1.40	0.57	1.33	0.98	1.26	1.43	1.32
Yleistieteelliset lehdet	717	0.94	1.51	1.14	1.22	1.35	1.31	0.62	1.02	1.17	1.19	1.29	1.95	1.52	1.89
All disciplines	47,396	1.20	1.52	1.31	1.27	1.42	1.10	1.05	1.12	0.96	1.29	1.04	1.52	1.43	1.33

- The top 10 index describes the proportion of the 10% most cited publications in the discipline. The world average in each discipline is 1. A top 10 index greater than 1 means that more than 10% of a country's/organisation's publications rank among the 10% most cited publications. When calculating the top 10 index, the number of citations to a publication is only compared to the number of citations to publications appearing in the same discipline in the same year.
- The top 10 index value is not calculated if the publication count is less than 50 or if internal coverage is below 40%. Internal coverage refers to the proportion of references in database publications that are also indexed in the database.

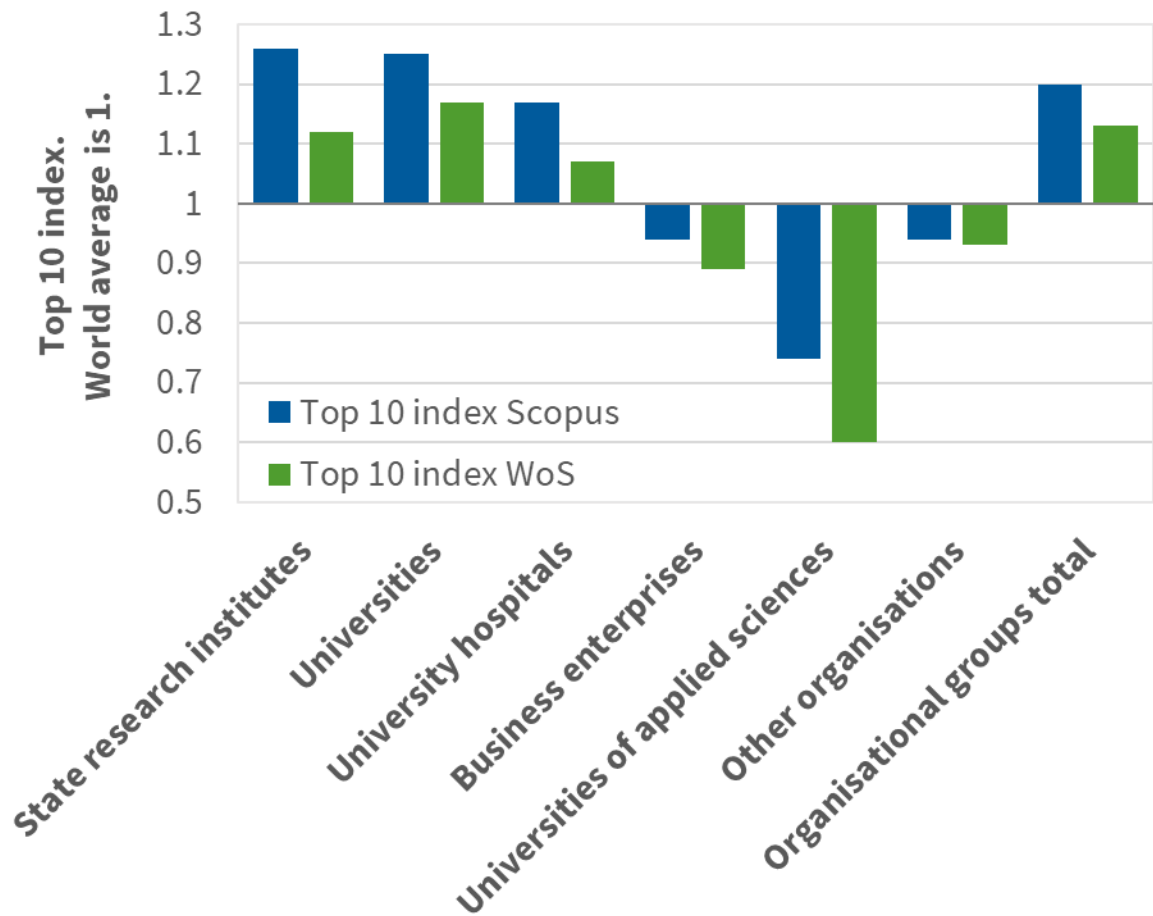
Source: Elsevier Scopus based data, bibliometric computing by CSC Ltd, 2022.



