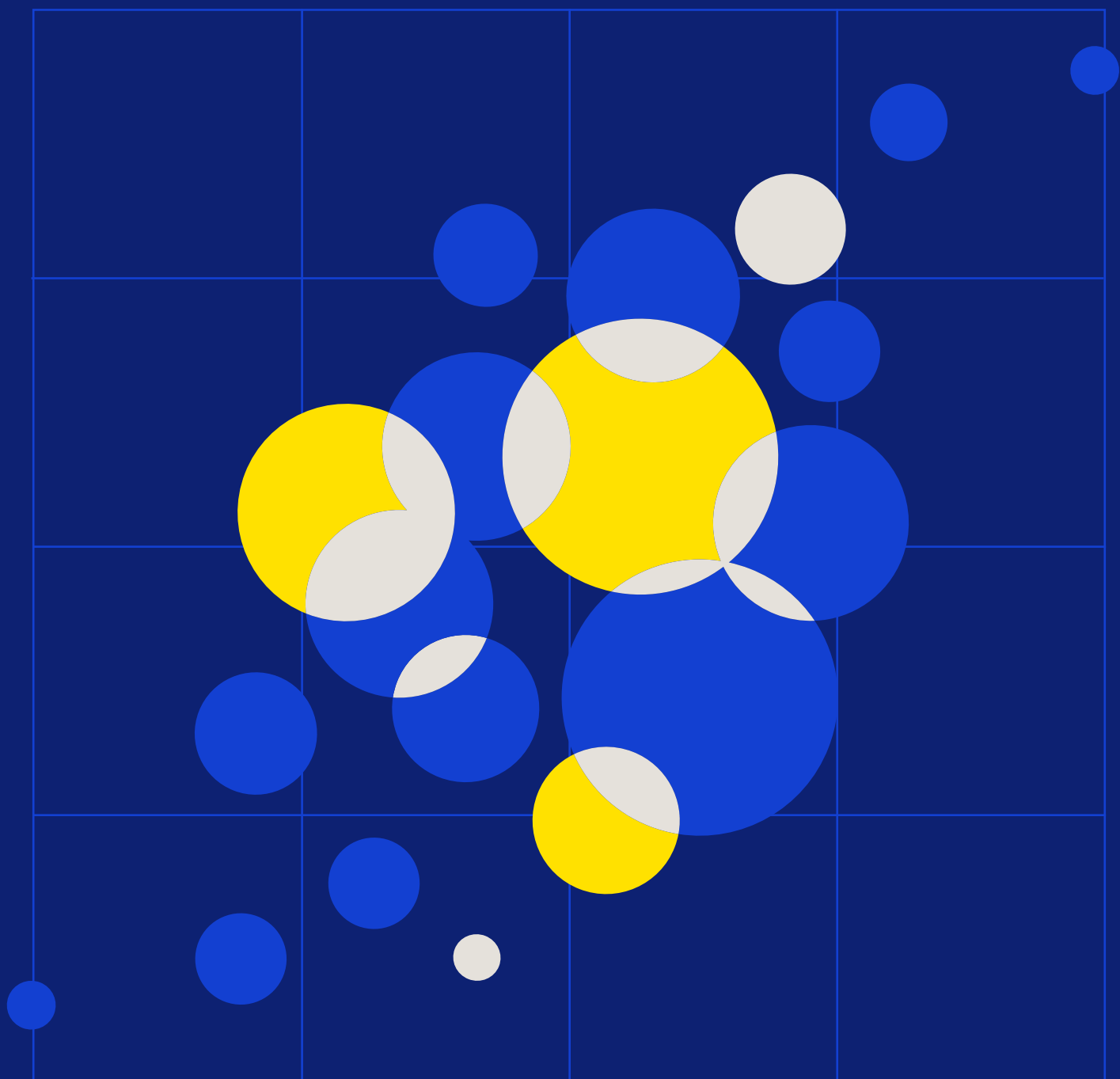


The Swedish Research Barometer 2023

Swedish research in international comparison



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Swedish Research Council
Vetenskapsrådet
Box 1035
SE-101 38 Stockholm, Sweden

Table of contents

Foreword	5
Summary	6
Swedish research in international comparison.....	6
Research funding.....	8
Research personnel.....	8
Scientific publication	10
1 Research funding	13
1.1 Funding of the R&D system in international comparison.....	13
1.2 The R&D system in Sweden	26
1.3 Expenditure on R&D in higher education	33
2 Research personnel	46
2.1 The R&D system's personnel in international comparison	46
2.2 Higher education sector in Sweden.....	50
3 Scientific publication	70
3.1 Scientific publication in international comparison	70
3.2 Higher education in Sweden	87
Method appendix	98
The purpose and focus of the Swedish Research Barometer	98
International comparisons	98
Data sources.....	99
Classification into fields of research	101
Bibliometric analysis	102
Country codes.....	105
Explanations of concepts and abbreviations.....	106

Foreword

The Swedish Research Barometer aims to give an overall description of the state and progress of the Swedish research and development (R&D) system. The report highlights both how Sweden compares internationally as a research nation, and also how the Swedish higher education sector has developed.

The particular strength of the Swedish Research Barometer is that it gathers information from several sources of statistics, while also reporting unique information about scientific publications and their citation impact. This year's report has been produced by a project group at the Swedish Research Council, consisting of Gustav Hansson (project manager), Karin Tegerstedt, Linnea Wickström Östervall and Kristina Tegler Jerselius.

I hope this year's Swedish Research Barometer will provide the basis for conversations and discussions about the Swedish research system. Reports and documentation such as this make us better equipped to make informed decisions about what more we can do to strengthen Sweden as a research nation.

Stockholm, 30 November 2023

Katarina Bjelke

Director General, Swedish Research Council

Summary

The Swedish Research Barometer aims to give an overall description of Swedish research and development (R&D) in international comparison, and to describe R&D in the Swedish higher education sector. The report consists of three chapters: research funding, research personnel, and scientific publication. Each chapter has a section that describes the Swedish R&D system in international comparison, and a section that describes R&D in the Swedish higher education sector.

Swedish research in international comparison

An overall description of the Swedish R&D system in international comparison is provided in Figure 1. The figure shows both input (investments in R&D) and output (outcome and results of R&D) for the years 2019–2021. In summary, the figure shows that Sweden is one of the five top countries in the OECD in terms of investment in R&D, but not when it comes to outcome and results of R&D.

Sweden is one of the countries in the OECD with the highest R&D expenditure as a percentage of GDP. This relates both to total R&D expenditure and to the business sector's R&D and the higher education sector's R&D. Sweden is also among the top five countries in the OECD with the greatest proportion of researchers in the population. This therefore shows that Sweden is one of the top countries in terms of investment in R&D, and that we have a high level of R&D intensity.

However, Sweden is not one of the top five countries in the OECD in terms of number of publications per thousand inhabitants, nor citation impact. Sweden misses out on being in the top five in terms of number of publications by a very small margin. Thus, Sweden still has a high volume of publications, which is testament to Sweden's investments in R&D.

Sweden's citation impact (measured as the proportion of publications among the 10 per cent most highly cited) is 11 per cent. This is a citation impact above the world average, but at the same time it means that Sweden is not included among the five countries with the highest citation impact in the OECD. Although Sweden's citation impact has fallen slightly in the last few years, it has still been relatively unchanged over time, which speaks of an ability to maintain a high level over time. The top five countries in the OECD in relation to citation impact for the years 2019–2021 are the United Kingdom, Netherlands, Switzerland, Australia, and Luxembourg, which have citation impacts of 13 to 14 per cent.

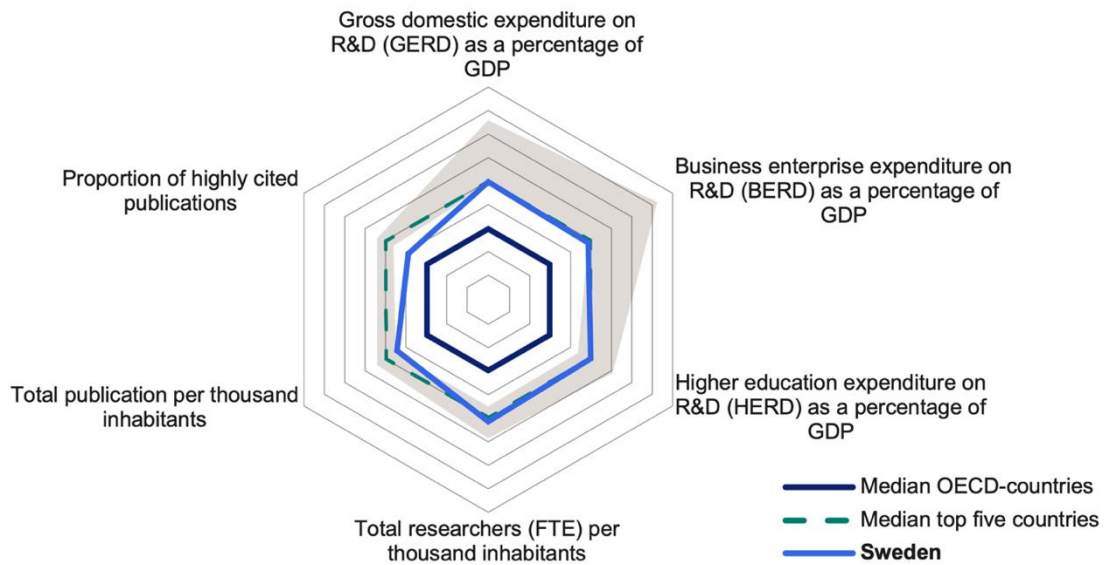


Figure 1. The Swedish research system in international comparison 2019–2021. Source: OECD, Clarivate Analytics and UN.

Note: The figure is based on averages for the years 2019–2021, where Sweden’s values are compared with the median value for all OECD countries, and the median value for the top five OECD countries. The figure also contains a grey area, which shows minimum and maximum values for the top five countries. The values in the figure have been normalised to relate to the median value for the OECD countries in relation to the top countries in the OECD.

The top countries are the five countries with the highest values for each indicator: Total expenditure on R&D as a proportion of GDP (Israel, South Korea, Sweden, USA and Japan). Business enterprise sector’s expenditure on R&D as a proportion of GDP (Israel, South Korea, Japan, USA and Sweden). Higher education sector’s expenditure on R&D as a percentage of GDP (Denmark, Switzerland, Sweden, Finland and Norway). Number of researchers (full-time equivalents) per thousand inhabitants (South Korea, Sweden, Denmark, Finland and Iceland). Number of publications per thousand inhabitants (Denmark, Switzerland, Australia, Norway and Iceland). Proportion of highly cited publications (United Kingdom, Netherlands, Switzerland, Australia and Luxembourg).

Considering that Sweden is one of the top countries in the OECD in terms of investment in R&D, we should ask ourselves what expectations we should have in relation to citation impact, and why Sweden is not one of the top countries in the OECD also in this respect. At the same time, it is important to remember that research does not only aim to create scientific impact. The research carried out in Sweden also aims to increase our knowledge, to address societal challenges, and to increase the competitiveness of the business sector. A high citation impact is no guarantee of achieving this, but is an important indicator for showing we are moving in the right direction.

Research funding

Total R&D expenditure in Sweden amounted to 186.7 billion SEK in 2021, which is an increase of 7.2 billion SEK compared to 2019. R&D expenditure as a percentage of GDP amounted to 3.3 per cent in 2021, and Sweden therefore exceeds the EU's goal of 3 per cent.

The business sector is responsible for around 72 per cent of R&D expenditure in Sweden, while the higher education sector is responsible for 23 per cent and other sectors for 4.5 per cent. This means that Sweden has a higher proportion of R&D expenditure in the business sector than Norway and Denmark, while these countries have a higher proportion of R&D expenditure in the higher education sector.

A new feature of this year's Research Barometer is that it presents statistics for different types of research. Of the total R&D expenditure, 14 per cent constitutes basic research, 28 per cent applied research, and 58 per cent experimental development. The high proportion of experimental development is explained by a large share of the R&D expenditure being spent in the business sector, and the fact that this expenditure largely consists of experimental development. Of the R&D expenditure in the higher education sector, equal shares (41 per cent) are spent on basic research and applied research, while 18 per cent of the R&D expenditure is spent on experimental development.

Another new feature in this year's Research Barometer is that R&D expenditure is reported per higher education institution (HEI) and per field of research. The HEIs vary greatly in their R&D expenditure, both within and between HEI categories. Lund University and Karolinska Institutet are the HEIs with the greatest R&D expenditure. Lund University has more than double the R&D expenditure of Umeå University and Linköping University, for example. By reporting R&D expenditure per HEI and per field of research, an overall picture of the HEIs' research focuses is provided. For example, it can be seen that many of the university colleges spend a large proportion of their R&D expenditure in engineering and technology.

Research personnel

Sweden is one of the five countries in the OECD with the highest percentage of researchers in relation to population size. The percentage of researchers in the population of Sweden is at roughly the same level as in Denmark and Finland. In Sweden, 75 per cent of the researchers worked in the business sector, while just over 20 per cent worked in the higher education sector and 5 per cent worked in the government sector in 2021. This reflects largely how the R&D expenditure is divided up between the sectors.

Within the Swedish higher education sector, the researching and teaching personnel (including doctoral students) amounted to 51 692 individuals in 2022, which was an increase of 6 360 persons since 2012. Senior lecturers form the employment category with the greatest number of employees, closely followed by doctoral students. Most employee categories show an increase in the number of employees. Senior lecturer is the employment category that has increased most in number of persons between 2012 and 2022, while postdocs and support personnel have increased most in percentage terms.

In all fields of research, the youngest career age cohort (that is, the group with the most recently awarded doctoral degrees) is clearly smaller than the group that was awarded their doctoral degrees during the previous period. This means that there are fewer R&D employees in this group compared to the group that was awarded their doctoral degrees a few years earlier. This differs from what we have seen in previous years in the Research Barometer, where the youngest career age cohort has been the largest in most fields of research.

On average, research and teaching personnel in higher education spend 43 per cent of their working hours on research, 24 percent on teaching at first and second cycle level, and just over 2 per cent on teaching at third cycle level. The rest of their time is spent doing other work, such as administration, various expert and representative assignments, and so on. Postdocs and doctoral students spend the greater part of their working hours on research, while senior lecturers and lecturers spend most of their time on teaching. On the other hand, if we look at R&D full time equivalents (showing who does the most research), then doctoral students followed by senior lecturers have the most R&D full time equivalents. This means that, despite senior lecturers being among those that spend a relatively small part of their working hours on research, they still carry out a large part of the research done in the higher education sector. This is because senior lecturers form such a large employee group.

The proportions of men and women as associate senior lecturers and research associates, as well as senior lecturers, fall between 40 and 60 per cent, which is considered an even gender distribution. Among professors, women account for 30 per cent and men for 70 per cent of the total, however. The proportion of professors who are men is particularly high in the older career age cohorts. If we instead look at the entire group of researching and teaching personnel with doctoral degrees, then men are in the majority in older career age cohorts, while women are in the majority in the younger ones. If the current development continues over time, women will be in the majority in humanities and arts, in social sciences, and in medicine and health sciences.

Scientific publication

The total number of scientific publications in the world increased by 72 per cent between 2012 and 2021. This is largely due to the great increase in publications in Asia and, in particular, China. Asia is now responsible for 41 per cent of the total number of publications in the world, followed by Europe, which produces 30 per cent, and North America, which produces 19 per cent. The number of publications from China increased by 75 per cent between the years 2017 and 2021, and China has now surpassed USA in the number of publications.

If we look at citation impact, then China increased here too between 2017 and 2021, from 11 to 12 per cent of highly cited publications. As China also produces so many publications, this means that many other countries have seen their proportions of highly cited publications drop. For example, USA's citation impact has fallen from 14 to 12 per cent during this period.

The number of publications in Sweden has increased slightly between 2017 and 2021, at the same time as Sweden's citation impact has fallen from 12 per cent in 2017 to 11 per cent in 2021. However, this means that Sweden is still above the world average of 10 per cent. Sweden has a citation impact above the world average in humanities, biology, and agricultural and veterinary sciences. On the other hand, we have dropped within engineering and materials science, where we now are below the world average.

In the Swedish higher education sector, it is primarily the broad-based established universities and the specialised universities that are responsible for the scientific production. The citation impact for these HEIs have long been above the world average. The new universities and university colleges are responsible for a smaller proportion of the scientific production, and do not in general have as high a citation impact. However, there is variation over time and variation between HEIs.



Research funding



1 Research funding

This chapter contains a description of expenditure on and funding of R&D. The first section provides a description of the Swedish R&D system in international comparison, and the second section a description of R&D within the Swedish higher education sector.

1.1 Funding of the R&D system in international comparison

Expenditure on R&D

Sweden is a country with a high level of expenditure on R&D in relation to its size. A country's expenditure on R&D refers to the overall expenditure on R&D carried out within the country over a given period of time. Expenditure on R&D as a proportion of GDP or in relation to population size (per capita) are two different measures of R&D intensity. Figure 2 shows both these measures of R&D intensity for a selection of countries, and the average for the entire OECD and EU respectively, for 2021. The figure shows that there are great differences in R&D intensity between countries, irrespective of whether it is measured in relation to GDP or per capita.

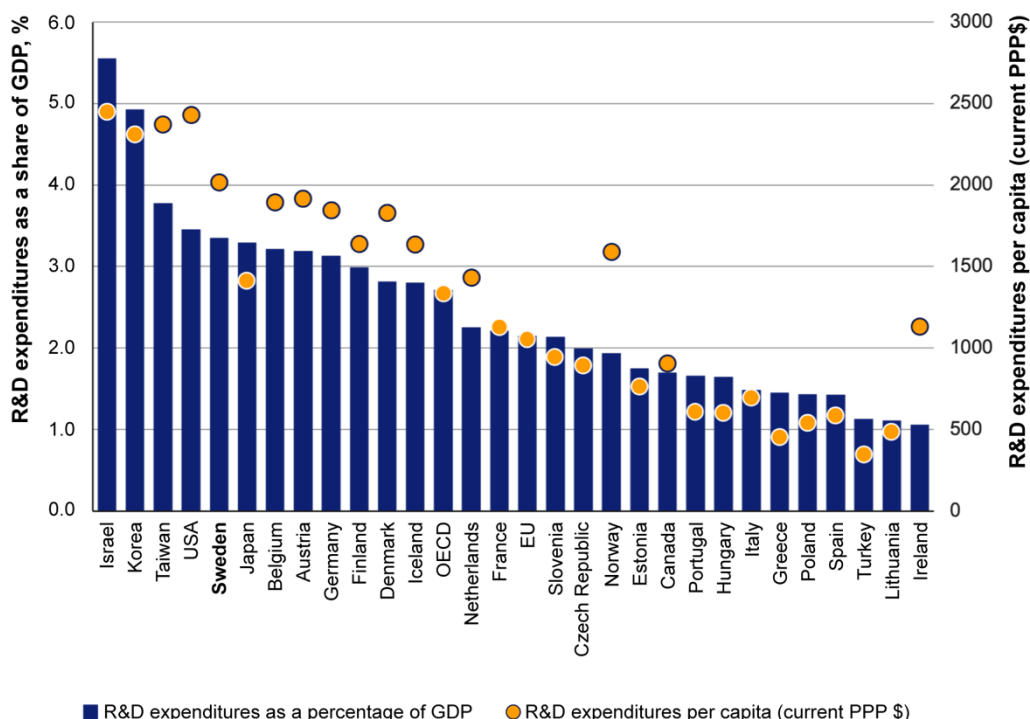


Figure 2. Gross domestic expenditure on R&D (GERD) as a proportion of GDP and expenditure on R&D per capita (PPP\$) for 2021, for a selection of countries. Source: OECD.

Note: The figure covers the 30 countries with the highest expenditure on R&D per GDP in 2021 and with available statistics for that year.

Sweden's expenditure on R&D as a proportion of GDP amounted to 3.3 per cent in 2021, which means that Sweden had greater R&D intensity than the averages for both the EU and the OECD, and countries such as Germany, Finland, Norway and Denmark according to this measurement.

The Government's research policy goal is that Sweden shall be one of the world's foremost research and innovation countries, and a leading knowledge nation, where high-quality research, higher education and innovation lead to societal development and well-being, a competitive business sector, and address the societal challenges we are facing, both in Sweden and globally.¹ One of the Government's interim goals is that Sweden's public and private investment in R&D shall exceed the EU's goal of 3 per cent of GDP. Within the framework for the Europe 2020 strategy, there has also been a goal that the total expenditure on R&D in Sweden should amount to around 4 per cent of GDP in 2020.² Sweden fulfils the goal of exceeding the EU's 3 per cent goal, but still has some way to go to get close to the 4 per cent goal.

¹ Govt. Bill 2022/23:1 Expenditure area 16, p 209.

² Govt. Bill 2020/21:1 Expenditure area 16, p 250.

How is R&D defined in the statistics?

To measure expenditure on research and development (R&D) and to ensure statistics are comparable between countries, the OECD has developed the following definition for R&D: "Research and development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge (including knowledge of man, culture and society) and the use of this knowledge to devise new applications."

In order for an activity to be classified as R&D according to the OECD's definition, it should be characterised by:

1. Novelty: The purpose of R&D activities is to create new knowledge and to find new applications for existing knowledge.
2. Creativity: R&D activities are based on original concepts and hypotheses.
3. Uncertainty: The outcome of R&D activities, including economic and personal resources, cannot be securely known in advance.
4. Systematics: R&D activities are carried out systematically and are planned and budgeted for.
5. Transferable and/or reproduceable: R&D activities aim to achieve results that could be transferred and/or reproduced.³

Figure 2 shows that countries with a high proportion of expenditure on R&D as a proportion of GDP generally have a high proportion of expenditure on R&D per capita as well; that is, there is a positive correlation between the two measures of R&D intensity. There are countries that diverge more or less from this overall pattern, however. Expenditure on R&D as a proportion of GDP for Norway and Czechia, for example, are approximately the same, while expenditure on R&D per capita is considerably higher for Norway than for Czechia. Another such example is China, which has a relatively high R&D intensity measured in relation to GDP, but relatively low R&D intensity in relation to population size (China is not included in the figure above, as the most recent available statistics for the country are from 2017). Hereafter, the Swedish Research Barometer will use expenditure on R&D as a proportion of GDP as a measure of R&D intensity.

³ OECD (2015). Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris., SCB (2021). Statistikens framställning – Forskning och utveckling i Sverige. UF0301, 2021-10-27.

Development of R&D intensity for a selection of countries

Figure 3 shows the development of expenditure on R&D as a proportion of GDP for a selection of countries. Sweden is here described in relation to a selection of countries, consisting of our neighbouring countries (Norway, Denmark and Finland), comparable countries in terms of expenditure on R&D, and the largest research nations in Europe and the world in terms of scientific production (for more information about the selection, see the fact box and description in the appendix).

The figure shows that R&D intensity in Sweden for the period 2012–2021 was between 3.1 and 3.5 per cent. Our neighbouring countries, the comparable countries, and the large research nations all have lower R&D intensities. The only times one of these countries had a higher proportion than Sweden was during the years 2012–2014 for Finland, and 2021 for USA. Throughout the period, Sweden has had a higher R&D intensity than the EU and the OECD. During the period, the EU had an R&D intensity of between 2.0 and 2.2 per cent, and the OECD one of between 2.3 and 2.7 per cent.

Most of the countries, including Sweden, have had a relatively unchanged R&D intensity over time. Belgium and USA are, however, among the countries that have had larger increases. Finland's R&D intensity has decreased from 3.4 per cent in 2012 to 3.0 per cent in 2021. This is explained by Finland's expenditure on R&D having decreased while its GDP increased. The comparable countries have seen a development that means that they in 2021 had expenditure on R&D as a proportion of GDP at roughly the same level as in Sweden. This is expected, as the selection of these countries was made on the basis that they were similar to Sweden in terms of expenditure on R&D and R&D intensity. Netherlands is the exception in the group, with a considerably lower total R&D intensity than Sweden, but is included among the comparable countries on the basis that Sweden and Netherlands have similar expenditure on R&D and R&D intensity for their higher education sectors.

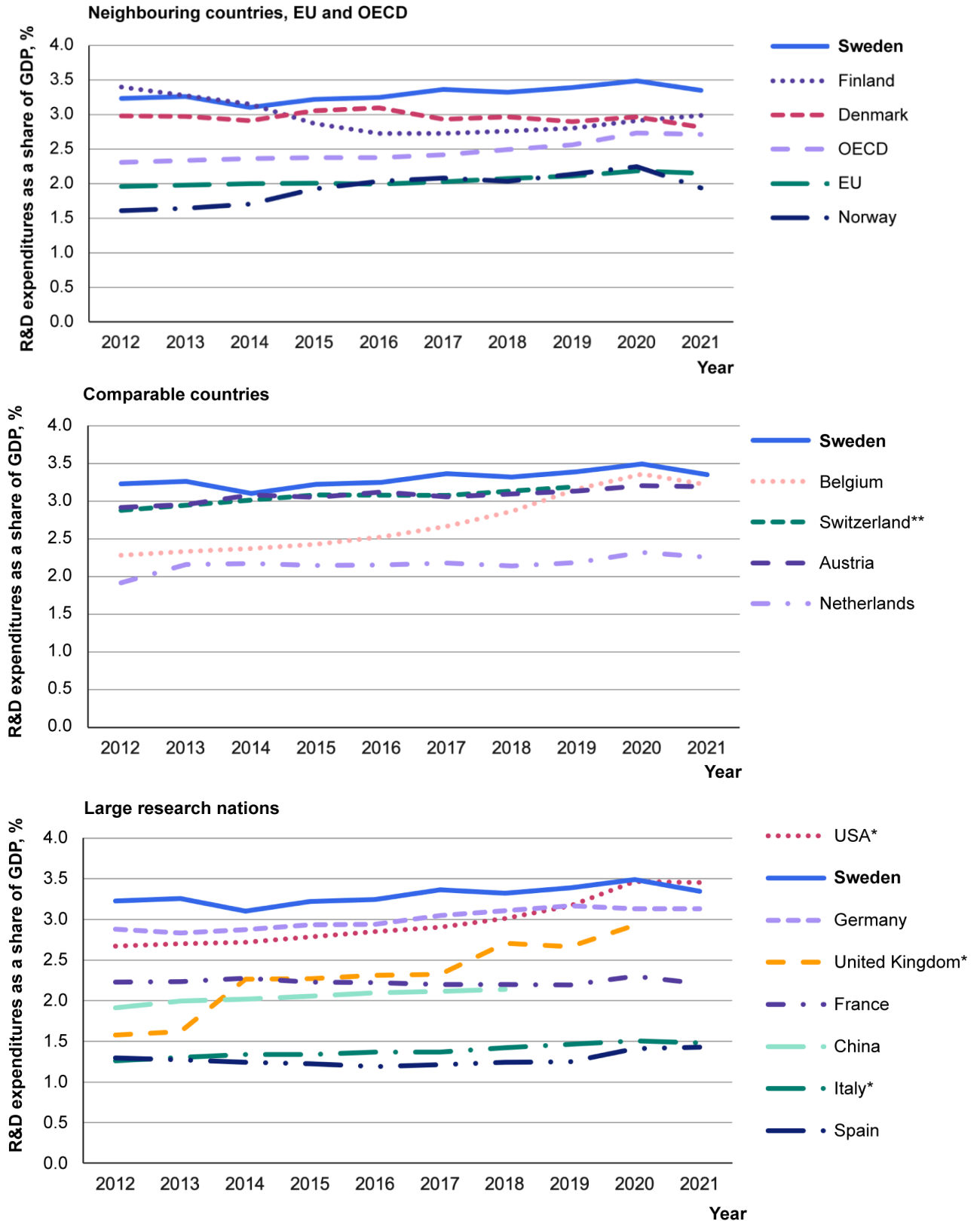


Figure 3. Gross domestic expenditure on R&D (GERD) as a proportion of GDP over time, for a selection of countries, the EU and the OECD for the years 2012–2021. Source: OECD.

Note: * Time series breaks for France in 2014, Italy 2016, Netherlands 2012 and 2013, United Kingdom 2014 and 2018, USA 2015 and 2016., ** only data for 2012, 2015, 2017 and 2019.

The large research nations show a great span of expenditure on R&D as a proportion of GDP, with 1.4 per cent for Spain and 3.5 per cent for USA. Being a large research nation in terms of having a large scientific production does therefore not necessarily entail having a high R&D intensity.

Five of the countries in the figure have breaks in their time series; that is, the way statistics are produced has changed, which means that comparisons over time are made more difficult. One of the countries with several breaks in the time series is the United Kingdom, which is also shown in the figure, as R&D intensity makes big jumps at the time of the breaks in the time series. This shows that it is sometimes difficult to make international comparisons, and that we should not pay too much attention to the United Kingdom's time series in this respect.

What selection of countries has been used?

The Swedish Research Barometer 2023 makes international comparisons with the following selection of countries:

1. **Neighbouring countries:** Norway, Finland and Denmark,
2. **Comparable countries:** Belgium, Netherlands, Switzerland and Austria, and
3. **Large research nations:** France, Italy, Spain, United Kingdom, Germany, USA and China.

Norway, Finland and Denmark are interesting to include because they are our closest neighbours, and because their R&D systems are similar to Sweden's. The "comparable countries" are the countries outside the Nordic countries that are the most similar to Sweden in relation to expenditure on R&D and expenditure on R&D in relation to GDP (either for the R&D system as a whole or for higher education). It is worth noting that Norway and Denmark also fulfil the criteria for being comparable countries in terms of total expenditure on R&D and expenditure on R&D in relation to GDP. The "large research nations" are those that are among the five countries in Europe or the world with the largest scientific production (measured in number of publications) and that therefore are of great importance to research internationally.

In addition to this selection of countries, Sweden's development is also seen in relation to the EU (EU 27), the OECD and the world (in relation to bibliometrics). For further information on the selection of countries, please see the appendix.

Source of funding and performing sectors

Expenditure on R&D can be described based on the sectors funding the R&D work (source of funding) and based on the sectors carrying out the R&D work (performing sector). This section first shows the sectors responsible for the funding, and thereafter the sectors that carry out R&D.

Figure 4 shows the proportion of R&D in relation to GDP that is funded by business enterprise, higher education, private non-profit sector, governmental sector, and funding from abroad for our selection of countries. The figure provides an overall picture of the countries that have seen an increase or a decrease in their expenditure on R&D as a proportion of GDP during the period 2011 to 2021. The figure also shows if this increase or decrease can be attributed to any of the funding sectors. From the figure, we can see that Finland's decrease in R&D intensity can be explained primarily by decreased funding from business enterprise. During the period, Belgium and USA have increased their expenditure on R&D as a proportion of GDP. For both Belgium and USA, it is primarily funding from business enterprise that is responsible for the increase.

Sweden's R&D intensity has also increased over the period, but at a slightly lower rate compared to those of Belgium and USA. Between the years 2011 and 2021, Sweden's expenditure on R&D as a proportion of GDP increased by 0.1 percentage points. This is primarily due to funding from business enterprise, which has increased from 1.8 per cent of GDP in 2011 to 2.1 per cent in 2020.

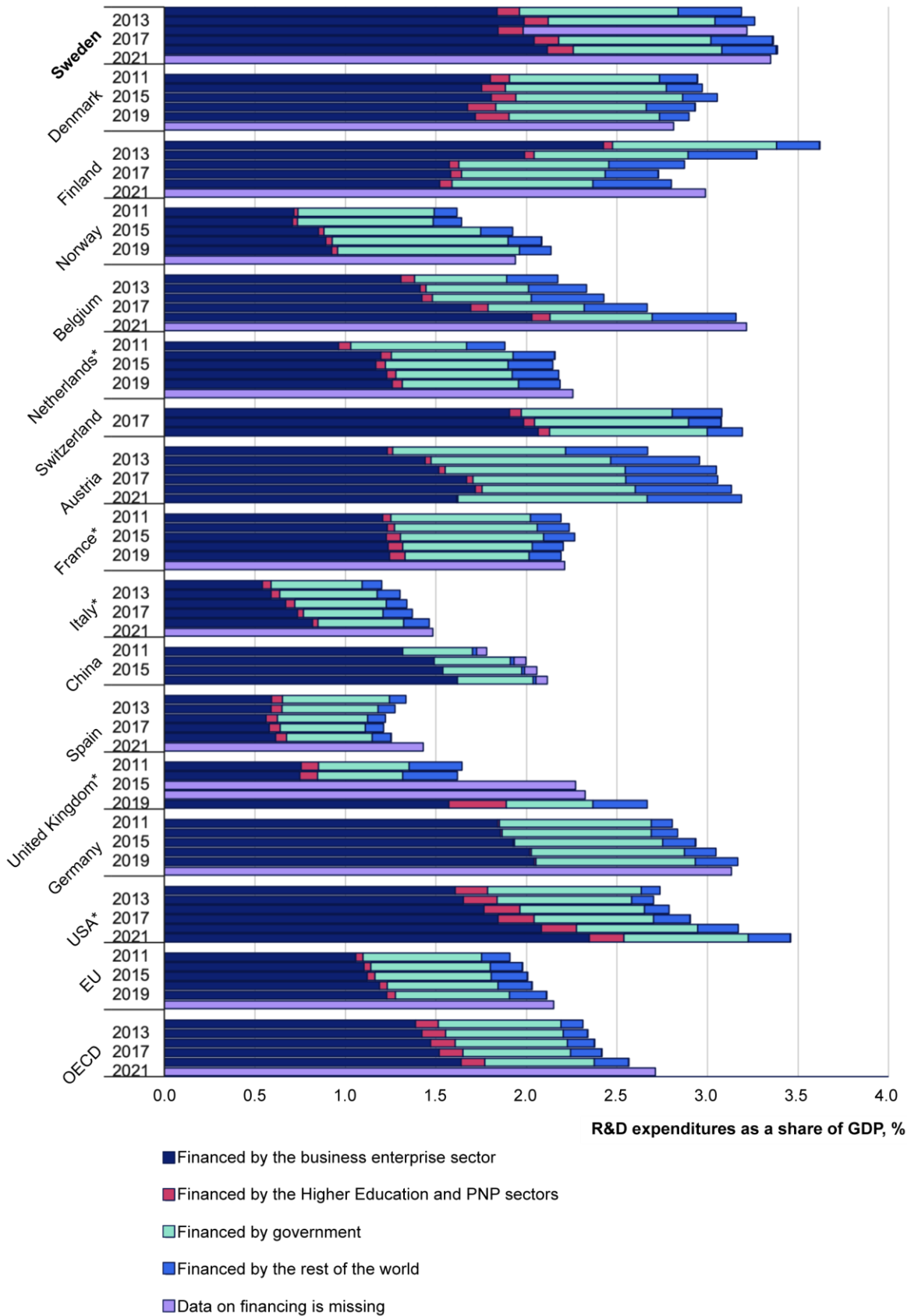


Figure 4. Gross domestic expenditure on R&D (GERD) as a proportion of GDP per funding sector, for 2011–2021 (every second year). Source: OECD.

