Report on Science & TechnologyIndicators for Norway 2017

Human Resources

Research and Development

Technology

Innovation

A national report of research and innovation indicators for Norway has been published regularly in Norwegian since 1997. From 2009 the report has been published annually. This is an English version of the 2017 report in Norwegian consisting of selected parts of the full Norwegian report. The English version has been prepared by Ole Wiig and Marte Blystad (both from NIFU) and proofread by Chris Allinson at Allinson Editorial. It is available at the following web address: http://www.rcn.no/english/.

The title and reference for the original report in Norwegian is: Det norske forsknings- og innovasjonssystemet – statistikk og indikatorer 2017, (ISBN 978-82-12-03636-9), published in Oslo, September 2017, by the Research Council of Norway. Editor of the Norwegian was Espen Solberg and Kaja Wendt (NIFU). Other members of the editorial committee: Svein Olav Nås and Tom Skyrud (both Research Council of Norway), Frank Foyn and Lars Wilhelmsen (both from Statistics Norway), Knut Senneseth (Innovation Norway), Magnus Otto Rønningen (University of Oslo) and Beate Rotefoss (SIVA), as well as Marte Blystad, Olav R. Spilling, Susanne L. Sundnes and Michael Spjelkavik Mark (NIFU).

The reports are available as net versions on:
www.forskningsradet.no/indikatorrapporten

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For 20 years, the Research Council of Norway has published the Report on Science and Technology indicators for Norway («The Indicator Report») as a collection of indicators, statistics and analysis of the Norwegian research and innovation system. The full-length version (in Norwegian) presents a larger set of indicators and analyses. Contributions from that report have been adapted and abridged to make up this biennial English version. The report has evolved over time, but has preserved its raison d'être; Innovation and knowledge development depends on many factors that must interact to reach the goals. Policy design and insight into what works must be based on the best data we are able to collect and analyse, and there are many elements that need to be considered at the same time.

Data are important, but analysis and solid understanding of the indicators' possibilities and limitations are necessary companions. The indicator report has its strength in providing a thorough and comprehensive presentation and assessment of methodology, data quality and, not least, international comparability. Comparisons with developments in other countries are essential for assessing one's own position and rate of change. The underlying data are also made available to researchers who can conduct a more thorough causal analysis of the relationships between efforts and results in research and innovation.

An anniversary edition like this gives the opportunity to take the long view. Changes are often not visible from one year to the next year, but stand out in a longer perspective. The report presents, to the extent that the available data allow, the development over the past 20 years. This is a good and necessary basis for the reorientation of the Norwegian economy and the global challenges facing us. As an innovation in the anniversary edition, a separate chapter on economic restructuring has been included.

A fundamental trend over the 20 years under scrutiny is the digitisation of virtually all areas of society. This poses new requirements for organising all types of businesses, including research itself. In addition, it provides new opportunities for generating, analysing and publishing statistics and indicators.

Throughout its lifetime, the Indicator Report has maintained a parallel web publication that will become the main channel for publication from now on. The broad and thorough perspective of the paper version will be retained, along with good explanations and thorough analyses. There will also be better opportunities for analysis, visualisation, faster publication and access to interactive use of the underlying material in the web publication.

The report is produced as a collaboration between NIFU, Statistics Norway and the Research Council of Norway. Innovation Norway, SIVA and the University of Oslo are also represented on the editorial committee. I want to thank the editors and all other contributors for their efforts. I hope the resulting book and online information will be of use for foreign and national readers.

John-Arne Røttingen
Chief Executive
Research Council of Norway

The main report in Norwegian

This report presents a selection of science and technology (S&T) indicators for Norway. It is based on the more comprehensive Norwegian report, which has been published annually since 1997, making this year's Norwegian report the 20th anniversary edition. The abridged English report has been published biennially since 2001, aiming at providing useful information and perspectives on a range of S&T issues for foreign readers who may not be familiar with the Norwegian S&T system and its context. Thus, it complements the full version, which can be found online (in Norwegian).

R&D and innovation statistics

As stated above, this report is the latest in a series going back to 1997. Thus, the 20-year perspective has been emphasised. However, it also draws on measurements and indicators with a much longer history and time series. Statistics on resources devoted to research and experimental development (R&D) in Norway, in terms of expenditure, full-time equivalents and personnel, have been compiled since 1963. This report continues the series' original aim of presenting a wide range of relevant statistics and indicators and of ensuring their ongoing development. Norwegian R&D statistics are based on the guidelines of the OECD Frascati Manual, which were revised in 2015. The classifications are updated to be in line with the latest edition.

Indicators relating to patents, bibliometric analyses and advanced technology have been included with data back to the 1980s. Innovation studies were first introduced in the 1990s, and the range of innovation indicators has been considerably extended following the revision of the Oslo Manual in 2005. A further revision of the Oslo Manual is in progress.

The full-length Norwegian report presents a more extensive set of indicators and commentary, divided into international, national and regional sections, with sections on results, effects and cooperation on research and innovation. It also includes a separate section with detailed tables. The executive summary in this English report is a full-length English translation of the text in the Norwegian report and therefore has a slightly broader scope than the English version of chapters 1–6, which consists of selected sub-chapters etc. from the Norwegian edition.

Structure of the report

Even so, this abridged English report offers information across a wide range of topics. The executive summary is followed by a short description of the Norwegian system of education, research and innovation, and an overview of Key Indicators. Chapter 1 presents the main international trends with results from R&D surveys, as well as comparisons over time and between countries of statistics on scientific publications and citations, educational level, and doctoral degrees. Chapter 2 draws on national R&D statistics for the three research-performing sectors in Norway: the industrial sector, the institute sector and the higher education sector. Data for health trusts are also presented separately. Chapter 3 presents available data on knowledge sharing and cooperation, including indicators of Norwegian participation in the European research programme/Horizon 2020, cooperation on scientific publishing and on innovation. Chapter 4 presents results and effects of research and innovation activities, while Chapter 5 includes selected regional indicators for R&D and innovation. Chapter 6 is new in the 2017 edition and offers a few more indicators on structural change and adaptability in a broader perspective.

While less extensive than the original Norwegian report, this English edition includes more «fact boxes» and more short comment pieces from experts in «focus boxes» than its predecessors. The latter are signed by the authors and views are on their account. We should also mention that this abridged report does not feature full references. These can be found in the Norwegian report, which is available online, together with a complete set of updated tables: http://www.forskningsradet.no/indikatorrapporten

Currency rates

As of 2015 (year average):
1 Euro = 8.9 NOK (Norwegian kroner)
1 US$ = 8.1 NOK

As of November 2017:
1 Euro = 9.5 NOK
1 US$ = 8.2 NOK

Main trends and developments

Research and innovation are long term activities. Hence the need for long time series for analyses and monitoring in this area. As 2017 marks the 20th anniversary of the Report on Science & Technology Indicators for Norway. This year's report focuses on trends and developments during the last two decades, both in the Norwegian R&D and innovation system and beyond.

R&D growth and emerging economies

Over the past 20 years, the world's total R&D investment has more than doubled. Global R&D expenditure now accounts for 1.7 per cent of GDP against 1.4 per cent in 1995. Furthermore, we see a strong growth in the production of scientific articles, increasing from 500,000 articles in 1981 to 1,500,000 in 2015. This expansion is partly explained by the fact that more journals are captured in the databases, but the numbers also reflect a significant real growth in the world's scientific production.

Although the United States is still the world's largest R&D nation, the western countries' hegemony shows a weakening trend, mainly due to the remarkable rise in Chinese R&D investment. Since 1995, China's R&D spending has increased by 30 times, while the number of scientific articles has increased by 22 times. Countries such as Korea, India and Iran have also expanded their research efforts significantly over the past 20 years. A similar pattern can be seen also in Europe, where major R&D nations such as UK, Germany and France show moderate and partly weak R&D growth trends, while smaller nations, especially new EU members from Eastern Europe have increased their R&D efforts, though from a very low starting point.

However, these trends do not necessarily imply that the world's R&D is moving towards a more distributed pattern. By 2015, the ten largest R & D nations accounted for a larger share of world R & D than the ten largest in 1995. The main difference is that the largest R&D "superpowers" no longer consist of only western countries.

Increased formalised research cooperation in Europe

From the mid-1990s we have also seen a significant strengthening of European research cooperation, driven primarily by the growth of EU research programmes. Until the Seventh Framework Programme in 2007, these programmes were relatively limited joint programmes with a major emphasis on technology and applied research. Since then, budgets have increased significantly and the portfolio of programmes and support mechanisms now embraces a wider set topics, purposes and performing sectors. The current Horizon 2020 has a total budget of around €70 billion for the period 2013–2020.

Hence, the EU Framework Programme has now become an important source of funding for many countries and a driving force for European research cooperation. This is also the case for Norway, where a number of measures have been put in place to strengthen Norway's participation in the programmes. By June 2017, about 1.8 per cent of the announced funds in Horizon 2020 have been granted to Norwegian researchers and institutions. This return is slightly below the official target of retrieving 2 per cent of total EU funding.

Fewer and larger units in the Norwegian higher education sector

Looking at the Norwegian system, the higher education sector has changed significantly during the last 20 years. In 1994, 98 district colleges were converted to 26 state colleges. In addition, several colleges have upgraded their status to university or university college. In recent years, the current government has encouraged and facilitated a large-scale process of mergers between universities and university colleges, resulting in a new institutional landscape with fewer and larger higher education institutions:

- In 1997, Norway had 4 universities, 10 university colleges and 26 state colleges
- By 2017, Norway has 8 universities, 8 university colleges and 8 state colleges

During the same period, the Norwegian higher education sector has experienced a significant expansion. The number of R&D full-time equivalents (FTE) has almost doubled, from more than 7,000 in 1997 to almost 14,000 in 2015. This means that more research is performed by fewer institutions, and that the gap between research-intensive and less-research-intensive higher education institutions is reduced.

Institute sector: Gradual structural changes

Structural changes in the Norwegian institute sector[1] have been less extensive than in the higher education

[1] Due to the strong role of research institutes in the Norwegian system, Norwegian R&D statistics operates with a specific sector encompassing all research institutes and actors outside higher education and industry. See also chapter 2.x for further definitions and data.

sector, and followed a more diverse pattern, often based on assessments of individual institutes or groups of institutes. A significant change in the 1990s was the incorporation of several industry research institutes in SINTEF, which has made SINTEF one of the largest research institutes in Northern Europe. Furthermore, a number of agricultural and fisheries research institutes have been subject to mergers and reorganisation processes, resulting in a landscape with a handful of large institutes, some of which combine research in fisheries, aquaculture and agriculture. Some social science institutes have also merged with higher education institutions, although to a lesser extent than the mergers of sectoral institutes with universities in Denmark. The Norwegian institute sector still comprises more than 50 dedicated research institutes, accounting for 24 per cent of total R&D in Norway.

Signs of quality improvement, but still behind the very best

Increased research quality has long been one of the main objectives of Norwegian research policy. Recent data show that Norway is among the western countries with the strongest growth in article production. At the same time, the Norwegian articles are increasingly cited. Norway has now reached the same level as Finland and Sweden as regards the number of citations per article, but Denmark, the Netherlands and Switzerland are still well ahead. Also in terms of the proportion of highly-cited articles, Norwegian research has shown significant progress. Citation is, however, not a sufficient measure of scientific quality.

Internationalisation is increasing

Another key trend over the past two decades is the increasing internationalisation of Norwegian research. Today, more than two thirds of Norwegian scientific articles have a foreign co-author, compared with only 17 per cent in the early 1980s. International co-authorship has now become the rule rather than the exception. The increase in foreign PhD students reflects the same trend towards more internationalisation. Twenty years ago, only 10 percent of Norwegian doctoral degrees were awarded to foreigners, while this proportion has now increased to 38 percent.

More innovative and research-active enterprises

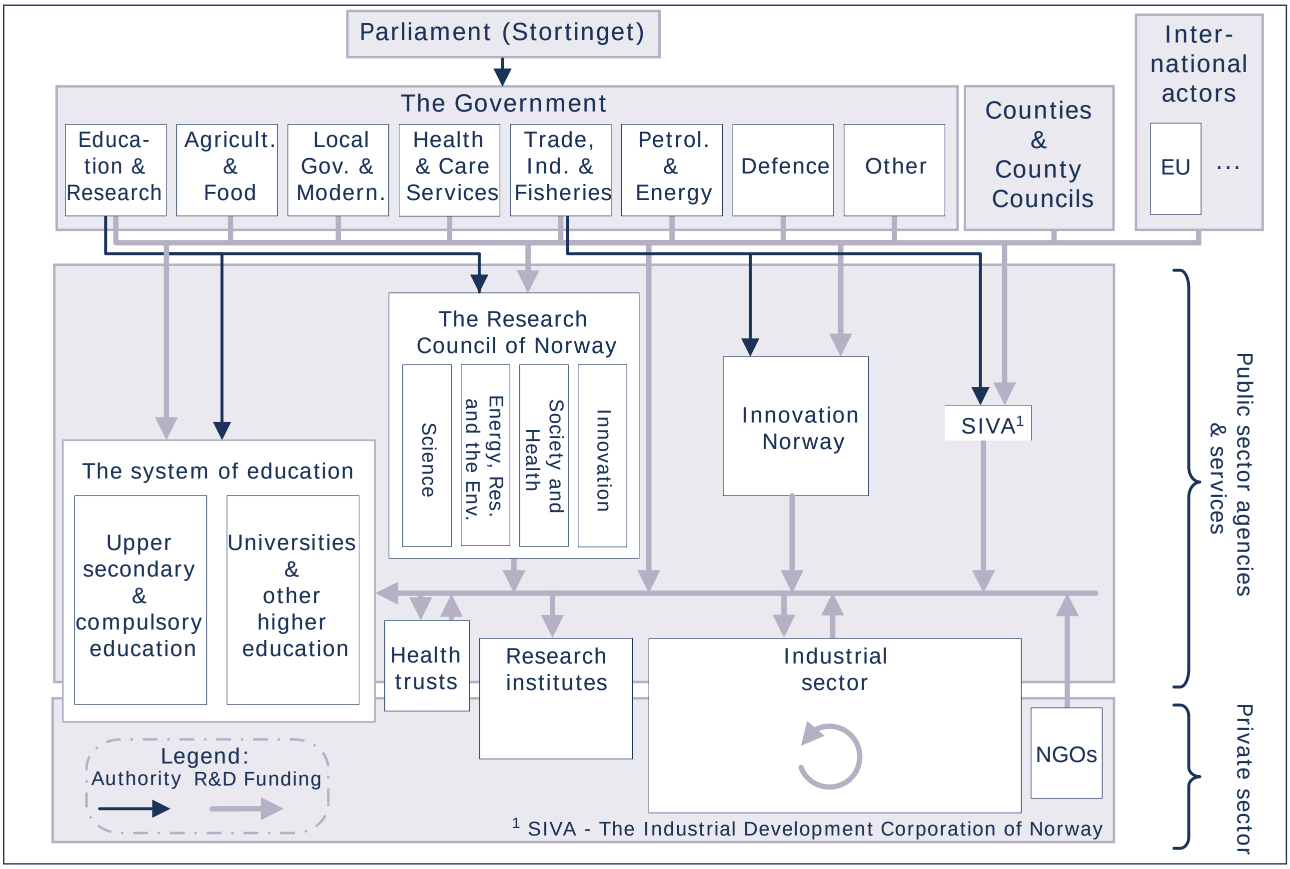
The number and frequency of R&D and innovation-active enterprises is also important for the structure of the R&D and innovation system. In the last 20 years, three major trends are worth highlighting:

First, an increasing share of business R&D is carried out in service industries. Some of this is due to reclassification of business activities between industries, but some is also related to real changes in the industrial structure and R&D intensity. Second, R&D investment in the business enterprise sector has increased steadily throughout the 20-year period, except during the first couple of years after the financial crisis in 2008. However, the crisis was short-lived in Norway, and from 2010 onwards, industry's R&D efforts have again shown stable and significant growth. Third, an increasing proportion of Norwegian enterprises report that they are engaged in innovation. Due to changes in the Norwegian survey methodology, it is difficult to compare innovation activity over time. The most recent innovation survey (CIS) for 2014–2016 shows that almost two thirds of Norwegian enterprises are innovation-active, which is far above the levels we have seen in previous surveys. Overall, it seems that business research and innovation activities are more frequent and more widespread than 20 years ago. This can be explained both by better measurement methods and by a real increase in knowledge development and renewal.

Prepared for transition?