Figure 3.5

# Number of publications and scientific impact of organisational groups 2016–2019

Data from Scopus and Web of Science databases.



Publication count		
	Scopus	WoS
All organisational groups	47,286	47,594
Universities	34,442	34,730
University hospitals	4,215	4,230
State research institutes	3,228	3,398
Business enterprises	2,251	2,023
Universities of applied sciences	716	798
Other organisations	2,434	2,415

- Other organisations include: National Defence University, Police University College, Åland University of Applied Sciences, Finnish Institute of International Affairs, other hospitals, municipal organisations, scientific societies, central government organisations, religious organisations, sports clubs, labour market organisations, industry federations and associations, interational organisations, and publications with incomplete Finnish address.
- The top 10 index describes the proportion of the 10% most cited publications in the discipline. The world average in each discipline is 1. A top 10 index greater than 1 means that more than 10% of a country's/organisation's publications rank among the 10% most cited publications. When calculating the top 10 index, the number of citations to a publication is only compared to the number of citations to publications appearing in the same discipline in the same year.
- The top 10 index value is not calculated if the publication count is less than 50 or if internal coverage is below 40%. Internal coverage refers to the proportion of references in database publications that are also indexed in the database.
- Publication counts for Finland vary depending on whether the figures are drawn from Education Statistics Finland's data for Finland and Finnish organisations or from international comparative data. The difference stems from the fact that in international comparative data, publications are fractionalised based on country data alone, whereas for Finnish publications this is done based on the publishing organisation.

Sources: Elsevier Scopus based data and Clarivate Analytics Web of Science based data, bibliometric computing by CSC Ltd, 2022.

Table 3.11

## Share of open access publications 2016–2021

Publication data from Ministry of Education and Culture.

Organisational group	Share of open access publications		Number of all publications (full count)	
	2016–2019	2018–2021	2016–2019	2018–2021
Universities	53 %	72 %	115,165	122,083
Universities of applied sciences	59 %	71 %	2,904	3,292