Note: * Time series breaks for France in 2014, Italy 2016, Netherlands 2012 and 2012, United Kingdom 2014 and 2018, USA 2015 and 2016.

Figure 5 shows different sectors' proportions of R&D funding for our selection of countries for 2020 (or most recent available). Compared to the previous figure, Figure 5 provides a clearer picture of the size relationships between different sources of funding and how these differ between countries. For all countries in the figure, business enterprise is the largest source of funding. The proportion of funding from this sector usually amounts to more than 50 per cent of the total funding. In Sweden, funding from business enterprise covers 62 per cent, which is a higher proportion than the EU in total, but slightly lower than the OECD. This means that the funding from business enterprise is a significant reason for why Sweden's R&D intensity is one of the highest in the world. In we instead look at the proportion of funding from the government, then Sweden is lower than several countries, but on a par with the OECD and countries such as Finland and Switzerland.

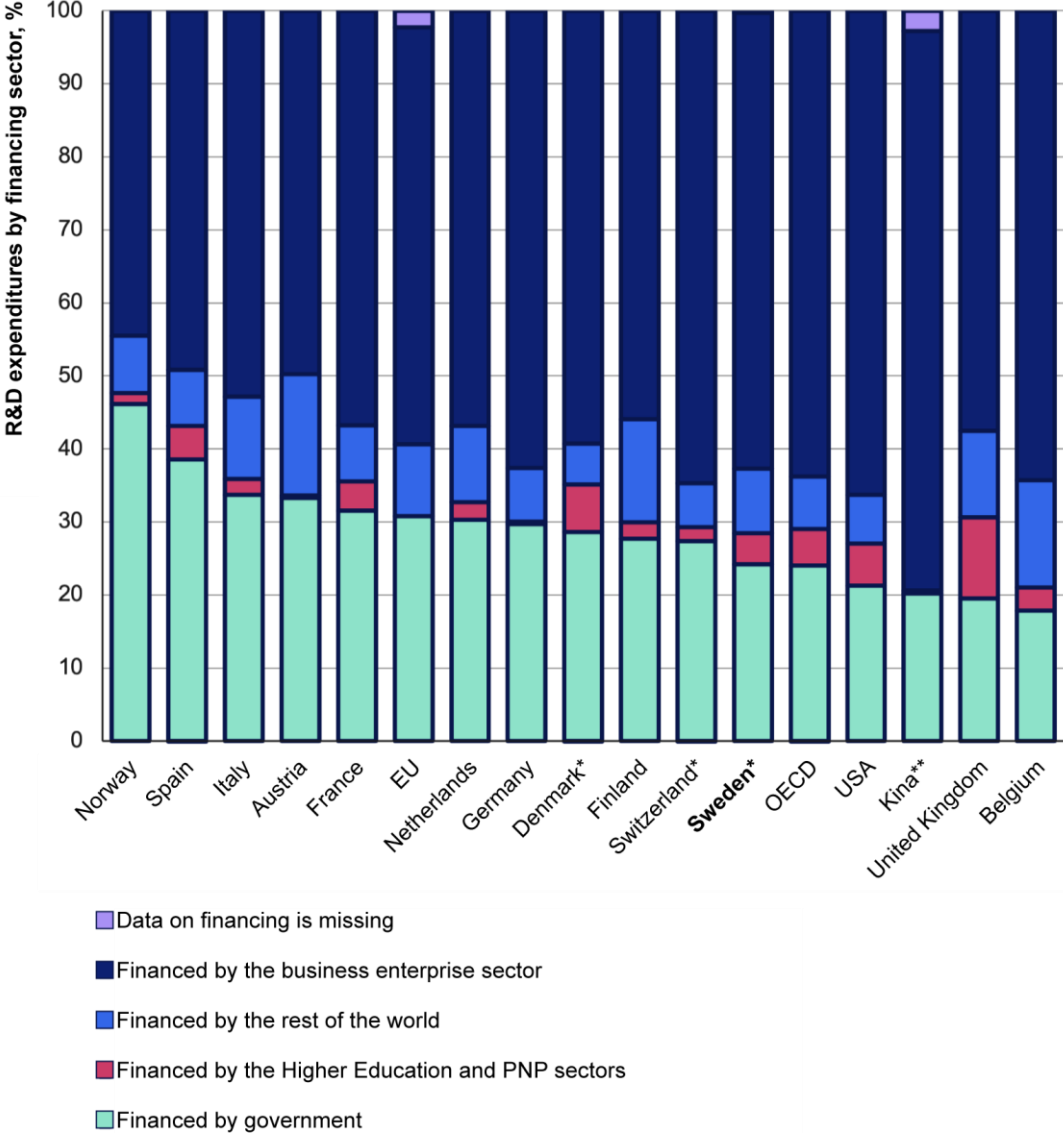


Figure 5. Gross domestic expenditure on R&D (GERD) divided up by source of funding, for 2020 or most recent available. Source: OECD.

Note: *values for 2019, **values for 2018.

Figure 6 shows expenditure on R&D divided up by performing sector, that is, based on where the research and experimental development have been carried out and performed. The largest proportion of expenditure on R&D is found in business enterprise for all countries in the selection, and the proportion is between just over 50 per cent and just below 80 per cent. For Sweden, the proportion of expenditure on R&D in business enterprise is 72 per cent, which is equal to that of the OECD, but higher than the EU countries and lower than USA.

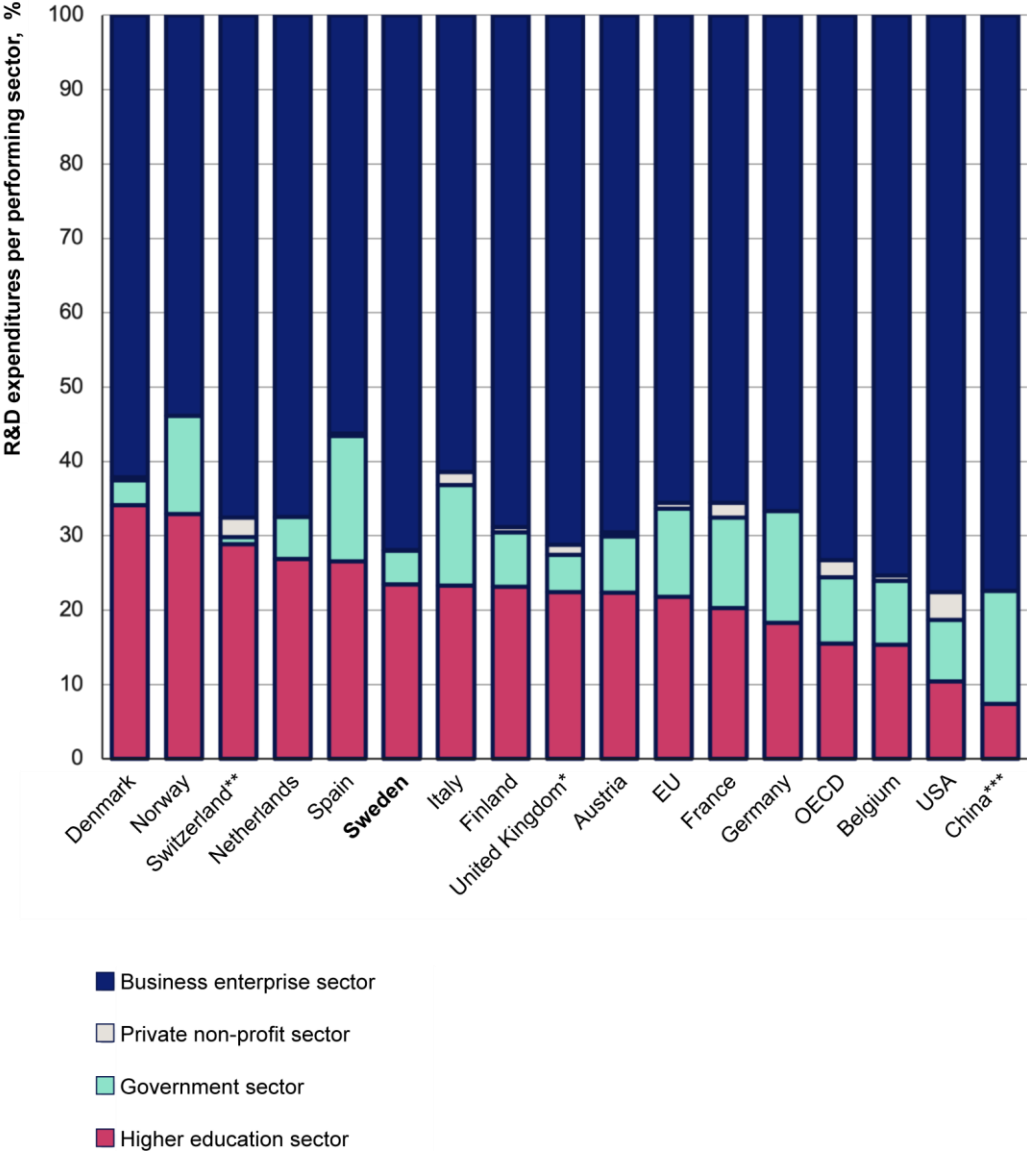


Figure 6. Expenditure on R&D divided up by performing sector, for 2021 or most recent available. Source: OECD.

Note: *values for 2020, **values for 2019, ***values for 2018.

The proportion of expenditure on R&D in higher education ranges from 7.4 per cent to 34 per cent for the countries in the figure. For Sweden, this proportion is 23 per cent, which is higher than both the EU and the OECD,

but lower than Norway and Netherlands, for example. It is interesting to note that the proportions of expenditure on R&D in the governmental and private non-profit sectors are considerably lower in Sweden compared to most of the countries in the figure. For example, for the EU and the OECD, the proportions of expenditure on R&D in the governmental sectors are 12 per cent and 8.9 per cent respectively, but in Sweden it is 4.5 per cent.

Sweden's participation in Horizon Europe

An important source of funding for R&D in Sweden is the EU's framework programme for research and innovation, Horizon Europe. The programme has a budget of more than 95 billion EUR, and runs for the period 2021–2027. Horizon Europe is intended to fuel the EU's scientific and technical excellence and to strengthen the European Research Area (ERA), it shall tackle policy priorities, including sustainable development, and boost Europe's innovation uptake, competitiveness, and the number of job opportunities.⁴

Figure 7 shows three indicators for Sweden's participation in Horizon Europe. "Relative number of applications" shows the number of applications in relation to the number of researchers, "relative success" shows the number of approved applications in relation to the number of researchers, and "success rate" shows the number of approved applications in relation to the number of applications (see the method appendix for further descriptions).

⁴ [European Commission \(2021\). The EU's research and innovation programme 2021–2027, \(pdf\) \(europa.eu\)](#)

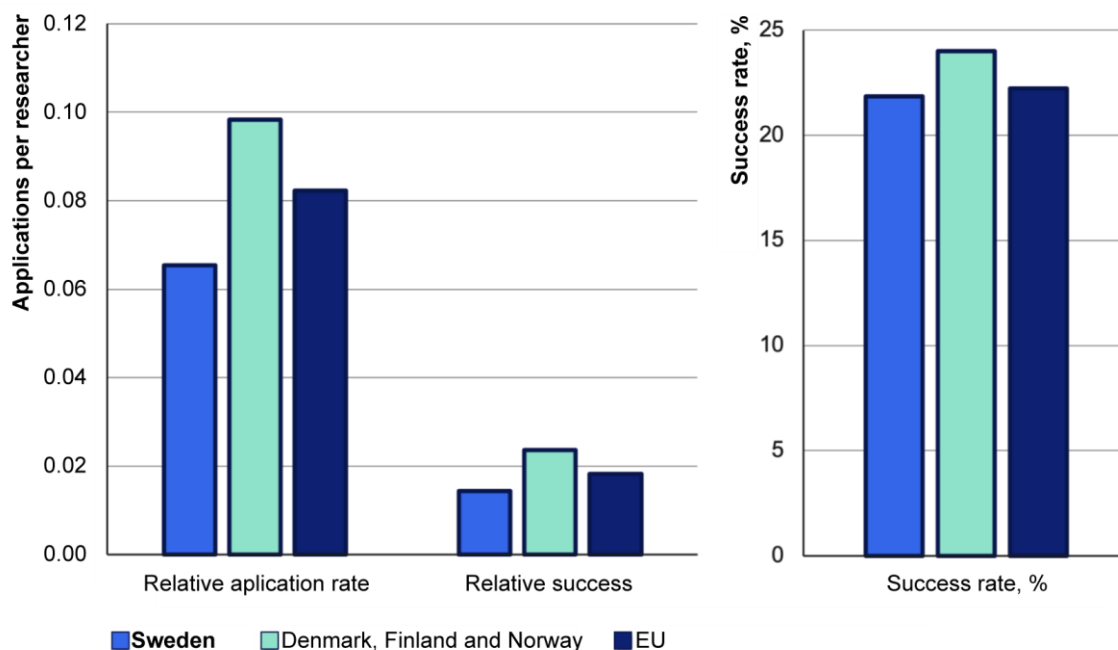


Figure 7. Indicators for Sweden's participation in Horizon Europe. Source: eCORDA (2023/06/15) and OECD.

Note: Researchers (R&D full-time equivalents) 2020.

In comparison with our neighbouring countries (Denmark, Finland and Norway) and with the EU, Sweden is slightly lower for all three indicators. (Sweden is lower for all three indicators even when compared two and two with Denmark, Finland and Norway.) Sweden therefore has a lower number of applications, lower rate of relative success, and a slightly lower success rate than both our neighbours and the EU area as a whole. These results are similar to Sweden's performance under Horizon 2020 (the previous framework programme), where Sweden was lower in terms of relative application rate and relative success, but on a par with the EU in terms of success rate.⁵ This means that, according to these measures, Swedish researchers are as competitive as researchers in the EU area in general (that is, in terms of success rate), but that Swedish researchers apply for funding from the framework programme to a lesser extent (make a lower number of applications), which means that Sweden receives less research funding per researcher compared to our neighbours and the EU in general.

The Swedish Government's goal is for Sweden to receive 3.7 per cent of the overall funding awarded under Horizon Europe.⁶ By the middle of

⁵ See Vetenskapsrådet (2021). Forskningsbarometern 2021 - Svensk forskning i internationell jämförelse. VR2110.

⁶ Regeringskansliet (2021). En nationell strategi för svenskt deltagande i Horisont Europa 2021–2027

June 2023, Sweden had received 3.0 per cent of the funding awarded to date.⁷ One way of achieving the Government’s goal is to increase the number of applications by encouraging researchers to make more applications, and thereby hopefully also increase the proportion of funding awarded. This, however, is on condition that the success rate does not fall too much when the number of applications increases. Another way of increasing Sweden’s share of research funding from Horizon Europe is to increase the success rate, which means that Swedish researchers’ applications need to become even more competitive.

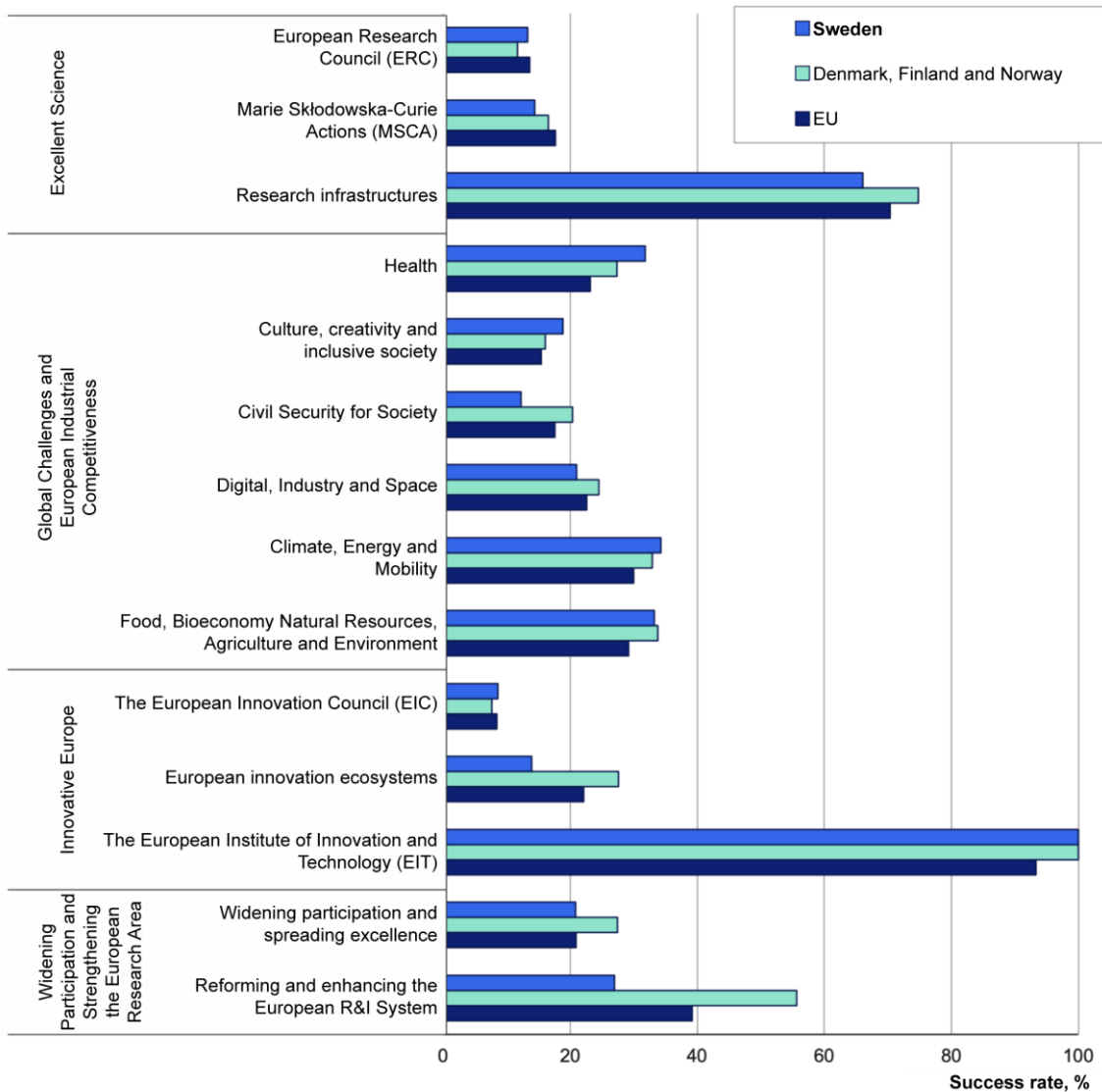


Figure 8. Success rate for subsidiary programmes in Horizon Europe, for Sweden, its neighbouring countries, and the EU. Source: eCORDA (2023/06/15).

Note: The various subsidiary programmes are of differing sizes and have differing numbers of calls. The European Institute of Innovation and Technology has, for example, received five applications with Swedish participation, where all the applications have been awarded funding.

⁷ eCORDA 2023/06/15

Figure 8 shows the success rate for subsidiary programmes in Horizon Europe, for Sweden, its neighbouring countries, and the EU. The various subsidiary programmes differ in scope in terms of the number of calls and number of applications received, which does of course affect the approval rate. The European Institute of Innovation and Technology has, for example, received five applications with Swedish participation, all of which were awarded funding. The number of applications submitted for infrastructure with Swedish participation was 56, while the number of Swedish applications to the ERC was 699.

The figure shows that there is great variation in terms of success rate per subsidiary programme. Sweden has a higher success rate than our neighbouring countries in 5 of the 14 subsidiary programmes, and a higher success rate than the EU in 6 of the 14 subsidiary programmes. For example, Sweden has a higher success rate than the EU in the subsidiary programmes “Health”, “Culture, Creativity and Inclusive societies”, and “Climate, Energy and Mobility”. When it comes to the “European Research Council (ERC)”, Sweden has a higher success rate than our neighbouring countries, but a slightly lower success rate than the EU overall.

1.2 The R&D system in Sweden

Performers and sources of funding of R&D in Sweden

Figure 9 shows the total expenditure on R&D in Sweden in 2021, based on the sectors funding the R&D (sources of funding), and the sectors performing R&D (performers). The figure also shows the size of the payment streams between the sources of funding and the performers. The figure thereby gives an overall picture of the Swedish R&D system.

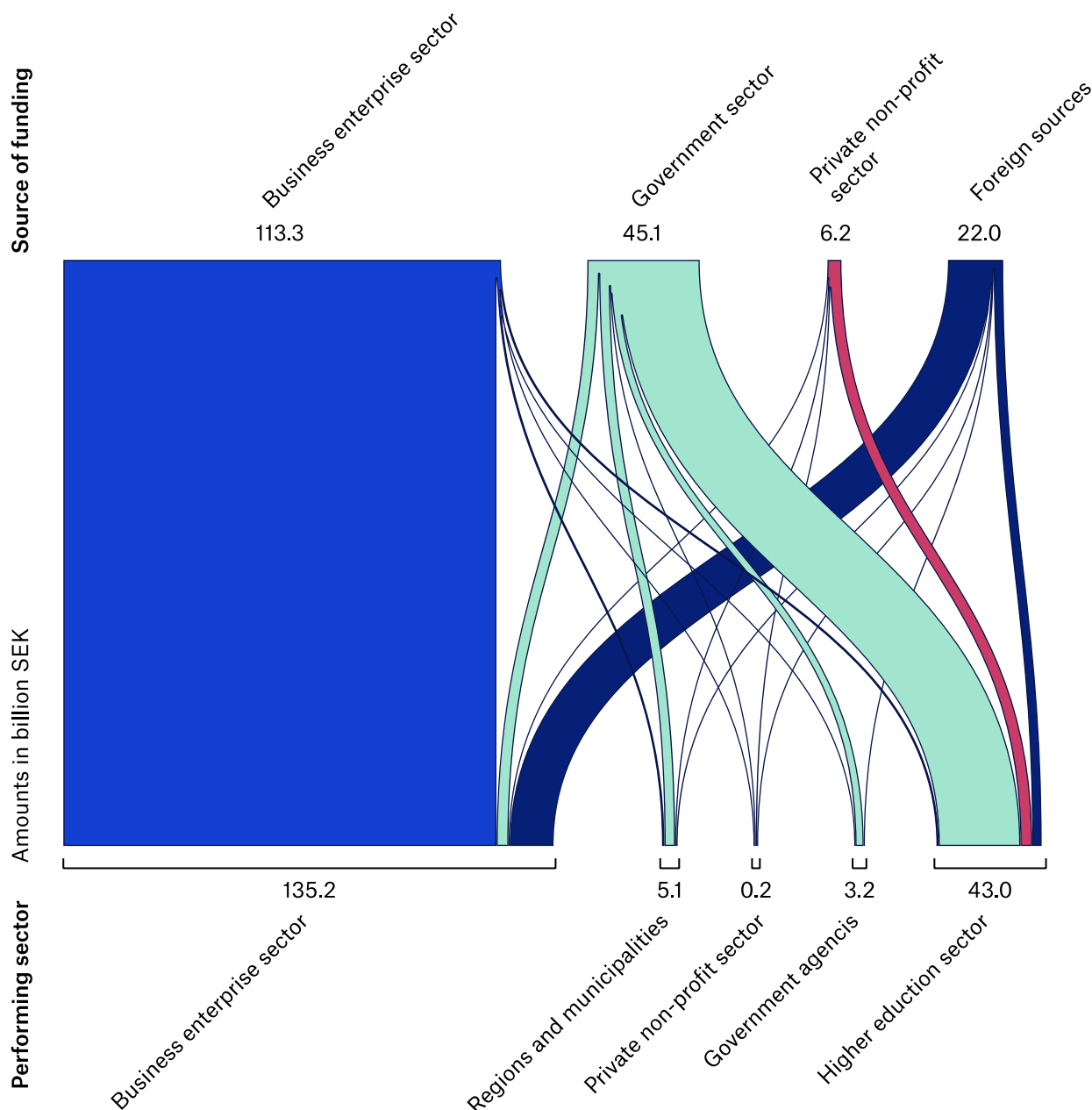


Figure 9. The R&D system in Sweden divided up into sources of funding and performers of R&D, 2021 (billion SEK). Source: Statistics Sweden.

Note: The lines represent the sizes of the flows from sources of funding to performers of R&D. The flows to the private non-profit sector are estimated.

Performers

R&D in Sweden is primarily carried out by two sectors: business enterprise and higher education. Business enterprise's share of total expenditure on R&D amounted to 72 per cent, and higher education's share to 23 per cent. This means that other sectors (government agencies, municipalities and regions, and the private non-profit sector) only account for 4.5 per cent of the total expenditure on R&D in Sweden.

Expenditure on R&D amounted to 186.7 billion SEK in 2021, which is an increase of 7.2 billion SEK (constant prices) compared to 2019. The increase was noted in all sectors, where business enterprise was the sector that increased the most, both in SEK (6.4 billion) and in percentage terms (5.1 per cent).

R&D in business enterprise is concentrated to a few major enterprises in Sweden. The ten largest R&D performers in business enterprise accounted for between 40 and 48 per cent of the total expenditure of the sector during the period 2007–2021. The five industries with the greatest expenditure on R&D were: manufacture of motor vehicles and other transport equipment, information and communication service activities, scientific research and development, manufacturing of machinery and equipment, and the manufacture of basic pharmaceutical products and pharmaceutical preparations. The industry that invested the most of these was the manufacture of motor vehicles and other transport equipment, where the expenditure on R&D amounted to one quarter of business enterprise's entire expenditure on R&D.⁸

Sources of funding

The sources of funding are divided up into business enterprise, government, private non-profit and funding from abroad. By far the largest source of funding of R&D in Sweden is business enterprise, where the funding goes almost entirely to business enterprise (99 per cent). It should also be noted that funding to business enterprise from abroad consists primarily of funding from companies within the own group of companies, and from other companies.

The governmental sector accounts for 24 per cent of the total funding of R&D. The largest share of this funding goes to higher education (73 per cent), but business enterprise and municipalities and regions also receive a considerable share (11 per cent and 10 per cent respectively). Funding from the private non-profit sector amounts to 6.1 billion SEK, of which 97 per cent goes to higher education.

As the expenditure on R&D has increased between 2019 and 2021, the funding has consequently increased by the same amount. It is in particular funding to business enterprise from business enterprise and from abroad that accounts for the entire increase. Funding from abroad to business enterprise alone increased by 6.2 billion SEK.

⁸ SCB (2022). Forskning och utveckling inom företagssektorn 2021. For further information on business enterprise's R&D, see also Vetenskapsrådet (2022). Företagen som finansierar och utförare i det svenska forskningssystemet. VR2212

What is included in expenditure on R&D?

Expenditure on R&D is the sum of the current costs for and investments in (or capital costs of) R&D performed in Sweden during a specific year.

Current costs for R&D consist of personnel costs (salary costs, payroll tax, and so on), premises costs (rent, maintenance, and so on) and other current costs (administration costs, consumables, and computer programmes, for example). Investments are made up from expenditure on assets and equipment. Investments are reported at acquisition value and, for higher education, are divided up into investments in buildings, land and property, and investments in machines and equipment. The Swedish Research Barometer reports expenditure on R&D and does not divide it up into current costs and investment expenditure. Reporting the source of funding divided up into expenditure on R&D is a new feature and an improvement on previous years, when statistics were only available for R&D revenue (where the revenue was also used as an approximation of the current costs). Another new feature in the statistics compared to previous years is that the ALF funding is now not reported as a source of funding for higher education, but only for the regions.⁹

Basic research, applied research and experimental development

Figure 10 shows how expenditure on R&D is divided between basic research, applied research and experimental development in 2021 (for a description of different type of R&D, see the fact box “Different types of R&D”).

Business enterprise, higher education, government agencies, and municipalities and regions show clear differences when it comes to the allocation between the different types of research. Business enterprise is more focused on experimental development, while the higher education and other government sectors are primarily focused on basic and applied research.

⁹ ALF is the Swedish abbreviation of “Avtal om läkarutbildning och forskning” (English: “Agreement on physician training and research”), and is a national agreement between the government and seven regions relating to their participation in the training of physicians, conducting clinical research and developing health and medical care. The ALF funding is paid by the government to the universities, which in turn transfer the ALF funding to the regions. The ALF funding therefore funds costs that arise in the regions.

For the R&D system as a whole, 14 per cent of the expenditure on R&D was spent on basic research, 28 per cent on applied research, and 58 per cent on experimental development. This emphasis on experimental development is due to business enterprise being responsible for such a high proportion of the total expenditure on R&D, at the same time as business enterprise also has a clear emphasis on experimental development.

In business enterprise, 6 per cent of the expenditure on R&D was spent on basic research, 21 per cent on applied research, and 73 per cent on experimental development. This means that business enterprise spends 8.1 billion SEK on basic research, 28.0 billion SEK on applied research, and 95.4 billion on experimental development.

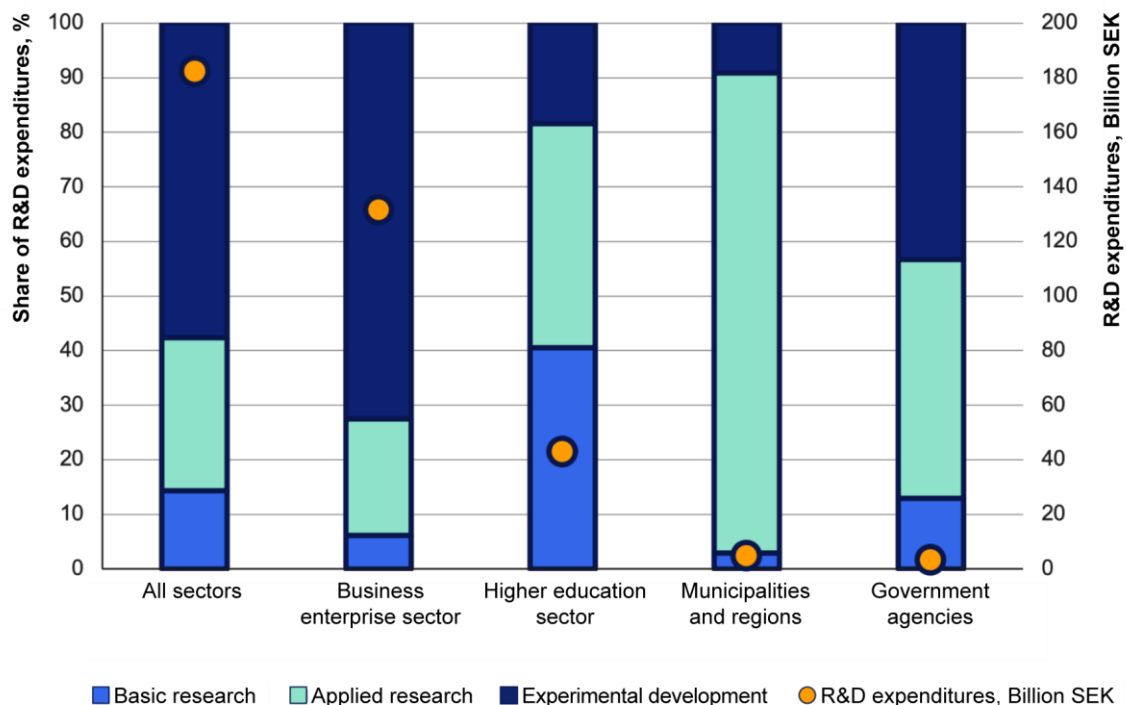


Figure 10. Proportion of expenditure on R&D on basic research, applied research and experimental development, and total expenditure on R&D for different sectors, 2021. Source: Statistics Sweden.

Higher education's expenditure on R&D divides up into 41 per cent each on basic research and applied research, and 18 per cent on experimental development. In total, higher education's expenditure on basic and applied research amounts to 35.1 billion SEK. This is interesting to compare with business enterprise, where the expenditure on R&D on basic and applied research amounts to 36.1 billion SEK. This means that business enterprise spends 1 billion SEK more on basic and applied research than higher education does. If we were to assume that all research is equally costly, this would mean that it is business enterprise that carries out the most basic and applied research in Sweden.

In higher education, the proportions of basic research, applied research and experimental development differ between different fields of research. For all fields of research, however, basic and applied research dominate, while experimental development constitutes a smaller proportion. The proportion of expenditure on R&D in experimental development varies between 16 and 23 per cent for the different fields of research, where social sciences has the lowest proportion, and engineering and technology the highest. The proportion of basic research varies between 22 and 62 per cent. Engineering and technology and agricultural sciences have the lowest proportion of basic research (22 and 25 per cent respectively), while humanities and arts have the highest proportion (62 per cent). Other fields – natural sciences, social sciences, and medicine and health sciences – have proportions between 41 and 47 per cent.¹⁰

Different types of R&D

R&D (research and experimental development) includes basic research, applied research and experimental development. Basic research is defined as systematic work to search for new knowledge, without any particular application in mind.