Although Norway is a well-functioning society, there is broad consensus that there will be a need for renewal and transition in many areas of society in the coming years, first and foremost related to the need to develop sources of value creation other than oil and gas. This concern is both an issue of economic and environmental sustainability. New figures in this year's report show that Norway has invested heavily in both petroleum-related R&D and more environmentally-friendly energy. After the downturn in oil prices in 2014, petroleum research seems to decline, but there are so far few signs of a corresponding increase in renewable energy research. Transition is also about handling and preparing for major shifts in the working life. Although the consequences of digitisation and automation are still unknown, many work tasks will undoubtedly change content, which in turn means that large parts of the workforce will need to change their methods, exploit new technology and learn new things. In this respect, most international comparisons show that Norway is well positioned.

The Norwegian system of education, research and innovation



The Norwegian research and innovation system includes a large number of institutions with different roles. It is common to distinguish between three levels: the political, the strategic and the performing level. Extensive internationalisation also applies to Norwegian research, and contributes an increasingly important dimension to all parts of the Norwegian R&D system.

The figure above provides a simplified picture of the organisation and the division of labour in the R&D and innovations system. The description is limited to research and research-based innovation. The system can be characterised by considerable pluralism at the political level. According to the «sector principle», all 18 ministries are responsible for financing both short-term and long-term research within their respective sectors. Hence, public research funding and science policy involves extensive coordination.

At the same time R&D budgets are fairly concentrated, as five ministries account for 85 per cent of total R&D funding. The Ministry of Education and Research alone allocates approximately half the funding and has a coordinating role in R&D policy. The main funding streams consist of 1) basic funding to universities and university colleges with an integrated R&D component and 2) funds allocated via the Research Council of Norway.

The strategic level may be described as institutionally more unified, and has two main coordinating institutions. The establishment of one unified Research Council of Norway in 1993 is internationally unique. Furthermore, the innovation agency «Innovation Norway» fulfils functions which in many other countries are shared between several institutions.

At the performing level, there is a broad variety of institutions, including 8 universities, 18 state university colleges (in 2015) and a number of private higher education institutions. At the same time, research activity is concentrated, as universities, including university hospitals, accounted for more than 80 per cent of the higher education sector's total R&D expenditure in 2015. Compared with other countries, a relatively high share of Norwegian R&D is performed by research institutes. The Norwegian institute sector is rather heterogenous, in terms of institute size, profile and legal status. The sector includes both public sector oriented and industrial sector oriented institutes, of which the latter group plays an important role in carrying out contract research for Norwegian and foreign companies. Even though the industrial sector accounts for nearly half the R&D expenditure in Norway, the proportion of research performed in this sector is low compared with other countries. Given the resource-based structure of the economy, there are relatively few large R&D-intensive companies in Norway.

Key indicators

The following two tables present a set of key indicators. The intention is to introduce essential trends of Norwegian research and innovation in a concise form. The first table shows main trends in Norway.

The second table compare the status of Norway to that of the other Nordic countries, the EU, and the OECD. See also the indicators in the appendix of this report.

Key indicators for R&D and innovation in Norway in 2009, 2011, 2013, 2014 and 2015.

	2009	2011	2013	2014	2015
Resources for R&D and innovation					
R&D expenditure as a percentage of GDP	1.72	1.63	1.65	1.71	1.93
R&D expenditure per capita in constant 2010-prices (NOK)	8,674	9,174	9,990	10,486	11,599
R&D expenditure funded by government as a percentage of total R&D expenditure	46.4	46.1	45.5	..	44.7
R&D expenditure funded by industry as a percentage of total R&D expenditure	41.9	42.6	41.5	..	41.3
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	32.0	31.4	31.5	31.0	31.1
Human resources					
Percentage of the population with higher education	37.0	38.0	40.0	41.8	42.7
R&D full-time equivalents per 1,000 capita	7.5	7.5	7.6	7.8	8.2
R&D full-time equivalents per qualified researcher/scientist per 1,000 capita	5.4	5.5	5.6	5.7	5.9
Percentage doctoral degree holders among qualified researchers/scientists	29.6	32.0	33.7	34.3	34.5
Percentage women among qualified researchers/scientists	35.2	36.2	36.1	37.4	37.4
Cooperation in R&D and innovation					
Extramural R&D expenditure compared to intramural R&D expenditure in the industrial sector (%)	31	27	27	26	24
Companies involved in cooperation on R&D as a percentage of all R&D companies	39	34	33	..	38
Companies involved in cooperation on innovation as a percentage of all innovative companies	37[1]	31[2]	47[4]	43	38[3,4]
Articles in international scientific journals co-authored by Norwegian and foreign researchers as a percentage of all articles by Norwegian researchers	56	57	60	62	64
Results of R&D and innovation					
Percentage innovative companies in the business enterprise sector	27[1]	23[2]	35[4]	36	50[3,4]
Percentage of turnover of new or substancially altered products in the industrial sector	4.5[1]	5.2[2]	6.8[4]	5.9	6.8[3,4]
Number of articles in international scientific journals per 100,000 capita	198	224	238	247	253
Number of patent applications to the European Patent Organization per million capita[5]	104	113	108	95	..

[1] 2008.
[2] 2010.
[3] 2016.
[4] Break i series.
[5] By inventor address and by application date, European applications only (EP-A).

Sources: NIFU, Statistics Norway, OECD, Eurostat

Key indicators for R&D and innovation in last available year with comparable data in Norway, Sweden, Denmark, Finland, EU and OECD.

	Year	Norway	Sweden	Denmark	Finland	OECD	EU 28
Resources for R&D and innovation							
R&D expenditure as a percentage of GDP	2015	1.93	3.28	2.96	2.90	2.38	1.96
R&D expenditure per capita (NOK)	2015	11,599	15,188	14,035	11,859	9,464	7,342
R&D expenditure funded by the government as a percentage of total R&D expenditure	2015	44.9	28.3[1]	29.4	28.9	26.2	..
R&D expenditure funded by the business enterprise sector as a percentage of total R&D expenditure	2015	44.2	61.0[1]	59.4	54.8	62.2	..
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	2015	31.1	26.7	33.4	24.4	17.6	23.2
Human resources							
Percentage of the population with higher education	2015	42.7	39.8	37.1	42.7	35.7	32.5[2]
R&D full-time equivalents per 1,000 capita	2015	8.2	8.4	10.5	9.2	..	5.6
R&D full-time equivalents per qualified researcher/scientist per 1,000 capita	2015	5.9	6.7	7.5	6.8	3.7	3.6
Cooperation in R&D and innovation							
Companies involved in cooperation on innovation as a percentage of all innovative companies	2014	44	33	38	38	..	33
Companies involved in cooperation on innovation as a percentage of innovative companies in manufacturing and mining	2014	47	33	42	40	..	31.4
Results of R&D and innovation							
Percentage of innovative companies in the business enterprise sector	2014	46	44	38	48	..	36.8
Percentage of innovative companies in manufacturing and mining	2014	35	50	40	54	..	47.3
Percentage of turnover of new or substantially altered products in the business enterprise sector	2014	6.2	6.9	7.0	9.3	..	13.4
Percentage of turnover of new or substantially altered products in Manufacturing or Mining	2014	11.5	9.5	14.1	14.1	..	20.3
Number of articles in international scientific journals per 100,000 capita	2015	253	281	326	243	83	104[3]
Number of patent applications to the European Patent Organization per million capita[4]	2013	108	306	242	291	98	114

1 2013.

2 EU 22.

3 EU 27.

4 By inventor address and by application date, European applications only (EP-A).

Sources: NIFU, Statistics Norway, OECD, Eurostat, DG Enterprise

1 Norwegian R&D and innovation in an international context

Dag W. Aksnes, Frank Foyn, Eric Iversen, Espen Solberg, Kaja Wendt, Lars Wilhelmsen

International main trends in R&D

- Over the last twenty years, the world's R&D spending has doubled, amounting to over $1,800 billion in 2015. During this period, the world's R&D share of GDP has increased from 1.4 per cent to almost 1.7 per cent.
- In the same way as global economic growth is highest outside OECD countries, it is also such countries which account for the strongest growth in R&D spending.
- The United States and Europe's shares of the world's R&D have decreased to less than 50 per cent in the previous twenty-year period, while Asia and especially China's shares have increased.
- The United States is still the world's largest R&D nation, followed by China, which was number eight in 1995. Norway is ranked 29th in absolute R&D in 2015.
- Norwegian R&D has grown more strongly than the R&D of the other Nordic countries in the past decade, but the R&D share of GDP is still lowest among the Nordic countries by 1.93 per cent in 2015.
- For most OECD countries, the business enterprise sector's share of total R&D has increased over the last twenty-year period and is between 60 and 70 per cent of total R&D. In Norway, the share was 54 per cent in 2015, the same as in 1995 after it had reached 60 per cent in 2001.
- For OECD countries, the share of public funding for R&D has fallen from 34 to 26 per cent from 1995 to 2015. For Norway, it has been around 45 per cent for many years.
- Compared with the other Nordic countries, R&D efforts in the Norwegian business enterprise sector is characterised by a high proportion of *services* and *oil and gas* industries.

Human resources

- UNESCO estimates that there is a total of over 8 million researchers worldwide measured in R&D full-time equivalents (FTE). The corresponding figure in 1996 was 4.6 million. Nearly 80 per cent of the world's researchers work in North America, Europe, Asia, and the Pacific.
- The research density in Norway is among the world's highest with around 6,000 researchers per million capita. The other Nordic countries, Israel, South Korea, and Singapore are also at the top of this indicator.

Measuring innovation

- In international innovation rankings, Norway scores higher on broad political and economic indicators, while the other Nordic countries are at the top of innovation rankings with countries such as Switzerland and Singapore.
- In the EU's European Innovation Scoreboard 2017, Norway is for the first time in 12th place of 36 countries, considered to be in the «strong innovator» group. Some of the explanation for the higher ranking is of a methodological nature due to the introduction of a separate national research survey.
- The latest Innovation Survey (CIS) shows that the Norwegian industrial sector is not so different from the Nordic region, regarding either the level of innovation or types of innovation.

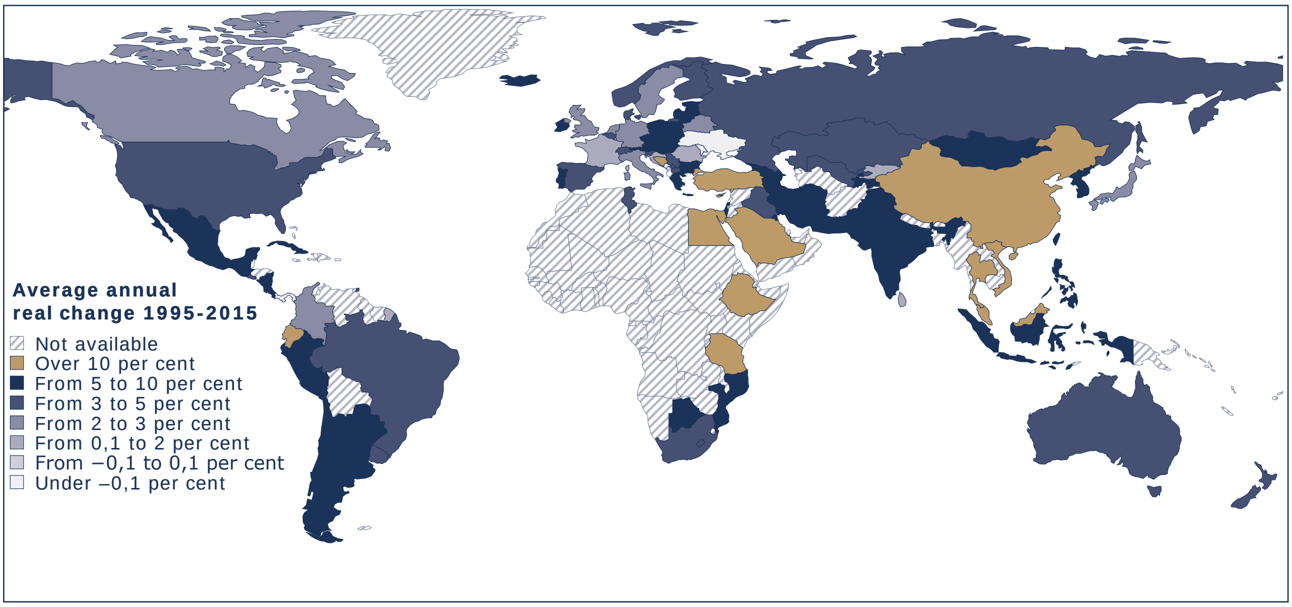
Intellectual property rights

- While the number of patent applications from the Nordic countries and other European countries is relatively stable, the number of patent applications from other countries is increasing.

Scientific publishing

- The United States accounts for over 19 per cent of all international scientific publications, followed by China with nearly 14 per cent. Growth in the number of publications in China is, however, many times stronger. Measured in publications per capita, Norway, together with the other Nordic countries, is a world leader.

Figure 1.1
Average annual real change in R&D expenditure in the World. 1995–2015 or last available year.[1]



[1] Only countries with updated data after 2011 and minimum data for 7 years, are included in the chart.
Source: UNESCO Institute for Statistics, OECD – MSTI 2017:1

How to measure the international development?

The anniversary edition of the Indicator Report 2017 presents key trends for research, education and innovation developments over the last 20 years. In this chapter, we look at the international trends in the period and Norway's position in relation to these. It is challenging to compare the efforts in these areas. For some indicators and countries, we lack time series over 20 years, but we present a selection of the most robust indicators in the field. Several indicators provide different pieces to the picture: we look at R&D investments, human resource developments and contributions from different sectors of society in the form of scientific publishing and intellectual property rights.

In this chapter, we first look at international trends for economics and R&D expenditure, then present trends in human resources. Furthermore, an overview of Norway's position in international innovation rankings, from the EU's Community Innovation Survey (CIS), the European Innovation Scoreboard (EIS) and other measurements of innovation and competitiveness. Thereafter, data on Norway's internationalisation of patents are presented. The last section deals with international trends in scientific publishing and citation. The chapter ends with a focus box on the international trends science, technology and innovation politics.

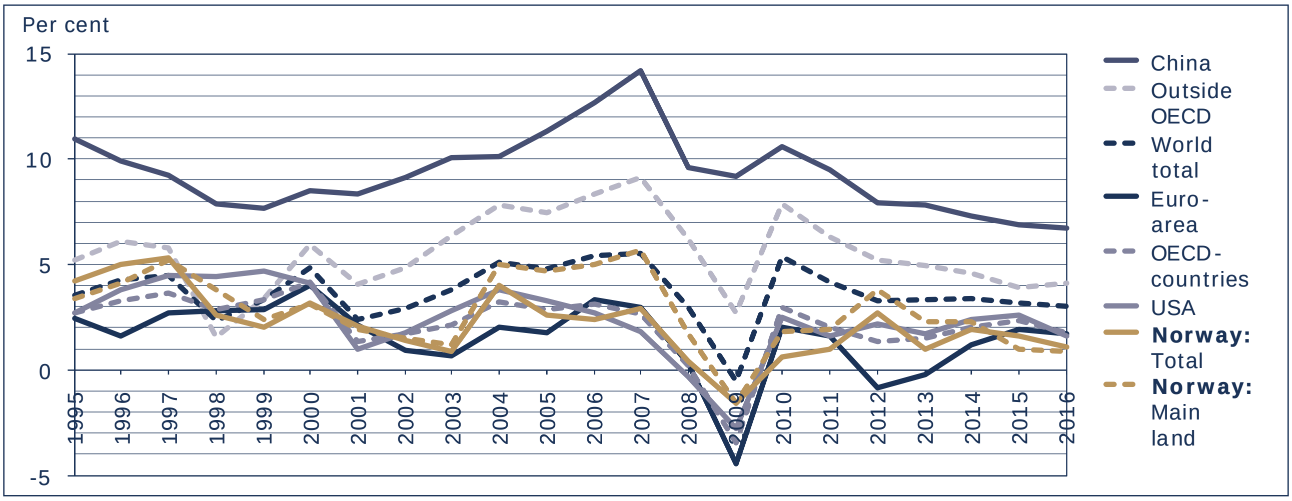
Shift in the allocation of R&D

During the twenty-year period there has been strong growth in global R&D expenditure. At the same time, we have seen major changes in the distribution of world R&D. Until the 1990s, the United States alone accounted for about half of the world's R&D expenditure. Despite continued growth, the United States, Japan and Europe's shares of the world's R&D declined over the past 20 years, while Asia's and China's share rose more sharply. The biggest change has taken place in the past ten years. At the same time, the growth rate in world R&D spending is slower than in the years before the financial crisis (2008). It is especially publicly-funded R&D that has lower growth, although the latest figures on OECD state R&D budgets again indicate growth.