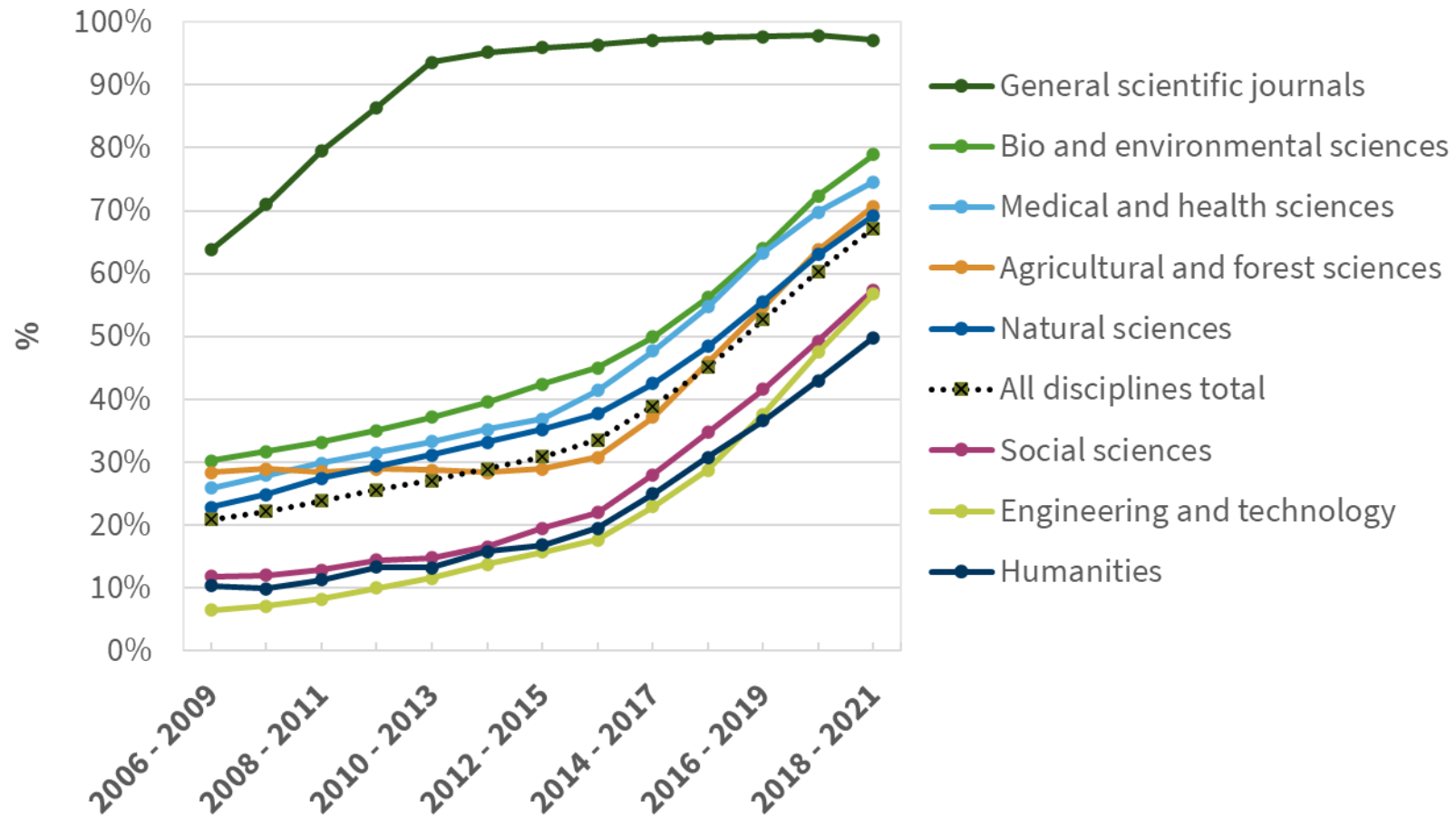
- The Table shows the publication counts for the following main categories of the Ministry of Education and Culture's classification of publication types: A) peer-reviewed scientific articles and C) scientific books (monographs).
- Publications not included in total publication count if data on open access is missing.

Source: Vipunen – Education Statistics Finland, Higher education and R&D activity, Publications.

Figure 3.13

## Share of open access publications in Finland by main field of science

Data from Web of Science database.



### Number of publications 2018-2021

Natural sciences	10,090
Bio and environmental sciences	5,076
Engineering and technology	8,305
Medical and health sciences	11,062
Agricultural and forest sciences	1,406
Social sciences	8,559
Humanities	2,260
General scientific journals	1,378
All disciplines total	48,134