Applied research is defined as systematic work to search for new knowledge, with a particular application in mind.

Experimental development is defined as systematic work using research findings, scientific knowledge or new ideas to produce new materials, goods, services, processes, systems, methods or significant improvements of already existing ones.¹¹

Government budget allocations for R&D

The government is a significant source of R&D funding. Figure 11 shows government budget allocations for R&D for 2023. Please note that the figure does not show actual expenditure, but budgeted. However, it does provide a picture of the government's prioritisation.

The government's budgeted funding for R&D is estimated to amount to 46.8 billion SEK for 2023. This constitutes 3.74 per cent of the overall government budget, and represents an increase of 3.31 billion SEK from 2022. Part of the change compared to last year is, however, because

¹⁰ For further information, see SCB (2022). *Forskning och utveckling vid universitet och högskolor 2021*.

¹¹ OECD (2015). *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities*, OECD Publishing, Paris.

Statistics Sweden has changed how it produces these figures; 1.46 billion SEK of the 2023 increase is expected to be a result of this change in method.¹²

The government budget allocations for R&D are divided up into general advancement of knowledge and socio-economic objectives. This division is based on an international classification (NABS 2007), and is therefore not specific for Sweden. The budget allocation for general advancement of knowledge accounts for 70 per cent of the total R&D budget allocations, while the socio-economic objectives account for 30 per cent. The budget allocations to general advancement of knowledge can in turn be divided up into fields of research. From the figure we can note that the government's allocation of funding on an overarching level follows the relative size of the fields, with the highest level of R&D funding related to medical sciences, followed by natural sciences.

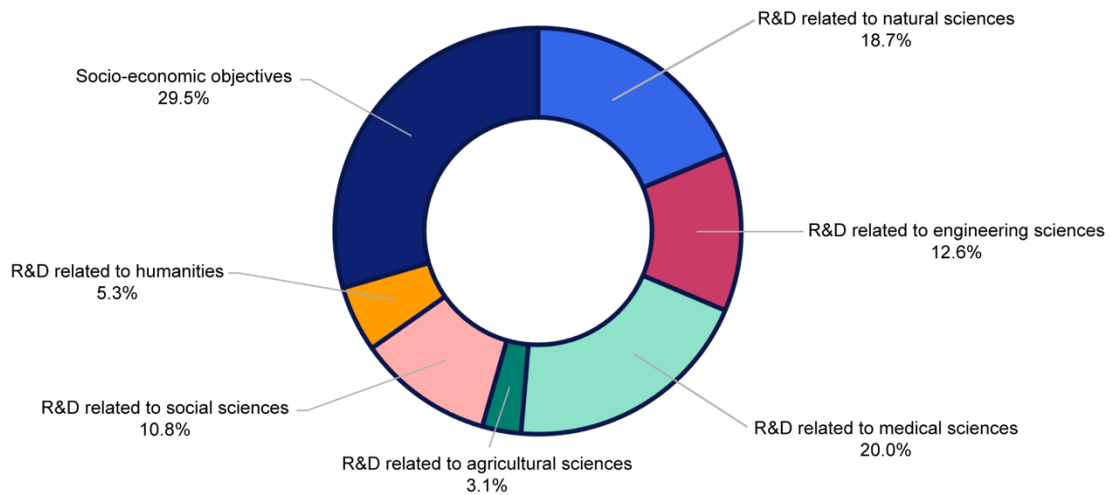


Figure 11. Government budget allocations for R&D for 2023 according to purpose (per cent). Source: Statistics Sweden.

The socio-economic objectives are divided up into twelve different areas. The largest areas are “transport, telecommunications and other infrastructure”, “industrial production and technology”, and “defence”. The government budget allocations for R&D for “transport, telecommunications and other infrastructure” is even higher than the government’s budget allocations for R&D in humanities. The socio-economic objectives do not have a clear link to any specific field of research. There is some overlap, however, for example between the socio-economic objective “health” and general advancement of knowledge in medical sciences.

¹² [Statliga anslag till forskning och utveckling 2023 \(scb.se\)](https://www.scb.se/statlaga-anslag-till-forskning-och-utveckling-2023)

1.3 Expenditure on R&D in higher education

Figure 12 shows higher education's expenditure on R&D for 2021, divided up per source of funding. Higher education's largest source of funding for R&D is direct government funding, that is to say block grants and other allocations paid direct by the government to higher education institutions (HEIs). Direct government funding amounted to 18.2 billion SEK, which is 42 per cent of the overall funding for higher education.

The second largest source of funding is the governmental research councils (the Swedish Research Council, Forte, Formas and Vinnova). The governmental research councils' funding amounted to 7.5 billion SEK, which is 17 per cent of the overall funding for higher education. The largest funding body among these is the Swedish Research Council, which contributed 4.8 billion SEK.

The third largest income source is private non-profit organisations. These organisations consist of foundations and funds in both Sweden and abroad. The private non-profit organisations' funding amounted to 6.1 billion SEK, which constituted 14 per cent of the funding.

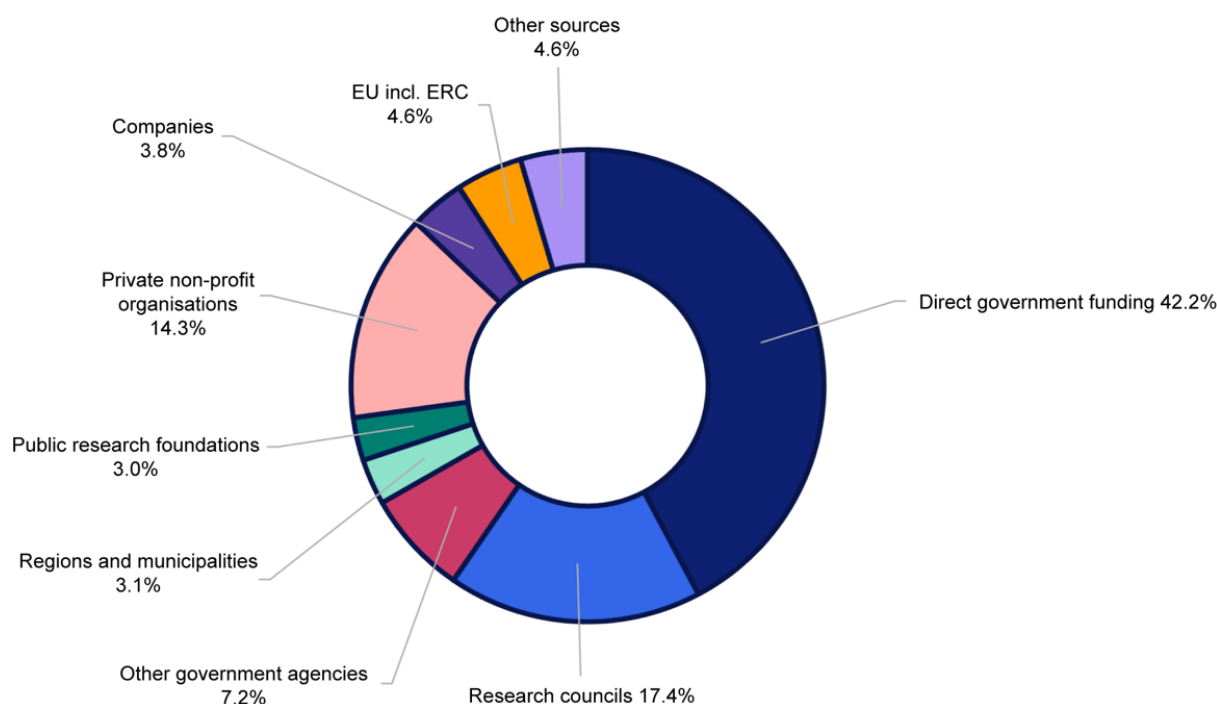


Figure 12. Expenditure on R&D in higher education 2021 divided up by source of funding. Source: Statistics Sweden

Funding from business enterprises (in Sweden and from abroad) amounted to 1.6 billion SEK, or 3.8 per cent. This is approximately equal to the funding from Forte and Formas together.

The total funding from the public sector (direct government allocations, research councils, other governmental agencies, regions and municipalities as well as public research foundations) adds up to 31.3 billion SEK, which was 73 per cent of the total funding of higher education.¹³

Higher education's expenditure on R&D over time

Higher education's expenditure on R&D has increased from 40.9 billion SEK in 2017, to 42.5 billion SEK in 2019 and 43.0 billion SEK in 2021. To understand the background to this change, we need to study how the funding from other sources of funding have changed over time, as shown in Figure 13.

The figure shows that between 2019 and 2021, funding increased in particular from direct government allocations, from other governmental agencies (such as the Swedish Energy Agency and the Legal, Financial and Administrative Services Agency), from private non-profit organisations (such as funds and foundations), and from the EU. Direct government allocations increased by 806 million SEK, while funding in total increased by 499 million SEK. This means that funding has decreased from several sources of funding, and that direct government allocations have played an important part in maintaining higher education's total R&D funding.

¹³ ALF funding is no longer reported as a source of funding for higher education. See the fact box "What is included in expenditure on R&D?"

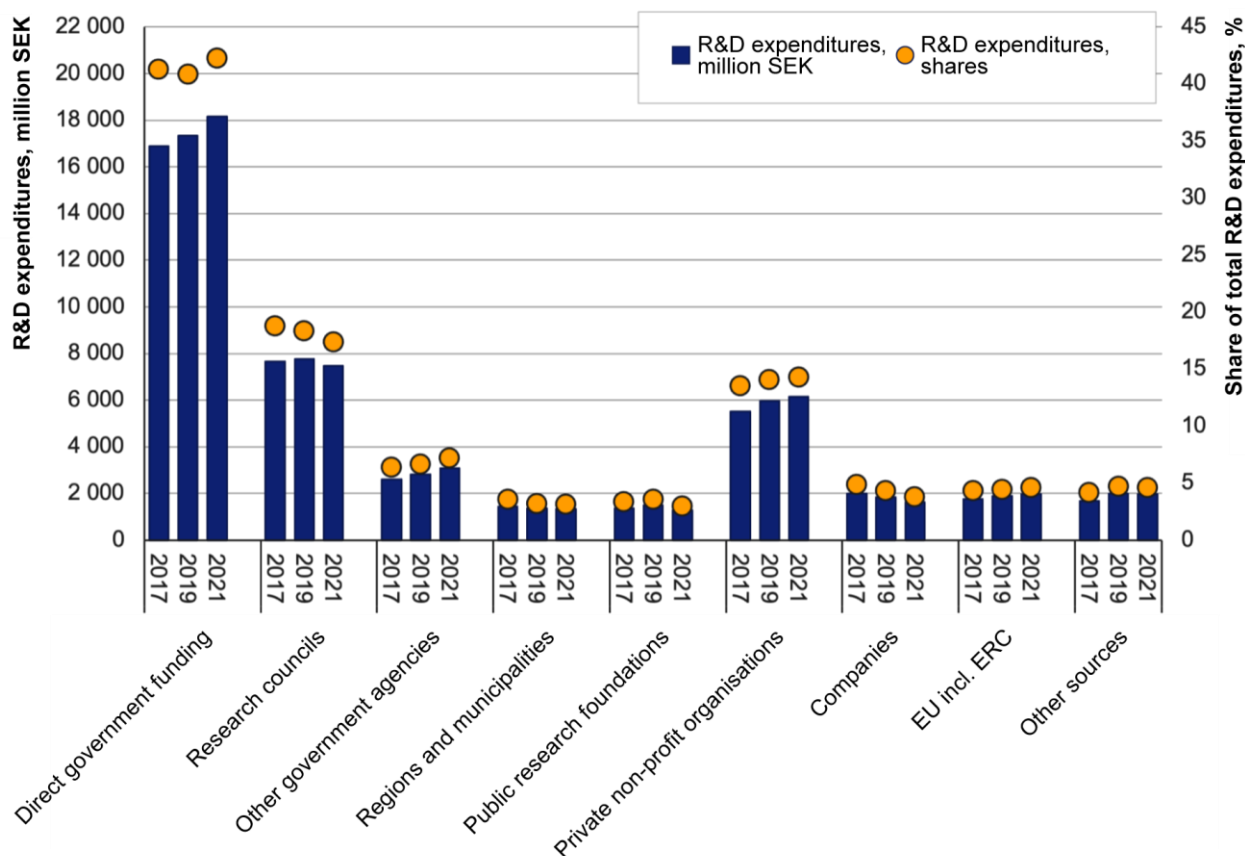


Figure 13. Development of higher education's expenditure on R&D 2017–2021, by source of funding (million SEK, constant prices and proportions). Source: Statistics Sweden

Funding from research councils, regions and municipalities, public research foundations, companies and other sources decreased between 2019 and 2021. In total, research councils, public research foundations and companies decreased their funding by 770 million SEK.

Funding from the research councils decreased by 310 million SEK in constant prices (that is, corrected for inflation), which is a decrease of 4.0 per cent. In current prices, however, funding from the research councils has increased slightly, but this increase has not kept up with inflation, which means that in actual terms funding has decreased slightly.

Another way of studying how R&D funding has changed over time is to study the sources of funding's proportions of total funding (see Figure 13). The figure shows that the proportion of direct government funding decreased between 2017 and 2019, at the same time as the same funding increased in terms of Swedish krona. This means that, despite the direct government funding increasing in krona terms, other sources of funding increased more, in particular from private non-profit organisations. This shows the importance of studying changes to the sources of funding based on both proportions and Swedish krona.

Higher education's expenditure on R&D divided up by higher education institutions and higher education institution categories

Figure 14 shows the development of higher education's expenditure on R&D for different fields of research and higher education institution (HEI) categories for 2017 to 2021. The figure shows that there are large differences between different fields of research, and that these differences have remained over time.

Medicine and health sciences is the field of research with the highest expenditure on R&D, followed by natural sciences, and thereafter engineering and technology, social sciences, humanities and arts, and agricultural and veterinary sciences. 30 per cent of higher education's expenditure on R&D was in medicine and health sciences, while 6 per cent was in agricultural and veterinary sciences.

The largest increase in expenditure on R&D between 2019 and 2021 was in natural sciences, where expenditure increased by 8 per cent, or 814 million SEK. Between 2019 and 2021, expenditure on R&D increased for all fields of research, apart from agricultural and veterinary sciences, which decreased, and humanities and arts, where expenditure on R&D was unchanged. For agricultural and veterinary sciences, it should be noted that expenditure on R&D in this field increased markedly between 2017 and 2019. This means that expenditure on R&D in 2021 was still slightly higher than expenditure on R&D in 2017 in agricultural and veterinary sciences.

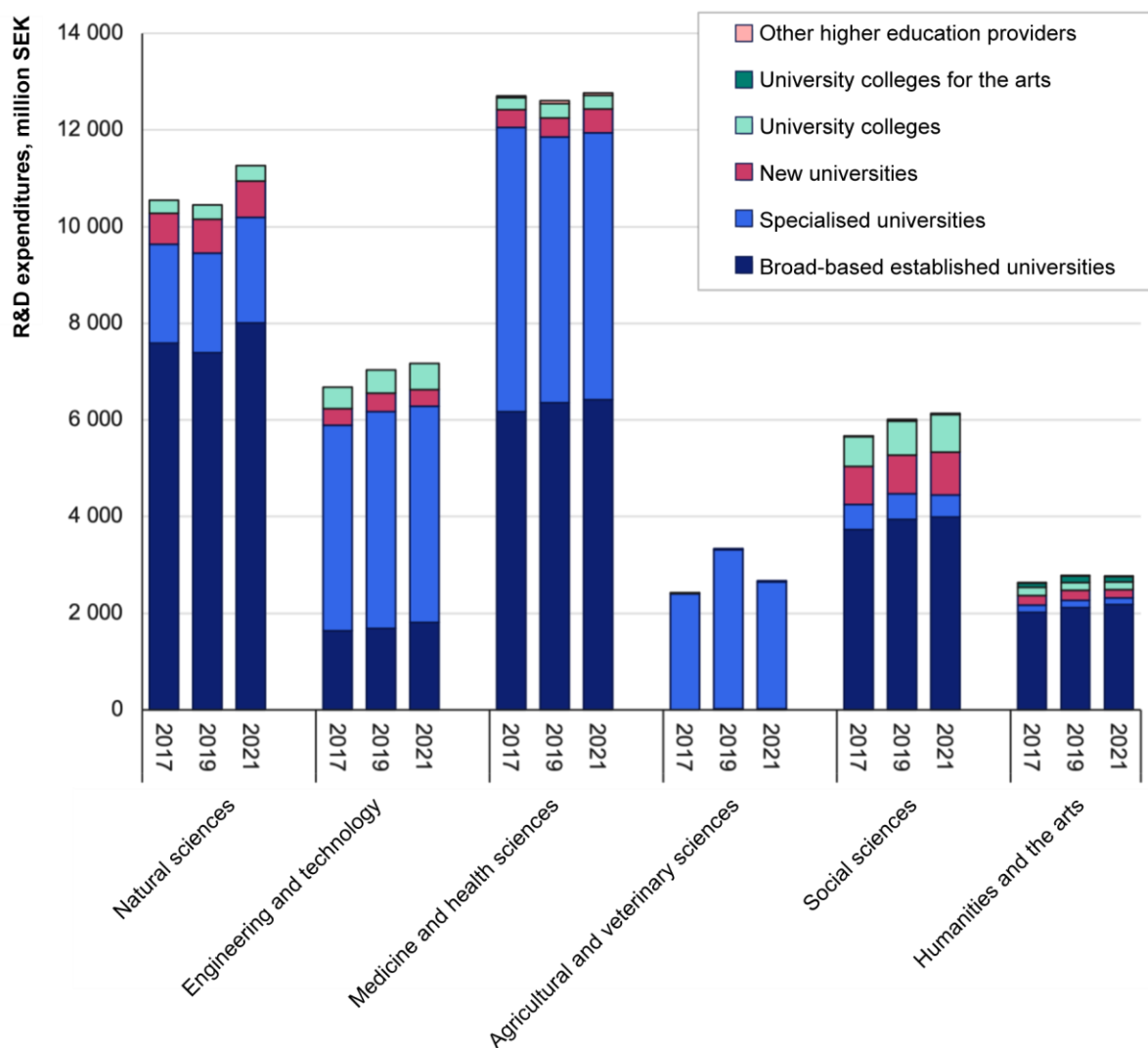


Figure 14. Development of higher education's expenditure on R&D 2017–2021, divided up by fields of research and higher education institution categories (million SEK, 2021 constant prices). Source: Statistics Sweden and National Institute of Economic Research.

Figure 14 also shows expenditure on R&D divided up by HEI categories. From the figure, it is clear that most of the research in Sweden is carried out at the broad-based established universities and at the specialised universities. Research in natural sciences, engineering and technology, and medicine and health sciences is carried out primarily at these universities. Research in agricultural and veterinary sciences is carried out primarily at one of the specialised universities (Swedish University of Agricultural Sciences), and research in social sciences and humanities is carried out primarily at the broad-based established universities. In social sciences, however, a large part of the research is also carried out at the new universities and at university colleges.

What are the different HEI categories?

The higher education institutions (HEIs) have been divided up into different HEI categories. An HEI category aims to represent a group of HEIs that share similar characteristics. This does not mean that there cannot also be considerable differences within an HEI category. HEIs are included in the report if the official statistics contain data about expenditure on R&D or number of research and teaching personnel.

Broad-based established universities:¹⁴ University of Gothenburg, Linköping University, Lund University, Stockholm University, Umeå University, and Uppsala University.

Specialised universities: Chalmers University of Technology, Stockholm School of Economics, Karolinska Institutet¹⁵, KTH Royal Institute of Technology, Luleå University of Technology, and the Swedish University of Agricultural Sciences.

New universities: Karlstad University, Linnaeus University, Malmö University, Mid Sweden University, Mälardalen University, and Örebro University¹⁶.

University colleges: Blekinge Institute of Technology, Swedish Defence University, Swedish School of Sport and Health Sciences, Dalarna University, University of Borås, University of Gävle, Halmstad University, Jönköping University, University of Skövde, Kristianstad University, University West, and Södertörn University.

University colleges for the arts: University of Arts, Crafts and Design, Royal Institute of Art, Royal College of Music, Stockholm University of the Arts, Beckmans College of Design, and Stockholm University College of Music Education.

¹⁴ For indicators relating to publications and citations, this also includes the university hospitals' data for the University of Gothenburg (Sahlgrenska University Hospital), Linköping University (Linköping University Hospital), Lund University (Skåne University Hospital), Umeå University (Norrland University Hospital), and Uppsala University (Uppsala University Hospital).

¹⁵ For indicators relating to publications and citations, this also includes Karolinska University Hospital.

¹⁶ For indicators relating to publications and citations, this also includes Örebro University Hospital.

Other higher education providers: University College Stockholm, Erica Foundation, Ersta Sköndal Bräcke University College, Swedish Red Cross University College, Sophiahemmet University, Örebro School of Theology, Gammelkroppa School of Forestry, Johannelund School of Theology, Högskolan SAPU, World Maritime University, Swedish Institute for CBT & Schema Therapy, Högskolan Evidens, and Brunnsvik Folk High School.

There is variation in each HEI category in terms of how the HEIs are focused on different fields of research. Figure 15 shows expenditure on R&D divided up by HEIs and fields of research. For reasons of limited space in the report, university colleges for the arts and other higher education providers have not been included in this figure.

The figure shows that there are big differences in expenditure on R&D between different HEI categories and between HEIs. In particular, the broad-based established universities and the specialised universities have significantly higher expenditure on R&D than the other HEI categories. We can also see that the new universities, in turn, generally have considerably higher expenditure on R&D than the university colleges.

The variation in expenditure on R&D is not just big between the HEI categories, but also between the HEIs in each HEI category. Among the broad-based established universities, Lund University has the highest expenditure on R&D (5.7 billion SEK). This is more than double the expenditure on R&D at Linköping University (2.4 billion SEK) and at Umeå University (2.3 billion SEK).

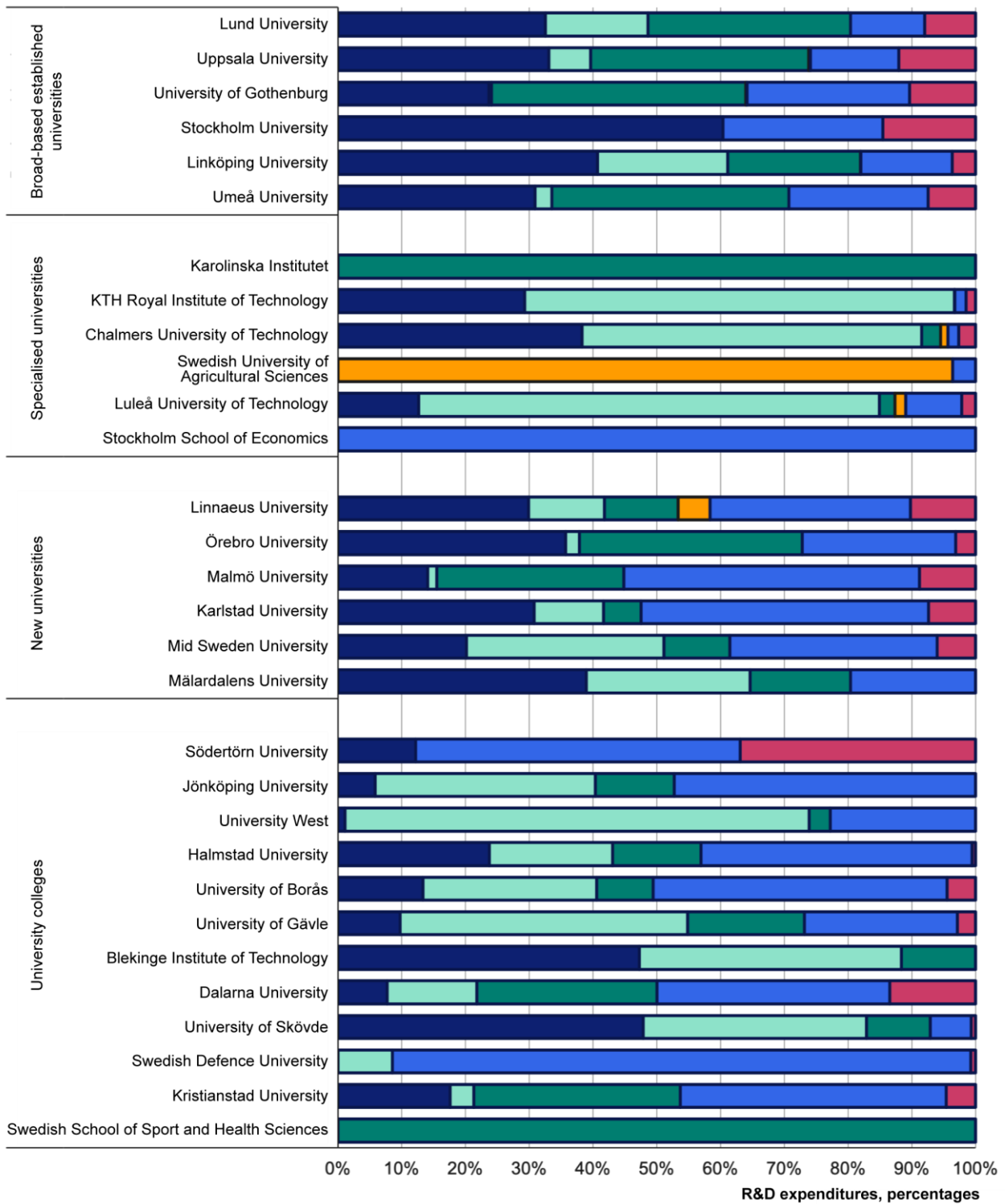
Among the specialised universities, Karolinska Institutet has the highest expenditure on R&D (5.4 billion SEK). Chalmers University of Technology has expenditure on R&D of roughly the same magnitude as Linköping University (2.7 billion and 2.4 billion SEK respectively), while that of KTH Royal institute of Technology is of roughly the same magnitude as that of Stockholm University (3.5 billion and 3.2 billion SEK respectively). It is interesting to note that, although agricultural and veterinary sciences is the smallest of the fields of research, the Swedish University of Agricultural Sciences has expenditure on R&D of roughly the same scale as Chalmers University of Technology (2.7 billion SEK).

Figure 15 also shows the HEI's expenditure on R&D divided up by fields of research. The figure thereby gives an overall picture of the different HEIs' research profile. The research profiles vary greatly. The broad-based established universities are active in all fields of research, at the same time as they generally carry out a slightly smaller proportion of research in engineering and technology than the new universities and university

colleges, for example. The broad-based established universities are also generally less specialised in social sciences than the new universities and university colleges.

The specialised universities are – for obvious reasons – clearly focused on natural sciences and engineering and technology (KTH, Chalmers, and Luleå University of Technology), while Stockholm School of Economics, and Karolinska Institutet specialise in entirely different fields of research.

Among the university colleges there is great variation in terms of research focus. Blekinge Institute of Technology, the Swedish Defence University and the Swedish School of Sport and Health Sciences (GIH) are specialised university colleges and therefore have a clear focus on one or two fields of research. It is also interesting to note that a large proportion of the university colleges' expenditure on R&D is in engineering and technology. University of Skövde and University West both have a strong emphasis on natural sciences and engineering and technology, not entirely different from the technology universities.



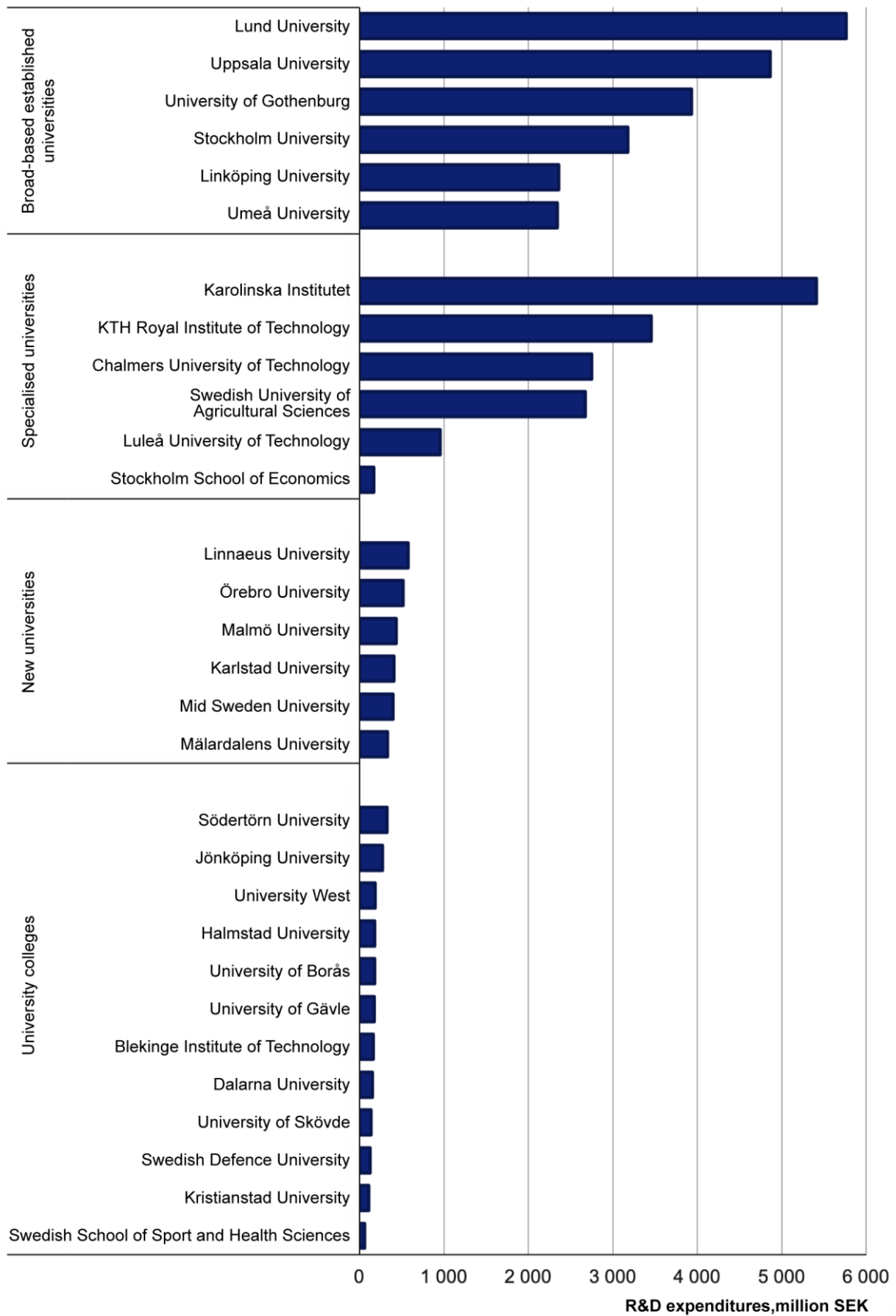


Figure 15. Expenditure on R&D for different HEIs divided up by field of research 2021 (proportions of total expenditure on R&D) and in total (million SEK). Source: Statistics Sweden.

What is the cost of research infrastructure?

Research infrastructure is used for conducting experiments, making observations, and analysing collected data and/or samples. Research infrastructure includes plant, instruments, databases, sample collections and services. It is intended to be used by researchers or groups of researchers in basic research or applied research in all fields of research.¹⁷

Research infrastructure can come in many different formats. Examples of research infrastructure in different fields of research are: biobanks and various measuring instruments in medicine and health; laboratories in physics, chemistry, materials science, engineering and technology, and life sciences; telescopes and other measuring platforms in astronomy, environmental and geosciences; questionnaires and context data in social sciences; and digitised material and language technology instruments in humanities. Costs for research infrastructure consist of costs for development and purchase, and also for operation. The current costs (running costs) include items such as maintenance, premises rental, and personnel costs.

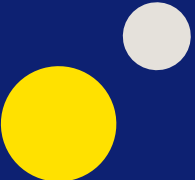
Statistics Sweden's figures for expenditure on R&D are divided up into current costs and investment expenditure. Investment expenditure is made up from expenditure on assets and equipment. Investments are reported at acquisition value and, for higher education, are divided up into investments in buildings, land and property, and investments in machines and equipment. In higher education, investment expenditure amounted to 1.7 billion SEK for 2021, which is 3.9 per cent of the total expenditure on R&D. These figures thereby form part of the expenditure on research infrastructure, but do not include operating costs, and therefore do not provide a complete picture. Statistics Sweden's figures for investments were formerly used to study changes over time, and as background documentation for a discussion of future needs for investment in research equipment.¹⁸

On the other hand, there is information on costs for research infrastructure that relates to parts of all research infrastructure in Sweden. One example is the Swedish Research Council's funding of research infrastructure of national interest.¹⁹

¹⁷ Govt. Bill 2016/17:50. Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft, p 46.

¹⁸ Vetenskapsrådet (2010). En studie av investeringar i utrustning för forskning vid svenska universitet och högskolor, 1997–2007. Vetenskapsrådet, Stockholm.

¹⁹ For further information, see Vetenskapsrådet (2023). Vetenskapsrådets guide till forskningsinfrastrukturen 2023. VR2309



Research personnel



2 Research personnel

This chapter describes the research and teaching personnel in the R&D system. The chapter consists of two sections. The first section provides a description of the Swedish R&D system in international comparison. The second section gives an in-depth picture of Swedish higher education.

2.1 The R&D system's personnel in international comparison

Proportion of researchers in the population

Figure 15 shows the proportion of researchers in the population of Sweden and in a selection of countries, for the years 2015–2021. The figure shows researchers as full-time equivalents and relates to researchers in all sectors of society; that is, those who work in higher education, in business enterprise, and in the government sector.