Highest economic growth outside the OECD

Over the last 20 years, countries outside the OECD had the highest economic growth, and this is also where the OECD expects the highest growth in the years to come. In the years following the 2008 financial crisis global economic growth has been lower than in the decade before. A possible reason for this is lower productivity growth, which can be due both to fewer technological innovations or to a slower spread of innovation. In the next couple of years, the OECD expects a slightly higher economic growth than in the previous years (OECD Economic Outlook, Volume 2017 Issue 1).

Figure 1.2
Average annual real growth in GDP by selected countries and groups of countries. 2016–1995.



Source: OECD

Investments in research and other knowledge development are closely linked to general economic developments. Knowledge development requires resources, and new knowledge is often a prerequisite for economic growth. Figure 1.2 shows GDP (gross domestic product) growth for the world, certain areas and countries from 1995 to 2016. Worldwide there has been real growth throughout the period, except for a decline in 2009 because of the financial crisis. Growth has been stable at just over 3 per cent in the last 5–6 years.

Growth in non-OECD countries has been clearly stronger than in the OECD area in almost every year in the current period. The difference was highest around the financial crisis. The crisis had relatively little impact for non-OECD countries, and GDP growth was about 6 percentage points higher than in the OECD area during this period. The euro area has had slightly weaker growth than the OECD area.

China is contributes to the high growth outside of the OECD. The annual growth rate has been well over 10 per cent over the past few years, but has declined to 6 per cent in recent years. This is still high compared with other countries. India and Indonesia also have with high GDP growth in the period.

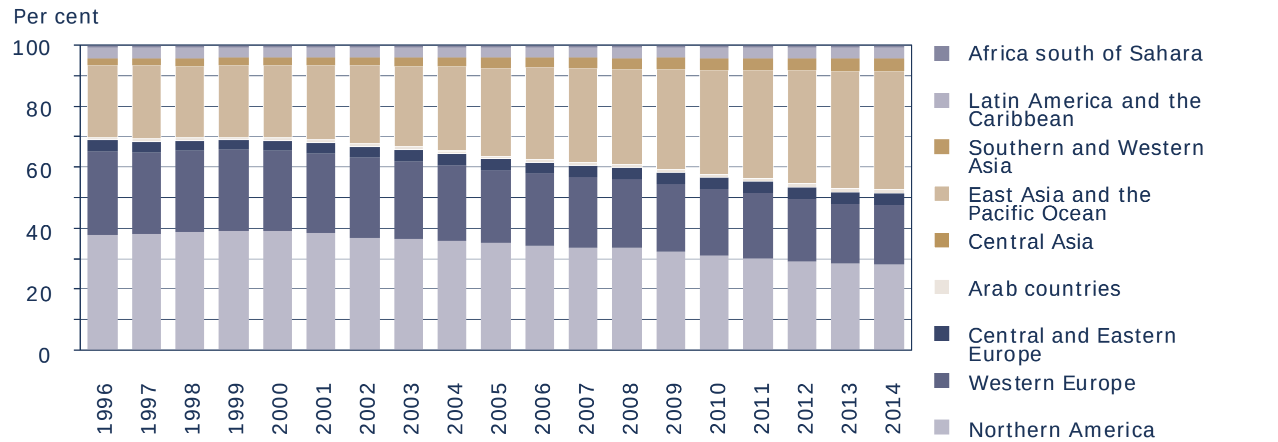
GDP growth in Norway was clearly higher in the 1990s than in the OECD area, but lately this has varied. In periods of low oil prices, growth has been weaker than in the OECD. Growth in mainland Norway has been higher than for overall GDP for Norway in recent years.

Complex business cycle to come

According to Statistics Norway's (SSB) analyses, higher growth in the international economy is expected in the future. Overall, it is assumed that Norway's trading partners have passed the trough of the business cycle. However, the economic upturn in the OECD area is still expected to be moderate. Very low investments in the OECD area combined with a generally high debt level and low demand have helped to reduce production potential and trend growth after the financial crisis. The lower growth, on the other hand, means that less growth is needed before we get a cyclical upturn. The transformation of China into a more consumer-driven economy is expected to have the same effect. Growth is expected to decline gradually to around 5 per cent by 2020. However, a gradual rise in commodity prices and improved international trends are expected to lead to a slight recovery in other emerging economies.

The international picture of economic growth is complex. While economic growth took place in the euro area and Japan in the last part of 2016 and into 2017, the rate of growth has fallen back in many other countries. The first quarter of 2017 growth fell in both the United States and the United Kingdom – in the United States after one year of high growth and in the UK after a continuous period of relatively high growth. In China, growth in the first quarter of 2017 was 5.3 per cent, the lowest in eight years and down from just under 7 per cent the previous year. There are indications of a slowdown in growth also in India at the beginning of 2017. In the manufacturing economies of Russia and Brazil, the situation now appears to have reversed. Annual growth rates in Russia are now positive, and in Brazil, the economy began to grow again in the first quarter of 2017, after falling coincidentally for almost two years. In both countries, inflation has recently shrunk. This has created room for expansive monetary policy. The period of falling GDP, therefore, appears to be over for the time being.

Figure 1.3
World R&D expenditure by region. 1996–2014.



Source: UNESCO Institute for Statistics, OECD – MSTI 2017:1

Geographical shift of R&D

By 2015, more than PPP$ 1,800 billion was spent on R&D in the world. Over the last 20 years, the world's global R&D capacity has more than doubled. In the same period, the share spent on R&D increased from 1.40 to 1.69 per cent of GDP. In the period 1996–2014 there has been a clear shift of world spending on R&D from North America and Western Europe to Asia. It is especially the development in China, but also South-Korea and Taiwan, which has contributed to the high Asian growth. In 1996, R&D expenditure in North America and Western Europe accounted for 65 per cent and in the Asia and Pacific region for 26 per cent of the world's R&D. By 2015, the proportions were 48 and 43 per cent, respectively. For other parts of the world, there have been only minor changes.

Stronger concentration of R&D

Although the R&D effort is more evenly distributed between the West and Asia, there is still a strong concentration on some key countries. By the middle of the 1990s, the top ten countries accounted for 76 per cent of the world's R&D; by 2014/2015 the top ten R&D accounted for 83 per cent. Table 1.1 shows that with PPP$ 500,000, the US is still the country that spends the most on R&D, followed by China with almost PPP$ 410,000. China's R&D activity was ranked 8th in 1995, reaching 2nd place in 2015. Other countries that have climbed many places are Turkey, India, Singapore and Taiwan. Among the countries that have descended on this ranking are several Western European countries, including Finland, Sweden and Denmark. Norway has also gone down from 27th place in 1995 to 29th place in 2015. Norway's share of world R&D expenditure has remained stable between 0.3 and 0.4 per cent over the last 20 years.

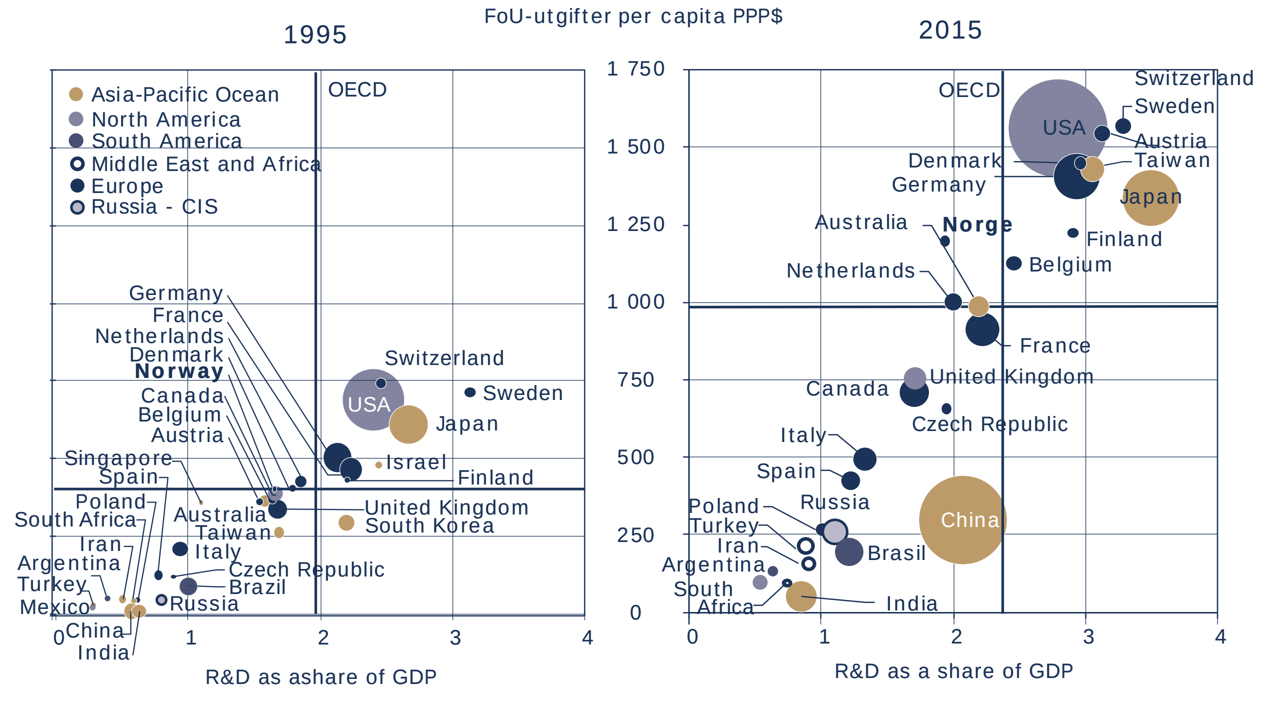
Table 1.1
R&D expenditure in selected countries1 in 2015 or last available year. Mill. PPP$ and rank 1995 and 2015.

Rank 2015	Country	Total R&D PPP$ 2015	Rank 1995
1	USA	502,893	1
2	China	408,829	8
3	Japan	170,003	2
4	Germany	114,778	3
5	South Korea	74,051	7
6	India	67,700	11
7	France	60,819	4
8	United Kingdom	46,260	5
9	Brazil	39,704	6
10	Russia	38,136	12
11	Taiwan	33,653	16
12	Italy	30,102	9
13	Canada	27,071	10
14	Australia	23,134	13
15	Spain	19,735	18
16	Switzerland	17,688	17
17	Netherlands	16,910	14
18	Turkey	16,604	28
19	Sweden	15,372	15
20	Austria	13,321	20
21	Israel	13,024	21
22	Belgium	12,625	19
23	Mexico	11,563	24
24	Poland	10,240	25
25	Singapore	10,102	30
26	Denmark	8,236	23
27	Czech Republic	6,927	31
28	Finland	6,712	22
29	**Norway**	**6,218**	**27**
30	Argentina	5,577	29
31	South Africa	4,975	26

[1] Countries with most R&D among the countries that the OECD collects statistics, in addition to Brazil and India. In 1995, Ukraine and Romania were also on the list, in 2015, Malaysia, Egypt and Thailand are among the 31 countries with most R&D in the World.

Source: OECD – MSTI 2017:1, Unesco Institute for Statistics, Global R&D Funding Forecast

Figure 1.4
R&D expenditure as a share of GDP and per capita in 1995 and 2015.



[1] Deviation years, 2013: Australia. 2014: Singapore.
Source: Unesco Institute for Statistics and OECD – MSTI 2017:1

Large changes in R&D volume

Figure 1.4 shows the development in countries' R&D efforts related to GDP and per capita in 1995 and 2015. The US dominates the picture in both years while China, with its formidable R&D growth, has approached the US position year by year. The growth rate in China has slowed somewhat and is no longer two-digit, but still over 2–3 times as high as in the United States and the OECD countries. The countries with the highest R&D as a share of GDP in 2015 were Israel, South Korea, Japan, Austria, and Taiwan, as well as the Nordic countries, except Norway. Although Norway's R&D effort is now close to 2 per cent of GDP, it remains among the half of the countries in the figure that spend the least on R&D as a share of GDP.

In China, strong R&D growth, but yet low per capita

When R&D efforts are related to the number inhabitants, Singapore, Switzerland and the United States have the highest effort. Measured in this way, Norway spends PPP$ 1,200 per capita, well above the average for the OECD countries and the EU 28 countries in 2015, but also for this indicator, somewhat below the level in the other Nordic countries. China's contribution here is far lower than when measuring the share of GDP, although there has been a clear growth from 1995.

About the data sources for international R&D statistics

In this chapter, we are using data from OECD – MSTI (Main Science and Technology Indicators) 2017: 1, Eurostat and the UNESCO Institute for Statistics (UIS). NIFU and Statistics Norway report R&D statistics for Norway to the OECD and Eurostat. UNESCO conducts an annual survey among statistical bodies (OECD, Eurostat, RYCIT, etc.) and individual countries. The update of international data takes a long time, and in some cases, we do not have 2015 figures – this is true, for example, for regional total numbers, where 2014 is the last year with data.

All statistical bodies work to ensure quality and timeliness of reported R&D data on human and financial resources and type of R&D. It is continuously sought to utilise existing and new data for best possible indicators. The indicators are important for policy design and for evaluating national innovation systems. The data can be used to say something about whether the investments are at the desired level or going in the desired direction, and whether the distribution on industries, fields of science and sectors is appropriate.

The strong global growth in R&D expenditure has occurred in all R&D performing sectors, but to a varying degree. Access to funding, where research is conducted and societal changes and economy affect the distribution. This is in many ways a two-way influence, where knowledge production offers solutions for societal challenges regarding demography, health and climate. At the same time, technological development itself represents societal challenges, as increased robotisation and distribution of research results affect future work opportunities.

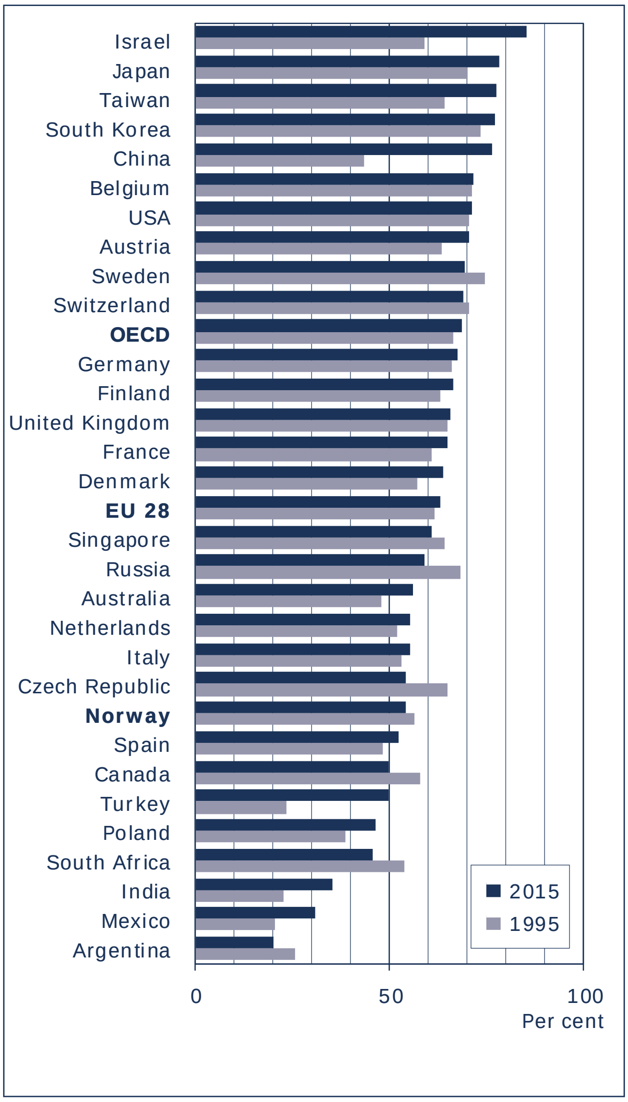
The business enterprise sector is the largest R&D sector in most countries

The distribution of R&D performance by sector varies between countries. The distribution is affected both by the design of the research system, historical development and economic development. Looking at the countries where the business enterprise sector accounts for most of the performed R&D (70–80%), it appears that these are the same countries with a high R&D as a share of GDP: Israel, Japan, Taiwan and South Korea.

For most of the countries in which the business enterprise sector accounted for more than 60 per cent of R&D in 2015, this proportion was high already in 1995. China, Denmark and Israel are the only countries below 60 per cent in 1995, but well over in 2015.