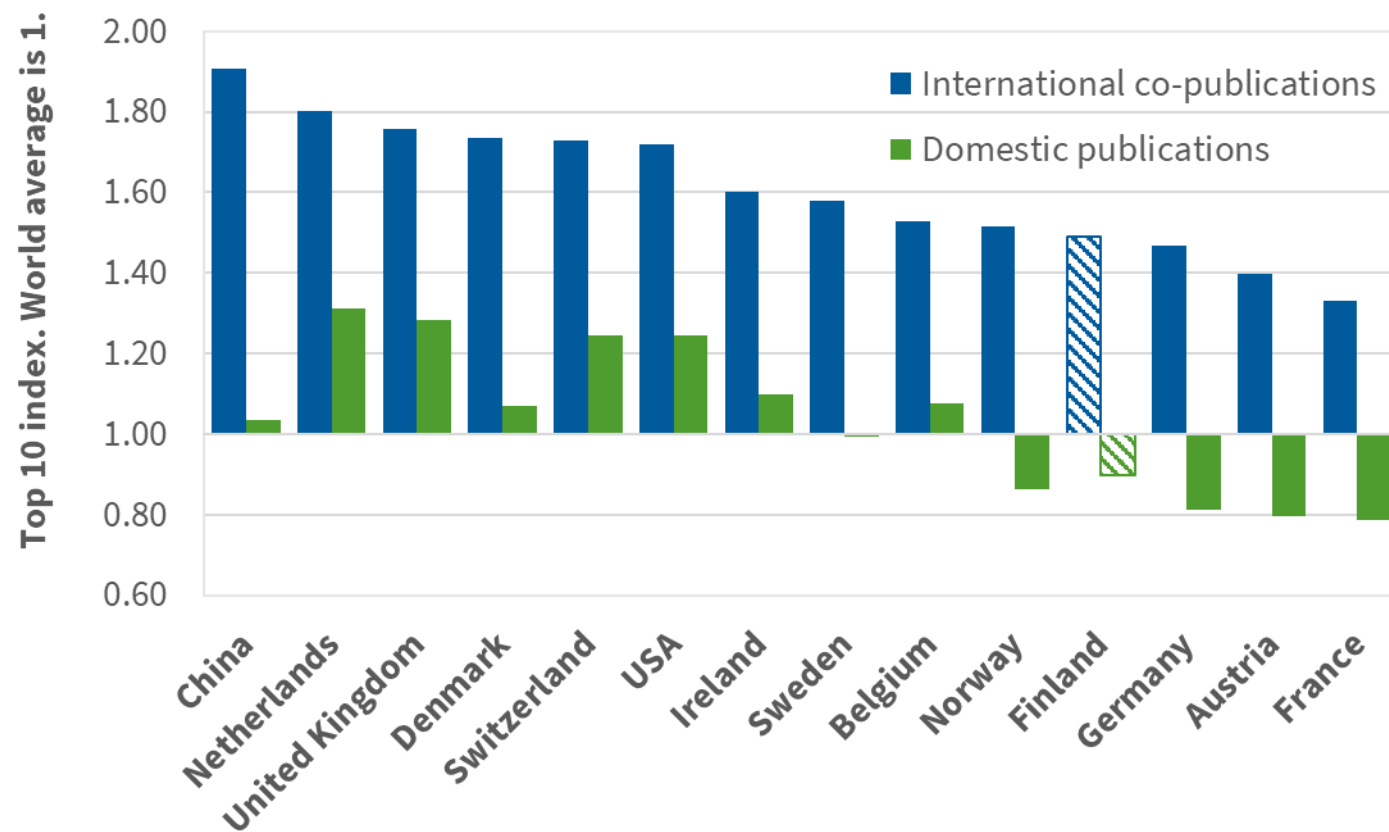
- The Figure follows the open access categories by Web of Science database: <https://webofscience.help.clarivate.com/en-us/Content/open-access.html>
- Publications not included if data on discipline or open access category is missing.

Source: Clarivate Analytics Web of Science based data, bibliometric computing by CSC Ltd, 2023.

Figure 3.15

## Scientific impact of publications in Finland and in peer countries by type of co-publishing 2016–2019

Data from Web of Science database. Countries listed in order of top 10 index for international co-publications.



- The top 10 index describes the proportion of the 10% most cited publications in the discipline. The world average in each discipline is 1. A top 10 index greater than 1 means that more than 10% of a country's/organisation's publications rank among the 10% most cited publications. When calculating the top 10 index, the number of citations to a publication is only compared to the number of citations to publications appearing in the same discipline in the same year.
- At least one author of international co-publications is affiliated with an organisation in a country other than that under consideration. The authors of domestic publications all work in the country concerned.