How are researchers defined in the statistics?

Statistics from Statistics Sweden and OECD relating to R&D personnel are based on the definitions and methods described in the Frascati Manual. In this, R&D personnel are divided up into researchers and other R&D personnel, where researchers are defined as professionals engaged in the creation of new knowledge with the help of advanced knowledge and skills. Although these skills may have been acquired through third cycle education, a doctoral degree is not a necessary criterion for inclusion as a researcher in the statistics.²⁰

The figure shows that the highest proportion of full-time researchers in the population in 2021 is in Sweden, followed by Finland, Denmark, and Norway. It should be noted here, though, that several countries lack data for 2021, which is due to limitations in the statistics. All countries in the figure have seen an increase in the proportion of researchers in the population during the period investigated (for years where statistics are available). The largest increase over the most recent two-year period was

²⁰ OECD (2015). Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris.

in Belgium. The number of researchers (full-time equivalents) in Sweden increased from around 67 000 to 85 000 between 2015 and 2021.

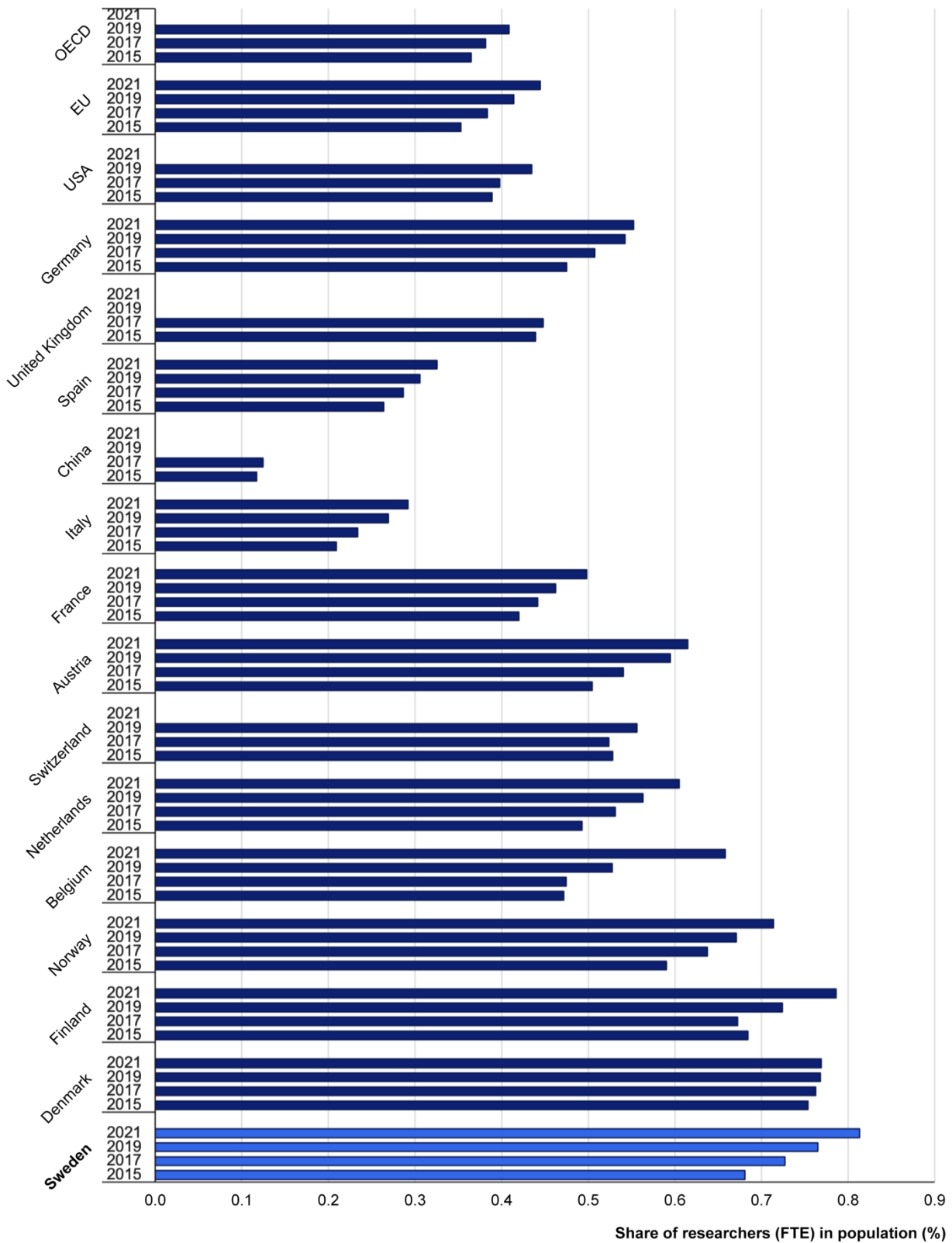


Figure 16. Proportion of researchers (full-time equivalents) in the population, over time, and for a selection of countries (per cent). Source: OECD.

Note: Time series break for Italy in 2016.

The proportion of researchers in the population tells us something about research intensity, and the preconditions for carrying out research in a country. The proportion of researchers is usually closely related to the resources available for research. Figure 17 therefore shows the relationship between expenditure on R&D as a proportion of GDP and the number of researchers per thousand inhabitants for the year 2021. The selection in this figure is broader than in Figure 16, and shows all countries (with available data) in the OECD. The sizes of the circles illustrate the magnitude of R&D expenditure in each country.

The figure shows that the expenditure on R&D as a proportion of GDP is positively correlated to the proportion of researchers in the population. That is, the countries with a high proportion of expenditure on R&D in relation to GDP generally also have a high proportion of researchers in their populations. It should, however, be noted that the correlation is not perfect; there is quite a lot of variation between countries for a given level of expenditure on R&D as a proportion of GDP.

Sweden (SE) is a country with a high proportion of researchers in the population and high expenditure on R&D as a proportion of GDP. Compared to the other countries in the figure, only South Korea (KR) has a higher proportion of researchers in its population, and a higher proportion of expenditure on R&D in relation to GDP than Sweden.

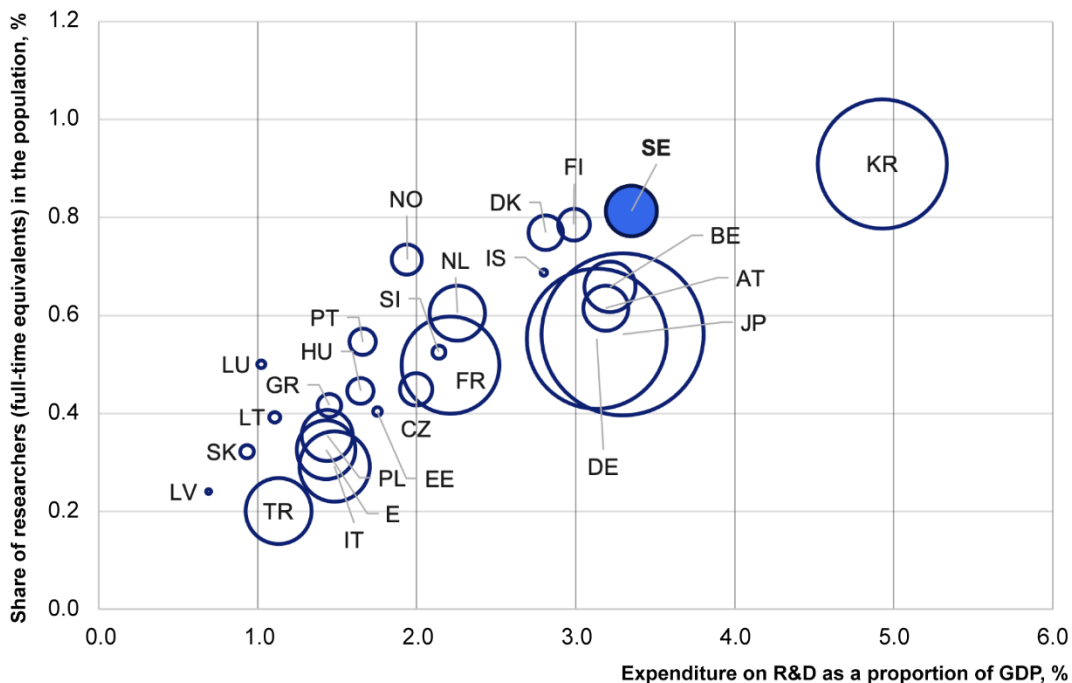


Figure 17. Relationship between expenditure on R&D as a proportion of GDP and proportion of researchers (full-time equivalents) in the population. The sizes of the circles represent expenditure on R&D (PPP\$) for 2021 for the OECD countries. Source: OECD.

Note: The figure does not show all OECD countries, since countries that lack statistics for 2021 are not included in the figure. The country codes can be found in the method appendix.

Proportion of researchers by sector

Figure 18 shows how the proportions of researchers (full-time equivalents) are distributed between business enterprise, the governmental sector and higher education in Sweden and a selection of countries, for the year 2021. The figure shows that USA was the country with the highest proportion of researchers - more than 80 per cent - who are active in business enterprise. Sweden also stands out in this respect, as 75 per cent of Swedish researchers work in business enterprise.

The figure also shows large variations between countries. In the United Kingdom and in Spain, less than 40 per cent of researchers work in business enterprise. In these countries, a large proportion of researchers (58 and 45 per cent respectively) work in higher education instead. This can be contrasted to Sweden, where just over 20 per cent of researchers work in higher education.

The countries in the figure also differ in terms of the proportion of researchers in the governmental sector. In China, almost 20 per cent of researchers work in the governmental sector. The corresponding proportions for Spain and Italy are 15 and 14 per cent respectively, while it is 1.4 per cent in Switzerland and 4.7 per cent in Sweden. The proportion of researchers in business enterprise, higher education and the governmental sector largely reflect the proportion of expenditure on R&D in these sectors (see Figure 6).

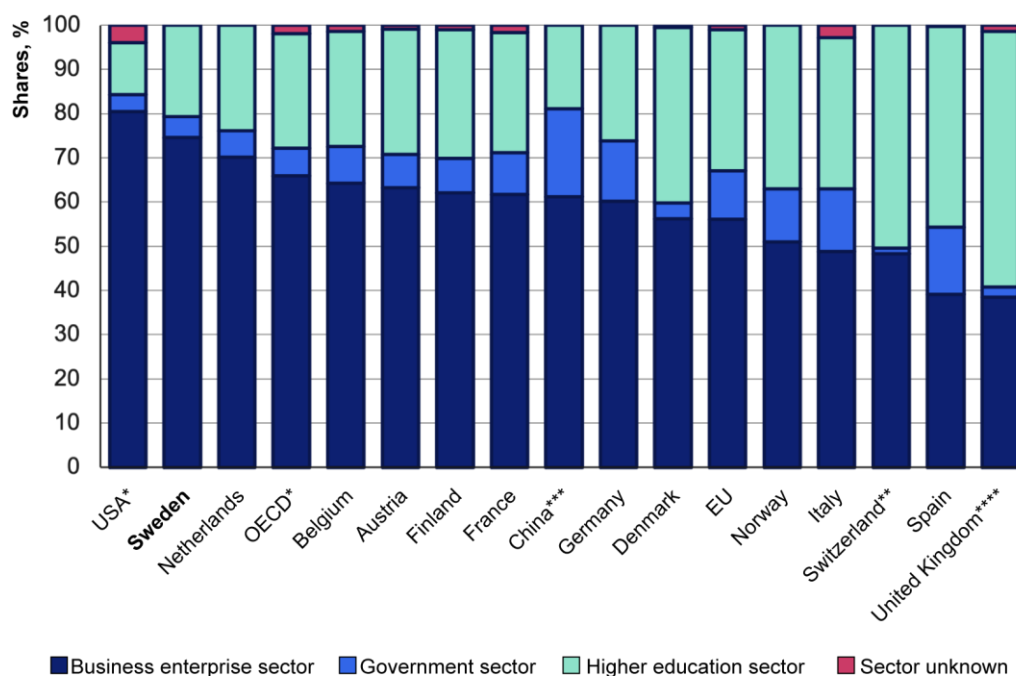


Figure 18. Distribution of researchers (full-time equivalents) between business enterprise, the government sector, and higher education, 2021 or most recent available year. Source: OECD.

Note: "Sector unknown" refers to the proportion of researchers who could not be allocated to a sector. *2020. **2019, ***2018, and ****2017.

2.2 Higher education sector in Sweden

The section above reports on the R&D system in Sweden in comparison with other countries. This section provides an in-depth description of higher education personnel in Sweden. Of the total number of employees (individuals) in higher education, the research and teaching personnel amounts to around 50 per cent, while doctoral students amount to 14 per cent, and personnel working with other tasks (such as administration) to 37 per cent.²¹ This section focuses on the research and teaching personnel in Swedish higher education.

Research and teaching personnel including doctoral students

Figure 19 shows the development of the number of employees in research and teaching personnel in different employment categories for the years 2012–2022. The figure also includes doctoral students, as they are also tasked with carrying out research, but by definition are not included in the statistics for the research and teaching personnel.

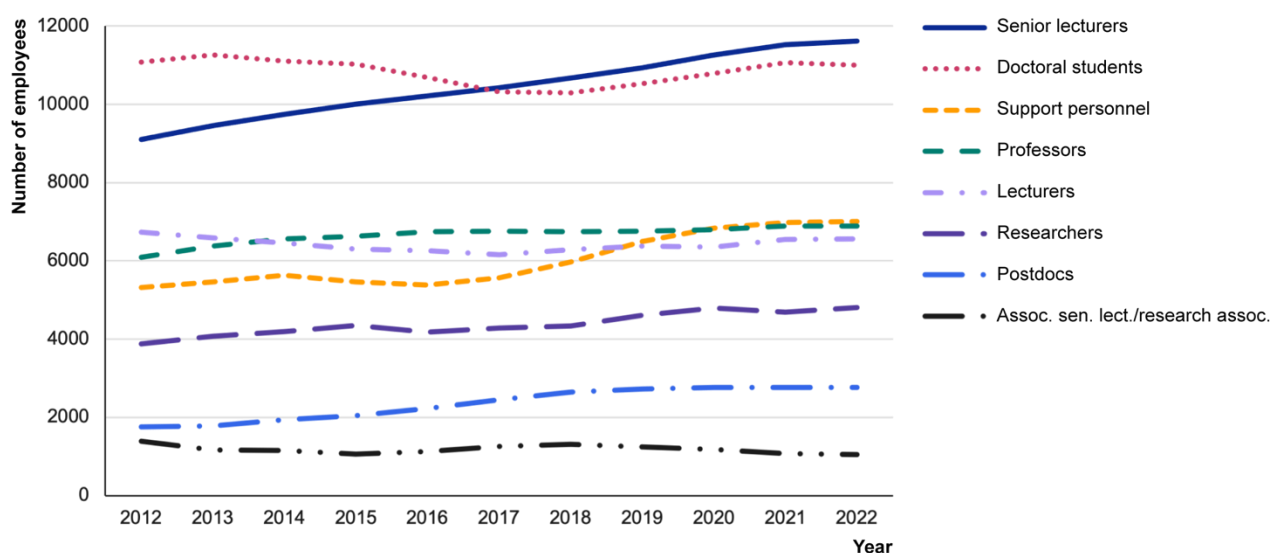


Figure 19. Development of research and teaching personnel including doctoral student employees (individuals) during the period 2012–2022. Source: Swedish Higher Education Authority.

Note: Assoc. sen. lect./research assoc. are abbreviations of “associate senior lecturer” and “research associate”.

In 2022, the research and teaching personnel amounted to around 40 692 persons (individuals) and 11 000 doctoral students. This is an addition of 6 360 persons since 2012. Senior lecturers form the employment category with the greatest number of employees, closely followed by doctoral students, support personnel, professors, lecturers, researchers, postdocs

²¹ Statistik för år 2022, [Högskolan i siffror - Universitetskanslersämbetet \(uka.se\)](https://www.uka.se/hogskolan-i-siffror)

and associate senior lecturers/research associates. (See fact box for a description of the different employment categories.)

Most employee categories show an increase in the number of employees. The employment category senior lecturer is the one with the largest increase in the number of employees over the ten-year period. Today, there are just over 2 500 additional senior lecturers than ten years ago, which is an increase of almost 30 per cent. The employment categories postdoc and support personnel have instead increased the most in percentage terms, by 58 and 32 per cent respectively. Associate senior lecturers and research associates, lecturers and doctoral students are the employment categories that have decreased during the period. Professors increased by 13 per cent during the period, with the fastest increase at the beginning of the period, which then slowed down slightly.

What are the different employment categories in higher education?

Employment in higher education is regulated in the Swedish higher education ordinance, (Högskoleförordningen 1993:100), through agreements between the parties on the labour market or, if otherwise is not stated, in the Swedish employment protection act (Lagen om anställningsskydd 1982:80).

Employment categories regulated in *Högskoleförordningen*:

Professor: Teaching position; there are also adjunct professor, visiting professor and combined employment with a healthcare principal.

Senior lecturer: Teaching position; there is also combined employment with a healthcare principal.

Associate senior lecturer: Four-year career development position as teacher, with the right to a review for consideration of permanent employment as senior lecturer. Can be achieved within five years of doctoral degree award. Has been subject to several changes, and was previously designated as 'research associate', and then without the right to a review for consideration of permanent employment.

Postdoc: Time-limited career development position, regulated via an agreement between the parties on the labour market. Can be achieved within two years of doctoral degree award. As from 1 February 2022, a new agreement applies, which among other things entails that postdocs may be employed for a period of between 2 and 3 years, from previously having been for 2 years at most.

Doctoral student: Employment for doctoral students to complete third-cycle education. Not all registered research students are employed as doctoral students. Doctoral student employees are not included in the statistics for teaching and research personnel in higher education.

In addition, there are other employment categories:

Other research and teaching personnel with doctoral degrees:
Designated as researcher employment ('researchers') in the Swedish Research Barometer.

Other research and teaching personnel without doctoral degrees:
Designated as 'support personnel' in the Swedish Research Barometer.

Lecturer: Teacher with or without a doctoral degree.

Postdoc, associate senior lecturer and research associate are known as 'career development positions' and are part of higher education's career progression system. These positions are time-limited in nature, and are aimed at creating opportunities for junior researchers to gain merit to advance further in higher education.

Associate senior lecturer was introduced as a time-limited employment format in 2017. To create clearer career paths and improve the conditions for junior researchers, in autumn 2021 the Government set up HEI-specific goals for 15 HEIs to increase their proportions of associate senior lecturerships.²² During the past ten years, the number of associate senior lecturers has increased by 142 per cent. At the same time as the associate senior lecturership was introduced, the previous career development position research associate was phased out, and only a few HEIs currently use this employment format. Since associate senior lecturership has replaced research associateship, these two employment formats are reported together in the Swedish Research Barometer. As the number of research associates has decreased more than the number of associate senior lecturers has increased, these two career development employment formats have decreased in total. The decrease is 24 per cent over the ten-year period.

Number of employees shown in Figure 19 is number of individuals. Another measure for describing personnel volume is full-time equivalents (work year equivalents), which are calculated based on the total hours of work carried out by the personnel. The total number of employees

²² UKÄ:s årsrapport 2023, p. 97.f

(individuals) in the research and teaching personnel (including doctoral students) was 51 692 persons in 2022, while the number of full-time equivalents was 43 205. The distribution across the different employment categories is similar, with the exception of doctoral students, who over the period reported in Figure 19 increased by 6 per cent in terms of full-time equivalents, but decreased by around 1 per cent in terms of number of individuals. Doctoral students were also the highest in number of full-time equivalents throughout the period.

Research and teaching personnel by HEI category

The previous section provided a description of the research and teaching personnel at national level. But the Swedish higher education sector consists of around 50 different HEIs, of varying sizes and with differing subject focuses. The different HEIs also differ in terms of the proportions of employees in the different employment categories.

Figure 20 shows the composition of the research and teaching personnel for different HEI categories for 2022. (See the fact box in Section 1.3 for which HEIs are included in the different categories). The figure shows the total number of employees (individuals) for the different HEI categories. Employed doctoral students are not included in the research and teaching personnel in the statistics, and we have chosen not to include them in this figure.

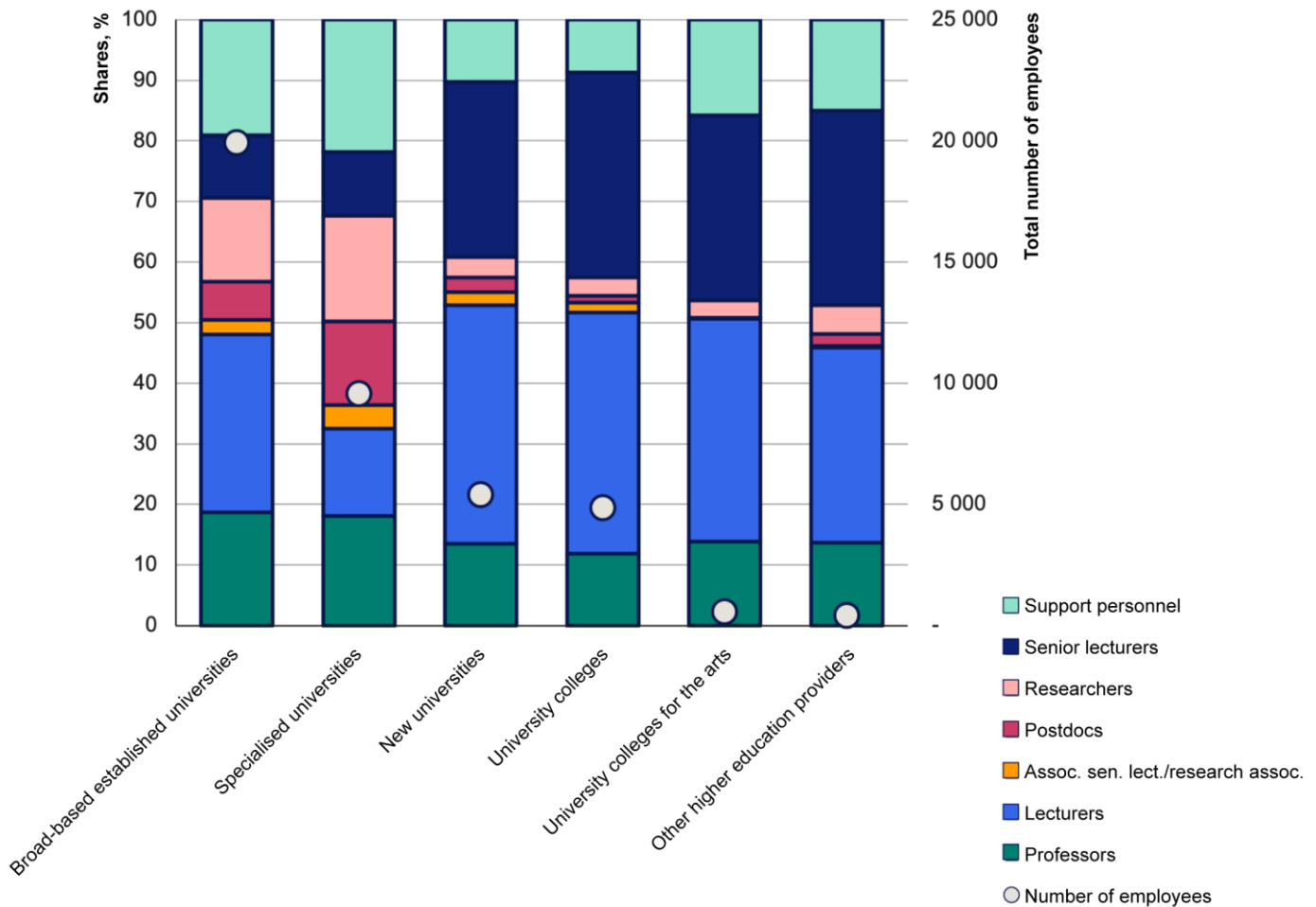


Figure 20. Number of employees (dots) and proportion of employed individuals (bars) for different employee categories for the teaching and research personnel in higher education, 2022, by HEI categories. Source: Swedish Higher Education Authority.

Note: Assoc. sen. lect./research assoc. are abbreviations of “associate senior lecturer” and “research associate”

The figure shows that the largest numbers of research and teaching personnel are employed at the broad-based established universities, followed by the specialised universities, the new universities, and thereafter the university colleges, the university colleges of the arts, and other higher education providers. At the broad-based established universities, the number of employees in the research and teaching personnel amounted to just under 20 000 persons. At the new universities, the corresponding figure is just under 5 000 persons.

At the broad-based established universities and the specialised universities, around 70 per cent of the personnel are in employment categories that normally require a doctoral degree (that is, professor, senior lecturer, researcher, postdoc and associate senior lecturer/research associate). The corresponding figure at the new universities and university colleges is slightly lower, around 60 per cent.

The highest proportion of professors can be found at the broad-based established universities and at the specialised universities (just under 20 per cent). The lowest proportion of professors is at the university colleges, just over 10 per cent. The university colleges and the new universities are instead characterised by a high proportion of senior lecturers (just under 40 per cent) and a high proportion of lecturers (around 30 per cent). Senior lecturers and lecturers are employment categories primarily focused on teaching. The broad-based established universities and specialised universities, on the other hand, have a higher proportion of postdocs, associate senior lecturers/research associates and researchers, which are positions focused primarily on research. This is also reflected in the fact that both the university colleges and the new universities receive a large part of their revenues from government budget allocations for education at first and second cycle levels. The broad-based established universities and specialised universities instead receive a large proportion of their revenues from both direct and external allocations for research and education at post-doctoral level.²³

Women and men in higher education

This section presents statistics for women and men with researching and teaching tasks in higher education. Investigating the proportion of men and women is important for following up gender equality in higher education. The objective of the government's gender equality policy is that women and men shall have the same power to shape their own lives.²⁴ Gender equality means that women and men have the same opportunities, rights and obligations in all areas of life.

Indicators for gender equality usually report the proportions of men and women. When the gender distribution falls within the interval 40 to 60 per cent, gender distribution is usually considered to be even. A gender distribution of 40 to 60 per cent is therefore interpreted as an indicator of gender equality, but is not, however, sufficient proof that this is the case. The gender balance may be even, while men and women do not have the same opportunities, or uneven, despite men and women having the same opportunities.²⁵

Figure 21 shows how the proportions of women and men at different career stages have developed over the last ten-year period. If, by an equal gender balance, we mean that the proportions of men or women lie within the 40 to 60 per cent interval, then the gender balance is considered to be even for all career stages in the figure except professors. Of the professors, 30 per

²³ [UKÄ:s statistik om högskolans ekonomi år 2022](#)

²⁴ Prop. 2008/09:1, bet. 2008/09:AUI, rskr. 2008/09:115.

²⁵ Vetenskapsrådet (2018). Redovisning av regeringsuppdrag att utveckla uppföljning av svensk forskning. VR1805

cent are women and 70 per cent men. The proportion of the professors who are women has increased by around 8 percentage points since 2012, but despite this large increase there is not an even gender balance at this career stage.

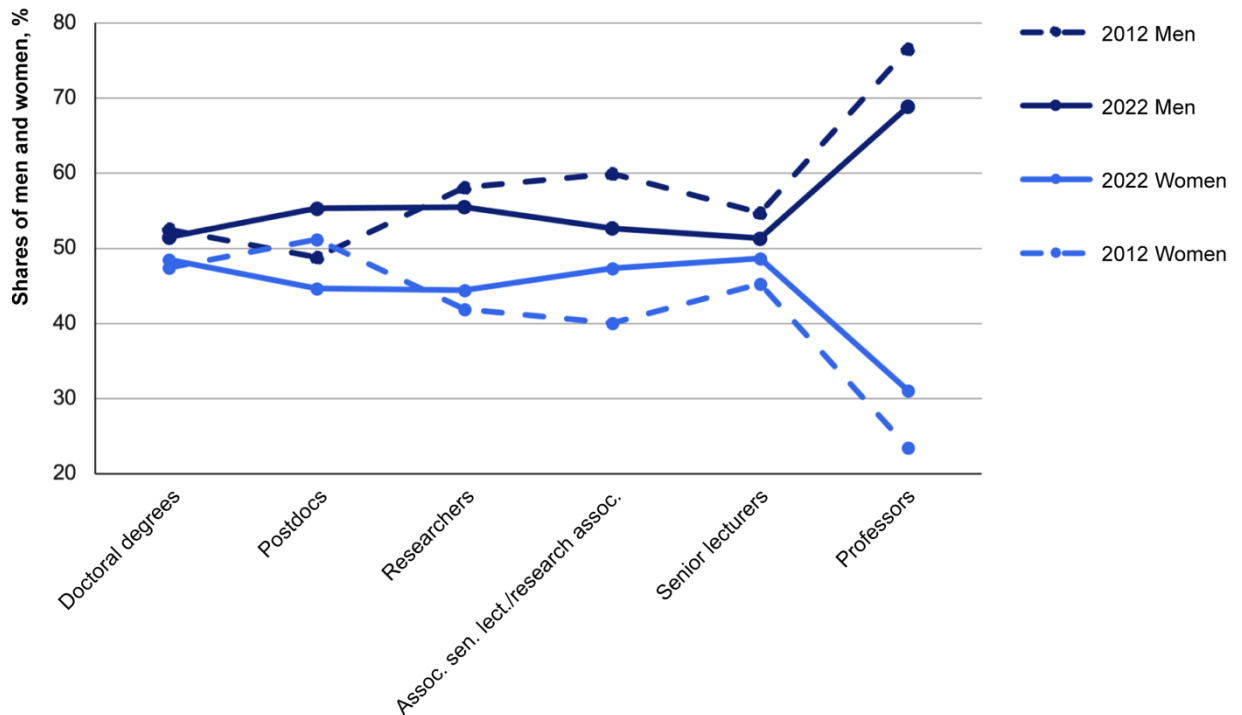


Figure 21. Proportions of men and women among those awarded doctoral degrees in 2012 and 2022 respectively, and for different employment categories in higher education in 2012 and 2022 (individuals). Source: Swedish Higher Education Authority.

Note: Assoc. sen. lect./research assoc. are abbreviations of “associate senior lecturer” and “research associate”.

Figure 22 shows the proportions of women and men of professors and senior lecturers distributed by year of doctoral degree award. Showing the statistics by year of doctoral degree award is a way of illustrating career age.

Like Figure 21, this figure shows that for professors, the proportion of men is higher than the proportion of women, while for senior lecturers the gender balance should overall be regarded as even. If we look at the gender balance per year of doctoral degree award, the proportion of professors who are men is higher than 60 per cent for all degree award years except 2003–2007. The proportion of professors who are men is particularly high in the older career age cohorts.

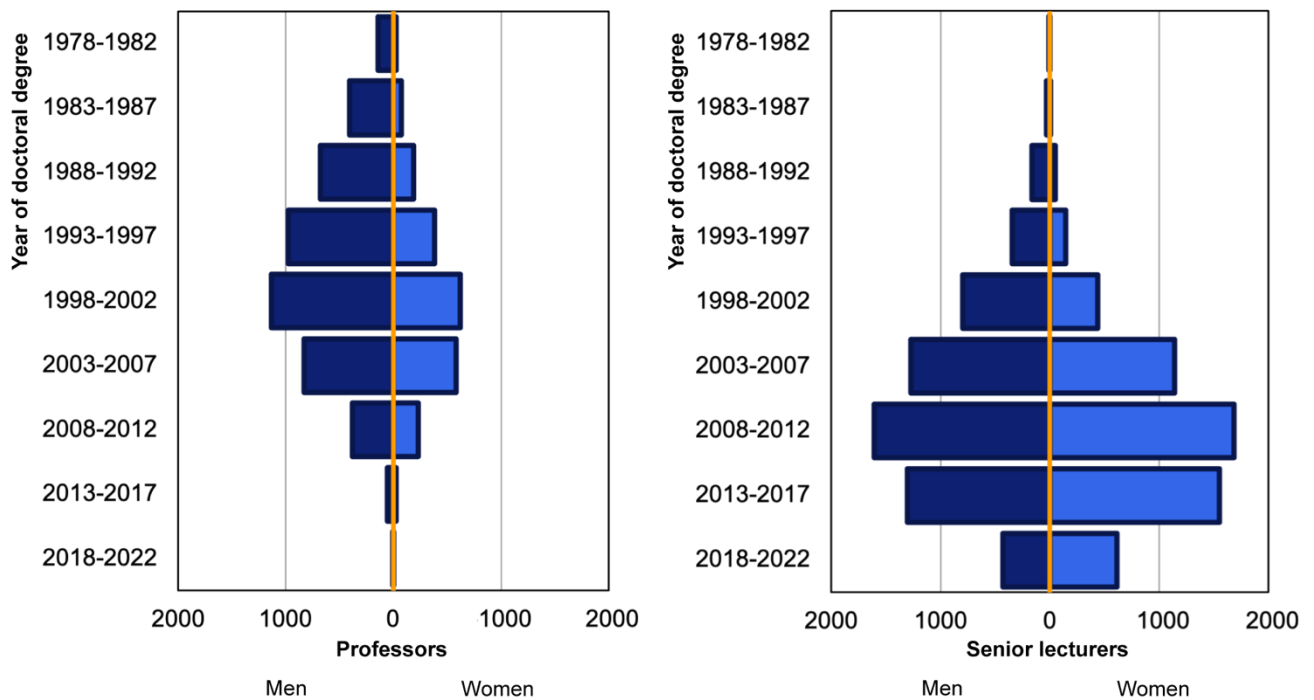


Figure 22. Number (individuals) of professors and senior lecturers by year of doctoral degree award and gender, 2022. Source: Statistics Sweden and own calculations.

Note: See the method appendix for further information.

Among senior lecturers, there are approximately the same number of women as men. Here too, men as a group are older in career terms than women. Among those who were awarded their doctoral degrees in 2003 or later, the gender balance is even according to the definition above.