For two thirds of the countries, the business enterprise sector's share has increased over the twenty-year period. Norway, together with Russia, Canada, South Africa and Sweden, belongs to the group of countries with a decreasing share of R&D performed in the business enterprise sector during the period. In Norway, the business enterprise sector's share of R&D was 55 per cent in 1995, rising to almost 60 per cent in 2001, but by 2015 the proportion had reduced to 54 per cent, and Norway is thus among the countries in the lower part of Figure 1.5.

Figure 1.5
Share of R&D expenditure performed in the business enterprise sector in selected countries. 1995 and 2015.[1]



[1] Deviation years, 2014: Singapore, 2013: South Africa, Australia.

Source: OECD – MSTI 2017:1

International sector classification

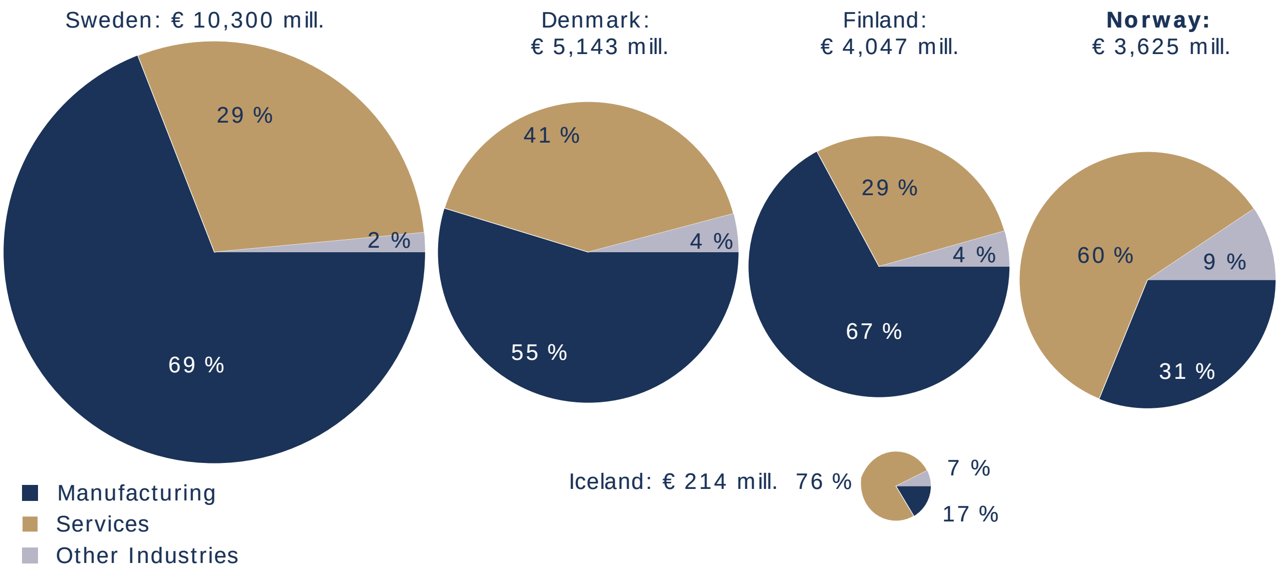
According to OECD guidelines (Frascati manual) the production of R&D statistics is to be based on four performing sectors:

- Business enterprise sector
- Government sector
- Private non-profit sector; PNP sector
- Higher education sector

In Norway, the business enterprise sector includes, in addition to the enterprises, business-oriented institutes that primarily serve business. The government sector comprises units in the institute sector which are government-related, as well as other public institutions. PNP-sector is small in Norway and only included as an R&D funding sector. The higher education sector is identical in national and international statistics.

In terms of R&D-funding, own revenues and public and private parts of the general university funds are classified differently in national and international statistics, which may cause minor discrepancies. Both sectoral division and sources of funding in national statistics deviate somewhat from international R&D statistics.

Figure 1.6
R&D expenditure in the Nordic countries in 2015 by main industry.



Source: Eurostat

The EU average of R&D expenditure as a share of GDP was almost 2.0 per cent in 2015. In Norway, the corresponding proportion was a little lower at 1.93 per cent.

Looking at R&D expenditure in the business enterprise sector as a share of GDP in 2015, Norway's level was lower than both the EU and the other Nordic countries. The Norwegian business enterprise sector's share is 1.05 per cent, while the share for the EU 28 is 1.3 per cent. Finland, Sweden and Denmark use around 2 per cent on R&D in this sector. But in recent years, the trend has risen for Norway and decreased for the other Nordic countries. Traditionally, the Norwegian business enterprise sector has a relatively low share of total R&D compared with the other Nordic countries. This is related to the fact that the Norwegian business enterprise sector is relatively commodity-based, with low production in industries with high R&D intensity.

In the international context, the growth in the business enterprise sector's R&D activity in Norway has been strong over the last two years. R&D FTEs in the Norwegian business enterprise sector increased by 7–8 per cent for each of the previous two years (2013 and 2014). For the EU 28, the corresponding growth was 2–3 per cent. Developments in the other Nordic countries have also been weaker. Both Sweden and Denmark have had a slight growth, around 1.5 per cent from 2014, while it is unchanged for Finland following a further negative trend for the Finnish business enterprise sector. For the whole 2010–2015 period, Norway's growth was higher than for the EU 28, and clearly higher than that of the other Nordic countries. The growth in R&D costs measured in national currency shows the same picture, but measured in euro, the development is weaker for Norway in recent years due to exchange rates.

Regarding the distribution of R&D expenditure by type of industry, Norway and Iceland stand out with a much smaller proportion of R&D expenditure in manufacturing industries, see Figure 1.6. Compared with the other Nordic countries Norway has a higher share of R&D activity in other industries, including *oil and gas extraction* and *fish farming*, while industries other than manufacturing and services are insignificant in the other Nordic countries, except for Iceland. Services represent the largest R&D activity in Iceland and Norway. In comparison with Denmark, which also has significant R&D activity in services, Norway has relatively much R&D activity in *information and communication technology* and *scientific and technical services* (including *scientific research and development*). Denmark has a relatively high share in *financial and insurance activities*. Sweden and Finland have a relatively similar structure, with a high overweight of R&D activity in manufacturing at about 70 per cent.

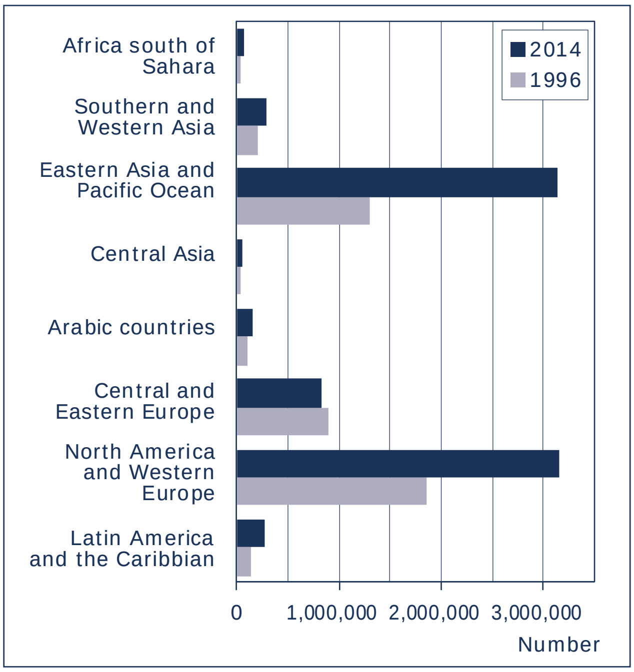
It can be problematic to compare R&D by industry between countries. The distinction between manufacturing and service production can be unclear, thus it becomes equally unclear how R&D activity is classified. There may also be differences in how much R&D activity is classified under the NACE group of *research and development* and what is classified in the industries where the R&D is applied.

UNESCO estimates that there is a total of 8 million researchers in the world (2014), measured as R&D FTE. This implies a growth of 74 per cent from 1996, when the corresponding figure was 4.6 million. The distribution between regions is shown in Figure 1.7. We see that East Asia and the Pacific have had the strongest growth (140%). Together, researchers in East Asia and the Pacific, North America and Europe account for over 6 million R&D FTE, equivalent to almost 80 per cent of human resources in World R&D.

Looking at countries, Figure 1.8 shows that the highest research density in the population was in Israel, South Korea, Taiwan, Singapore and the Nordic countries. Norway is in 7th place among the countries in the figure, with nearly 6,000 FTE performed by researchers per million capita. The average for OECD countries was 3,700 researcher FTEs per million inhabitants.

The highest percentage growth from 1995 to 2015 is found in Turkey, Singapore, the Czech Republic and China. China revised its annual figures down in 2009, but in the last twenty-year period China had the largest absolute increase with almost 1.1 million researcher FTEs. The US had a growth of 560,000 researcher FTEs, or 70 per cent, slightly lower than the percentage growth for the OECD countries of 79 per cent.

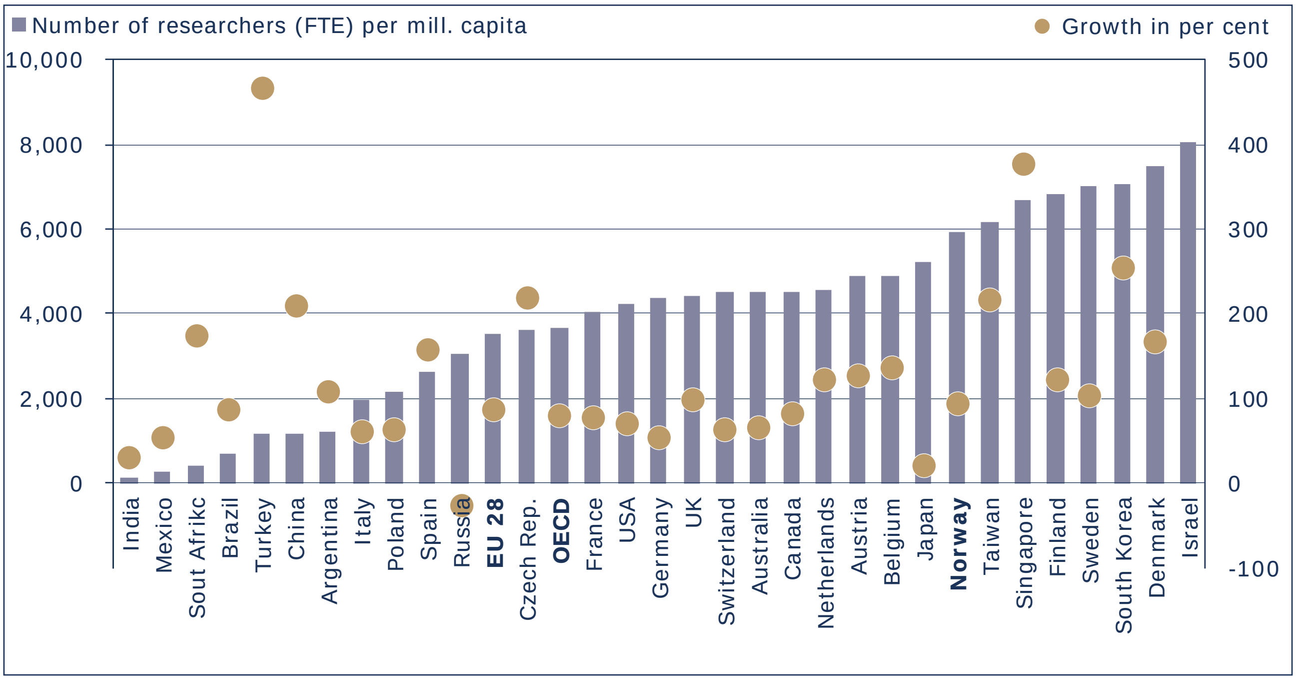
Figure 1.7
Researcher (R&D FTE) by region. 1996 and 2014.



Source: UNESCO Institute for Statistics

Among the Nordic countries, Denmark had the highest growth in researcher FTEs by nearly threefold, followed by Finland, Sweden and Norway, all with a doubling in the number of R&D FTEs performed by researchers.

Figure 1.8
Researchers (R&D FTE with higher education) per million inhabitants in 2015 and percentage growth in number of researchers. 1995–2015 or last available year.[1]



[1] 2014: Singapore, 2013: Canada, Mexico, South Africa, 2012: Israel, 2010: Australia.
Source: UNESCO Institute for Statistics and OECD – MSTI 2017:1

Table 1.2
Indicator systems for innovation, competitive ability, level of education and living conditions. 2005–2016.[1]

Study	Type of indicator	Number of indicators	Number of countries	Top 3	Norway 2016	Norway 2015	Norway 2014	Norway 2013	Norway 2005
Global Innovation Index 2017: Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO)	Composite indicator based on 57 hard variables, 19 composite indicators and 5 survey questions	81	127	1. Switzerland 2. Sweden 3. Netherlands	19	20	14	16	25
Innovationsindikator (2015) (BDI Deutsche Telekom Stiftung)	Composite indicator, business, society, research, education, government	38	35	1. Switzerland 2. Singapore 3. Belgium	14	14	7	9	..
European Innovation Scoreboard (2017)	Composite indicator	27	36	1. Switzerland 2. Sweden 3. Denmark	12	16	16	17	16
Global competitiveness report (2016–2017)	Composite indicator with three sub-indexes: basic factors, efficiency improvements, innovation and sophistication factors	114	144	1. Switzerland 2. Singapore 3. USA	11	11	11	11	6
World Competitiveness Scoreboard 2017 World Competitiveness Yearbook, IMD	2/3 hard data (economy etc.) 1/3 survey data, leaders in business	260	63	1. Hong Kong 2. Switzerland 3. Singapore	11	9	7	10	15
World Economic Forum Human Capital Index 2016	Levels of education, learning, skills, work, demography	46	130	1. Finland 2. **Norway** 3. Switzerland	2	2	..	7	..
Bloomberg Global Innovation Index 2017 (Global business and news firm)	7 equally weighted goals: R&D, industry, productivity, high-tech, education, researcher density, patents	7	50	1. South Korea 2. Sweden 3. Germany	14	14	15	14	..
FN Human Development Index 2016	Expected life expectancy, average number of years at school, expected number of years at school, GNI per capita	4	195	**1. Norway** 2. Australia 3. Switzerland	1	1	1	1	1
WB BNP per capita 2016	GDP per capita, PPP$	1	237	1. Qatar 2. Luxemburg 3. Macao	9	10	8	7	9
WB Ease of doing business (EDB) 2017	General conditions for doing business, 11 sets of indicators (start-up, credit, taxes, laws, electricity, etc.)	11	190	1. New Zealand 2. Singapore 3. Denmark	6	9	6	9	6
Global Talent Competitiveness Index 2017, INSEAD, Adecco and human capital leadership institute	Composite indicator with 6 pilars. Input: enable, attract, grow and keep talents. Output: technical and global skills	65	118	1. Switzerland 2. Singapore 3. United Kingdom	10	8	11	12	6

[1] Last available year. Type of indicator and number of all indicators and country are based on the most recent innovation survey.