Source: Clarivate Analytics Web of Science based data, bibliometric computing by CSC Ltd, 2022.

Table 3.16

## Finland's top 10 bilateral co-publishing partners, publication counts and scientific impact 2006–2009 and 2016–2019

Data from Web of Science database. Countries listed in order of co-publication counts.

2006–2009					2016–2019				
Country	Co-publications with Finland (fractional)	Top 10 index for co-publications	Total publication count (fractional)	Top 10 index for all publications	Country	Co-publications with Finland (fractional)	Top 10 index for co-publications	Total publication count (fractional)	Top 10 index for all publications
USA	1,022	1.46	1,452,442	1.44	USA	1,413	1.68	1,825,960	1.35
Sweden	629	1.02	63,425	1.21	Sweden	1,156	1.15	92,210	1.24
United Kingdom	591	1.43	371,629	1.29	United Kingdom	944	1.55	476,907	1.47
Germany	523	1.06	319,779	1.03	Chila	869	1.56	1,710,705	1.15
Russia	345	0.49	112,069	0.21	Germany	826	1.27	422,025	1.02
China	221	1.13	602,095	0.68	Russia	650	0.58	269,827	0.20
Netherlands	214	2.01	100,166	1.46	Italy	411	1.42	294,693	1.03
France	204	1.10	229,591	1.02	Spain	360	1.28	254,096	0.92
Italy	199	1.10	198,511	0.90	France	329	1.23	271,446	0.99
Canada	188	0.98	206,520	1.24	Australia	322	1.65	250,350	1.41
<b>Finland</b>			<b>35 922</b>	<b>1,04</b>	<b>Finland</b>			<b>47 620</b>	<b>1,13</b>

- The top 10 index describes the proportion of the 10% most cited publications in the discipline. The world average in each discipline is 1. A top 10 index greater than 1 means that more than 10% of a country's/organisation's publications rank among the 10 % most cited publications. When calculating the top 10 index, the number of citations to a publication is only compared to the number of citations to publications appearing in the same discipline in the same year.

Source: Clarivate Analytics Web of Science based data, bibliometric computing by CSC Ltd, 2022.

Table 3.19b

## Academic-corporate co-publications as proportion of by main field of science 2018–2021

Publication data from Ministry of Education and Culture.

Organisational group	Natural sciences	Engineering	Medical and health sciences	Agricultural and forest sciences	Social sciences	Humanities	All disciplines total
<b>Co-publications with business enterprises, %</b>							
Universities	6.7 %	13.0 %	8.2 %	9.7 %	2.1 %	0.5 %	5.9 %
Universities of applied sciences	4.4 %	7.5 %	2.4 %	4.3 %	1.4 %	1.4 %	2.8 %
<b>Total number of publications (fractional)</b>							
Universities	38,263	17,366	37,772	2,575	37,650	21,138	154,764
Universities of applied sciences	1,179	3,353	3,481	868	10,510	2,247	21,638