The report “Hur jämställt är det i högskolan?” (“How gender-equal is higher education?”) discusses possible explanations to why the proportion of women among professors is so low. One explanation is that the group that holds professorships is dominated by persons with a doctoral degree that is more than twenty years old, which is also shown in Figure 22. At that time, the proportion of women in the recruitment pool was also considerably lower. However, the report establishes that the increase in the proportion of professors who are women should have been greater, since the proportion of women in the group of doctoral degree holders that professors are recruited from is higher.²⁶

To create further understanding of the gender distribution among higher education research and teaching personnel with doctoral degrees, Figure 23 shows how men and women are distributed across the different fields of

²⁶ Vetenskapsrådet (2021). Hur jämställt är det i högskolan? Kvinnors och mäns förutsättningar att bedriva forskning. VR2106.

research in terms of employment categories and doctoral degree award years.

As Figure 23 shows, the research and teaching personnel varies between fields of research, in terms of both volume and composition. The largest number of employees is in medicine and health sciences, followed by social sciences, and thereafter natural sciences. These fields employ approximately the same number of researchers and teachers with doctoral degrees. Agricultural and veterinary sciences is the smallest field of research in terms of personnel numbers, followed by humanities and arts, and thereafter engineering and technology. (Please note that the scale for the different fields of research in Figure 23 is the same for all fields except agricultural and veterinary sciences.)

The personnel structures also differ when we compare fields of research. In agricultural and veterinary sciences, researchers comprise almost half of the employees with doctoral degrees. The corresponding proportion in social sciences and humanities is around 10 per cent. In medicine and health sciences, researchers constitute around 25 per cent of all employees with doctoral degrees, in natural sciences around 20 per cent, and in engineering and technology around 15 per cent. The largest number of postdocs are found in medicine and health sciences, and in natural sciences. The increase in the number of postdocs was largest in engineering and technology, however, where numbers have increased by more than 150 per cent since 2012.

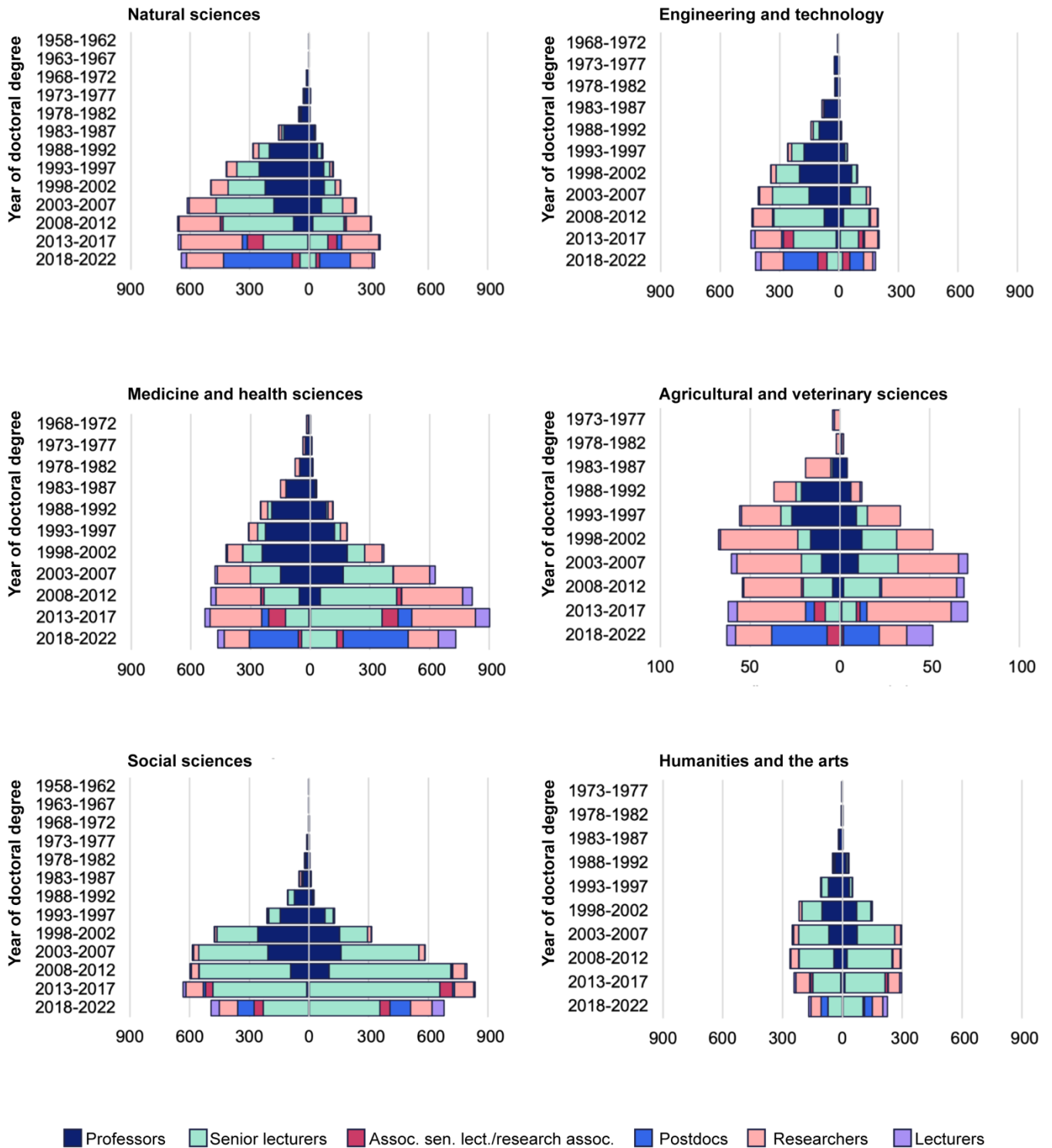


Figure 23. Research and teaching personnel (individuals) with doctoral degrees, according to doctoral degree award year, employment category, and gender. For different fields of research, 2022. Source: Statistics Sweden and own calculations.

Note: Please note that agricultural and veterinary sciences has a different scale on the horizontal axis. Assoc. sen. lect./research assoc. are abbreviations of “associate senior lecturer” and “research associate”. See the method appendix for further information.

Associate senior lecturers and research associates form a small proportion of the R&D personnel in all fields of research (less than 5 per cent), but the highest proportion can be found in engineering and technology, medicine and health sciences, and natural sciences. This is a reflection of the high proportion of research that is carried out in these fields of research.

The proportion of senior lecturers varies greatly between fields of research, and in social sciences and humanities they make up more than 60 per cent of the R&D personnel with doctoral degrees. Both social sciences and humanities are fields of research characterised by large student cohorts and a lot of teacher-led teaching. The lowest proportion of senior lecturers is found in agricultural and veterinary sciences, where they make up just under 20 per cent, followed by medicine and health sciences (just under 30 per cent), natural sciences (just over 30 per cent) and engineering and technology (around 40 per cent).

The proportion of professors also varies between fields of research. The highest proportion of professors is found in engineering and technology (just over 30 per cent of the employees with doctoral degrees), followed by medicine and health sciences, and natural sciences (just under 30 per cent). The lowest proportion is found in agricultural and veterinary sciences, (under 20 per cent), followed by social sciences (just over 20 per cent), and humanities and arts (just under 25 per cent). If we look at the gender distribution for professors by field of research, then the proportion of men is 60 per cent or more in all fields, except in humanities and arts, where the proportion is exactly 60 per cent. The proportion of professors who are men is highest in natural sciences, and in engineering and technology (around 80 per cent). The fact that the fields with a high proportion of professors are also those with a skewed gender distribution between men and women who are professors can explain the overall uneven gender distribution in Figure 22.

Figure 23 also shows differences between women and men and between different fields of research in terms of employment form in relation to career age. The shape of the pyramids in the figure can be used to investigate the researchers' overarching career paths, how they from the year of doctoral degree award go from career development positions to senior lecturer and thereafter to professor. The career age shows the number of years since the doctoral degree award. On the other hand, it does not show the individual's activity level or any parental leave or equivalent. Nor does it show whether the employment is a time-limited locum position or permanent employment.

Figure 23 shows that the research and teaching personnel with doctoral degrees are not evenly distributed across the various career ages. For most fields of research, the diagrams are more-or-less pyramidal in shape, as

from the second youngest career age interval and upwards, but there are variations. For humanities and arts, the three career age intervals 2003–2017 are approximately the same size, which means that humanities and arts has a more even distribution of career ages than other fields of research.

Another field of research that stands out is social sciences, where there is a large proportion of employees with doctoral degrees from the years 2003 to 2013, while the proportion with older doctoral degree award years is considerably lower.

In all fields of research, the youngest career age interval (that is, the group with the most recently awarded doctoral degrees) is decidedly smaller than the group that was awarded their doctoral degrees during the previous period. This means that there are fewer R&D employees in this group compared to the group that was awarded their doctoral degrees a few years earlier. This deviates from what we have seen in previous years, when the youngest career age interval has been the largest in most fields of research.

Figure 23 also shows the gender distribution in different employment categories in relation to year of doctoral degree award. From the figure, we can establish that the gender distribution varies between different fields of research. In natural sciences and engineering and technology, men form the majority in all personnel categories irrespective of their years of doctoral degree award, even if the proportion of women has increased for younger career age intervals. In medicine and health sciences, women are instead in the majority for all employment categories, except professor. In the other fields, the gender distribution is more even.

There are also differences in gender balance linked to career age. Men are in the majority in older career age groups, while women are in the majority in the younger career age groups. In medicine and health sciences, for example, women constitute more than 60 per cent of all employees with a doctoral degree from 2008 or later. If the current trend continues, women will be in the majority in humanities, in social sciences, and in medicine and health sciences.

Agricultural and veterinary sciences differ from the other fields of research, both because the number of employees is considerably smaller, and because it is relatively equally distributed across the different career age intervals. Agricultural and veterinary sciences, however, show a similar pattern to the other fields of research in that men form the majority in the older career age intervals and the pattern then switches, with women forming the majority in the younger career age intervals.

Use of working hours

Figure 24 shows the proportion of working hours spent on research, teaching and other tasks, for different employment categories and for men and women, for 2021. On average, research and teaching personnel in higher education spend 43 per cent of their working hours on research and experimental development, 24 percent on teaching at first and second cycle level, and just over 2 per cent on teaching at third cycle level. The rest of their time is spent doing other work, such as administration, various expert and representative assignments, and so on.

The figure shows that postdocs spend the highest proportion of their working hours on research, more than 80 per cent. Doctoral students and researchers spend most of their working hours doing research. Lecturers and senior lecturers spend the highest proportion of their working hours on teaching. The allocation of working hours between the different tasks is similar for women and men within the respective employment category. For associate senior lecturers/research associates, although it does appear that men spend more time on R&D than women, this difference is not statistically significant.²⁷ For technical and administrative personnel (“TA personnel”), however, men spend more time on R&D than women.

²⁷ The low response frequency means that the margins of error are large. See the method appendix for more information on this.

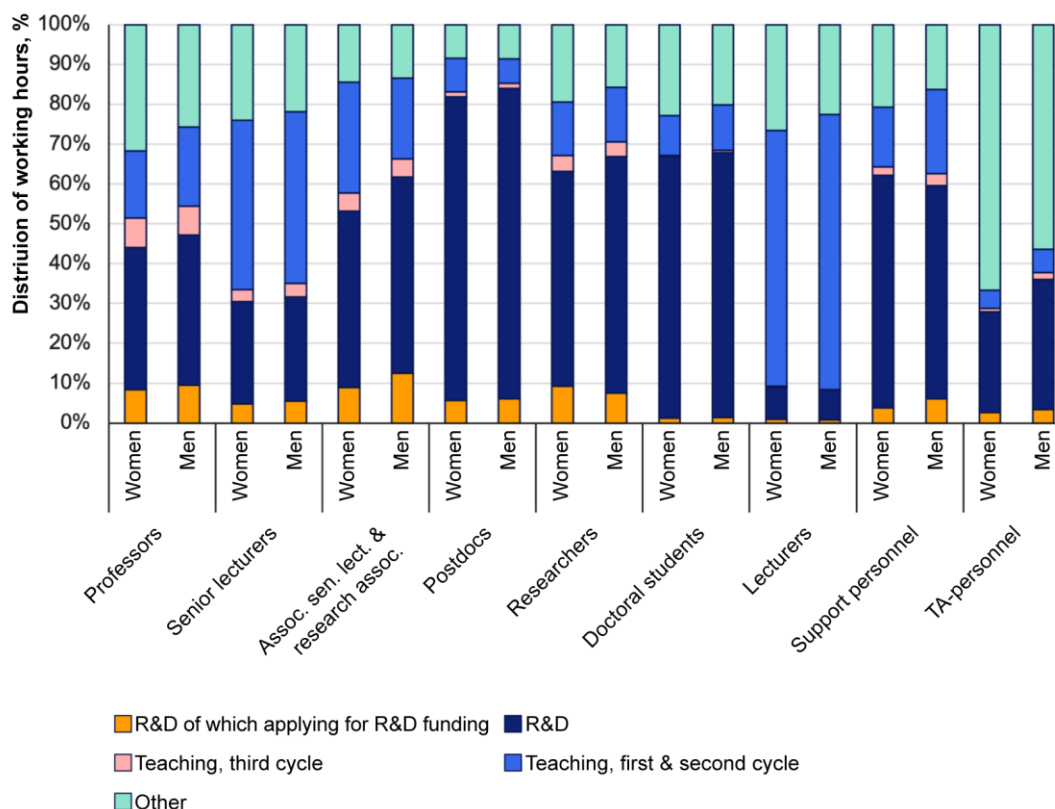


Figure 24. Relative distribution of working hours spent on different tasks, for women and men in different employment categories, 2021. Source: Statistics Sweden.

Note: TA personnel means “technical and administrative personnel”. These are not listed as research and teaching personnel, and are therefore not included in the other figures relating to personnel in this section. The total time spent on R&D consists of “R&D” and “of which applying for R&D funding”.

Research and teaching personnel also spend time on applying for R&D funding. Associate senior lecturers and research associates spend just over 11 per cent of their working hours on applying for R&D funding, and are therefore the employment category that spends the largest proportion of their working hours on this task. Professors and researchers on average use 9 per cent of their working hours on applying for R&D funding.

Figure 25 shows the total number of annual full-time equivalents as well as the number of annual R&D full-time equivalents, by employment category and gender. The figure is divided up according to the same employment categories as in Figure 24. These two figures therefore jointly provide a picture of who carries out the R&D conducted in higher education.

There are clear differences between the different employment categories in terms of how many annual full-time equivalents are carried out by women and men, respectively. For senior lecturers, associate senior lecturers and research associates, researchers and doctoral students, women and men work approximately the same number of annual full-time equivalents. For

the employment categories professors, postdocs, and support personnel, men work more annual full-time equivalents than women do. However, of these, it is only the gender difference for professors that is statistically significant. For professors, men work twice as many annual full-time equivalents, while for postdocs this figure is just over 40 per cent, and, for support personnel, men work around 35 per cent more annual full-time equivalents. For the employment categories lecturers and TA personnel, the opposite is true, where women work more annual full-time equivalents than men do. For lecturers and TA personnel, women work 50 per cent and 70 per cent more annual full-time equivalents, respectively, than men do.

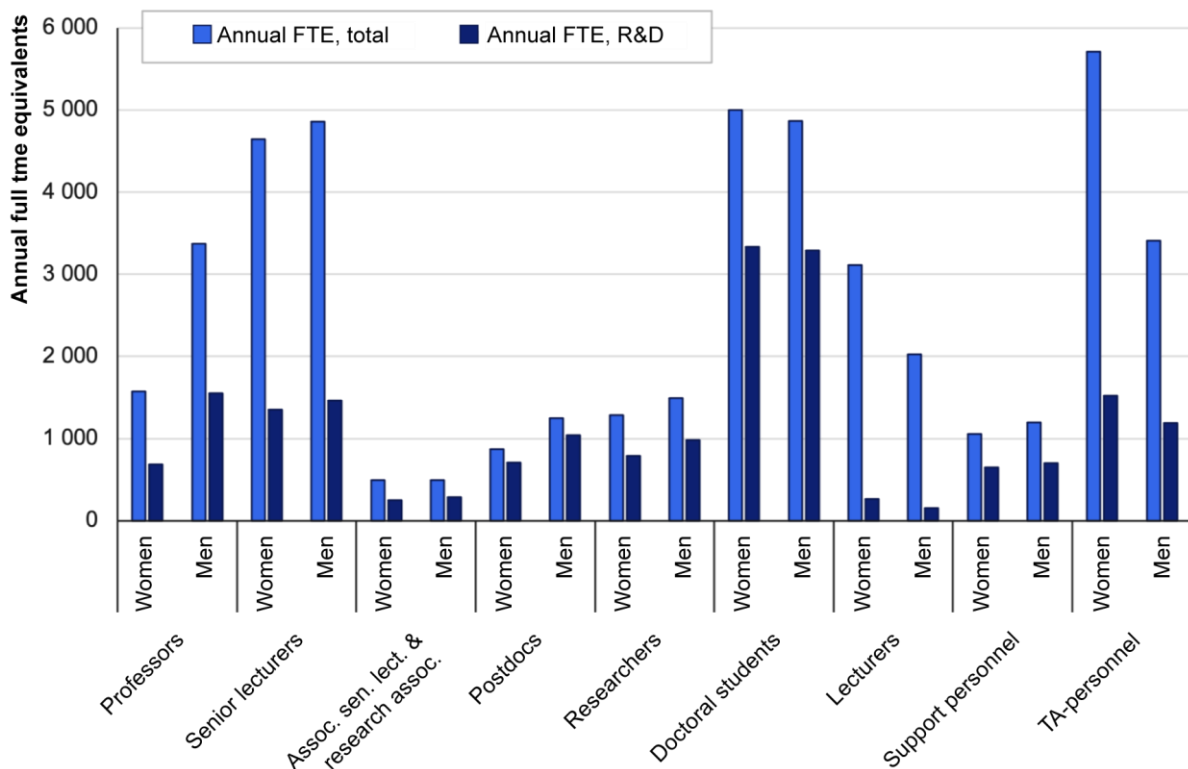


Figure 25. Annual full-time equivalents in total and in R&D per employment category and gender, 2021. Source: Statistics Sweden.

Note: TA personnel means “technical and administrative personnel”. These are not listed as research and teaching personnel, and are therefore not included in the other figures relating to personnel in this section.

Annual R&D full-time equivalents is a measure showing the number of annual full-time equivalents recalculated as if R&D were the only task. Annual R&D full-time equivalents therefore provide a picture of which employment categories carry out the most research. Doctoral students work the largest number of annual R&D full-time equivalents by a broad margin. Thereafter follow senior lecturers, TA personnel and professors. This means that, despite senior lecturers spending a relatively small part of their working hours on research, they still carry out a large part of the research done in the higher education sector, since they form such a large employment category.

In total, women work fewer annual R&D full-time equivalents. This is partly due to the gender distribution across the different employment categories, where women work significantly fewer annual R&D full-time equivalents in total than men do within the employment category TA personnel, and fewer than men within the employment category professors. As noted in Figure 24, men among the TA personnel also spend a larger proportion of their working hours on R&D.

Internal, national and international recruitment

Figure 26 shows the proportion of research and teaching personnel in higher education whose doctoral degree is from the same HEI as the one they are employed by in 2022, and the proportion whose doctoral degree is from another HEI in Sweden, or from an HEI abroad.

In total, almost half the R&D personnel with doctoral degrees are employed by the same HEI as awarded their degrees. The figure shows that the highest proportion with a doctoral degree from the same HEI, 60 per cent, is at the broad-based established universities. At the specialised universities, the corresponding proportion is 54 per cent, while at the new universities it is 33 per cent, and only 13 per cent at the university colleges. This can probably be explained by the fact that new universities and university colleges are not awarding as many doctoral degrees. This applies in particular for university colleges, which do not have general entitlement to award degrees at doctoral level.

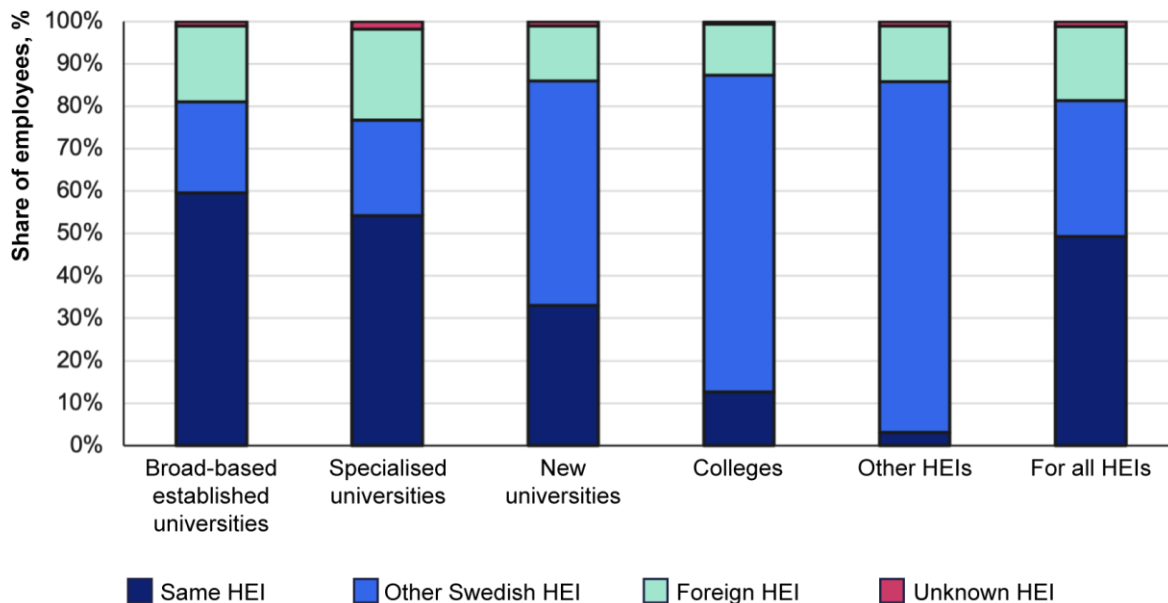


Figure 26. Proportion of higher education personnel (individuals) with doctoral degrees from the same or another HEI relative to where they work, by HEI category, 2022. Source: Statistics Sweden.

Note: Proportion of personnel with doctoral degrees from the same HEI as they were employed at in 2022, proportion with doctoral degrees from another Swedish HEI or a foreign HEI. Unknown HEI means that information on which HEI awarded the doctoral degree is missing.

In total, 17 per cent of the R&D personnel have doctoral degrees from a foreign HEI, and 1 per cent from an unknown HEI. The individuals shown in the statistics as missing data on where they were awarded their doctoral degrees were probably awarded them at a foreign HEI. Hereafter, the categories foreign HEI and unknown HEI are therefore merged, for the sake of simplicity, and are interpreted primarily as foreign HEI. The proportion with doctoral degrees from foreign or unknown HEIs is highest at the broad-based established universities and the specialised universities, where the proportions are 18 per cent and 21 per cent respectively. For the other HEI categories, this proportion is around 13 per cent. Overall, this means that the proportion with doctoral degrees from another Swedish HEI is lowest at the broad-based established universities and the specialised universities.

Figure 27 shows the proportion of research and teaching personnel in higher education whose doctoral degrees are from the same HEI as the one they are employed by for 2022, and the proportion whose doctoral degrees are from another HEI, by employment category and gender.

For the total (all employment categories together), around half have doctoral degrees from the same HEI as the one they are employed by. This also applies for all separate employment categories, except postdocs.

Professors and senior lecturers are the employment categories where the highest proportion was recruited from other Swedish HEIs, between 35 and 39 per cent. Gender differences are quite small, except when it comes to the proportion with doctoral degrees from a foreign or unknown HEI, where men form the majority.

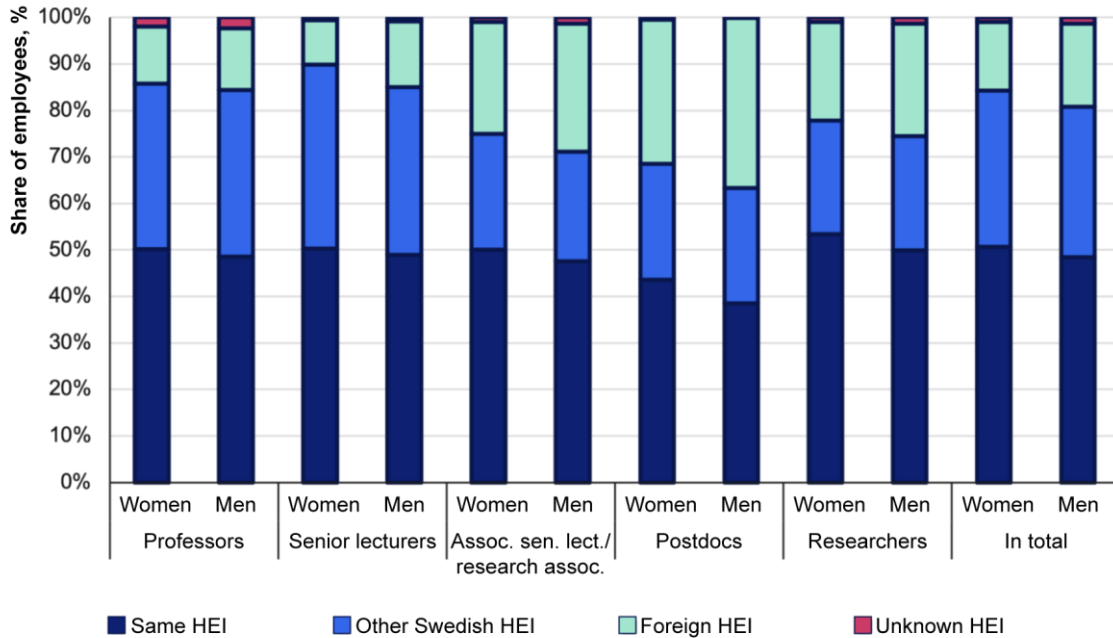
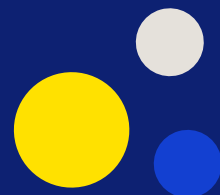


Figure 27. Proportion of higher education personnel (individuals) with doctoral degrees from the same or other HEI relative to where they work, by employment category and gender, 2022. Source: Statistics Sweden.

Note: Proportion of personnel with doctoral degrees from the same HEI as they were employed at in 2022, proportion with doctoral degrees from another Swedish HEI or a foreign HEI. Unknown HEI means that information on which HEI awarded the doctoral degree is missing. Assoc. sen. lect./research assoc. are abbreviations of “associate senior lecturer” and “research associate”.

Consequently, just over 80 per cent of the research and teaching personnel are recruited from a Swedish HEI, while just under 20 per cent are recruited from a foreign or unknown HEI. Having a foreign doctoral degree is more common among postdocs, associate senior lecturers/research associates and researchers. Among postdocs, 39 per cent of men and 34 per cent of women have doctoral degrees from a foreign or unknown HEI. Among associate senior lecturers/research associates, 32 per cent of men and 26 per cent of women have doctoral degrees from a foreign or unknown HEI. Only around 15 per cent of professors have doctoral degrees from a foreign or unknown HEI. For senior lecturers, 15 per cent of men and 11 per cent of women have doctoral degrees from a foreign or unknown HEI.



Scientific publication



3 Scientific publication

This chapter contains a description of Swedish researchers’ scientific publications and their citation impact. The first section describes Swedish publications and citations in international comparison. The second section gives an in-depth picture of Swedish higher education.

3.1 Scientific publication in international comparison

Scientific publication

Scientific publication in the world increased sharply between 2012 and 2021. In total, the number of publications in the world increased by 72 per cent. This is largely due to the rapid development in Asia. Figure 28 shows the development of the number of scientific publications for different continents during the period. In 2021, Asia was responsible for the largest scientific publication, and the proportion of publications from there was 41 per cent, followed by Europe with 30 per cent, and North America with 19 per cent. The remaining continents produced around 3 per cent each.

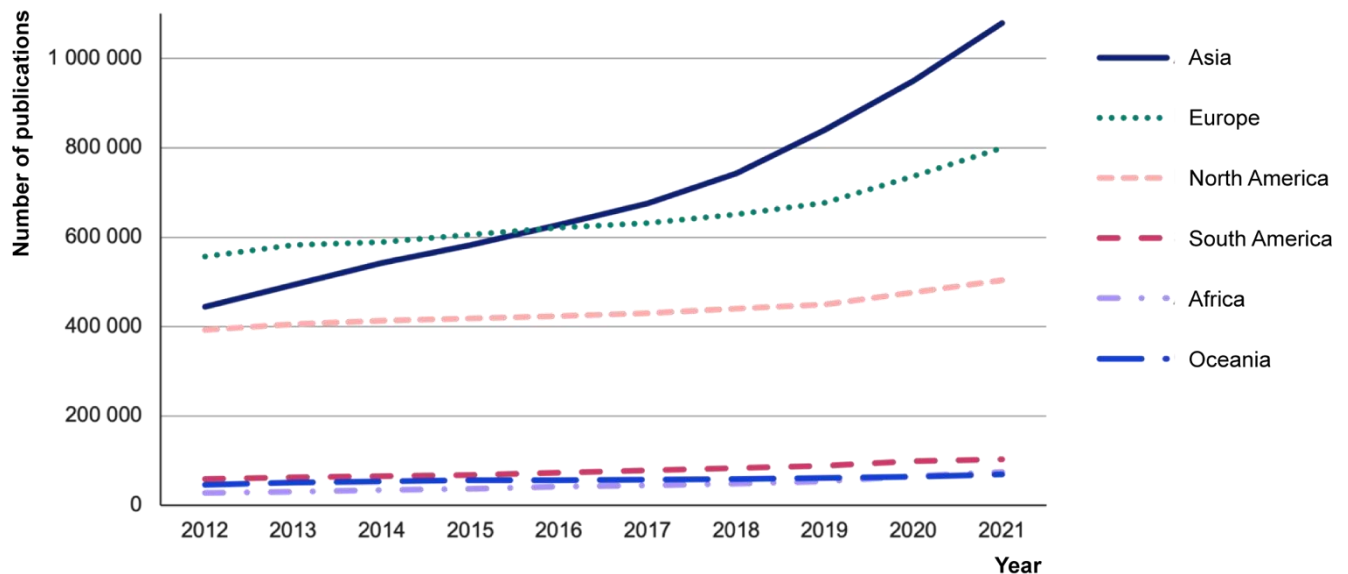


Figure 28. Number of publications per continent, 2012–2021. Source: Clarivate Analytics.

Figure 29 shows the proportion of publications in different fields of research, in total, and for different continents, for 2019–2021. Publications in medicine and health sciences represent the largest proportion in the world (36 per cent), followed by natural sciences (23 per cent), and engineering and technology (20 per cent). Publications in agricultural and veterinary sciences represent 8 per cent the world’s production. Social sciences and humanities together represent 13 per cent of the publications.

However, researchers in humanities and social sciences publish a lot in books and national journals, which are not included in the publication database, and are therefore not included in the statistics either.

If we look at differences between continents, then Asia publishes a much larger proportion in engineering and technology (29 per cent) and a much smaller proportion in social sciences and humanities (5 per cent). North America publishes a larger proportion than the world in total in medicine and health sciences (46 per cent). A relatively large proportion of the publications from South America are in agricultural and veterinary sciences (15 per cent) and in humanities and social sciences (22 per cent).

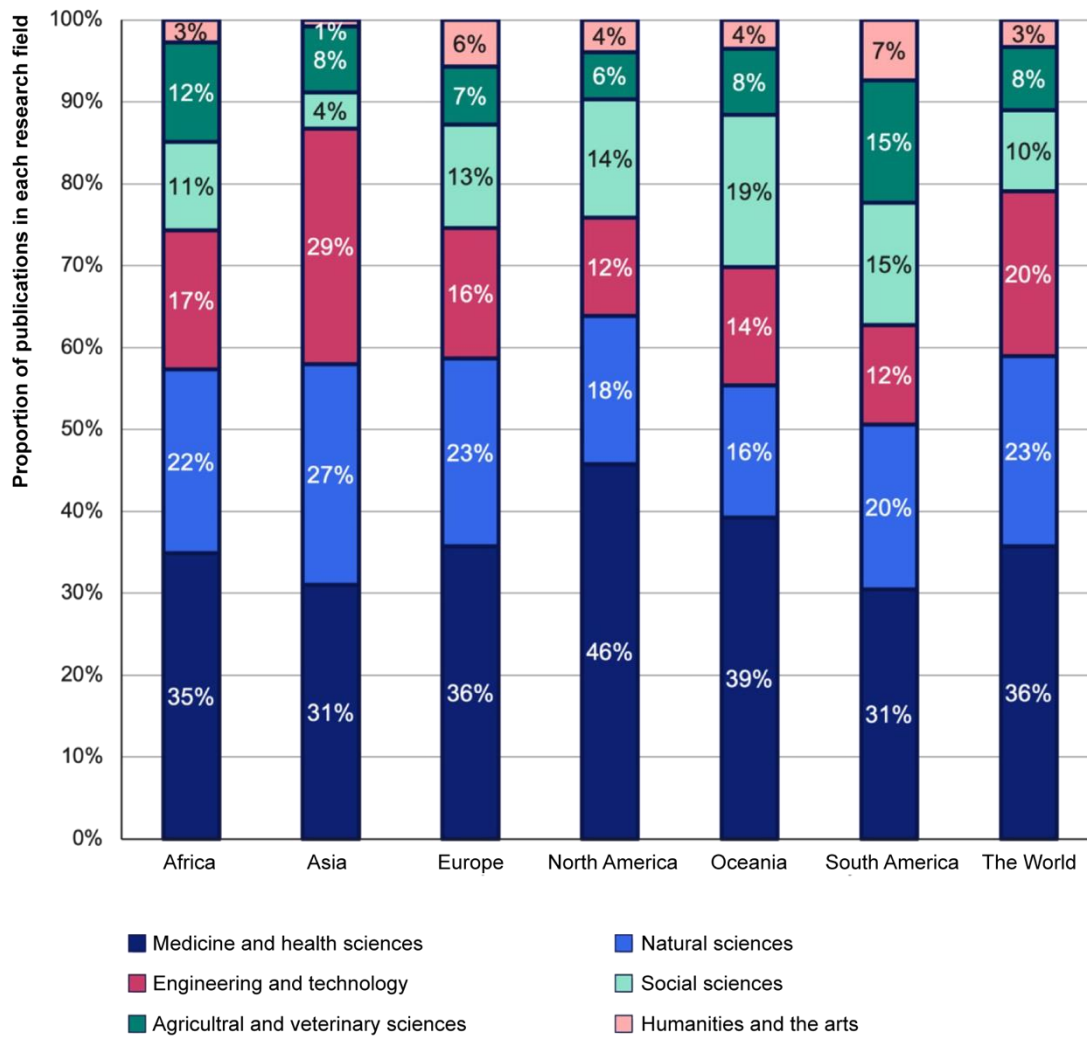


Figure 29. Continents' proportions of publications in different fields of research, 2019–2021. Source: Clarivate Analytics.