Source: Internett, NIFU

Norway best on general conditions and living conditions

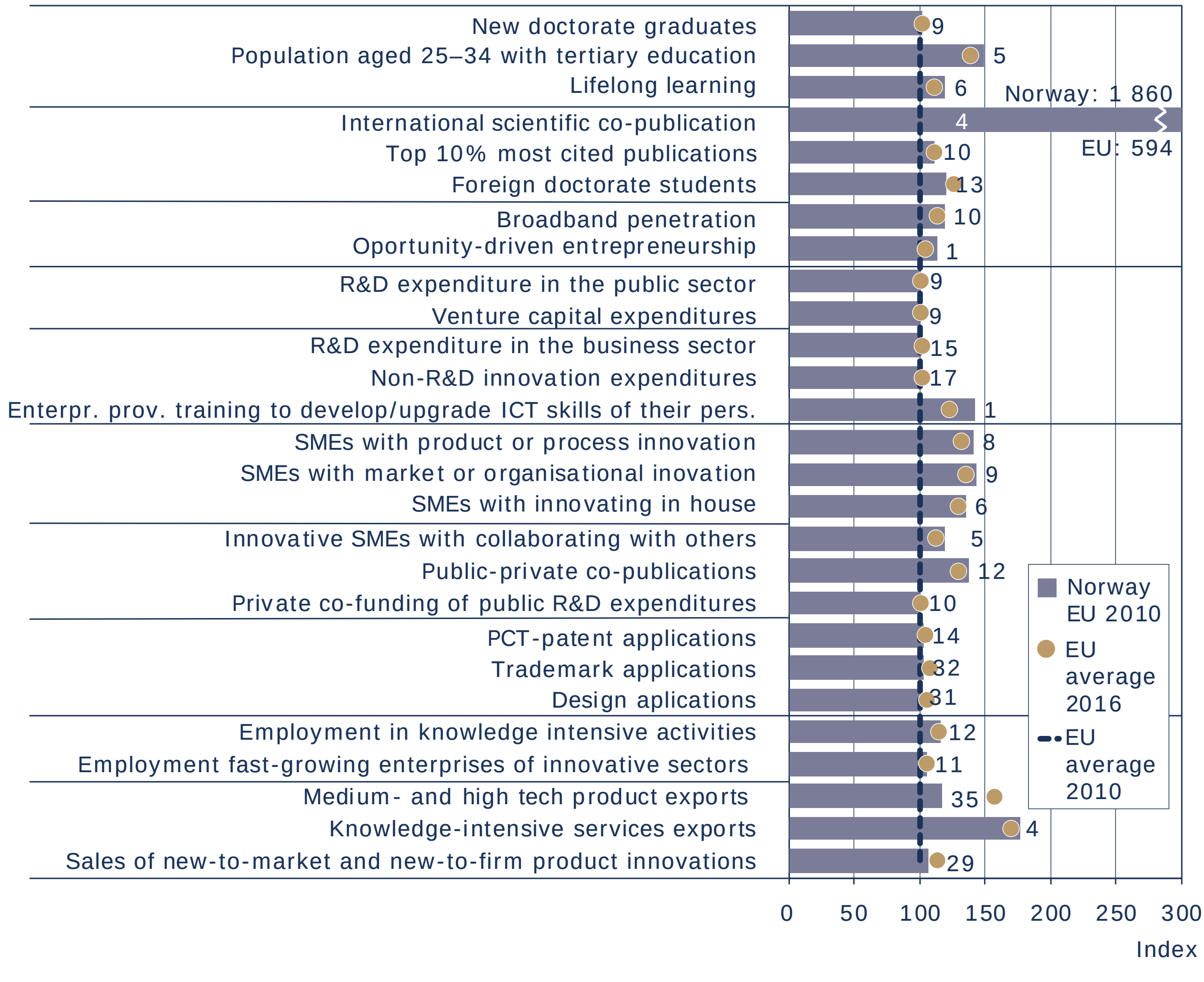
There are many international scoreboards and ratings of innovation and competitiveness. Composite indicators simplify complicated relationships, but they are also controversial.

The rankings can focus on the strengths and weaknesses of different innovation systems. The country's placement varies somewhat from measurement to measurement; both dependent on the country and indicator selection, weighting and other methodological conditions. At the same time, it is striking that the same countries score the highest on different rankings; Switzerland, Sweden, Singapore and the United States are often on top. Norway is often among the 5–10 best countries, with good results for indicators of social conditions and framework conditions etc.

The Global Innovation Index (GII) measures 127 countries on 81 indicators, and Norway is ranked in 19th place. Norway is attracting local competition, credit opportunities, knowledge absorption, export of ICT services and use of trademarks, but scores in the same measure as number one on infrastructure and number five on its institutional framework conditions. GII has included a digital competitive ranking this year: Norway is ranked 9th, while Singapore, Sweden and the United States are at the top. Generally, in several of the measurements, the key role of the public sector, education and investment in knowledge is emphasised.

The number of measurements is increasing and they change frequently. Long time series are therefore rare. For the ten years the table shows, there is no clear trend for the Norwegian score.

Figure 1.9
Norway's rank in the European Innovation Scoreboard 2017 relatively to EU 28 by type of indicator. Norway's rank in each category to the right of the columns.



Source: EU Commission/European Innovation Scoreboard Database 2017

Figure 1.9 shows Norway's score relative to the EU: The pillars show the score compared with the EU in 2010 (= 100), while the dots shows the score relative to the EU in 2016.

Best on research system and innovation culture

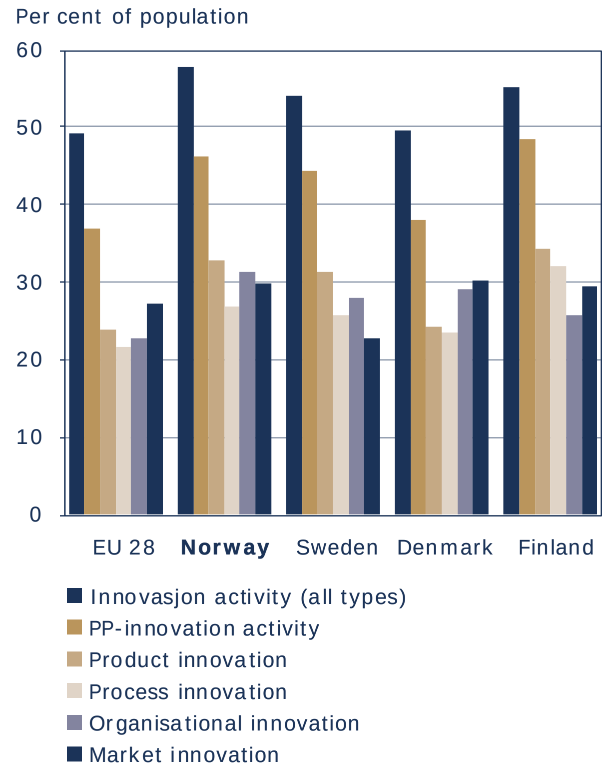
Norway has relatively high values in terms of *human resources* and *open, excellent research systems*. The proportion of *international scientific co-publications* is high. This is because Norway is a small R&D nation with a natural need to collaborate with foreign researchers.

Norway also scores high on *innovation-friendly environment*, innovation culture and conditions for innovation, where the degree of *opportunity-driven entrepreneurship* is highest among all countries in the ranking. It can be read as an expression of innovation culture, but also reflects that Norway has a sound labour market where few need to start their own business to survive. Norway is also at the top when it comes to share of *enterprises providing ICT training*. This new indicator is intended to capture aspects related to the digitisation of working life.

Norway scores low on indicators of intellectual assets, especially *trademark applications* and *design applications*. The lowest scores are for *Medium and high-tech product exports*. In return, Norway is among the top in terms of *knowledge-intensive services exports*.

A large part of the explanation is the Norwegian industrial structure with high value creation in commodity-based industries. Second, many of the indicators are measured in relation to GDP or total turnover, which makes Norway's high GDP and strong economy slow down the results. Several of the new indicators reflect structural conditions in the workplace, where Norway generally is at the forefront.

Figure 1.10
Type of innovation activity in the Nordic countries and the EU. 2012–2014.



Source: Eurostat, CIS

Nordic comparisons of innovation activity

The coordination of the European countries' innovation surveys is conducted through the European innovation survey, the Community Innovation Survey (CIS), coordinated by the EU statistical agency, Eurostat. The survey is conducted every two years and gives the opportunity to compare innovation activity in Norway with that in other EU and EU-associated countries. The results presented here are based on the 9th Innovation Survey, CIS 2014, which was conducted by a total of 35 countries for the period 2012–2014.

Such a comparison of innovation activity is interesting because it is not possible to set an exact target for the level of innovation efforts or for the expected or desired results. Innovation takes place as part of the enterprises' competition in the markets, which means that the appropriate level of innovation efforts – and innovation results – are largely determined by what the competitors are doing. Given that large numbers of Norwegian enterprises are exposed to international competition and that international competitiveness provides economic opportunities, international innovation measurements are a relevant comparison basis for how much similar enterprises invest and achieve.

Although the surveys should be equal, differences in coverage of industries and in compilation methods of results, may pose a challenge when comparing innovation activity across national statistical publications. Therefore, the figures are also reported to Eurostat in a manner that is intended to be directly comparable.

The Norwegian Innovation Survey was previously conducted as a part of the R&D survey for the industrial sector, resulting in a significantly lower proportion of innovation-active enterprises than in the other Nordic countries. In the survey covering the period 2010–2012, there was a 14 percentage points lower proportion of enterprises with PP innovation activity in Norway than in Sweden and Finland, while Denmark was in between.

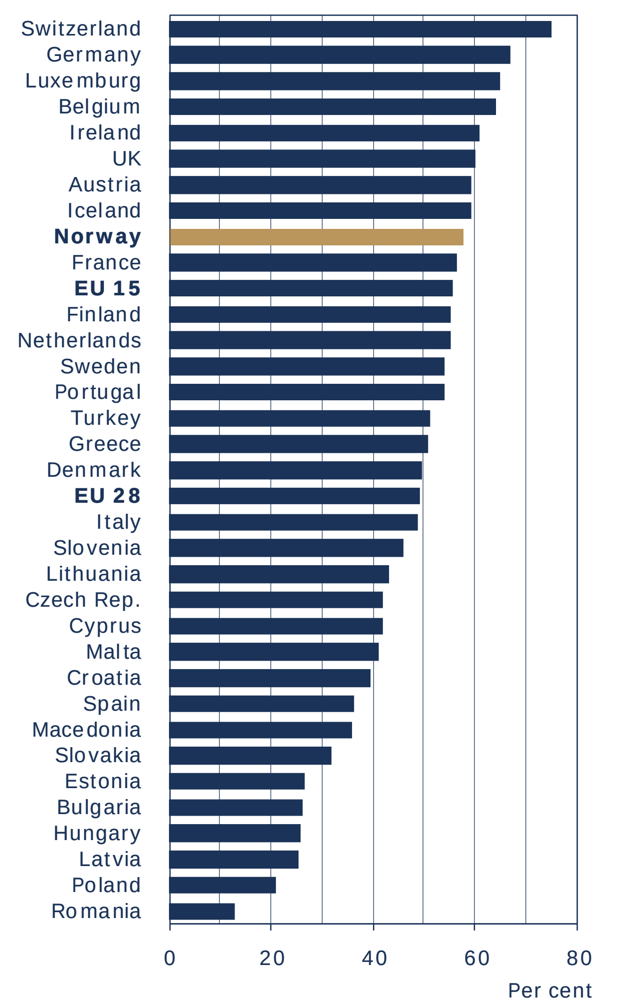
However, as of CIS 2014 covering the period from 2012 to 2014, the Norwegian survey has been conducted as a stand-alone innovation survey, considered to be better for international comparison. In the Nordic countries, Sweden and Finland have separate innovation surveys, while Denmark has a joint survey that alternates between having a focus on R&D and innovation every two years.

Norway, a slow innovator?

The results from the last innovation survey (2012–2014) change the previous image of Norway as a clear underdog among the Nordic countries regarding the proportion of enterprises with innovation and innovation activity, see Figures 1.10 and 1.11. In the broader picture, we can now say that the level of innovation is relatively similar between the Nordic countries. This also applies distinguishing between manufacturing and service industries. With 58 per cent of enterprises, Norway scores highest on the total number of enterprises with at least one form of innovation activity. Sweden has 54 per cent, Finland 55 per cent and Denmark 50 per cent. The average for the EU 28 is 49 per cent.

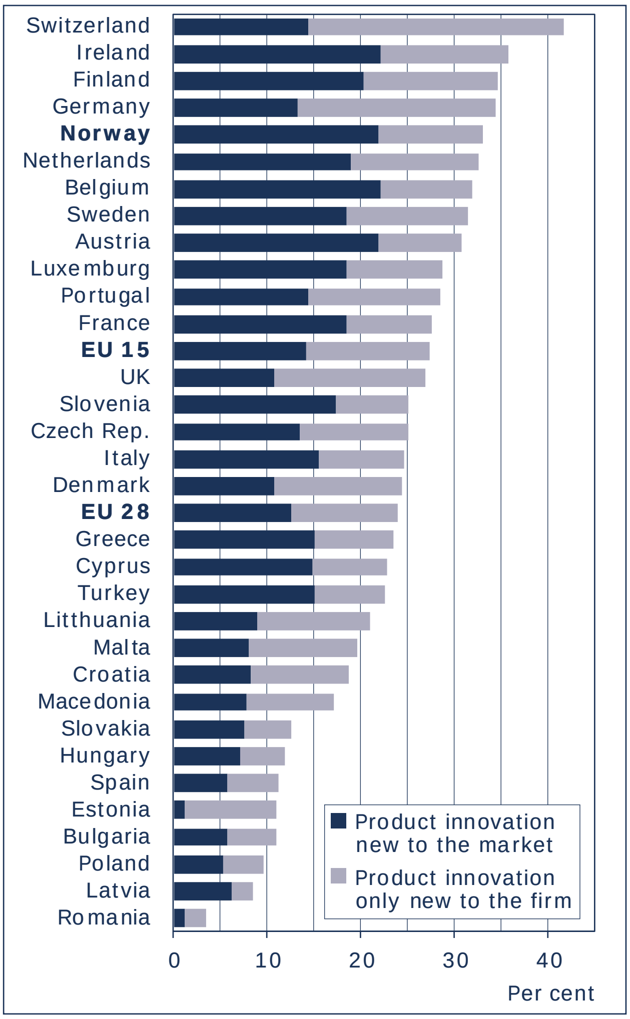
Norway also has the largest share of enterprises with market innovation. Finland has the highest proportion of product and process innovators and the highest proportion of PP innovation-active enterprises. Denmark has the lowest proportion of product and process innovators. Considering that the results are associated with some uncertainty, it is hard to conclude that there are significant differences in the innovation activity between the countries. The exception here is the proportion of product innovators that appears to be significantly lower in Denmark, which in turn affects both the overall innovation activity and the proportion of PP innovation-active enterprises.

Figure 1.11
Enterprises with innovation activity, all types. 2012–2014.



Source: Eurostat, CIS

Figure 1.12
Enterprises with product innovation by level of novelty and country. 2012–2014.



Source: Eurostat, CIS

Increase in all forms of innovation in Norway

Compared with the previous innovation survey, there are relatively small differences in innovation activity in the other Nordic countries – within a few percentage points. The Norwegian figures show a significant increase in all types of innovation activity, and especially for innovation activities related to products or processes (PP innovation). Here the results are 15 percentage points or 48 per cent higher in 2012–2014 than in 2010–2012. The increase can mainly be ascribed to the change in the way in which the Norwegian survey is carried out, but also an increased innovation focus in Norway's industrial sector may have contributed significantly here.

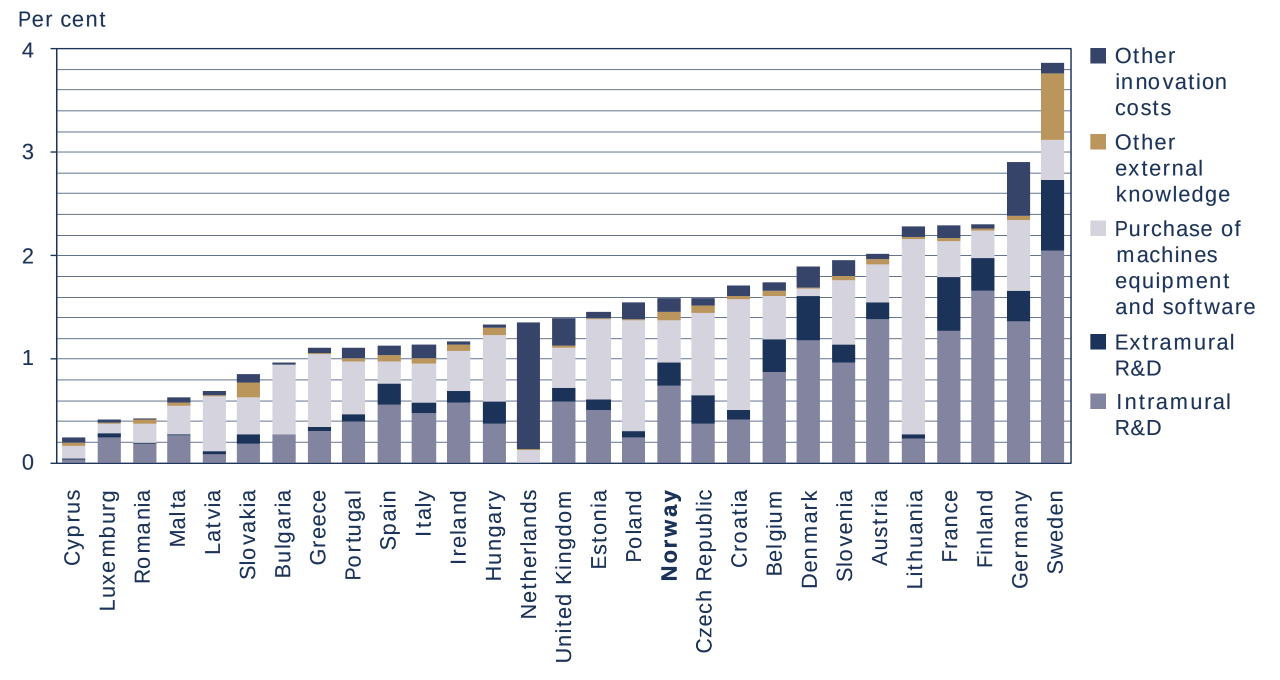
For overall innovation activity, Norway has moved from well below the EU average in the previous survey to reach a clear overall increase of more than 13 percentage points. Switzerland has the largest share of innovation-active enterprises with 75 per cent. The EU 28 average is almost unchanged with 49 per cent.