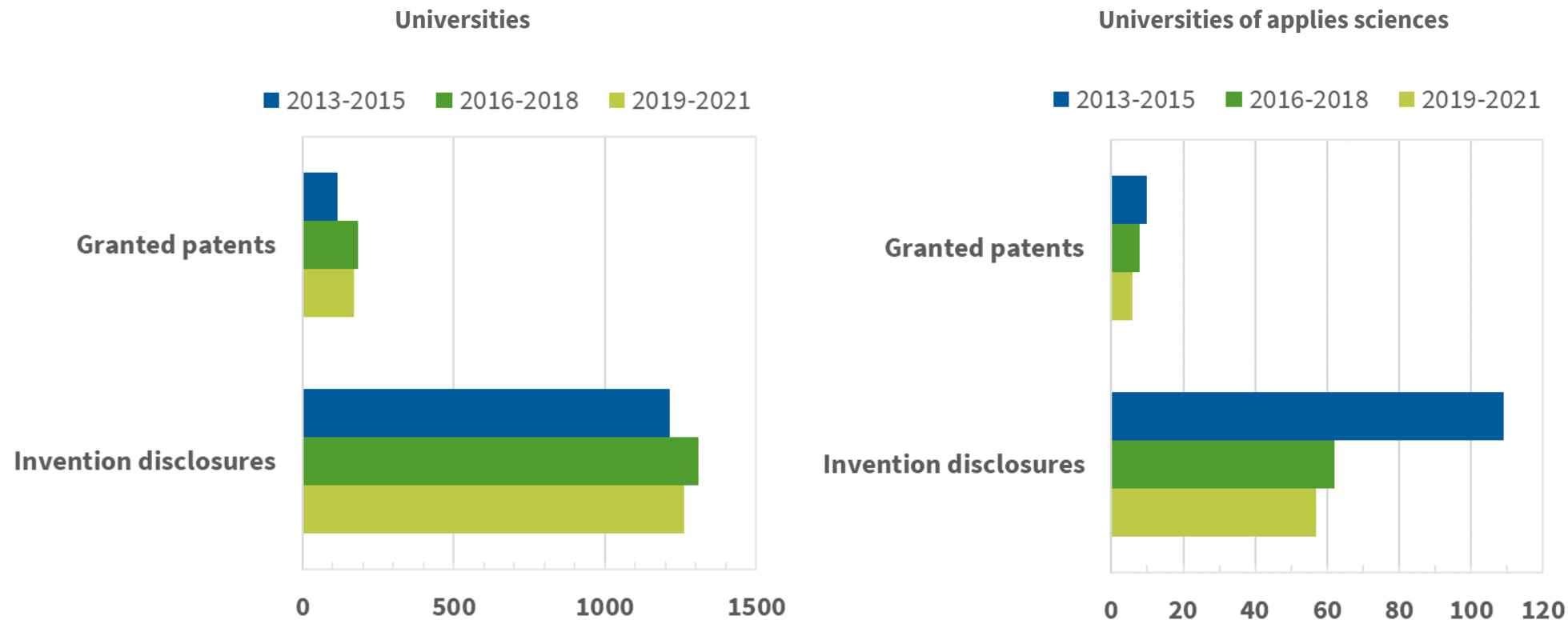
- The Table shows the publication counts for the following main categories of the Ministry of Education and Culture's classification of publication types: A) peer-reviewed scientific articles; B) non-refereed scientific articles; C) scientific books (monographs); and D) publications intended for professional communities.
- Publications not included in total publication count if co-publications data or if data on discipline is missing.

Source: Vipunen – Education Statistics Finland, Higher education and R&D activity, Publications.

Figure 3.20

## Invention disclosures and patents in higher education institutions 2013–2021

Publication data from Ministry of Education and Culture.



• The Table shows the publication counts for the following main categories of the Ministry of Education and Culture's classification of publication type H patents and invention disclosures.

Source: Vipunen – Education Statistics Finland, Higher education and R&D activity, Publications.

# Background, data and methods





# State of scientific research in Finland – statistics



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1. Research funding
2. Research personnel
3. Scientific publishing

## Main perspectives

- **Sectors** (universities, universities of applied sciences, state research institutes)
- **Disciplinary groups:** 17 groups (personnel) and 16 groups (publishing)
- **International comparisons** of research funding and publishing



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# Statistics production team

- Editors
  - Laura Taajamaa and Jasmiina Myllys
  - Contact and feedback: [tietoaineistot@aka.fi](mailto:tietoaineistot@aka.fi)
- Bibliometric calculations
  - Yrjö Leino, CSC – IT Center for Science Ltd.
- Layout
  - Source Creative Oy

# Peer countries

## **European countries comparable to Finland in terms of size and research system:**

Netherlands, Belgium, Ireland, Austria, Norway, Sweden, Switzerland, Denmark

## **Large, traditional science countries:**

United Kingdom, France, Germany, USA

## **Large, emerging science country:**

China



# Disciplinary groups

Statistics on research personnel are compiled using disciplinary groups formed by clustering together Statistics Finland's field of science categories.