How is the number of publications calculated?

The publication statistics are based on data from the Swedish Research Council's publication database, the contents of which correspond to the international publication database Web of Science, owned by Clarivate Analytics. The publication database covers around 21 000 international scientific journals. These journals are classified into one or several of around 250 subjects. The publications receive the subject classification of the journal they are published in. In the Swedish Research Barometer, the 250 subjects have been aggregated into two classifications, one with 6 fields of research and one with 16 research areas.

The proportion of all scientific publications that are included in the publication database, varies between different fields of research. It is very high for medicine and natural sciences, but less good for humanities and parts of social sciences. The coverage in humanities and social sciences has, however, improved since the last Swedish Research Barometer, as the Swedish Research Council's publication database has now been extended with the Emerging Sources Citation Index²⁸. As the calculations in the Swedish Research Barometer are based on the publications included in the publication database, the reliability of the bibliometric indicators varies between different fields of research.

Unless otherwise is stated, the Swedish Research Barometer uses fractional calculation of the number of publications. This means that if a publication has two authors and they are from different countries, these countries are awarded half a publication each. The same applies for publication in different subjects – if a publication is classed in two subjects, each subject is awarded half a publication each. The actual number of publications is consequently higher than the numbers shown in the figures.

Publications by researchers based in Sweden (hereafter called "Swedish researchers") are identified in the database according to the organisational affiliation that the authors themselves have stated in the publications.

Figure 30 shows the number of publications for the same selection of countries as used in Chapters 1 and 2, for 2017, 2019 and 2021. The figure shows that China and USA have a considerably higher production of scientific articles than the other countries. In 2021, 21 per cent of the

²⁸ Emerging Sources Citation Index is included in Web of Science's core collection, and includes peer-reviewed publications of regional importance and in emerging scientific fields.

world's publications came from China, and 16 per cent from USA. Sweden is in 22nd place in terms of number of publications, and in 2021 was responsible for 0.8 per cent of the world production. The number of publications from China increased by 75 per cent between 2017 and 2021, and China now tops the list. In 2017, USA was the country with the largest number of publications, and the numbers increased until 2021, but not at the same rate as those of China.

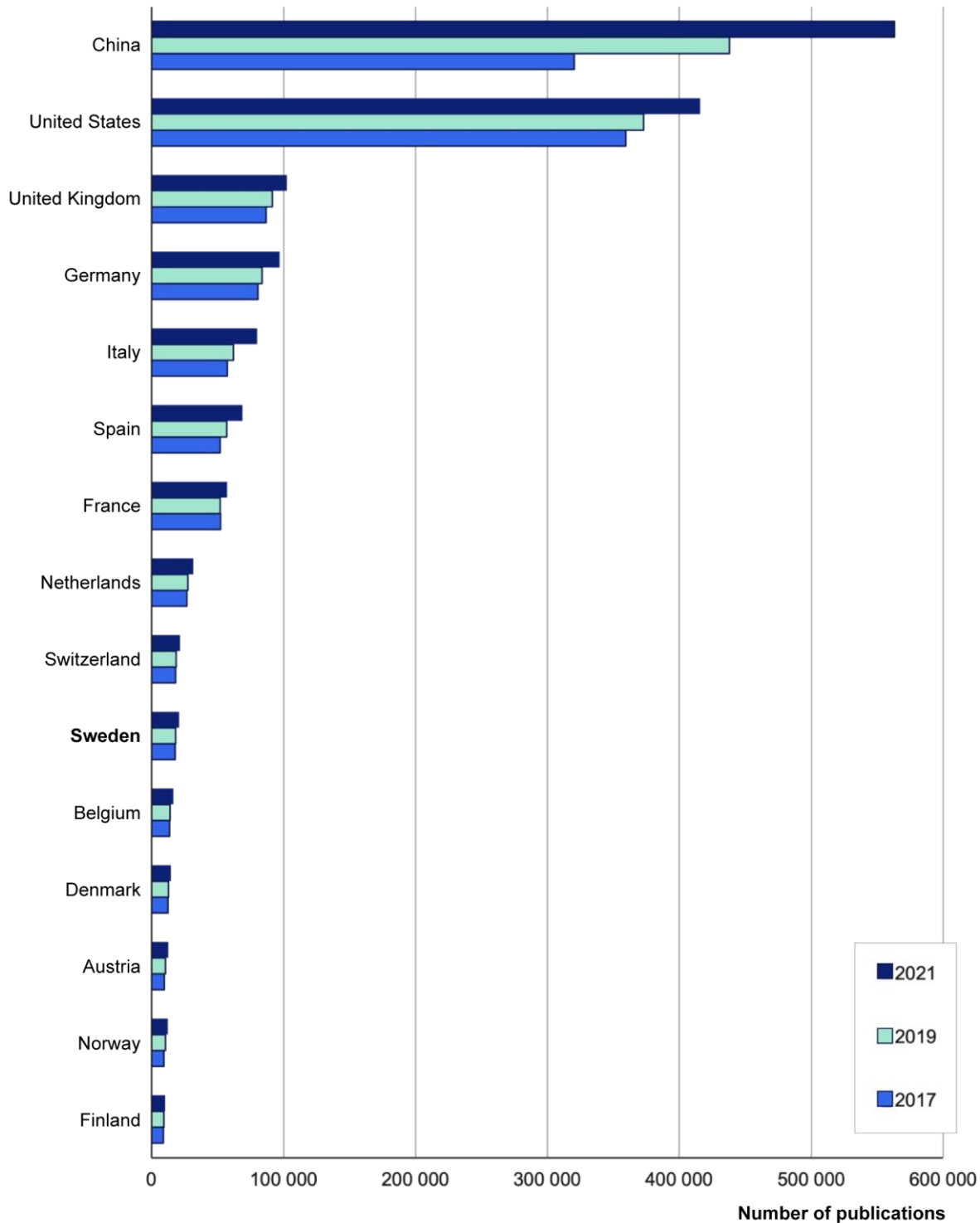


Figure 30. Number of publications from a selection of countries, 2017, 2019 and 2021.
Source: Clarivate Analytics.

Proportion of highly cited publications

A common measure of citation impact is to measure a country's proportion of highly cited publications, or, more specifically, the proportion of a country's publications that are among the world's 10 per cent most cited publications. If a country is above 10 per cent, the proportion of highly cited publications in the country is higher than the world average.

Figure 31 shows the proportion of highly cited publications for the same countries as in the previous figure, sorted according to the highest proportion of highly cited publications in 2021. United Kingdom (14 per cent), Netherlands (13 per cent) and Switzerland (13 per cent) top the lists, although they have lost ground compared to 2017 and 2019. China and Italy are the only countries in our selection that have increased their citation impacts during the same period. China has increased its proportion of highly cited publications from 11 to 12 per cent, and Italy from 10 to 11 per cent. Sweden's citation impact has decreased, from 12 per cent in 2017 to 11 per cent in 2021. The fact that many countries' citation impact is decreasing is largely due to China's having increased. Because China has such a large volume of publications, the result of its increase in citation impact is that that of many other countries is decreasing (as the world average per definition is always 10 per cent).

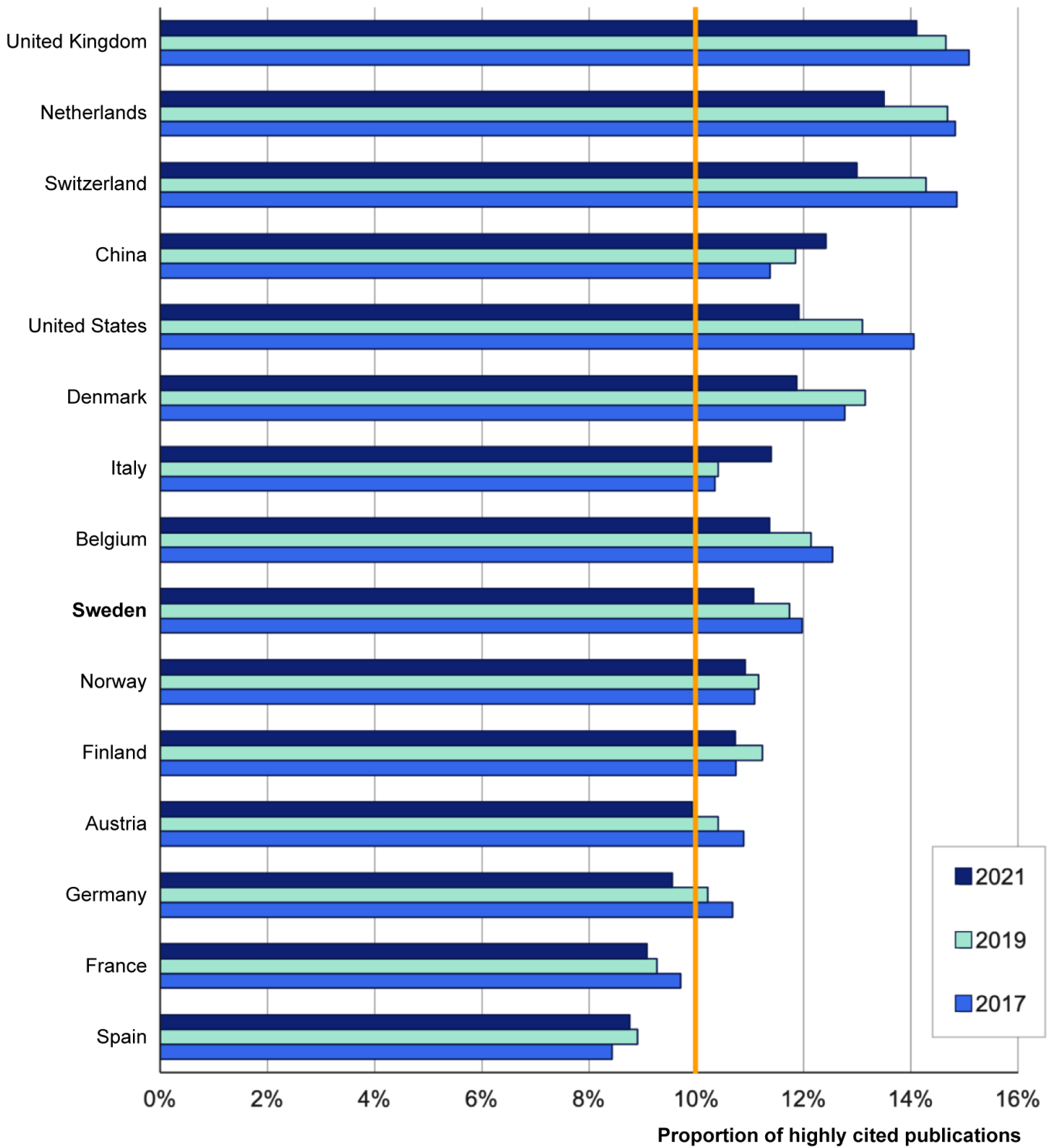


Figure 31. Proportion of highly cited publications for a selection of countries, 2017, 2019 and 2021. Source: Clarivate Analytics.

How is the proportion of highly cited publications calculated?

The proportion of highly cited publications indicates how large a proportion of a country's or an organisation's publication volume is in the 10 per cent most cited publications in the world. It is calculated for a country, for example, by dividing the sum of the country's publications that are among the 10 per cent most cited by the sum of all the country's publications. The global average for this indicator is 10 per cent. If a country has a proportion of highly cited publications of 12 per cent, this means that the country has a 20 per cent higher proportion of highly cited publications than the world average.

In order to correct for differences between subjects with differing citation traditions, the citation statistics have been field standardised. This means that all citations, before being summarised, are divided by a field factor that quite simply consists of the average number of citations for a specific subject during a specific year. The number of citations is counted during a three-year window, which means that the citations are counted as from the year the publication is published and for two years afterwards. Self-citations are excluded. For further details, please see the method appendix.

When the number of publications is expressed in relation to the country's number of inhabitants, instead of in absolute terms, this becomes a type of measure of productivity. Figure 32 shows the number of publications per 1 000 inhabitants in relation to the proportion of highly cited publications for the OECD countries and China, 2019–2021. The countries' relative publication volume is illustrated by the size of the circles in the figure.

The figure shows that there is some co-variation between the number of publications per inhabitant and citation impact. The countries with the highest number of publications per inhabitant also have a high citation impact, namely Denmark (DK), Switzerland (CH), and Australia (AU). The countries with the lowest number of publications per inhabitant also have the lowest citation impact: Mexico (MX), Colombia (CO) and Costa Rica (CR). Sweden (SE) and Norway (NO) have a high number of publications per inhabitant and a citation impact above the world average. As a proportion of highly cited publications, however, the United Kingdom (GB) and Netherlands (NL) top the list, despite slightly lower numbers of publications per inhabitant. China (CN) diverges from the overarching pattern in the figure, as it has a low number of publications per inhabitant and at the same time a high citation impact.

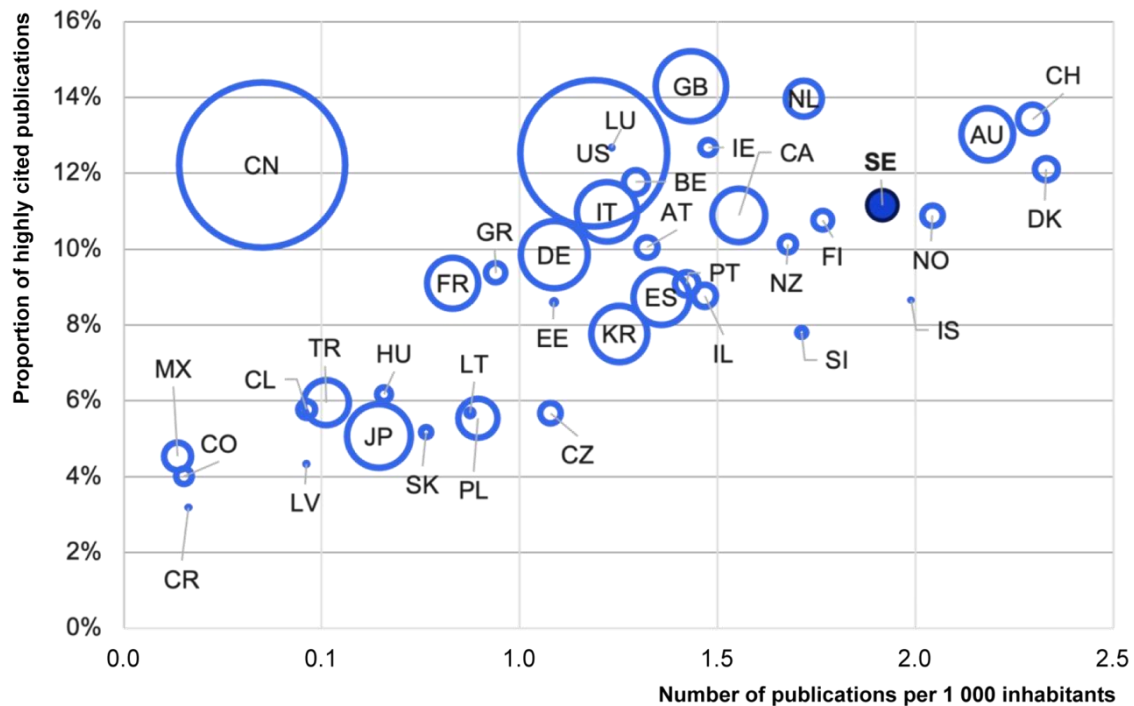


Figure 32. Number of publications per 1 000 inhabitants in relation to the proportion of highly cited publications for the OECD countries and China, 2019–2021. The countries' relative publication volumes are illustrated by the sizes of the circles. Source: Clarivate Analytics and UN.

Figure 33 shows higher education's expenditure on R&D as a proportion of GDP 2017–2019, in relation to the proportion of highly cited publications for the OECD countries and China, 2019–2021. In this figure too, the countries' relative publication volumes are illustrated by the sizes of the circles.

The figure shows that there is a positive co-variation between higher education's expenditure on R&D in relation to GDP and the proportion of highly cited publications. There are exceptions from the overarching pattern, however, and a fairly large variation between different countries. Latvia (LV) and USA (US) are, for example, relatively similar in terms of expenditure on R&D in higher education as a proportion of GDP, but differ greatly in citation impact. Another example is China (CN), with a relatively low score in terms of expenditure on R&D in higher education as a proportion of GDP, but a relatively high score in citation impact. However, the figure shows that no country has both a high score in relation to higher education expenditure on R&D as a proportion of GDP, and at the same time a low score for citation impact.

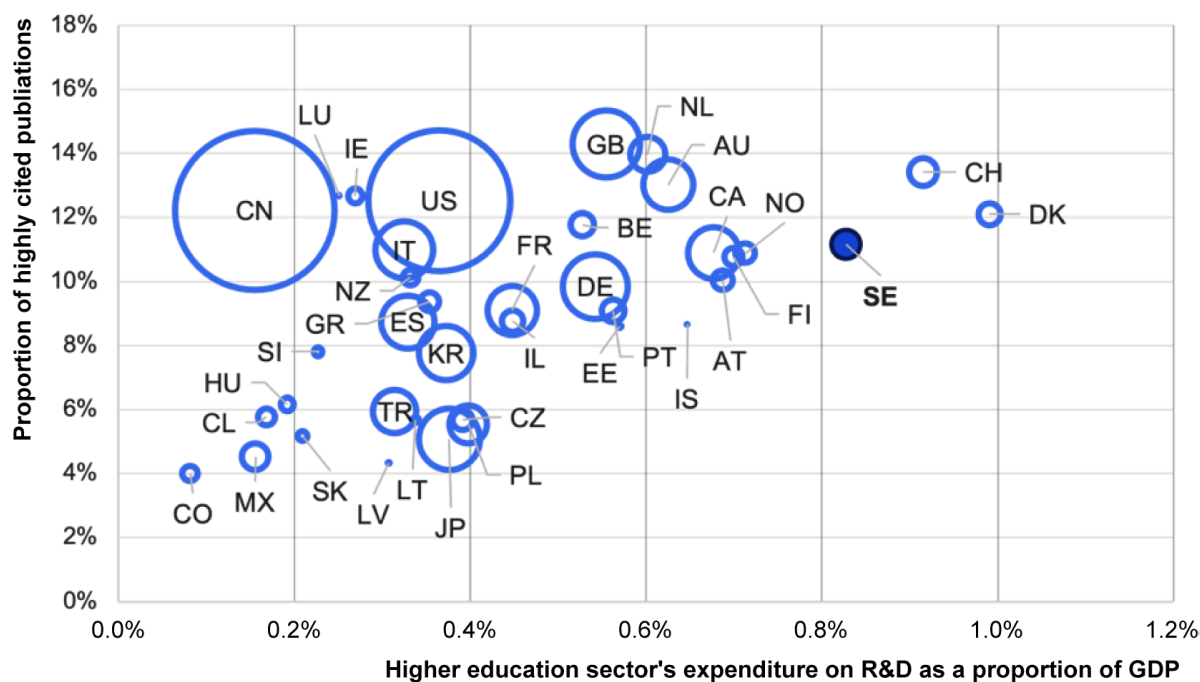


Figure 33. Higher education's expenditure on R&D as a proportion of GDP 2017–2019 in relation to the proportion of highly cited publications 2019–2021 for the OECD countries and China. The countries' relative publication volumes are illustrated by the sizes of the circles. Source: OECD and Clarivate Analytics.

Scientific publication in different research areas

To analyse Sweden's development at subject level, Figure 34 shows both the number of publications (lines, left axis) and the proportion of highly cited publications (bars, right axis). The publications are divided up into sixteen different research areas and two time periods, 2009–2011 and 2019–2021. The world average of 10 per cent is illustrated with a horizontal line in the figure.

The research areas are sorted according to the highest number of publications 2019–2021. Sweden's highest number of publications are in clinical medicine and biomedicine, which together represented 34 per cent of Sweden's publications in 2019–2021. The number of Swedish publications increased in total by 42 per cent 2019–2021 compared to 2009–2011. The largest percentage increase was in social sciences and humanities, where the number of publications more than doubled.

The bars in the figure show that for the period 2019–2021, Sweden's proportion of highly cited publications is highest in humanities (16 per cent), biology (15 per cent) and agronomy (14 per cent). Sweden's citation impact is also high in clinical medicine (12 per cent), social sciences (12 per cent) and biomedicine (11 per cent). The lowest citation impact (9 per cent) for Sweden is in psychology, materials science, mathematics and health sciences. This is a difference compared to 2009–2011, when Sweden was not below the world average in any area. Sweden's citation

impact has increased the most in humanities and biology, and decreased the most in chemistry, materials science, and engineering science.

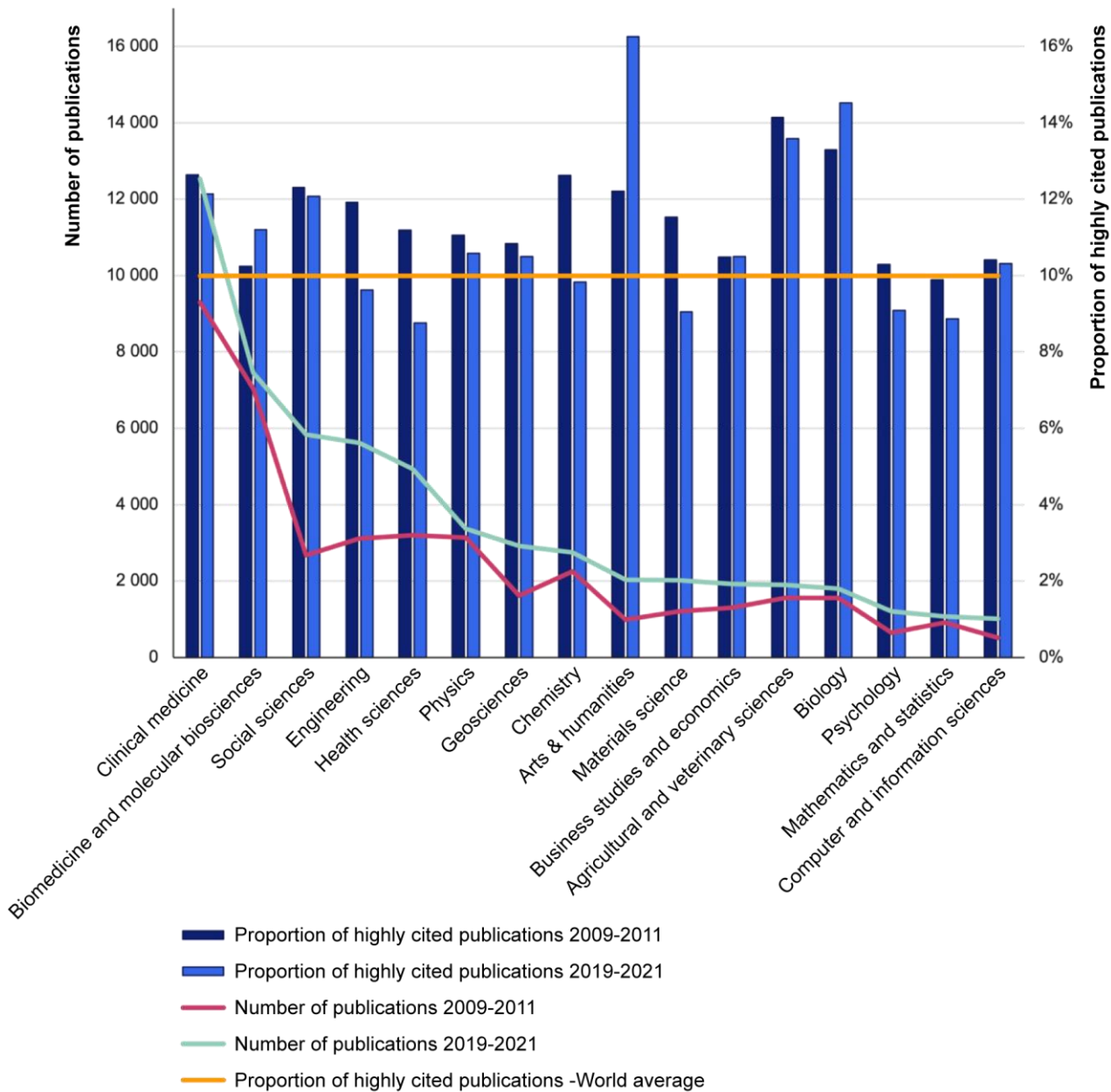


Figure 34. Number of publications and proportion of highly cited publications for different research areas in Sweden, 2009–2011 and 2019–2021. Source: Clarivate Analytics.

Note: ICT = Information and communications technology.

It is important to remember that Figure 34 shows fractionally calculated numbers of publications (see fact box), and that the actual number of publications with at least one Swedish researcher is higher. The actual number of publications also increased by more than the fractionally calculated number, which is a result of international co-publication increasing a lot between the two periods (see Figures 36 and 37). The more countries that are included in the publications, the fewer fractionally calculated publications are attributed to each country.

Research profile for Sweden, the EU, USA and China

Figure 35 shows the proportion of highly cited publications in relation to specialisation in different research areas, known as ‘research profile’, for Sweden, the EU, USA and China during 2019–2021. Specialisation means the proportion of publications in different research areas compared to the world average. If a research area is located to the right in the figure (above zero), this means that the region in question has published a larger proportion than the world average in this research area. If, conversely, a research area is located to the left in the figure (below zero), the region has published a smaller proportion than the world average in this research area. Furthermore, if a research area is located in the upper half of the figure (above 10 per cent), the citation impact was higher than the world average, while if a research area is located below 10 per cent, then the citation impact is lower than the world average. The sizes of the circles illustrate the relative sizes of the different research areas in terms of number of publications. (A more detailed description of how subject specialisation is calculated can be found in the method appendix.)

The figure shows that Sweden is most specialised – that is, publishes a higher proportion than the world average – in social sciences and health sciences, followed by economics, clinical medicine, and psychology. Sweden is least specialised in chemistry, mathematics, ICT and agronomy, followed by materials science, physics and engineering science. In biomedicine, geosciences, humanities, and biology, Sweden is located around the world average.

How high the citation impact is for Sweden in the different areas, and how large a proportion is published in each field (circle sizes) are both based on the same data as the corresponding period (2019–2021) in Figure 34. During this period, Sweden had the highest proportion of publications in clinical medicine, and Sweden also had a high citation impact in this area. In social sciences, Sweden also had a high citation impact. However, Sweden had a relatively low citation impact in health sciences; a research area where Sweden has a high number of publications. Sweden’s highest citation impact is in humanities and biology, two areas that neither stand out as the biggest or the most specialised research areas in Sweden.

When Sweden’s research profile is compared with that of USA, it can be seen that Sweden and USA are specialised in the same areas: clinical medicine, health sciences, social sciences, biology, humanities, and economics. In humanities, Sweden has a higher citation impact than USA; in biology and clinical medicine we are at the same level, while USA has higher citation impact than Sweden in the other areas.

In the EU’s research profile, most areas are close to the world average in terms of specialisation. EU is most specialised in humanities, and least

specialised in materials science. If we compare the citation impacts of Sweden and the EU, then Sweden's is placed higher in all areas except health sciences, psychology, and mathematics.

China's research profile differs a lot from that of the others, in particular Sweden's and USA's. China is most specialised in engineering science, chemistry, and materials science; areas in which China also has a high citation impact. On the other hand, China published a considerably lower proportion than the world average in social sciences, psychology, health sciences, and economics. Psychology is the only area in which China has a lower citation impact than the world average.

Biomedicine is the research area where Sweden, the EU, USA and China are the most alike, and where all consequently are close to the world average in terms of both specialisation and citation impact.

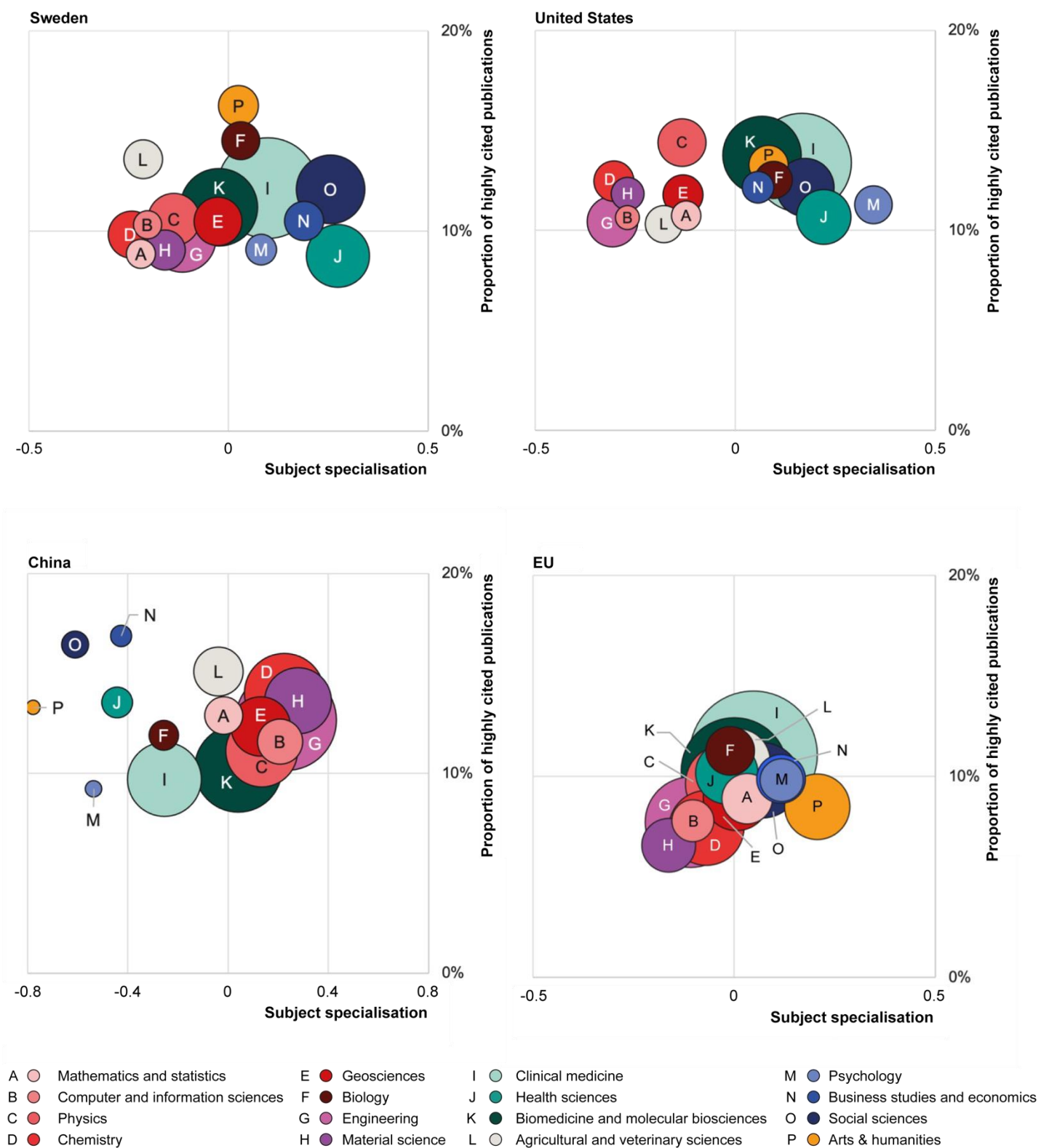


Figure 35. Research profile (subject specialisation and citation impact) for Sweden, the EU, USA and China for 2019–2021. Source: Clarivate Analytics.

Note: The scale is different for China in relation to Sweden, USA and the EU.

Co-publications with researchers in other countries

International collaboration in R&D is important, as international collaboration is assumed to raise the quality of the research and to strengthen Sweden's competitiveness and attraction. One way of measuring international research collaboration is to measure the proportion of Swedish publications that are co-authored with researchers from other countries.

The proportion of international co-publications has increased steadily in Sweden over a long period. During 2009 to 2011, the proportion of international co-publications was 44 per cent. For 2019 to 2021, the proportion had risen to 70 per cent.

Figure 36 shows the countries that Swedish researchers co-published with the most, in the form of proportion of co-publications compared to the total number of Swedish publications, for the periods 2009–2011 and 2019–2021 respectively. Swedish researchers co-publish the most with researchers active in USA; during the latter period, USA is listed in every fifth Swedish publication. After USA follow the United Kingdom (17 per cent) and Germany (15 per cent). The greatest increase that has occurred between the two time periods is co-publication with China, where the proportion of co-publications increased from 4 to 10 per cent. A large increase in co-publications with Australia, Brazil and India is also noticeable.