Many Norwegian product innovations are new to the market

The proportion of Norwegian enterprises reporting product innovation, in either goods or services, increased from 19 per cent in the previous survey to 33 per cent in the period 2012–2014. This is among the highest shares of product innovation in Europe. Especially innovations that were new only for the enterprise, but not new to the market, have risen sharply, see Figure 1.12. In the previously combined R&D survey for 2010–2012, the Norwegian share was among the lowest in Europe with 3.8 per cent of all enterprises, now the figure is just below the average for the EU 28 countries by 11 per cent.

These findings help to strengthen the assumption that a separate innovation survey captures more of incremental or small-scale innovation than combined surveys.

Figur 1.13
Innovation investments as a share of total turnover by country. 2012–2014.



Source: Eurostat, CIS

Innovation and the company's most important market

The Norwegian innovation survey has previously shown a correlation between the markets in which the enterprises operate and the innovation frequency, where larger and more internationalised markets increase the probability of being innovative.

It is not possible to make this distinction of enterprises in the figures from Eurostat, but it is possible to distinguish between enterprises with product and process innovation activities and other enterprises, and which markets the companies state to be most important. The trend here is the same, namely that the more important domestic and foreign markets are for the enterprises, the greater the chance that they have product or process innovation. This can be an indicator of the companies' ambition level as well as of the competition in the markets in which they operate. Innovations can provide opportunities to compete effectively in larger geographic areas, and can explain some of this effect. At the same time, greater ambitions make enterprises face stronger competition in local and regional domestic markets, which may necessitate innovation to maintain market share.

Increased innovation investment compared with other countries

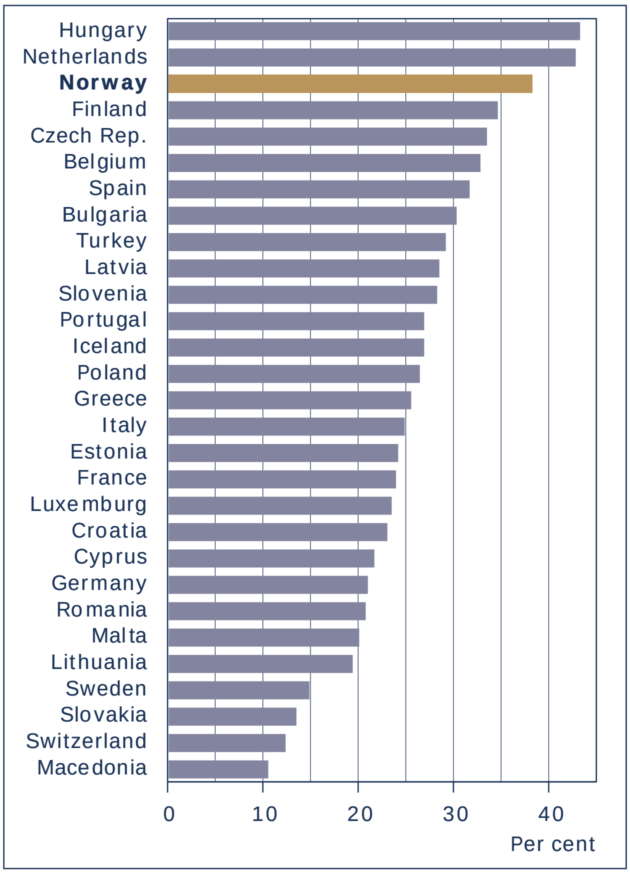
If the Norwegian innovation survey traditionally has shown weak results for the share of innovators in enterprises, the figures have been even worse looking at quantitative indicators that try to measure the resource input for innovation (innovation investment). However, this has also changed since the transition to a separate innovation survey.

As shown in Figure 1.13, in 2014, the total contribution to innovation in Norway was 1.6 per cent as a percentage of enterprises' total turnover, up from 1.1 per cent in 2012. As a share of turnover, Swedish enterprises have the highest share of innovation investment in Europe, at 3.9 per cent, which is an increase compared with the previous survey. Denmark and Finland also have larger shares of investment than Norway, respectively 1.9 and 2.3 per cent of total turnover, but both countries have had a relative decline in innovation investment.

Apparent weak for revenue from innovations

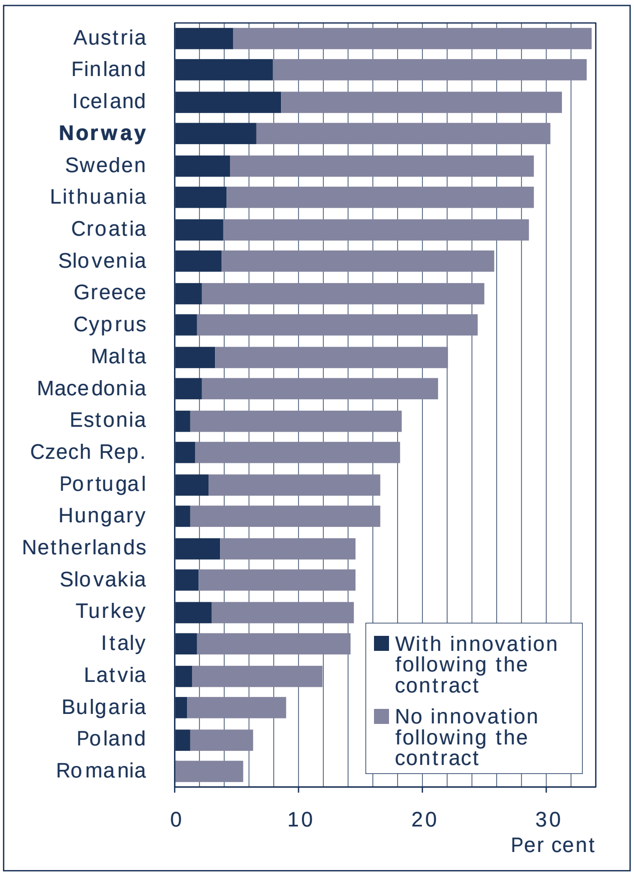
Also in terms of the economic results of the innovations, the level of Norwegian enterprises has traditionally been lower than the other countries in the survey. For the share of enterprises' turnover in the reference year that is a result of innovative products – that is, from new or significantly improved products (goods or services) introduced during the last three-year period – Norway ranked in 2012 among the lowest in Europe, with 5.2 per cent of total turnover.

Figure 1.14
Public grants for the development of product - and process innovations. 2012–2014.



Source: Eurostat, CIS

Figure 1.15
Enterprises with public procurement contracts. 2012–2014.



Source: Eurostat, CIS

Public support for innovation is high in Norway

A higher share of Norwegian innovators report receiving public financial support for the development of their product and process innovations than most other countries, see Figure 1.14. Norwegian enterprises state that public support often is provided by central authorities, which is probably partly explained by Norway being among the countries with rights-based tax incentives for R&D (SkatteFUNN). Finland also provides public funding for relatively many of its innovators, while Sweden belongs to the group of countries that rarely reports that they receive such support.

EU funding is relatively uncommon in the Norwegian industrial sector, like other non-member countries. However, many of the EU's major economies also have a relatively low proportion of innovators who receive EU funding, and the highest figures are reported from countries in Eastern Europe. This may be an effect of EU programmes that allocate development funds to Eastern Europe. Furthermore, the economies of Eastern Europe are less developed and less innovative, thus their enterprises may rely more on EU support in order to carry out their innovation projects.

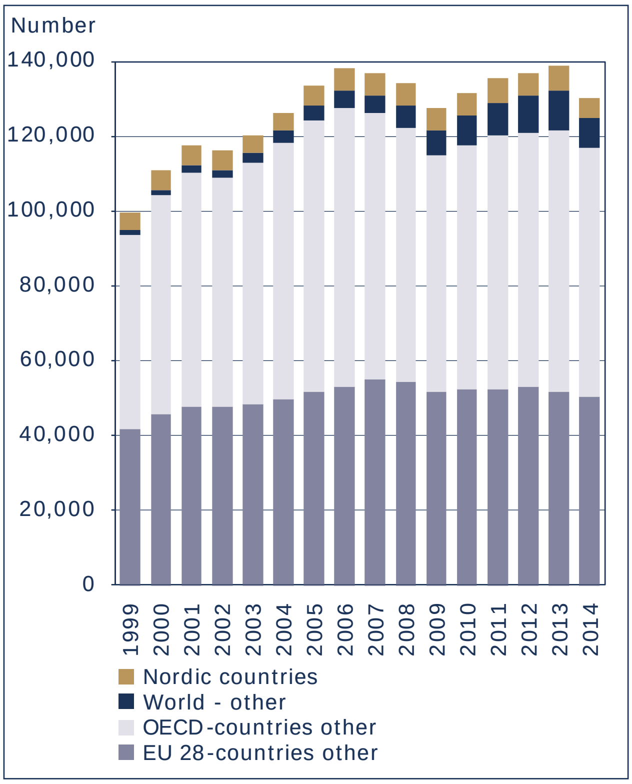
Innovation potential in public procurement

Norway's public consumption of goods and services amounted to 15 per cent of GDP in 2015, and public procurement represents a significant element of the economy in Europe. If such purchases allow for or require innovative solutions, this can be a powerful tool for innovation, hence there has been great interest in measuring this.

The latest innovation surveys have included questions about public procurement, and whether this has contributed to innovation. For the countries that have reported such data, the responses indicate that it is seldom the case. This is also true in Norway, but Norwegian enterprises are among the most frequent in Europe to innovate in the context of public supply contracts, see Figure 1.15.

The results of the questions on innovation cooperation may also indicate that the public sector has an untapped potential for public procurement in Europe; both in terms of using the public sector's significant procurement of goods and services to stimulate innovation in the industrial sector, and in terms of providing residents with innovative goods and services.

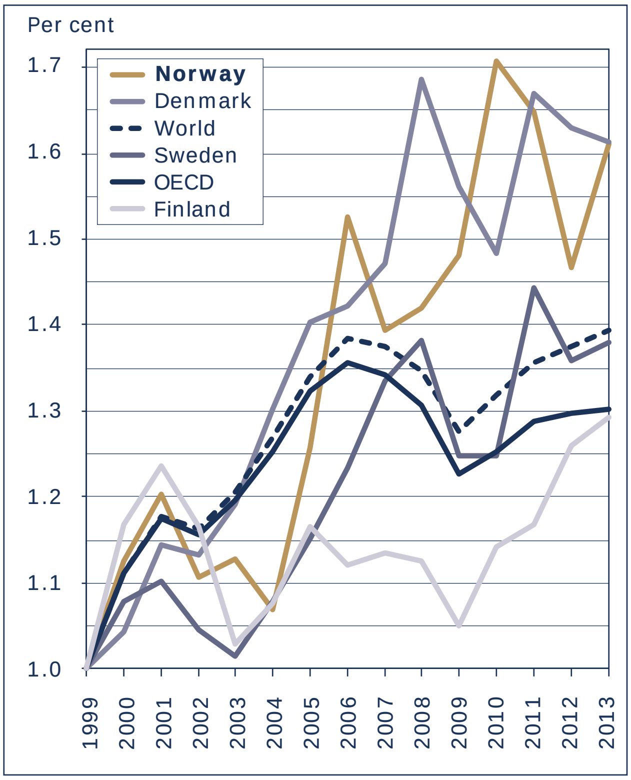
Figure 1.16
International patenting: patents filed at the EPO by country of origin.[1] 1999–2014.



[1] Applications (EP-A) at The European Patent Office (EPO), country based on inventor address, year based on priority year.

Source: NIFU based on OECD.stat data (2017) and Patstat (2017a). Incomplete counts for 2014 due to 36 month publication period.

Figure 1.17
Relative change in international patenting (EPO).[1] 1999–2013.



[1] Applications (EP-A) at The European Patent Office (EPO), country based on inventor address, year based on application year.

Source: NIFU based on OECD.stat data (2017) and Patstat (2017a).

Norwegian domestic patenting has fallen by about 10 per cent since 2001. At the same time, Norwegians have increased their filings abroad, particularly via the PCT (Patent Cooperation Treaty) and/or the EPO (European Patent Office) route. There were about 1.17 foreign applications per domestic application in 2001. By 2015 there were about four foreign applications for each domestic filing. The growth is mainly driven by PCT applications, which is a relatively inexpensive route for filings in multiple jurisdictions.

When European applications (EP-A) are distinguished from all other filings, we see that fewer Norwegian applications go through EPO cooperation as a share of all international filings now (11%) than before Norway joined EPO in 2008 (15%). There is also an increase in EP applications per domestic application; from 0.31 domestic applications per EP application in 2001 to 0.44 in 2014. A larger proportion of Norwegian inventions are sought in Europe now than before the EPC membership, although developments are characterised by annual variations.

In 2014, more than 130,000 patent applications were filed in Europe, most of which (122,000) originated from European and other OECD countries. The data for 2014 are not final, but they indicate that growth from the previous years has declined. Figure 1.16 presents the number of patent applications of EPO after origin. The figure compares the Nordic countries with other EU 28 and OECD countries and shows another important dimension in the internationalisation of patenting. While the number of applications originating from the Nordic countries and EU 28 countries is relatively stable, filings from other countries increased, both inside and outside the OECD.

Figure 1.17. presents the relative growth in European filings by applicants in the Nordic region. The Nordic countries accounted for about 4.2 per cent of all OECD country EPO applications in 2014. The proportion seems to fall significantly below the average, which has been stable at five per cent since Norway joined 2008.

The figure shows that European patenting has increased strongly for Norway during the period, and approaches Denmark in the figure. However, the increase in Norwegian patenting in Europe is primarily an effect of Norway becoming a full member of the EPC later than its Nordic neighbours.

In the period 1981–2015, a total of about 30 million scientific journal articles were published globally. World production has increased throughout the period from almost 500,000 articles in 1981 to over 1,500,000 in 2015. Also, Norwegian production has grown significantly over these years. In 1981, Norwegian researchers published almost 2,500 articles. By 2015, this number had risen to almost 13,000. Growth reflects the large expansion that has taken place in knowledge production during the period, but also that the journal coverage of the database, the number of journals included, has increased. A significantly increasing proportion of these «Norwegian» articles have author addresses from other countries as well. In 2014, 62 per cent of the articles involved international co-authorship.

Norway – a small player in international research

There are major differences between the different countries in terms of article production. The United States is by far the largest research nation worldwide with over 400,000 publications in 2015. This represented 19.2 per cent of world scientific knowledge production, measured as the sum of all countries' output. China is the world's second largest knowledge producer with almost 290,000 articles and a share of 13.7 per cent, see Table 1.3. Second, United Kingdom and then Germany follow with about 100,000 articles each. Norwegian researchers published 12,890 articles in 2015 and rank as the 32nd largest research nation in the world. Norway's share was 0.61 per cent, which is almost identical to the shares in 2013 and 2014. Of the Nordic countries, Sweden is by far the largest research nation with 50 per cent more articles than number two (Denmark). Norway's article numbers are marginally lower than Finland's.

Measured in relation to the population, Norway has 2.53 articles per thousand inhabitants and then ranks as number five of the countries in Table 1.3. Switzerland is the country which has the highest productivity with 3.73 per thousand capita. Then Denmark and Sweden follow, both of which have higher productivity figures than Norway, with 3.26 and 2.81 articles per thousand inhabitants respectively.

Differences in population size do not necessarily, however, reflect differences in research effort. A better indicator would therefore be to calculate the relationship between article production and input factors such as R&D expenditure and R&D FTEs. However, it is problematic to say something about such productivity differences, partly due to differences between countries in the scientific specialisation profile.

Table 1.3
Scientific publishing in 2015 in selected countries (over 8,000 articles in 2015). Number and per cent.