- Mathematics, statistics
- Physics, geosciences, space science
- Chemistry, chemical engineering
- ICT and electrical engineering
- Materials science, materials engineering
- Engineering, other fields
- Business studies and economics
- Ecology, environmental science, plant biology
- Agricultural and forest sciences
- Biomedicine, biosciences
- Clinical medicine
- Health sciences
- Behavioural sciences
- Social sciences, other fields
- Languages
- Arts, literature studies
- Humanities, other fields





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# Bibliometric disciplinary groups

Statistics on publishing are compiled using Scopus and Web of Science subject categories that are merged into larger clusters primarily based on Statistics Finland's field of science categories.

- Mathematics, statistics
- Physics, geosciences, space science
- Chemistry, chemical engineering
- ICT and electrical engineering
- Materials science, materials engineering
- Engineering, other fields
- Business studies and economics
- Ecology, environmental science, plant biology
- Agricultural and forest sciences
- Biomedicine, biosciences
- Clinical medicine
- Health sciences
- Behavioural sciences
- Social sciences, other fields
- Humanities
- General scientific journals



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# Definition of concepts 1/5

## **Research and development** (Statistics Finland)

- Research and development (R&D) refers broadly to systematic work aimed at increasing the existing stock of knowledge and to the use of this knowledge for developing new applications.
- R&D should involve an appreciable element of novelty.
- R&D comprises basic research, applied research and experimental development.

## **R&D expenditure** (Statistics Finland)

- R&D expenditure comprises wage and salary spending, costs from purchased services, other current expenditure and investment and acquisition costs.





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[Statistics Finland](#)

# Definition of concepts 2/5

## **Gross domestic product (GDP)** (Statistics Finland)

- GDP, gross domestic product at market prices is the final result of the production activity of resident producer units.

## **R&D intensity**

- In this set of slides R&D intensity is expressed in terms of national R&D expenditure as a percentage of GDP.



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# Definition of concepts 3/5

## **Public sector and private non-profit agencies** (Statistics Finland)

- The public sector comprises central government administrative branches and state research institutes, municipalities (since 2007), social security funds and institutions, as well as private non-profit agencies.

## **Higher education sector** (Statistics Finland)

- The higher education sector comprises universities, university hospitals, universities of applied sciences and the National Defence University (since 2016).
- Some public or private research institutes that have close links with university research can also be included in the higher education sector.



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[Statistics Finland](#)

# Definition of concepts 4/5

## **Full-time equivalent (FTE)** (Ministry of Education and Culture)

- Regular annual working hours, excluding overtime and other work exceeding normal working hours.
- FTE is not reduced by paid or partly paid sick time.
- The maximum FTE for a full-time person is 1.

## **Research FTE** (Statistics Finland)

- Calculated full-time R&D work (including holidays) conducted during one year.

## **R&D personnel** (Statistics Finland)

- Persons who during the statistical year spend at least 10% of their working hours in administrative, office or other support roles directly related to R&D work or R&D projects.



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# Definition of concepts 5/5

## **Research career stages** (Ministry of Education and Culture)

- FTE statistics for university teaching and research personnel use a four-tiered research career model:

**Stage I** (e.g. doctoral student, early-career researcher)

**Stage II** (e.g. postdoctoral researcher)

**Stage III** (e.g. university lecturer)

**Stage IV** (e.g. professor, Academy professor, research professor, research director)

Universities differ in how they allocate positions to different career stages.



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# Data sources 1/2

- Data for the analyses of scientific publishing are drawn from Elsevier's Scopus database, from the Clarivate Analytics Web of Science database, and from the national VIRTa publication data service (data gathering by the Finnish Ministry of Education and Culture)
- For Scopus and WoS data, the following publication types are included: article, review, letter, proceedings paper (WoS), conference paper (Scopus), book chapter and book.
- Citations are calculated using an open citation window from the year of publication until 2021. The most recent publication period for the top 10 index is 2016–2019. The use of an open citation window means that the citation indicator values for earlier publications are also updated as new citations are added.