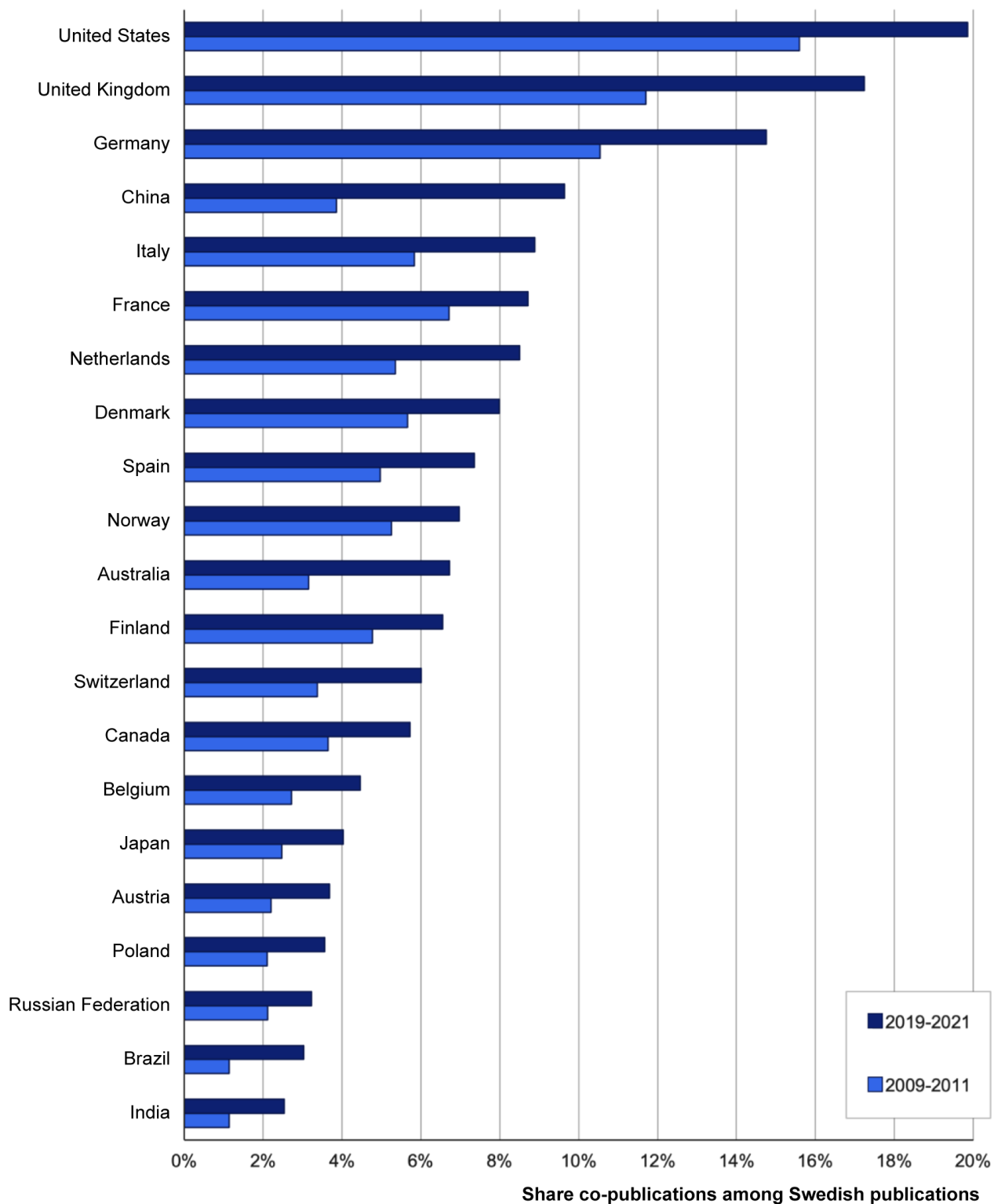


Figure 36. The proportion of internationally co-authored publications out of all Swedish publications, per collaboration country 2009–2011 and 2019–2021 (number of publications in integers). Source: Clarivate Analytics.

Note: As a publication can have collaborating researchers from several countries, the proportions of co-publications for all countries in the figure summarise to more than 100 per cent.

Figure 37 shows the proportion of international co-publications for different research areas, for the periods 2009–2011 and 2019–2021. The figure is sorted according to the areas with the largest proportion of international co-publications during 2019–2021 (clockwise). The figure shows that co-publication increased over the ten-year period in all research areas. However, the proportion of international co-publication varies greatly between the different research areas. In biology, physics, agronomy, biomedicine, and geosciences, there is at least one author from another country included in around 80 per cent of the publications. This is significantly higher than the corresponding proportion in humanities and social sciences (33 and 48 per cent respectively).

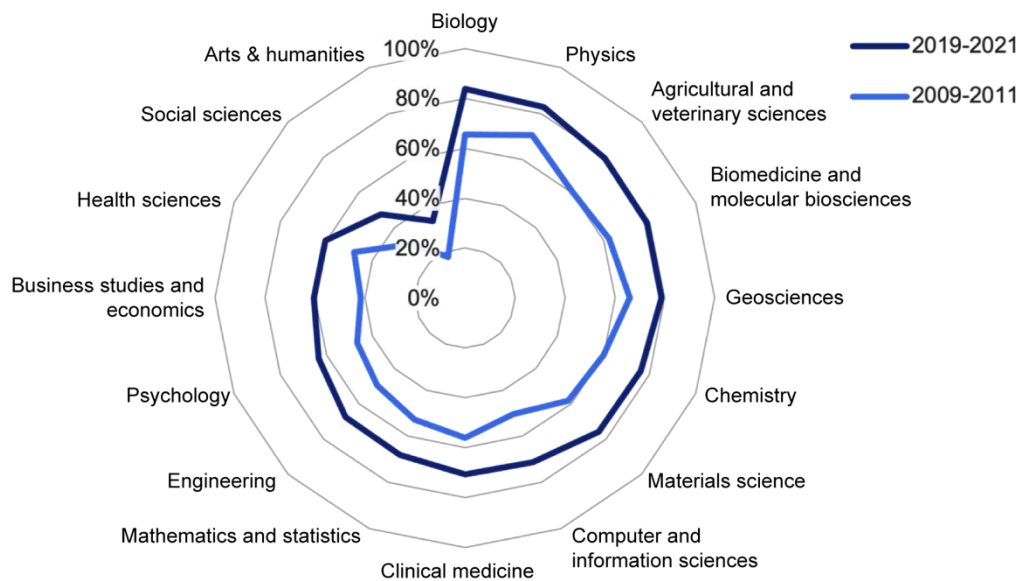


Figure 37. Swedish researchers' international co-publications as a proportion of the overall number of publications, for different fields of research in 2009–2011 and 2019–2021. Source: Clarivate Analytics.

Open access to publications

For some time, a transition to an open science system has been in progress, where open access to publications is an important part. Open access means that publications are made available in digital format, without any cost to the reader²⁹. The Swedish Government's research bill from 2020 highlights that scientific publications that are a result of research financed by public funds shall be openly accessible immediately, starting from 2021³⁰.

The National Library of Sweden (KB) has a Government mandate to coordinate the development towards open access to publications. Via the

²⁹ Read more on the [National Library of Sweden's website about open access and the Bibsam consortium](#).

³⁰ Prop. 2020/21:60, page 101.

Bibsam consortium, Swedish universities, university colleges, public agencies and governmental research institutes have entered into reading and publication agreements with a number of journals, known as ‘transformative agreements’. Through these agreements, researchers at associated organisation can publish with open access, either without any cost or at reduced cost, in both entirely open journals (gold) and in subscription-based journals (hybrid). The purpose of the reading and publication agreements is to speed up the transition to an entirely open system, but the long-term goal is that payment streams shall be redirected from a subscription-based to an openly accessible publication system.

What do gold, hybrid, green and locked mean?

Figure 38 uses the concepts of gold, hybrid, green and locked, but what do these concepts mean?

Gold: Publication in an openly accessible journal.

Hybrid: Publication in a subscription-based journal that is made openly accessible via a fee paid by the author (or through transformative agreements).

Green: Publication in a subscription-based journal that is made openly accessible by the author by placing a copy in a digital archive, known as a ‘repository’. This type of open access is also known as ‘parallel publication’ or ‘self-archiving’. Green publication usually involves an embargo, which means that publication in an open archive may only be done after a certain delay.

Locked: Publication that is not openly accessible.

Figure 38 shows the proportion of open access publications in Sweden, the EU and the world, for 2017, 2019 and 2021. The proportion of Swedish publications that are openly accessible in some way (gold, hybrid or green) increased from 53 to 83 per cent between 2017 and 2021. A similar, but considerably slower, development has occurred in the EU and the rest of the world during the same period. In the EU, 68 per cent of publications were openly accessible in 2021, compared to just over half for the world in total. Sweden’s considerably higher proportion of openly accessible publications in 2021 is primarily due to the increase in hybrid publications that has occurred during the period. The increase is mostly due to Sweden having many reading and publication agreements. Sweden and Finland are

the countries in the world that publish the largest proportion of their publications using reading and publication agreements³¹.

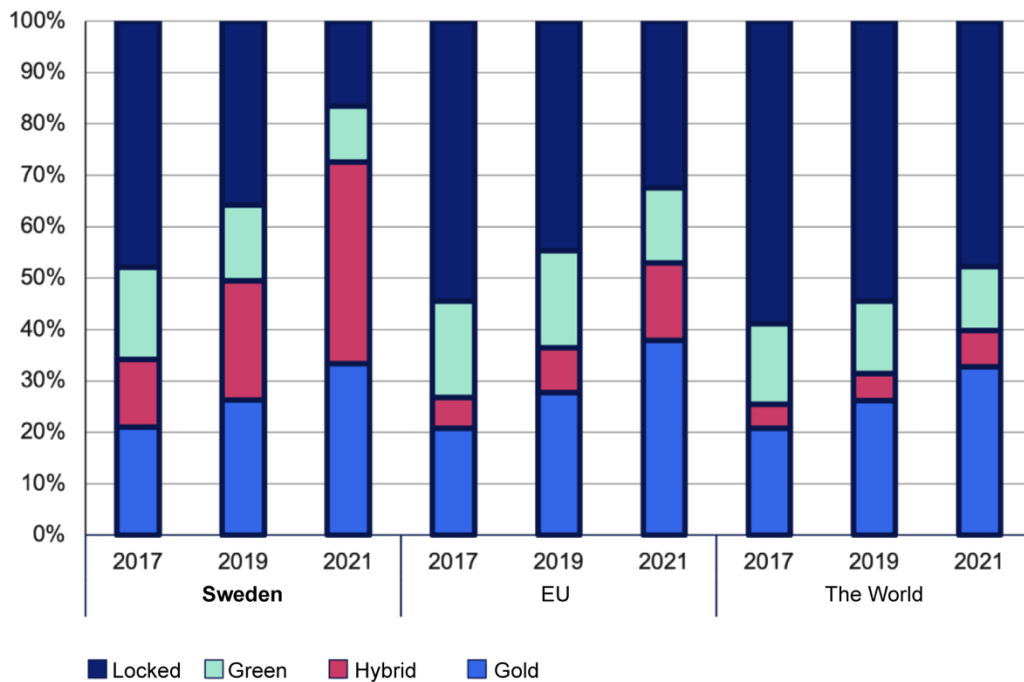


Figure 38. Proportion of openly accessible and locked publications in Sweden, the EU, and the world, for 2017, 2019 and 2021. Source: Clarivate Analytics.

Note: Gold, hybrid and green constitute different classifications of openly accessible publications, see the fact box. The category 'locked' covers publications that are not openly accessible.

3.2 Higher education in Sweden

Scientific publication

Figure 39 shows the number of scientific publications for different HEI categories between 2012 and 2021. The figure shows that the broad-based established universities and the specialised universities produce the most publications in Sweden. In 2021, the broad-based established universities were responsible for half of the publications in Sweden, while the specialised universities produced almost one third. The new universities produced 7 per cent, and the university colleges 5 per cent of the total Swedish production. This correlates fairly well with the number of research personnel within the different HEI categories (see Figure 20, Chapter 2).

The university colleges and new universities have seen the largest percentage increase in the number of scientific publications. Between 2012

³¹ For further information, see the [ESAC Initiative's website about market watch and transformative agreements](#).

and 2021, the university colleges' production increased by 84 per cent, and the new universities by 71 per cent. During the same period, the broad-based established universities and the specialised universities both increased the number of publications by around 30 per cent. (Figure 41 presents the number of publications per HEI.)

University colleges for the arts and the other higher education providers are not represented in Figure 39, as there are very few scientific publications from these HEI categories in the publication database.

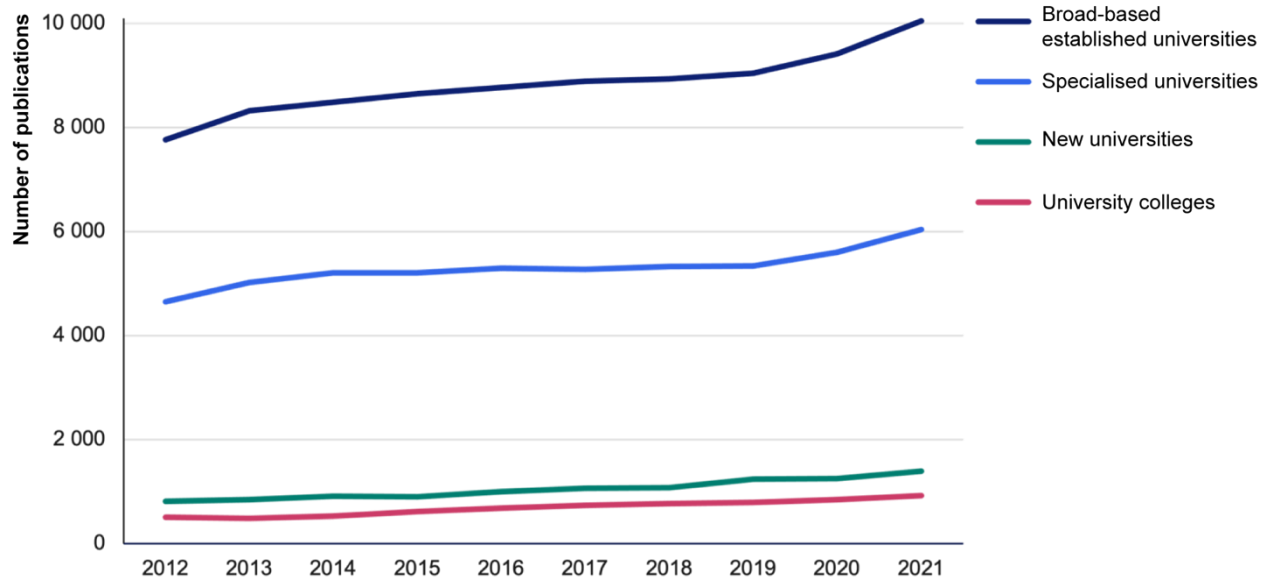


Figure 39. Number of scientific publications from different HEI categories 2012–2021. Source: Clarivate Analytics.

Proportion of highly cited publications

Figure 40 shows the proportion of scientific publications for different HEI categories between 2012 and 2021. The proportion of highly cited publications from broad-based established universities and specialised universities is above the world average of 10 per cent throughout the period. The proportion of highly cited publications from the new universities is fairly stable around the world average over the period, but with a slight decrease in recent years. The proportion of highly cited publications from the university colleges has varied between being above and below the world average over the period.

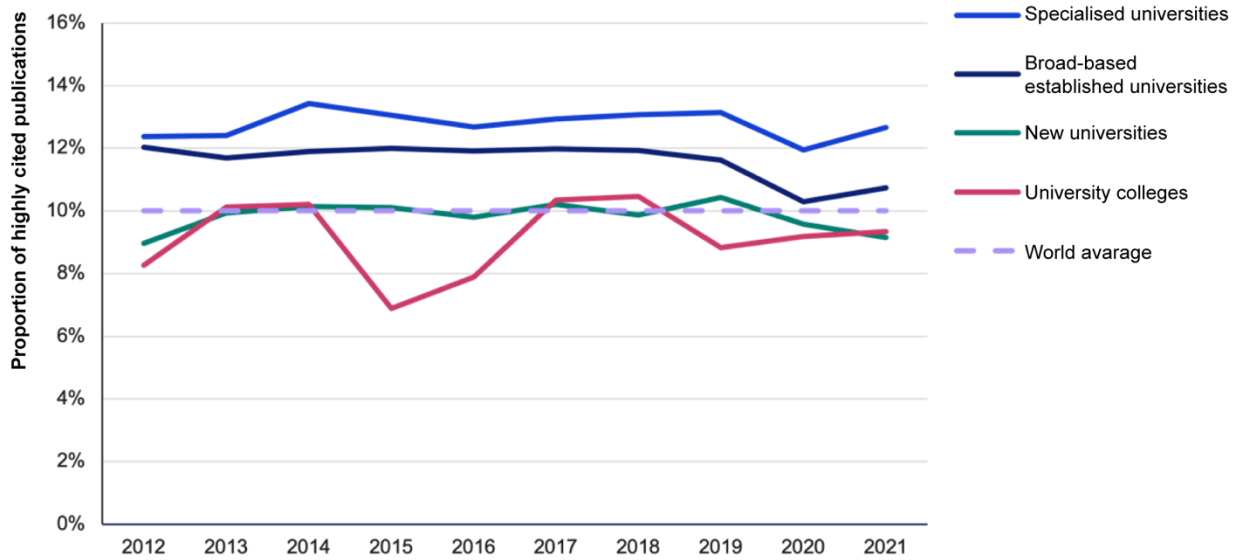


Figure 40. Proportion of highly cited publications for different HEI categories, 2012–2021. Source: Clarivate Analytics.

Figure 41 shows the number of publications (lines, left axis) and the proportion of highly cited publications (bars, right axis) per HEI. As some HEIs produce a very small number of publications per year, the results are here shown for time periods, 2009–2011 and 2019–2019, to obtain reliable statistics. The HEIs are sorted according to the highest number of publications during 2019–2021. The world average for proportion of highly cited publications of 10 per cent is illustrated with a horizontal line in the figure.

Only HEIs with at least 100 publications during the latter period are shown in the figure, which means that the Swedish School of Sport and Health Sciences and the Swedish Defence University are not included in the figure.

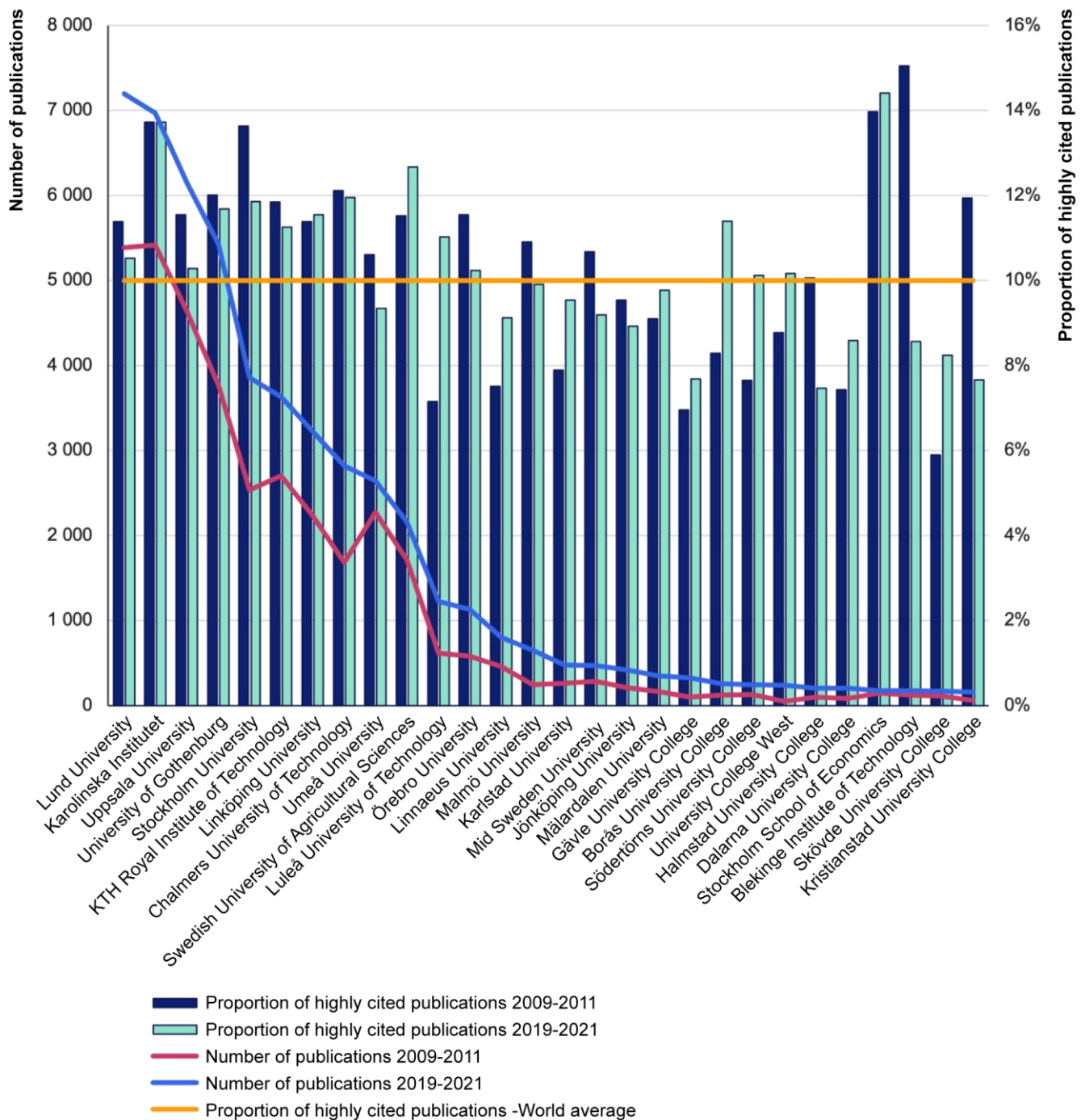


Figure 41. Number of publications and proportion of highly cited publications per HEI, 2009–2011 and 2019–2021. Source: Clarivate Analytics.

Note: Only HEIs with at least 100 publications during 2019–2021 are shown in the figure. Publications from the respective university hospitals are included.

Lund University and Karolinska Institutet published the most in Sweden during both periods, followed by Uppsala University and the University of Gothenburg. Thereafter, there is quite a large gap to Stockholm University and KTH Royal Institute of Technology. All HEIs increased their publication volumes between the periods. In total, Sweden increased its number of publications by 42 per cent (Figure 34). The largest relative increases in publication volume were from University College West,

University of Gävle, Malmö University, Kristianstad University and Dalarna University, which all more than doubled the number of publications between the periods. Umeå University and Stockholm School of Economics increased their publication volumes the least (by 16 per cent and 20 per cent respectively).

The highest citation impact for 2019–2021 was found at the Stockholm School of Economics (14 per cent), Karolinska Institutet (14 per cent), and the Swedish University of Agricultural Sciences (13 per cent), followed by Chalmers University of Technology, Stockholm University, University of Gothenburg, and Linköping University, which all have a 12 per cent proportion of highly cited publications. The greatest increase in the citation impact between the periods was achieved by Luleå University of Technology, the University of Borås, Södertörn University and the University of Skövde. The greatest decrease in the citation impact between the periods was for Blekinge Institute of Technology and Kristianstad University, followed by Halmstad University and Stockholm University. Note that the percentage of highly cited publications tends to vary more over time for HEIs with smaller publication volumes.

Higher education institutions' research profiles

Figure 42 shows the research profiles for each of the Swedish universities and for the university colleges as a group. The research profiles are based on publications from 2019–2021 and are shown as the proportion of highly cited publications in relation to the specialisation within different research areas. Specialisation means the proportion published in different research areas compared to the world average. If a research area is to the right in the figure (above zero), this means that the HEI in question has published a larger proportion than the world average in this research area. If, on the contrary, a research area is located to the left in the figure (below zero), the HEI has published a smaller proportion than the world average in the research area. Furthermore, if a research area is located in the upper half of the figure (above 10 per cent) the citation impact is higher than the world average in that area, while if a research area is below 10 per cent, then the citation impact is lower than the world average. The sizes of the circles illustrate the relative sizes of the different research areas in terms of number of publications. Only research areas where the HEI has produced at least 30 publications during the period are shown in the figure. (A more detailed description of how subject specialisation is calculated can be found in the method appendix.)

The diagrams show the relationship between the areas in which the HEI carried out a lot of research and the areas in which the HEI has had a high impact during the period. The broad-based established universities had publications in all 16 research areas, but show some range in their specialisation. All broad-based established universities except Stockholm University (which is lacking a medical faculty) had their largest proportion

of publications within clinical medicine. Stockholm University and the University of Gothenburg, which both lack engineering science faculties, had a low proportion of publications in engineering science and materials science. Stockholm University is the most specialised in humanities and social sciences, and had the highest citation impact (16 per cent) in biology, agronomy, and clinical medicine. Both the University of Gothenburg and Umeå University are the most specialised in social sciences, health sciences, and clinical medicine. The University of Gothenburg had its highest citation impact in humanities (17 per cent), biology (15 per cent), mathematics, and physics (both 14 per cent). Umeå University had its highest citation impact in humanities (19 per cent) and agronomy (16 per cent). Lund University is the most specialised in clinical medicine and health sciences, and had the highest citation impact in humanities (19 per cent), social sciences and biology (16 per cent for both). Uppsala University is the most specialised in humanities and social sciences, and had the highest citation impact (16 per cent) in humanities and biology. Linköping University is the most specialised in health sciences, psychology, social sciences and materials science, but had its highest citation impact in humanities (29 per cent), agronomy (19 per cent), chemistry (19 per cent) and economics (18 per cent).

The specialised universities are considerably more specialised than other HEIs. For example, publications from the Stockholm School of Economics are almost exclusively in economics, where they also had a high citation impact (12 per cent). Karolinska Institutet has a considerable proportion of publications in clinical medicine, biomedicine, and health sciences, and was above the world average in clinical medicine (13 per cent) and biomedicine (14 per cent). The Swedish University of Agricultural Sciences has its highest publication volume in agronomy and biology, where both areas had proportions of highly cited publications of 15 per cent. The technical universities, KTH Royal Institute of Technology, Chalmers University of Technology and Luleå University of Technology are specialised in engineering science and materials science, where they all were around the world average in citation impact. As we saw in Figure 34, engineering science and materials science are areas where Sweden's proportion of highly cited publications decreased between 2009–2011 and 2019–2021. On the other hand, the technical universities have high citation impacts in physics.

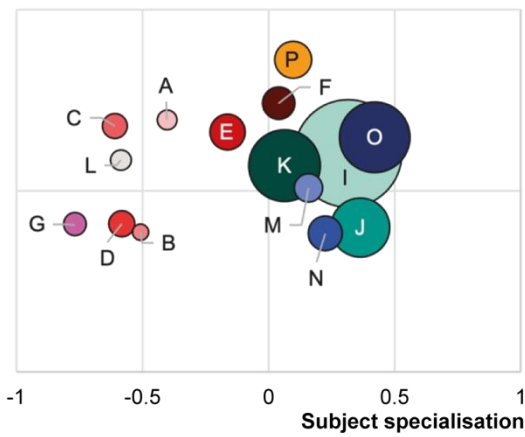
The new universities have a relatively low volume of publications (see Figure 41), and for that reason (with the exception of Örebro University and the Linnaeus University) only a few research areas are included in the diagrams (those with more than 30 publications). A common denominator for the new universities is that all have a large proportion of publications in social sciences and health sciences. Mälardalen University, which is now included in the group of new universities, stands out in engineering

science, both in terms of volume and of citation impact (14 per cent). However, the percentage of highly cited publications tends to vary more for HEIs with smaller publication volumes.

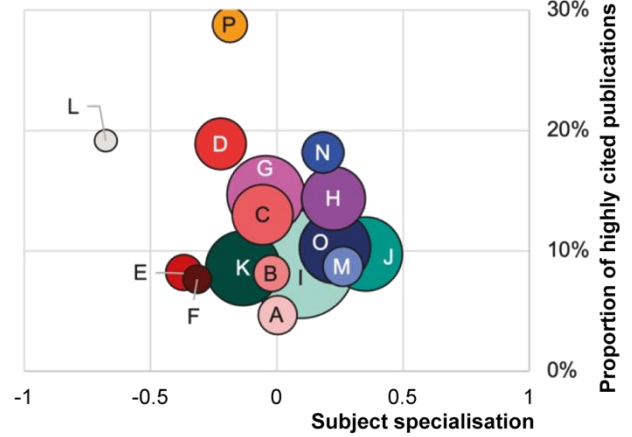
The university colleges have limited publication volumes. They have therefore been merged together in one diagram. In total, this group published the largest number of publications in social sciences, health sciences, and engineering science. In citation terms, they scored highest in biomedicine (16 per cent) and humanities (14 per cent).