Country	Number of articles 2015	Number of articles per 1,000 inhabitants[1]	Percentage of World production[2]	% average annual in-crease in number of articles 1995–2005[3]	% average annual increase in number of articles 2005–2015[3]
USA	403,110	1.27	19.20	1.6	3.3
China	286,640	0.21	13.70	45.5	29.8
United Kingdom	117,529	1.83	5.60	2.1	4.8
Germany	107,639	1.31	5.13	4.0	4.0
Japan	77,223	0.60	3.68	2.9	0.0
France	74,313	1.13	3.54	2.7	3.6
Canada	67,750	1.93	3.23	2.7	5.3
Italy	67,081	1.11	3.19	5.8	6.3
Australia	62,053	2.63	2.96	4.9	12.6
India	60,823	0.05	2.90	6.4	14.3
Spain	58,324	1.25	2.78	9.1	8.6
South Korea	57,877	1.15	2.76	35.0	11.9
Brazil	43,054	0.21	2.05	19.9	14.8
Netherlands	39,950	2.37	1.90	4.0	6.5
Russia	34,951	0.24	1.66	-0.7	3.9
Switzerland	29,937	3.73	1.43	4.9	7.5
Iran	29,579	0.38	1.41	93.1	52.5
Turkey	28,823	0.38	1.37	44.9	10.2
Poland	27,589	0.72	1.31	8.3	9.7
Sweden	27,034	2.81	1.29	3.0	5.7
Taiwan	26,496	1.13	1.26	14.0	6.4
Belgium	22,562	2.03	1.07	5.9	6.8
Denmark	18,322	3.26	0.87	4.1	9.9
Austria	15,533	1.83	0.74	6.6	7.2
Israel	14,370	1.78	0.68	2.6	3.2
Portugal	14,314	1.37	0.68	21.9	16.4
Saudi-Arabia	13,604	0.45	0.65	-0.6	88.2
Mexico	13,598	0.11	0.65	13.4	8.9
Singapo-re	13,296	2.46	0.63	22.6	10.5
Finland	13,215	2.43	0.63	4.3	5.7
South Africa	12,924	0.25	0.62	3.1	16.9
Norway	**12,887**	**2.53**	**0.61**	**5.0**	**9.4**
Czech Republic	12,881	1.23	0.61	7.4	11.4
Malaysia	11,409	0.39	0.54	15.7	60.6
Greece	10,733	0.97	0.51	13.4	3.6
Egypt	10,113	0.12	0.48	3.7	24.2
New Zealand	9,554	2.13	0.46	5.3	7.2
Argentina	9,136	0.22	0.44	8.8	7.7
Ireland	8,045	1.74	0.38	11.1	9.0

[1] Number of articles in 2015 per 1,000 inhabitants in 2013.
[2] Share of World production calculated from total production from all countries.
[3] Growth in number of publications is also caused by the expansion of the Web of Science-database, whose scope has increased significantly, especially after 2008.

Source: Data: Clarivate Analytics, Web of Science. Computations: NIFU.

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Recent trends in STI policy

Following more than 8 years of weak economic performance since the burst of the 2009 financial crisis, global growth has finally picked up in several advanced countries, driven by a noticeable rebound in consumer demand, industrial production, global trade and investment. However, this performance remains modest by pre-crisis standards and many countries are still facing unprecedented challenges, in particular growing income inequalities, population ageing, climate change, resources depletion and digitally-induced structural change. Although governments increasingly acknowledge the key role that research and innovation activities can play in alleviating these economic and societal challenges, the persistent budgetary austerity has often limited their capacity to support these activities. Moreover, while recovery plans in many countries included research and innovation initiatives as counter-cyclical measures during the crisis, a slowdown or retraction of public R&D budgets and a change towards more market-friendly, business-oriented and «neutral» policy approaches (in particular various forms of R&D tax concessions) has been observed in recent years. A growing share of public spending is allocated to the business sector as policy makers are more and more focused on improving the innovation ability of firms, in particular start-ups and SMEs, which have suffered the most from the contraction of external sources of funding. Although still relatively marginal, governments also increasingly put in place «no-spending» initiatives such as public procurement for innovation and facilitation of unconventional forms of funding (crowdfunding, valuation of intellectual assets, etc.), especially in areas of pressing societal needs.

Public research is also affected by these changes. Research in higher education institutions and public research organisations is increasingly financed through competitive funding and performance-based approaches, even in countries where institutional «block» funding remains high. Several governments have also found ways to better align the latter to national agendas and societal challenges, including through various forms of contractual arrangements (performance contracts) and «hybrid» means of financing (e.g. additional block funding allocated to institutions implementing «relevant» projects; centres of excellence, etc.). In the current budgetary context, governments tend to partner with non-state actors such as business (via public-private partnerships and different forms of consortia), NGOs and philanthropists in order to share costs and risks.

It is still too early to identify clear policy trends led by the growing concerns of policy makers about future disruptions triggered by «the Next Production Revolution» at the confluence of new digital technologies, new materials and processes. At this early stage, the level of uncertainty and the scope of consequences in terms of redistribution of economic value have called for both a strengthening of strategic intelligence, not the least foresight, to feed into policy making and a multiplication of experimental initiatives. In parallel to a few flagship digital programmes, many countries have set up significant measures to support the dissemination of new ICT technologies to industry (in particular to SMEs, including via extension services) to ensure that they benefit from this emerging revolution.

Societal challenges have moved higher up on the research and innovation agenda and are addressed through different mixes of basic research (e.g. in health) and customer-oriented programmes involving a range of stakeholders depending on the country. Interdisciplinary and network approaches are central to these initiatives, as reflected in the restructuring of research agencies to reduce “silos”, the changes in request-for-proposal procedures, the knowledge transfers between programmes, etc. Open science is also now firmly established in many countries, particularly as a means to address societal challenges as well as various digital initiatives, most often led by research agencies. Reforms of existing legal frameworks are also being launched to support the sharing of research results and data and to foster more inclusive participation in the development of science policy itself (from priority-setting to selection of proposals and monitoring of projects).

Improving governance is a permanent priority across all countries. Budget pressure is again a major driver for all types of rationalisation of public spending (streamlining of research programmes and innovation instrument portfolio, simplification of policy delivery, etc.). STI policy evaluation and impact assessment have also gained more policy attention to ensure the efficiency and effectiveness of policy instruments. In some countries, their scope has been widened to cover entire components of innovation systems or policy portfolio (systemic evaluations). As a result of both the growing acknowledgement of the importance of innovation, inter-ministerial coordination has become a key priority. The solutions found to cope with this challenge are very specific to national institutional settings, ranging from various high-level councils and committees, with different scope, mandate and dedicated resources, to the merger of research agencies and the launching of large-scale cross-cutting programmes.

It is likely that the above trends will continue to prevail in the coming years. Fiscal pressure will persist at a high level and most probably even rise, led by long-term demographic shifts, which will place considerable pressure on public social expenditure. The costs of the adjustments needed to tackle global warming and other environmental issues will further add to these rising costs. Although they will not displace national competitiveness goals, these societal challenges will become more prominent on policy agendas. Governments will more frequently implement «soft» policy approaches to support research and innovation in general, while remaining the largest investors in public research and engaging in large, challenge-focused initiatives that will be international in scale. The process of digitisation is crossing a new threshold and governments will continue to deploy dual policy approaches: creating favourable conditions for leading firms to invest in frontier technologies while also supporting the wider digital transformation of SMEs. Research and research policy will become increasingly open to the participation of stakeholders, which however could gradually affect research orientations away from public goals.

Andrew W. Wyckoff, Director OECD Directorate for Science, Technology and Innovation

Chapter 2

2 The Norwegian system of R&D and innovation

Frank Foyn, Hebe Gunnes, Elisabeth Hovdhaugen, Bjørn Magne Olsen, Bo Sarpebakken, Susanne L. Sundnes, Kaja Wendt, Ole Wiig, Lars Wilhelmsen

Resources for R&D and innovation

- From 2014 to 2015 there was strong growth in Norway's R&D efforts. R&D expenditure increased by NOK 6.4 billion, which corresponds to a real growth of 9 per cent. Growth was about the same magnitude in all three R&D performing sectors from 2014 to 2015 and far higher than from 2013 to 2014.

- In 2015, R&D expenditure's share of GDP is calculated at 1.93 per cent. This is a sharp increase from 2014, when the share was 1.72 per cent.

- In the twenty-year period 1995–2015, the higher education sector has had the highest growth in R&D efforts, followed by the industrial sector. The lowest real growth rate is found in the institute sector. Public sources finance a significantly higher proportion of R&D expenditure by 2015 than twenty years earlier.

- Medical and health sciences – with almost 6 per cent average annual real growth – had the greatest growth in R&D efforts in the period 1995 to 2015, with the most modest growth in R&D related to agricultural sciences at 0.7 per cent.

- R&D efforts in the higher education sector have increased sharply in recent years: some structural changes have contributed, among other things. The sector accounted for 26 per cent of total R&D in Norway in 1995 and 31 per cent in 2015.

- The institute sector's share of total R&D has fallen slightly over the last twenty years, from 28 per cent in 1995 to 23 per cent in 2015. In the same period, industry's share of R&D funding in this sector shows a corresponding decline.

- Health trusts and private hospitals had R&D expenditures of NOK 4 billion in 2015, accounting for almost 7 per cent of the total R&D expenditure in Norway this year.

- For the second consecutive year there is a sharp increase in industrial sector R&D activity. By 2015, industrial sector R&D amounted to almost NOK 28 billion, and at the same time, the share of R&D-performing companies increased.

- Manufacturing industries' overall R&D efforts have been sustained for a long time, but manufacturing's share of R&D costs has fallen from 59 per cent in 1995 to 36 per cent in 2015. Conversely, services have increased their share of R&D efforts from 31 to 52 per cent in the same period.

- 65 per cent of Norwegian enterprises covered by the innovation survey reported innovation activity in 2014–2016, a clearly higher share than in the period 2012–2014.

Grants and funds

- 2017 is the fifth fiscal year in a row with a significant real growth in the government budget allocations for R&D (GBARD). Part of the growth in the 2017 budget relates to investments in university buildings and research vessels.

Human resources

- The number of researchers in Norway almost doubled from 1995 to 2015, from almost 27,000 to more than 52,000. The proportion of women increased from 24 to 37 per cent in the period.

- The number of doctorates has more than doubled in the last half of the 1990s, now 1,400–1,500 doctoral degrees are administered annually, with about the same number of women as men. Now there are 7 times more foreigners who defend theses than twenty years ago.

- In 2014, a quarter of the researchers and the academic staff at Norwegian universities, colleges, research institutes and health enterprises were immigrants or descendants of immigrants.

- The number of students is rising – from 181,000 in 1997 to around 273,000 in 2016, and students choose other disciplines now than 20 years ago. Except in STEM subjects and economics, there is now a predominance of female candidates in all subjects.

Chapter 2 presents the status and developments of the national R&D and innovation system. We focus on the development of R&D resources from the mid-1990s and twenty years onwards, corresponding to the period the Report on Science & Technology Indicators for Norway has existed. The descriptions largely follow the division into the research-performing sectors used in the Norwegian R&D statistics; business enterprise, institute and higher education sectors. Hospitals, which are included in the R&D statistics in the higher education sector and the institute sector, are given their own review.

The Norwegian government's new long-term R&D priority areas are included in the R&D surveys for the first time, so that we get a starting point to look at developments in the R&D resources over time. The latest survey on innovation in the industrial sector is presented. Last in the chapter we have included new statistics on diversity, more specifically a description of the researcher population at Norwegian universities, university colleges, research institutes and health trusts that are immigrants or descendants of immigrants.

The OECD definition of research and experimental development (R&D)

Research and experimental 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 stock of knowledge to devise new applications.

The term R&D covers three activities:

- ***Basic research*** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- ***Applied research*** is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific aim or objective.
- ***Experimental development*** is systematic work drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems or services, or to improving substantially those already produced or installed.

The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty.

More on the definition and distribution of R&D in the Frascati manual. Proposed Standard Practice for Surveys on Research and Experimental Development (OECD, 2002). A new edition of the manual was published October 2015. From the 2016 surveys, guidelines in revised manual are used. This will not cause significant changes in the statistics.

The OECD definition of innovation

The terms innovation, innovative and innovation activity are used about product or process innovations (PP innovation) that include the introduction of new or considerably improved products or processes. The innovation survey of 2004 also mapped organisational and marketing innovation. However, unless otherwise stated, innovation in this context refers to PP innovation. The definitions of the different terms used in the innovation survey are:

- ***Product innovation*** is a product or a service that is either new or significantly improved with regard to its characteristics, technical specifications, built-in software or other immaterial components or its user-friendliness. The innovation must be new to the enterprise, but not necessarily new to the market.
- ***Process innovation*** includes new or significantly improved production technology/ methods and new or significantly improved methods for delivery of goods and services. The innovation should be new to the enterprise, but the enterprise does not necessarily have to be the first to introduce this process.
- ***Organisational innovation*** is the implementation of a new or significantly changed structure in the enterprise or new or significantly changed managerial strategies in order to increase the enterprise's use of knowledge, the quality of goods and services or the efficiency of working processes.
- ***Marketing innovation*** means introduction of a new or significantly changed design, in addition to the introduction of new or significantly changed sales methods in order to make the products of the enterprise more attractive or to open up new markets.

OECD (2005): Oslo Manual. Guidelines for collecting and interpreting innovation data/ a joint publication of OECD and Eurostat. 3rd ed.

Norway's total expenditure on research and development (R&D) amounted to more than NOK 60 billion in 2015. In current prices, this increases the R&D effort of NOK 6.4 billion from 2014, corresponding to a real growth of almost 9 per cent.

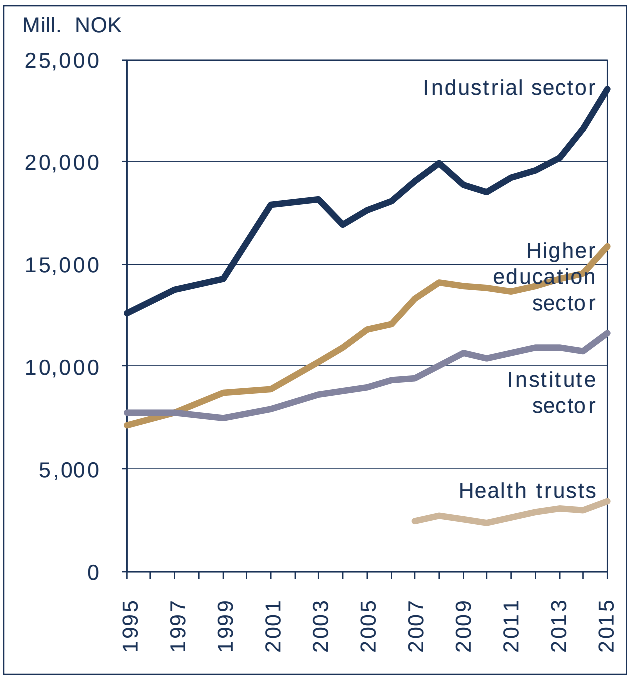
Large growth in all sectors

The results from the R&D surveys in 2015 thus show a significant growth in Norway's total R&D expenditures from 2014 to 2015. Adjusted for wage and price inflation, real growth in R&D expenditure was highest in industrial sector (9.0%), closely followed by the higher education sector and the institute sector with 8.8 and 8.1 per cent, respectively, real growth.

The health trusts, which in the R&D statistical context are part of the higher education sector (university hospitals) and the institute sector (other health and private hospitals) had a real increase in R&D expenditure of 13.4 per cent from 2014 to 2015. Some of the growth was due to technical conditions, see Chapter 2.4. Adjusted for this, real growth in health enterprises was about 4 per cent.

During the twenty-year period 1995–2015, there have been several changes in the Norwegian R&D system. R&D efforts measured in R&D expenditure has increased significantly, while the relationship between the three R&D sectoral contributions to Norway's total R&D has changed. Figure 2.1 shows the increase in R&D expenditures from 1995 to 2015 per sector at fixed prices; it is noticeable that the level of the industrial sector has been fluctuating over time. Looking at the entire period, the growth in R&D efforts has been highest for the higher education sector and the greatest in the period 2003–2008 and from 2014 to 2015.

Figure 2.1
Total R&D expenditure by sector of performance.[1] 1995–2015. Fixed 2010 prices.



[1] 'Health trusts with university hospital functions' is also included in the higher education sector, and 'other health trusts' is a part of the institute sector.

Source: Statistics Norway/NIFU, R&D statistics

In 1995, the institute sector's level of R&D was slightly over that of the higher education sector. Between 1995 and 2015 the institute sector has had the lowest average annual real growth rate of the three sectors, and ends well below the level of higher education sector in 2015. However, for this sector, there has also been a significant increase in the latter part of the period. The industrial sector had strong growth in

Table 2.1
Total R&D expenditure in Norway by sector of performance / type of institution. 1995, 2014 and 2015. Mill. NOK and per cent.