# Data sources 2/2

- The Web of Science's internal coverage (the proportion of citations in database publications to other publications that are also indexed in the database) is too low (less than 40%) for some organisations and disciplines and therefore citation indices cannot be calculated in these cases.
- The Scopus database is used to complement WoS data in analyses of individual organisations or disciplinary groups.
- Main differences between Scopus and Web of Science databases:
  - In country-level analyses WoS-based and Scopus-based data give a very similar picture of the standard of research as assessed using the top 10 index.
  - Analyses based on disciplinary groups yield somewhat different results, among other reasons because of differences in database coverage. Scopus covers a larger number of scientific journals, and there are also some differences in fields of science classifications.





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# Methods: disciplinary group

- A publication's disciplinary group is determined based on the subject category used in the Clarivate Analytics Web of Science database or in Elsevier's Scopus database for the publication channel (e.g. a scientific journal or conference publication).
- Many publication channels are classified into several different disciplinary groups.
- For the present review, disciplines are clustered into larger groups based on the bibliometric classification of fields of science (see slide 37).
- Approaches based on field of science classifications are poorly suited for examinations of interdisciplinary or phenomenon-based research.



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# Methods: co-publications

- Co-authorship analyses make a distinction between
  - international co-publications: authors are affiliated with organisations from at least two countries (based on the authors' affiliation as reported in the publication and not, for instance, on nationality)
  - domestic co-publications: authors are affiliated with at least two organisations from the same country (e.g. Finland), no authors from outside the country concerned
  - single organisation publications: authors from one research organisation only



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# Methods: fractionalisation

- International co-publications are equally fractionalised between the countries contributing to the publication.
- The sum of the country-specific fractions is 1.0.
- Publications classified into several disciplines are fractionalised between the disciplines concerned, and domestic publications are fractionalised between the Finnish research organisations.
- Fractionalisation is based on the number of countries and disciplines and in the case of Finnish publications on the number of organisations contributing to the publication and not, for instance, on the number of researchers involved from different countries.



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# Methods: top 10 index 1/2

- Index describes the proportion of the 10% most cited publications in the discipline.
- The average for each discipline is 1. An index value greater than 1 means that more than 10% of a country's/organisation's publications rank among the 10% most cited publications.
- When calculating the top 10 index, the number of citations to a publication is only compared to the number of citations to publications appearing in the same discipline in the same year.
- Self-citations are omitted from the analysis.
- Publications are fractionalised between countries and organisations and in the case of Finland additionally between Finnish research organisations.
- The top 10 index is not calculated if the publication count is under 50 or if internal coverage is less than 40%. Internal coverage refers to the proportion of references in database publications that are also indexed in the database.



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# Methods: top 10 index 2/2

- If calculations are based on a small publication count, the top 10 index value can vary for random reasons. An examination of trends over several years will yield a more reliable picture of how the index has developed.
- The top 10 index describes the proportion of the 10% most cited publications in the discipline, and therefore the numbers and shares of all publications impact upon the index values. In comparisons of countries and organisations, variation in the top 10 indices especially for countries and organisations with large publication numbers impacts upon the index values for others.
- Citations are calculated using an open citation window from the year of publication until 2021. The most recent publication period is 2016–2019. The use of an open citation window means that the citation indicator values for earlier publications are also updated as new citations are added.



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# Limitations of the data and methods used

- Citation indicators such as the top 10 index offer only one perspective on scientific impact, but they do not in themselves provide a true overall impression of the standard of research.
- Peer reviews are a key mechanism for the evaluation of scientific quality.
- Publications in the humanities and many social sciences in particular are inadequately represented in international citation databases.
- Publications indexed in these databases alone do not provide an accurate picture of the true extent of publishing in these fields of science.

# Bibliometric sources

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