Broad-based established universities

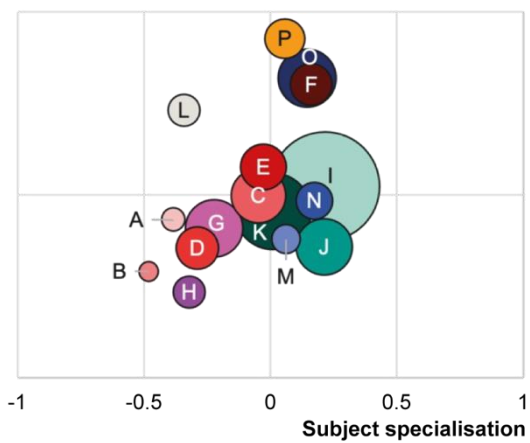
University of Gothenburg



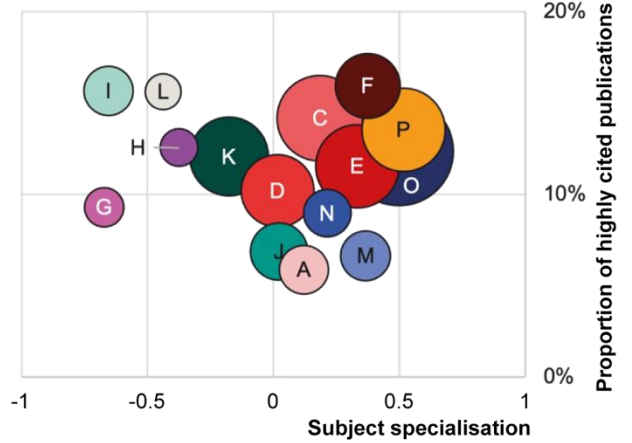
Linköping University



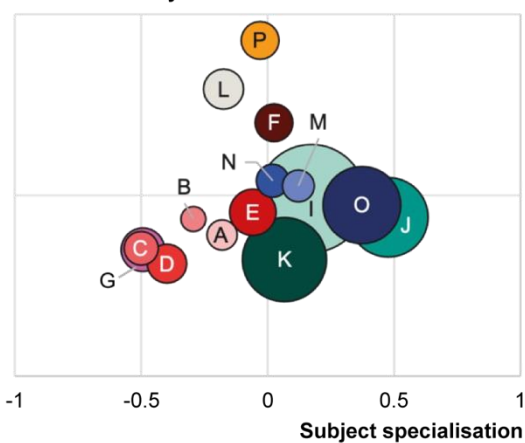
Lund University



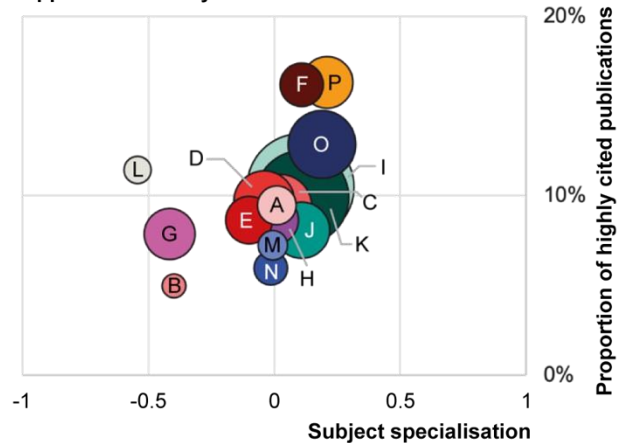
Stockholm University



Umeå University



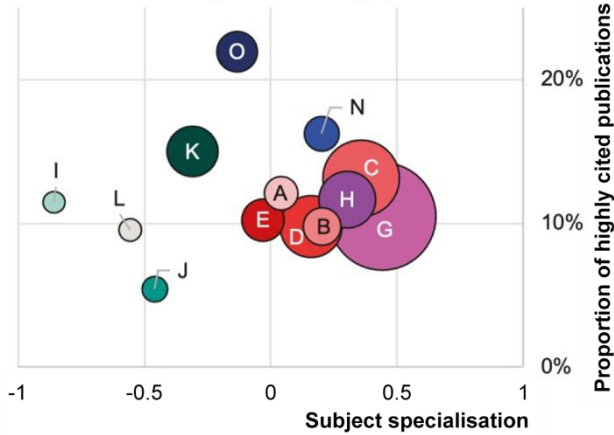
Uppsala University



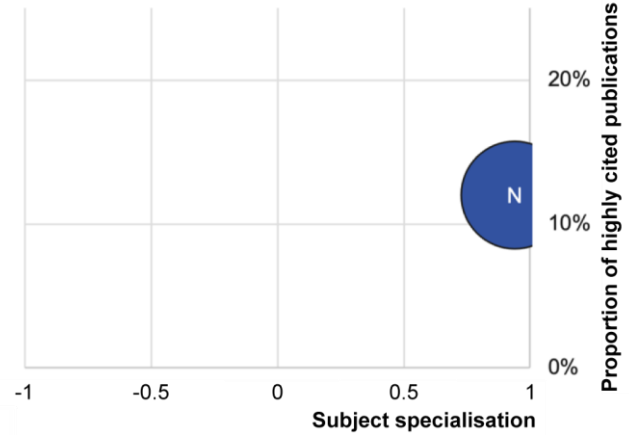
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|---|-----------------------------------|---|------------------|---|---------------------------------------|---|--------------------------------|
| A | Mathematics and statistics | E | Geosciences | I | Clinical medicine | M | Psychology |
| B | Computer and information sciences | F | Biology | J | Health sciences | N | Business studies and economics |
| C | Physics | G | Engineering | K | Biomedicine and molecular biosciences | O | Social sciences |
| D | Chemistry | H | Material science | L | Agricultural and veterinary sciences | P | Arts & humanities |

Specialised universities

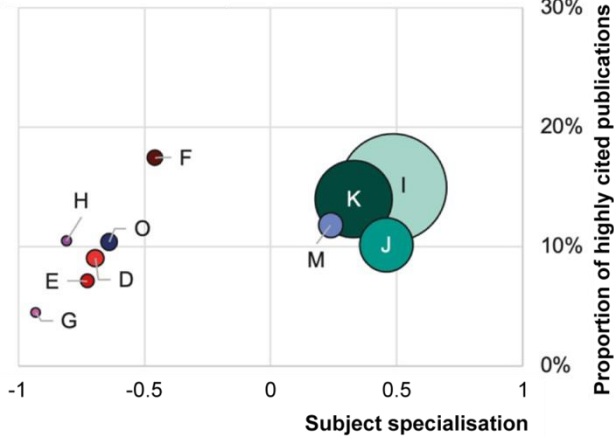
Chalmers University of Technology



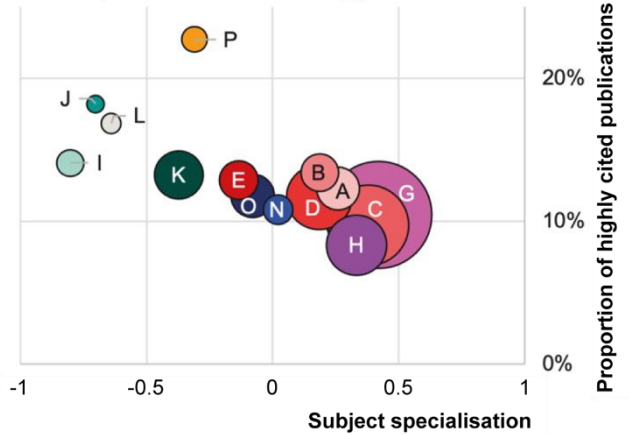
Stockholm School of Economics



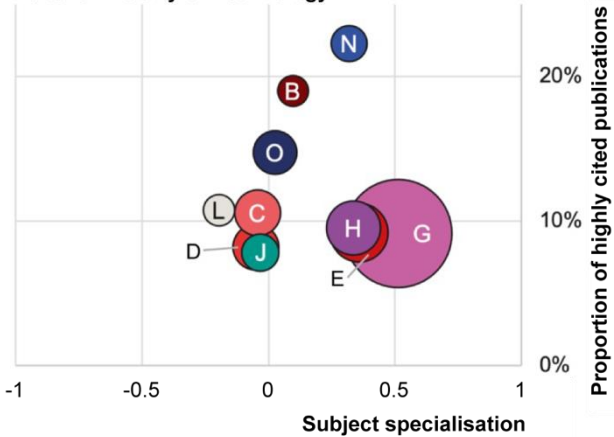
Karolinska Institutet



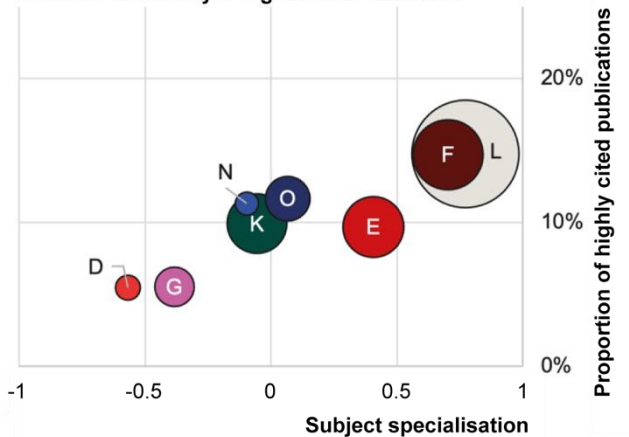
KTH Royal Institute of Technology



Luleå University of Technology

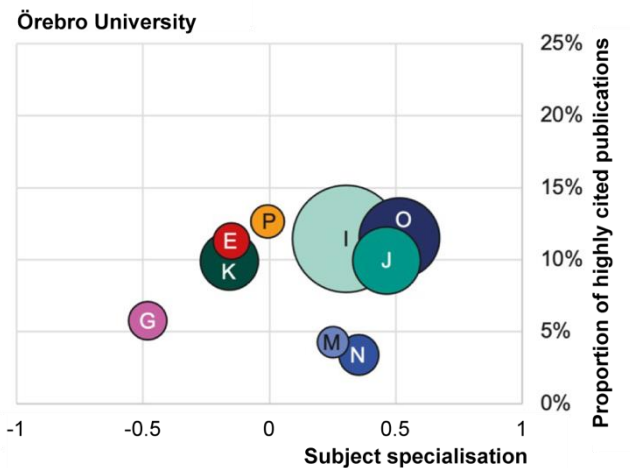
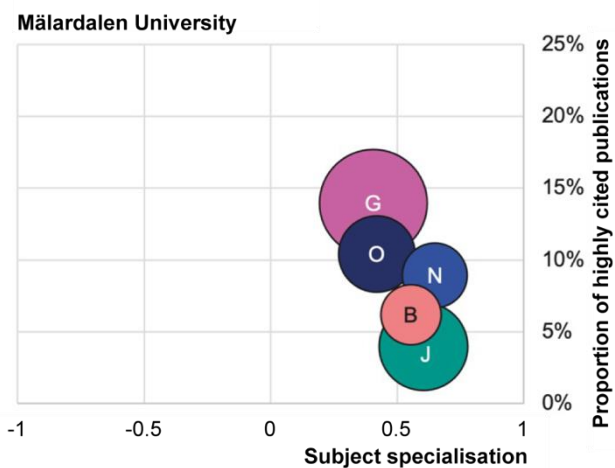
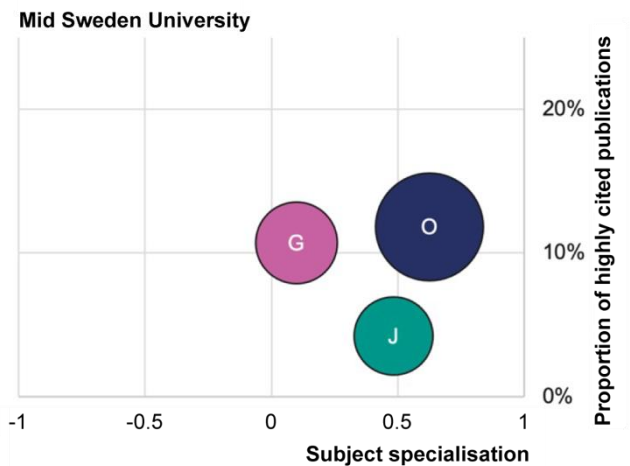
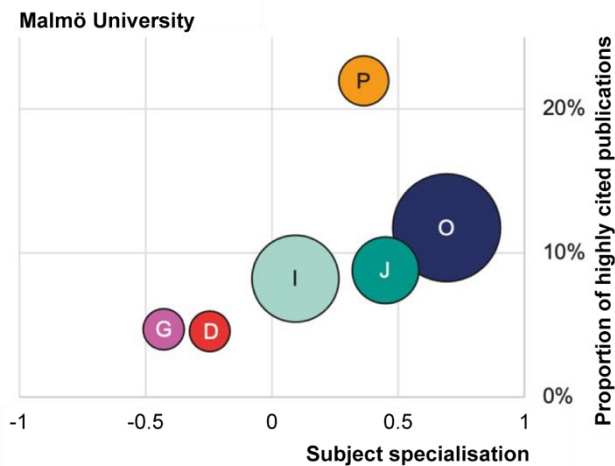
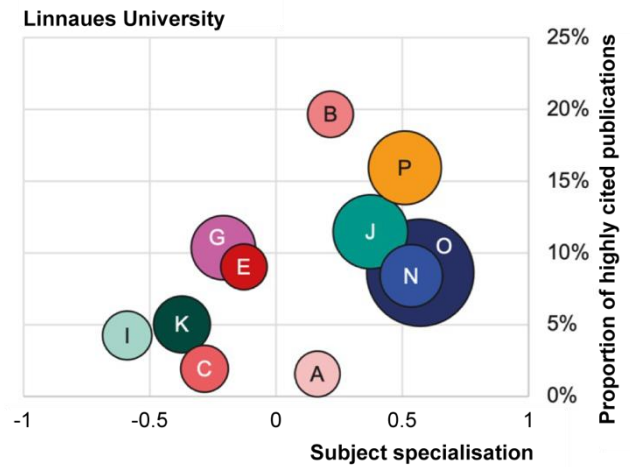
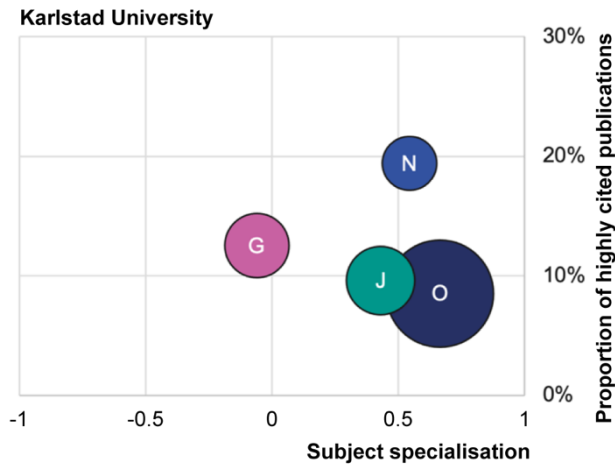


Swedish University of Agricultural Sciences



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|---|-----------------------------------|---|------------------|---|---------------------------------------|---|--------------------------------|
| A | Mathematics and statistics | E | Geosciences | I | Clinical medicine | M | Psychology |
| B | Computer and information sciences | F | Biology | J | Health sciences | N | Business studies and economics |
| C | Physics | G | Engineering | K | Biomedicine and molecular biosciences | O | Social sciences |
| D | Chemistry | H | Material science | L | Agricultural and veterinary sciences | P | Arts & humanities |

New universities



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|---|-----------------------------------|---|------------------|---|---------------------------------------|---|--------------------------------|
| A | Mathematics and statistics | E | Geosciences | I | Clinical medicine | M | Psychology |
| B | Computer and information sciences | F | Biology | J | Health sciences | N | Business studies and economics |
| C | Physics | G | Engineering | K | Biomedicine and molecular biosciences | O | Social sciences |
| D | Chemistry | H | Material science | L | Agricultural and veterinary sciences | P | Arts & humanities |

University colleges

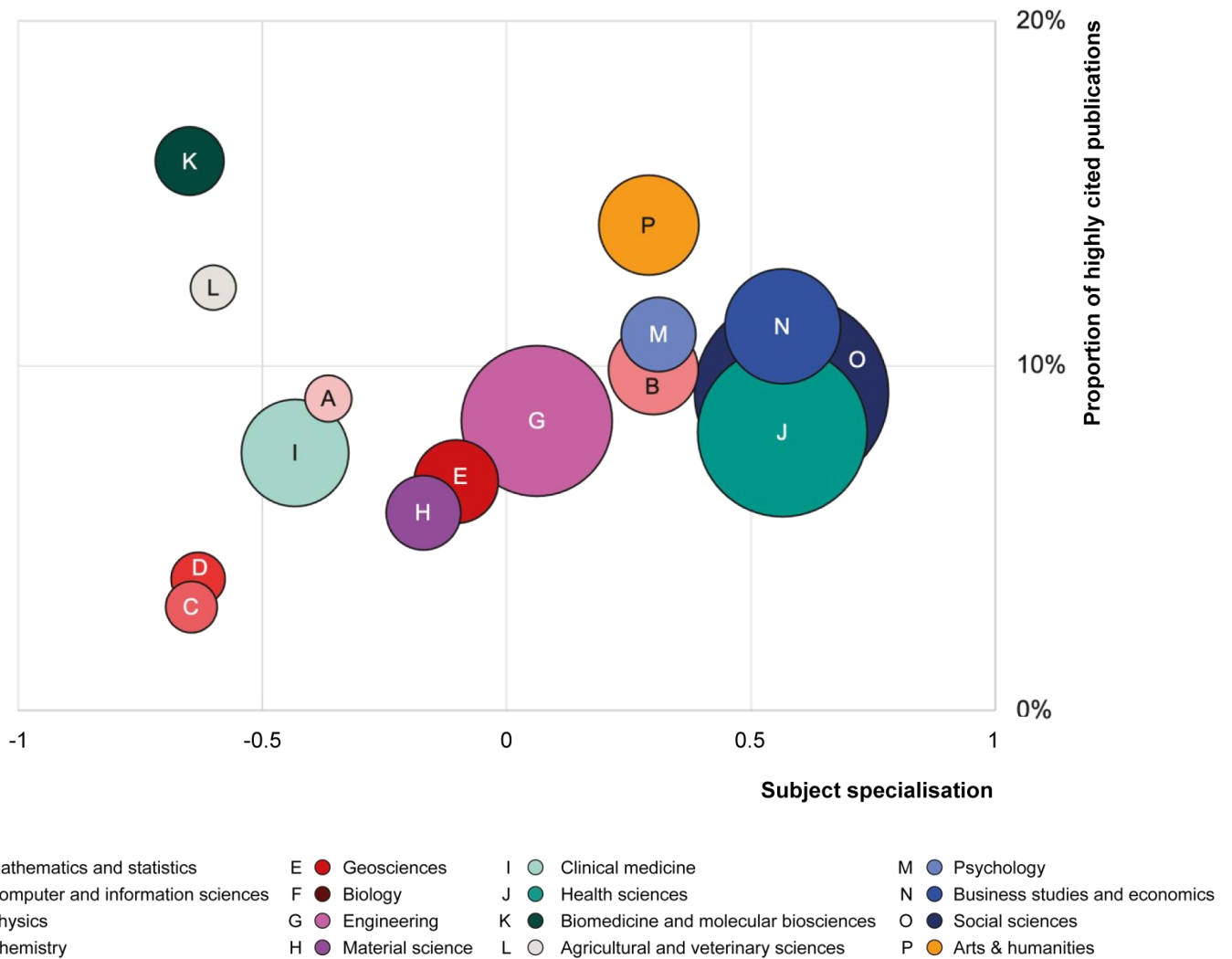


Figure 42. Research profiles (subject specialisation and citation impact) of Swedish HEIs. Source: Clarivate Analytics.

Note: The area of each circle is proportional to the field of research's share of the HEI's overall production. Only fields of research where the HEI published at least 30 publications during 2019–2021 are included in the figure. Publications from the respective university hospitals are included.

Method appendix

The purpose and focus of the Swedish Research Barometer

The Swedish Research Barometer aims to describe the status and progress of Swedish research and development (R&D). It includes an international comparison of the Swedish R&D system, with a particular focus on the Swedish higher education sector.

The Swedish Research Barometer gathers together information from several sources of statistics, while also reporting unique information about scientific publications and their citation impact. By reporting statistics from several different sources, the report can provide a comprehensive picture of the Swedish R&D system.

As the Swedish Research Barometer is a recurrent report, the choice of indicators and figures is largely repeated year by year, and the description focuses on development in the most recent years. The report takes a primarily descriptive approach.

International comparisons

As the Swedish Research Barometer aims to describe the Swedish R&D system and make international comparisons, the selection of countries and groups of countries to compare Sweden with is of central importance. International comparison of the R&D of different countries is not simple, as there are differences in factors such as organisation structure and funding model.

Limiting factors in international comparisons are access to statistics and the quality of the statistics. For information on expenditure on R&D and personnel, statistics from the OECD are used. The OECD's database has statistics for most OECD countries, including some further countries. For information on the number of publications and citations, we use information from Clarivate Analytics. Together, this entails a delimitation of the countries that can be included in the Swedish Research Barometer.

For international comparisons, we want to compare Sweden in relation to the rest of the world, and to various countries that are interesting comparison countries. For number of publications and citations, the comparisons are made in relation to world averages. For information on expenditure on R&D and personnel, there are limitations in the data, and we therefore compare Sweden with the EU (EU27) and the OECD. To describe how two variables co-vary with each other, we use bubble plots

(scatter plots combined with circles) with the OECD countries and China. As these comparisons intend to show how Sweden is doing in international comparison, a large selection of countries is to be preferred.

The Swedish Research Barometer also uses a selection of countries to make paired comparisons between Sweden and other countries. The selection of countries used in the Swedish Research Barometer 2023 are:

- Neighbouring countries: Norway, Finland and Denmark,
- Comparable countries: Belgium, Netherlands, Switzerland and Austria, and
- Large research nations: France, Italy, Spain, United Kingdom, Germany, USA and China.

Norway, Finland and Denmark are interesting to include because they are our closest neighbours, and because their R&D systems are similar to Sweden's. The comparable countries are the countries outside the Nordic countries that are the most similar to Sweden in relation to expenditure on R&D and expenditure on R&D in relation to GDP (either for the R&D system as a whole or for higher education)³². It is interesting to note that Norway and Denmark also fulfil the criteria for comparable countries in terms of expenditure on R&D and expenditure on R&D in relation to GDP. The large research nations are those countries that are among the five countries in Europe or the world with the largest scientific production (measured in number of publications).

In total, our neighbouring countries and the comparable countries constitute countries that are similar to Sweden. The large research nations are interesting comparison countries, as they are very important to research internationally.

Data sources

Funding and personnel statistics in the international comparisons are taken from the OECD database Main Science and Technology Indicators (March 2023 version). The statistics are based on individual countries' reporting to the OECD. The figures based on data from the OECD do not always

³² The highest permitted absolute difference in expenditure on R&D per GDP is 0.4 percentage points. The highest absolute for expenditure on R&D is 9 045 PPP\$ (which is half of Sweden's expenditure on R&D). The highest permitted absolute difference for higher education expenditure on R&D is 0.2 percentage points, and the highest permitted absolute difference for higher education's expenditure on R&D is 2 125 PPP\$ (which is half of higher education's expenditure on R&D in Sweden). Belgium, Switzerland and Austria are "similar" to Sweden in terms of expenditure on R&D in total, and Denmark, Netherlands, Norway, Switzerland and Austria are "similar" to Sweden in terms of higher education's expenditure on R&D.

include data for all years. This means that data for individual countries and years are sometimes lacking, and can therefore not be presented in the report. For a number of figures, data from the nearest available year have been used instead, which is then shown in the figure and in the figure text. This applies in particular for the information on personnel, which is lacking statistics for several countries and years.

Data on Sweden's participation in Horizon Europe are taken from eCORDA and the OECD. Applications ("eligible applications") and approved applications ("retained applications") are taken from eCORDA (15 June 2023). Number of researchers (full-time equivalents) refers to 2020 (due to limitations in the data) and data from the OECD. Number of researchers refers to the entire R&D system, that is the higher education sector, business enterprise sector, and government sector.

The statistics for expenditure on R&D for higher education in Sweden are taken from Statistics Sweden (SCB). The R&D statistics are updated every two years, and the latest available figures are from 2021. Expenditure on R&D that includes comparisons over time have been calculated at constant prices using the GDP deflator, which in turn is based on data from the National Institute of Economic Research³³.

Statistics for doctoral students and teaching and research personnel in higher education are taken from Statistics Sweden and the Swedish Higher Education Authority (UKÄ). Personnel statistics are collected yearly and are based on register data, which is why the latest available figures are from 2022.

Statistics for use of working hours are based on a questionnaire survey, carried out every two years by Statistics Sweden since 2005. The questionnaire survey is aimed at employees at higher education institutions in Sweden, and form the basis for calculating the number of full-time equivalents and the relative allocation of working hours in R&D activities (research and experimental development) in the sector. The sampling for the questionnaire survey is carried out using a sampling framework with position categories relevant to the sector. From the sampling framework, a stratified sample is drawn using SRS (simple random selection) within strata. The response frequency has throughout been around 50 per cent. The response proportion for the 2021 survey was 40 per cent.

There is a not inconsiderable lack of data on year of doctoral degree award in the register data. For professors and senior lecturers, around 10–12 per cent are missing this information. In the figures showing number of

³³ Prognosdatabasen, March 2023.

employees per employee category and career age, we have assumed that those lack information on year of doctoral degree award have the same relative distribution of year of doctoral degree award as those with data on year of doctoral degree award. This is not a self-evident assumption, but we find no reason to why this would give rise to any systematic skewness; that is, that the distribution among those that lack information about year of doctoral degree award would in any significant way differ from those that have information about year of doctoral degree award. The alternative would be to not include them at all in the figures, but we choose to include them as the figures also provide a description of the total size of the personnel.

Data on number of publications, citation impact and international co-publication are based on the Swedish Research Council's publication database, which in turn is based on the same background material as Web of Science which is owned by Clarivate Analytics. The data in the Swedish Research Barometer corresponds to the contents of Web of Science in September 2023. For information on population size for the measure of number of publications per thousand users, we have used statistics from the UN, as this database has greater coverage of countries than the OECD's database.

Classification into fields of research

The Swedish Research Barometer uses a total of two classifications of fields of research. For information on expenditure on R&D and R&D personnel in higher education in Sweden, we use fields of research from the "Standard for Swedish classification into fields of research", produced by the Swedish Higher Education Authority and Statistics Sweden.³⁴ For data on number of publications and citation impact, we also use fields of research that are based on the classification of scientific journals used in the Swedish Research Council's publications database. This classification of fields of research corresponds to the Swedish Higher Education Authority's and Statistics Sweden's classification of fields of research.

In addition, for the figures based on bibliometrics, we also use a classification with sixteen different research areas.³⁵ This classification is based on the classification of scientific journals used in the Swedish Research Council's publications database.

³⁴ UKÄ (2016). Standard för svensk indelning av forskningsämnen 2011.

³⁵ Agronomy, biology, geosciences, physics, chemistry, biomedicine, clinical medicine, health sciences, mathematics, materials science, ICT (information and communication technology), engineering and technology, humanities, economics, psychology and (other) social sciences.

Bibliometric analysis

This section summarises how the bibliometric indicators have been calculated and used in the Swedish Research Barometer. For a more detailed description of how bibliometrics are used at the Swedish Research Council, please see “Riktlinjer för användning av bibliometri vid Vetenskapsrådet” and “The bibliometric database at the Swedish Research Council – contents, methods and indicators”³⁶.

The Swedish Research Council’s database for bibliometrics

The Swedish Research Council’s publication database is based on data from Clarivate Analytics and the contents correspond to that of Web of Science (WoS).³⁷ A new feature for this year is that the publication database also includes the citation index Emerging Sources Citation Index (ESCI). ESCI is included in Web of Science’s core collection, and includes peer-reviewed publications of regional importance and in emerging scientific fields.

The publication database covers around 21 000 international scientific journals. These journals are classified by Clarivate Analytics into one or several of around 250 research subjects, and the individual publications receive the journal’s research subject classification. In the Swedish Research Barometer, the 250 subjects have been aggregated to two classifications, one with 6 fields of research and one with 16 research areas.³⁸ The Swedish Research Council reclassifies the journals classified as Other/Multi-disciplinary. Following reclassification of multi-disciplinary periodicals, very few publications remain in this category, and these have been excluded from the statistics in the Swedish Research Barometer.

Every publication in WoS is also classified as one of 39 different document types. The Swedish Research Council’s statistics are based on

³⁶ Vetenskapsrådet (2014). Riktlinjer för användning av bibliometri vid Vetenskapsrådet. 2014-12-15. Dnr 113-2014-7357., Vetenskapsrådet (2015). The bibliometric database at the Swedish Research Council – contents, methods and indicators 2015, 2015-09-18. Dnr 113-2010-6148.

³⁷ The Swedish Research Council buys raw data from Clarivate Analytics and the contents correspond largely to the contents of Web of Science. When Web of Science is stated, this means the Swedish Research Council’s database (consisting of the following products: Science Citation Index Expanded®, Emerging Sources Citation Index®, Social Science Citation Index®, and Arts and Humanities Citation Index®. These products have been compiled by Clarivate Analytics®, Philadelphia, Pennsylvania, USA© Copyright Clarivate Analytics® 2023. All rights reserved.)

³⁸ Agronomy, biology, geosciences, physics, chemistry, biomedicine, clinical medicine, health sciences, mathematics, materials science, ICT (information and communication technology), engineering and technology, humanities, economics, psychology and (other) social sciences.

publications of the types Article or Review, which are added together into a joint document type.

The proportion of all scientific publications that are included in the publication database, varies between different fields of research. The coverage is very high for medicine and natural sciences, but less good for humanities and parts of social sciences. At the same time, the degree of coverage in humanities and social sciences has improved since the last Swedish Research Barometer, as the Swedish Research Council's publication database has been extended with the Emerging Sources Citation Index.

As the Swedish Research Barometer's calculations of the number of publications and citation impact are based on the publications included in the publication database, the certainty of the figures is highest for the fields of research with the greatest degree of coverage.

Publication volume and fractioning

Unless otherwise is stated, the Swedish Research Barometer uses fractional calculation of the number of publications. This means that if a publication has two authors and they are from different countries, these countries are awarded half a publication each. The same applies for publication in different subjects – if a publication is classed in two subjects, each subject is awarded half a publication each. The actual number of publications is consequently higher than shown in the figures. Publications by researchers based in Sweden (hereafter called “Swedish researchers”) are identified in the database according to the organisational affiliation that the authors themselves have stated in the publications.

Proportion of highly cited publications

The proportion of highly cited publications indicates how large a proportion of a country's or an organisation's publication volume is in the 10 per cent most cited publications in the world. This is a measure of citation impact that, contrary to the citation average, is not significantly impacted on by one-off extremely highly cited publications. It is calculated for a country, for example, by dividing the sum of the country's publications that are among the 10 per cent most cited by the sum of all the country's publications. The global average for this indicator is 10 per cent. If a country has a proportion of highly cited publications of 12 per cent, this means that the country has a 20 per cent higher proportion of highly cited publications than the world average.

In order to correct for differences between subjects with differing citation traditions, the citation statistics have been field standardised. This means that all citations, before being summarised, are divided by a field factor that quite simply consists of the average number of citations for a specific

subject during a specific year. The number of citations is counted during a three-year window, which means that the citations are counted as from the year the publication is published and for two years afterwards. Self-citations are excluded.

Scientific publication with open access

Information on whether a publication is openly accessible is part of Clarivate's data via Unpaywall. Publications in the database may be openly accessible in several categories. For the summary in the Swedish Research Barometer, one category has been given to each publication, in the following priority order: "Gold", "hybrid" and "green". The publications that lack any form of open access are categorised as "locked".

Research specialisation

To relate the research specialisation of a country's (or an organisation's) publications, a measure of research specialisation is used: relative specialisation index (RSI). This is a symmetrical indicator that varies between -1 and +1 and is based on a country's (or an organisation's) activity index (AI).

The activity index for a specific country is calculated by dividing the proportion of publications it has within a specific research area by the proportion that the research area constitutes in the publication database as a whole. If 50 per cent of Sweden's publications were classified as physics, while the corresponding figure for the whole of the database is 25 per cent, then Sweden's activity index for physics will be 2. In this example, Sweden therefore has double the proportion of physics compared to the world. The activity index is an asymmetrical measure that can assume values between 0 and infinity. To make the figures easier to compare, we use RSI instead, which is calculated as follows:

$$RSI = (AI - 1)/(AI + 1).$$

If $RSI < 0$, the country (or the organisation) has a lower proportion of publications within the research area than the world average. If $RSI > 0$, the proportion is higher than the world average.

Country codes

AT = Austria

FI = Finland

LV = Latvia

AU = Australia

FR = France

MX = Mexico

BE = Belgium

GB = United Kingdom

NL = Netherlands

CA = Canada

GR = Greece

NO = Norway

CH = Switzerland

HU = Hungary

NZ = New Zealand

CL = Chile

IE = Ireland

PL = Poland

CN = China

IL = Israel

PT = Portugal

CO = Colombia

IS = Iceland

SE = Sweden

CZ = Czechia

IT = Italy

SG = Singapore

DE = Germany

JP = Japan

SI = Slovenia

DK = Denmark

KR = South Korea

SK = Slovakia

EE = Estonia

LT = Lithuania

TR = Turkey

ES = Spain

LU = Luxembourg

US = USA

Explanations of concepts and abbreviations

Table 1. Explanations of concepts and abbreviations

Concepts and abbreviations	Explanation
Proportion of highly cited publications	States the proportion of a country's or organisation's publications that are among the 10 per cent most cited scientific publications in the world (in the Swedish Research Council's publication database).
Success rate	The number of approved applications in relation to the number of applications. The concept is used in the description of Sweden's participation in Horizon Europe.
Gross domestic product (GDP)	The value of all goods and services produced in a country during a given period.
Clarivate Analytics	A company that publishes Web of Science, a publication database with citation indices. When Clarivate Analytics is referenced in figures and running text, this refers to the Swedish Research Council's database for bibliometrics, which is based on data from Clarivate Analytics.
eCORDA	Data source on participation in the EU's framework programme for research and innovation (External Common Research Data Warehouse).

Concepts and abbreviations	Explanation
EU	The countries that are currently part of the European Union (27 countries): Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Croatia, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Czechia, Germany, Hungary and Austria.
Constant prices	Constant prices are prices from a specific (fixed) time period. Studying the development over time of expenditure on R&D at constant prices therefore means that the development can be studied based on the same price level across the period, and therefore without any impact of changes in prices. The Swedish Research Barometer uses the GDP deflator.
Researchers	The Frascati Manual definition is: “Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods.” Researchers can be found in higher education, business enterprises, and the governmental sector.

Concepts and abbreviations	Explanation
Field of research	Classification of Swedish R&D according to the “Standard for Swedish classification into fields of research”. The classification has three levels. Field of research is the highest level and consists of: natural sciences, engineering and technology, medicine and health sciences, agricultural and veterinary sciences, social sciences, and humanities and arts.
R&D (Research and experimental development)	Defined in the Frascati Manual as: “Creative work undertaken on a systematic basis in order to increase the stock of knowledge (including knowledge of man, culture and society) and the use of this knowledge to devise new applications.” R&D includes basic research, applied research and experimental development. See also the fact box in the report.
R&D intensity	In the Swedish Research Barometer, the concept of R&D intensity is usually used to describe expenditure on R&D as a proportion of GDP.
Expenditure on R&D	Expenditure on performed intramural R&D. Consists of current costs and investment expenditure. See also the fact box in the report.
Frascati Manual	OECD’s guidelines for statistics on R&D. ³⁹

³⁹ OECD (2015). Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris.

Concepts and abbreviations	Explanation
Full-time equivalent	A full-time equivalent is the work carried out by one full-time employee during one year.
ICT	Information and communications technology. Also known as “computer and information sciences”.
Current prices	Expenditure on R&D at current prices means that expenditure on R&D is expressed at the actual price level for the time in question. Expenditure at current prices is used to describe and compare expenditure at a specific point in time. To describe the development of expenditure over time, expenditure at constant prices is used instead, which means that the price level does not vary over time. See also Constant prices.
OECD	Organisation for Economic Cooperation and Development. The OECD has 38 member countries. The OECD also produces statistics, and the Swedish Research Barometer uses the database OECD Main Science and Technology Indicators. The OECD’s member countries are: Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and USA.

Concepts and abbreviations	Explanation
PPPS	<p>Purchasing power-adjusted US dollars (USD). The abbreviation stands for “Purchasing Power Parity with USD”. Purchasing power adjustment is a way of taking into account price differences in different countries, and thereby expressing factors such as expenditure on R&D or GDP based on the country’s purchasing power. In simple terms, purchasing power adjustment takes into account that 100 SEK buys you different amounts in different countries, due to differences in the countries’ price levels for various goods and services.</p>
Publication volume	<p>Number of scientific publications over a specified period.</p>
Relative success	<p>Number of approved applications in Horizon Europe in relation to the number of researchers in the R&D system.</p>
Relative number of applications	<p>Number of applications in Horizon Europe in relation to the number of researchers in the R&D system.</p>
Statistics Sweden	<p>Statistics Sweden (Swedish: Statistiska centralbyrån (SCB)).</p>
Swedish Higher Education Authority	<p>Swedish Higher Education Authority (Swedish: Universitetskanslerämbetet (UKÄ)).</p>

Concepts and abbreviations**Explanation****Work year equivalent**

A work year equivalent is the work carried out by one full-time employee during one year. A full-time employee who spends half their time on R&D has carried out 0.5 R&D work year equivalents. Work year equivalent is the same as full-time equivalent.

The Swedish Research Barometer provides an overall description of research and development (R&D) in Sweden, and highlights how Sweden compares internationally. In addition, the Swedish Research Barometer places particular focus on the higher education sector in Sweden.

The report consists of three chapters:

- Research funding
- Research personnel
- Scientific publication

The Swedish Research Council publish the Swedish Research Barometer every two years. This is the fifth report.

Swedish Research Council
Box 1035, 101 38 Stockholm
Tel + 46 (0)8-546 44 00
Email: vetenskapsradet@vr.se

The Swedish Research Council has a leading role in developing Swedish research of the highest scientific quality, thereby contributing to the development of society. Besides funding research, the agency advises the Government on research-related issues and participates actively in the discussions to create understanding of the long term benefits of research.