Sector of performance/type of institution	1995	2014	2015	Share of total R&D 1995 (%)	Share of total R&D 2015 (%)	Real growth[1] 2014–2015 (%)	Average annual real growth1 1995–2015 (%)
Industrial sector	7,341	24,802	27,782	46.0	46.1	9.0	3.2
Higher education sector	4,139	16,720	18,709	25.9	31.3	8.8	4.1
Of which health trusts with university functions	527	2,701	3,186	3.3	5.3	14.7	5.6
Institute sector	4,490	12,345	13,718	28.1	22.8	8.1	2.1
Of which other health trusts	37	736	821	0.2	1.4	8.6	12.7
Total	**15,970**	**53,867**	**60,209**	**100.0**	**100.0**	**8.7**	**3.2**
Total fixed 2010 prices	**27,422**	**46,990**	**51,092**				

[1] Changes in the monitoring system for R&D in the Health trusts from 2007 means that some of the growth in the health trusts R&D expenditures is due to technical causes. This applies mainly to other health trusts (included in the institute sector) which before 2007 was based on estimates of R&D activity.

Source: Statistics Norway/NIFU, R&D statistics

Table 2.2
Total R&D expenditure in Norway by sector of performance, and source of funds. 2015. Mill. NOK.

Sector of performance/type of institution	Total	Industry	Government			Other sources[2]	Abroad	
			Total	Min., county, municipality	Research council of Norway[1]		Total	Of which: EU Comm.
Industrial sector	27,782	21,690	1,171	618	553	1,315	3,607	118
Higher education sector	18,709	586	16,674	13,891	2,782	887	561	409
Of which health trusts with university functions	*3,186*	*38*	*2,915*	*2,697*	*217*	*197*	*36*	*12*
Institute sector	13,718	2,563	9,040	6,031	3,010	741	1,374	432
Of which other health trusts	*821*	*24*	*756*	*734*	*22*	*39*	*2*	*1*
Total	**60,209**	**24,839**	**26,885**	**20,540**	**6,345**	**2,943**	**5,542**	**960**

[1] Numbers are based on information from R&D performing units. This will deviate from numbers from budgetary authorities. The deviation is the biggest for the industrial sector. This is primarily due to two factors; a) The funds from the Research Council are distributed to contract partners and not to individual partners in a project that may be in different sectors. b) R&D-performing entities may have difficulty specifying where the funds originate and may understate government funds.

[2] Includes private funds, gifts, own funds and the tax deducting fund «SkatteFUNN» in industrial sector.

Source: Statistics Norway/NIFU, R&D statistics

R&D expenditure from 1999 to 2001, a real decline from 2003 to 2004 and from 2008 to 2010 (financial crisis) and in recent years (2013–2015), a significantly greater focus on R&D. More detailed descriptions of the sectors follow later in this chapter.

In 2015, about 45 per cent, corresponding to almost NOK 27 billion of Norway's total R&D expenditure, was financed from public sources, see Table 2.2. Of this over NOK 6 billion came from the Research Council of Norway. The business sector contributed nearly NOK 25 billion, of which NOK 21.7 billion was used in its own sector. Other sources – including funds from private gifts, charitable organisations in addition to SkatteFUNN – funded just under NOK 3 billion of R&D activities, while the funds from abroad, including the European Commission, amounted to around NOK 5.5 billion.

Norwegian performing sectors for R&D

In Norway, national R&D statistics are categorised according to three basic sectors:

The industrial sector: Companies and enterprises aimed at commercial production of goods and services for sale at an economically significant price.

The institute sector: Private-non-profit research institutes mainly serving industry (the business enterprise sector in the OECD classification); research institutes and other R&D-performing institutes (other than higher education) mainly controlled by and funded by the government (government sector in OECD's classification)(PNP); and health trusts not conducting education and PNP hospitals.

The higher education sector: Units providing higher education; universities, specialised university institutions, state university colleges and university hospitals.

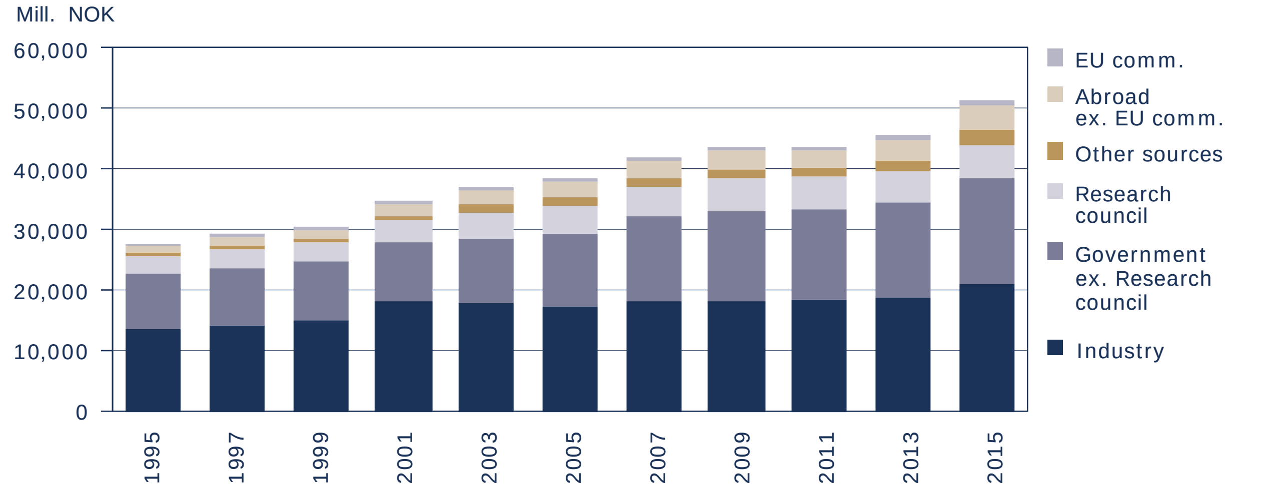
To highlight the R&D activities in health trusts these are presented separately where appropriate and possible (data from 2007).

OECD's sector classification, is used in Chapter 1.

R&D funding sources

- **Industrial sector:** Funds from private enterprises. Most go to R&D in own enterprises.
- **Government sources:** Funding from ministries' budgets. Mostly institutional grants, for example general university funds, and funds distributed through the Research Council of Norway, but there are also funds for programmes and projects by ministries and other state institutions. A smaller portion comes from counties, municipalities, state banks etc.
- **Other sources:** Own revenues at universities and research institutes; private foundations and gifts, loans, funds from NGOs and SkatteFUNN. SkatteFUNN is in principle public funding, but according to international guidelines (OECD Frascati manual) any tax incentive schemes are classified as own funding of the relevant sector. This is because the tax incentives are very different, and in many countries, there are period-related discrepancies between actual R&D activity and the associated tax benefits.
- **Abroad:** Funds from foreign enterprises and institutions, funds, EU, Nordic and other international organisations. Abroad includes both public and private funding, but often classified as private funds when total financing is divided into two main categories, public and private.

Figure 2.2
Total R&D expenditure in Norway by source of funds. 1995–2015. Fixed 2010 prices.



Source: Statistics Norway/NIFU, R&D statistics

Public funding has increased its importance to research

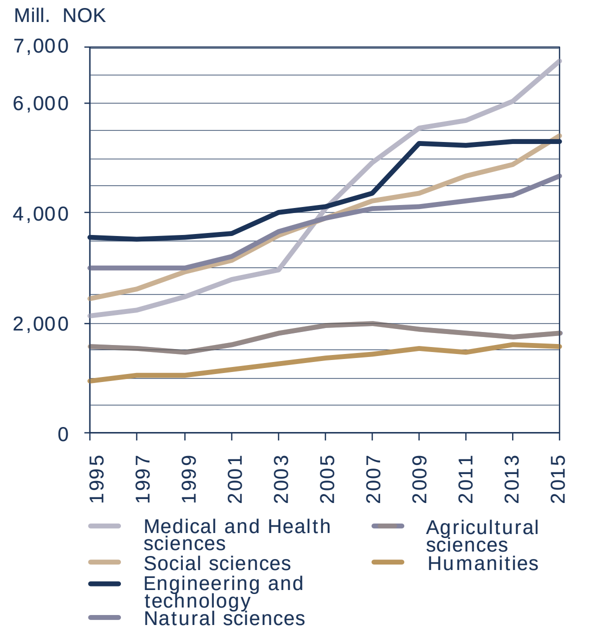
In absolute amounts, public funding had the largest growth in the twenty-year period 1995–2015. At the beginning of this period, the contribution from industry was clearly higher than funding from public sources. 2007 was the first year the picture was the opposite, with a slight predominance of R&D funding from the public sector. This coincides with a higher priority of research in health trusts, and the introduction of a new method for measuring the R&D resources in these institutions. Until 2015, the share of public funding has increased more than funding from industry and contributed NOK 2 billion more than private sources this year.

Figure 2.2 shows the growth in funding from the various sources related to Norwegian R&D activities. From 1995 to 2015 «Other sources» has the biggest increase with an 8 per cent annual real growth rate. Growth started from 2001 to 2003, after the Skatte-FUNN scheme was established and classified under «Other sources». «Abroad» and funds from the European Commission have also increased significantly over the period, with over 6 per cent annual real growth. Industry's contribution has had the lowest real growth from 1995 to 2015 by just over 2 per cent per year.

Medical and health-related R&D has significant growth

Over time, R&D resources for the different fields of science have evolved differently, see Figure 2.3. From 1995 to 2015, social sciences and medical and health sciences have increased the most, with slightly above 4 and almost 6 per cent, respectively, of average annual real growth in the twenty-year period. Engineering and technology, natural sciences and humanities all have about 2 per cent real growth per year, while agricultural sciences, with 0.7 per cent average annual real growth, have had the most modest increase in R&D expenditures over the period. The efforts of health trusts to research during this period have contributed to the strong growth in R&D expenditures for medicine and health care.

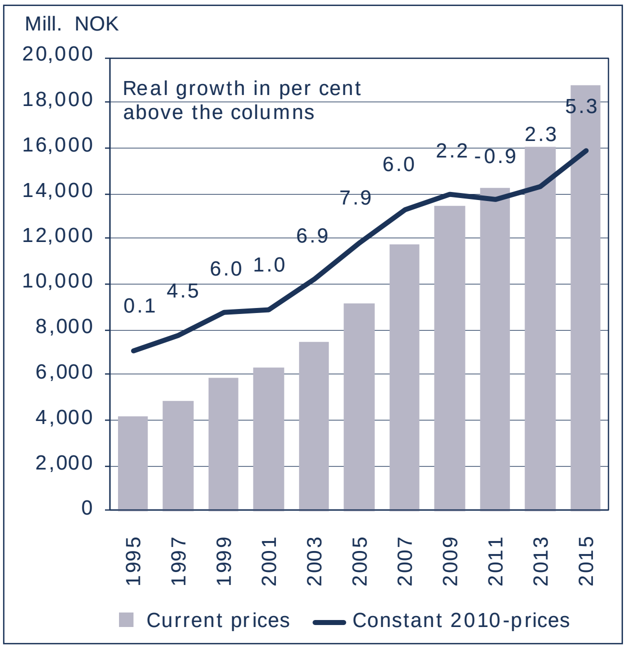
Figure 2.3
Current expenditure in the higher education sector and the institute sector by field of science.[1] 1995–2015. Fixed 2010 prices.



[1] Industrial sector R&D is not distributed by field of science.Source: NIFU, R&D statistics

Source: NIFU, R&D statistics

Figure 2.4
R&D expenditure in the higher education sector. 1995–2015. Current and fixed prices. Average yearly real change in per cent.



Source: NIFU, R&D statistics

R&D of nearly NOK 19 billion in 2015

In 2015, the R&D survey in the higher education sector included 47 educational institutions, consisting of eight universities, five specialised university institutions, three private academic institutions, 18 state university colleges and 13 other educational institutions/ university colleges. The sector also includes six health trusts with university hospital functions. In 2015, R&D amounted to NOK 18.7 billion in the sector. University hospitals accounted for NOK 3.2 billion or 17 per cent of the sector's R&D expenditures.
Between 2014 and 2015 there was a real growth in the sector's R&D expenditure of almost 9 per cent, corresponding to the growth in total R&D expenditures in Norway.
Structural changes in the higher education sector have contributed to a sharp increase in R&D efforts in recent years; from 26 per cent of total R&D in 1995 to 31 per cent of total R&D in 2015. More and more public research is taking place in the higher education sector, which has had higher R&D expenditures than the institute sector since 1997. From 1995 to 2015, the higher education sector has had the highest real growth in R&D expenditures in Norway, with 4.1 per cent average annual real growth, followed by the industrial sector (3.2%) and the institute sector (2.1%). This growth has not been quite even. In the twenty-year period, the sector has had two years of slowing down in R&D spending; 2001 and 2011. 2011 was the only year of real decline in R&D expenditures. The highest growth is found in the period 2003–2007. The growth from 2014 to 2015 was almost as high as that time.

Distribution of source of funds–stable over time

In the higher education sector for the twenty-year period, the distribution of sources of funding of R&D expenditure is stable. There has been high growth in various external sources of funding, but funding from general university funds, so-called basic funding, has grown equivalently. Thus, the basic funding has been the largest source of funding for all years, with an average annual real growth of 4.3 per cent, the same as for total current expenditure for R&D in the entire period. Basic funding's share in total funding amounted to 68 per cent both in 1995 and 20 years later, from 2003 to 2007, the share was down to 62 per cent. In broad terms, it can be said that the funding structure in 2015 resembles that in 1995, tending to a share of higher external funding in the middle of the period.

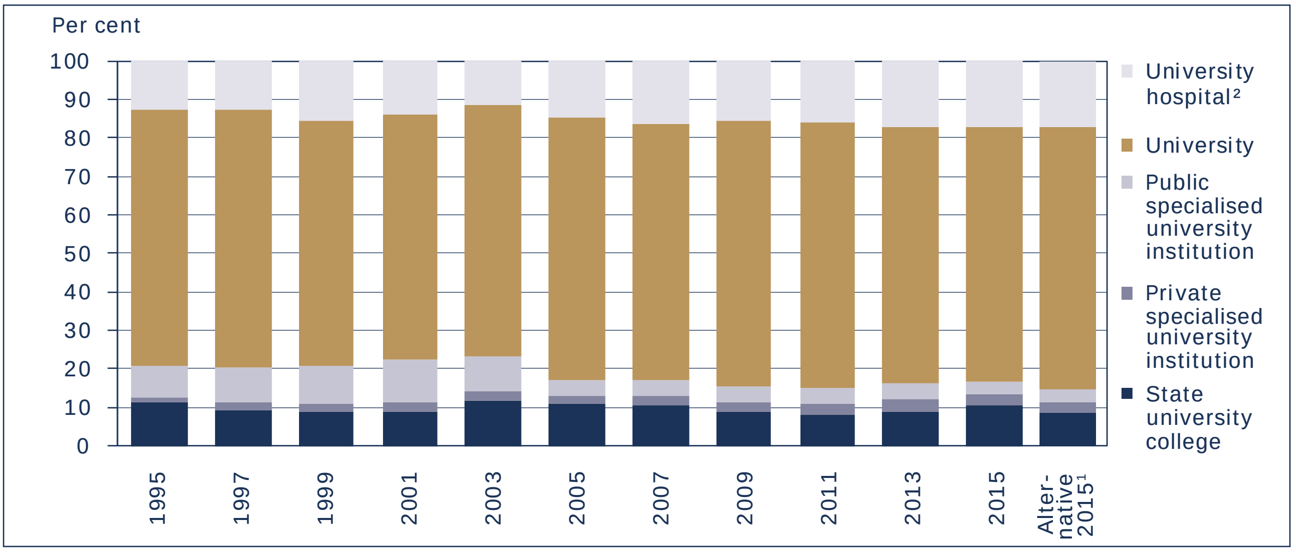
Funding from the European Commission had the strongest real growth in the period of almost 10 per cent average annual real growth, and as a proportion of total R&D in the sector, EU funding increased from 1 to 3 per cent. The lowest real growth was in funding from industry and counties and municipalities, respectively 1.4 and 2.6 per cent, while funding from the Research Council of Norway and other sources (funds, gifts and own revenues) was on a par with overall growth in R&D during the period. The growth in R&D funding from ministries and other public sources has varied between 5 and 9 per cent over the twenty years.

The universities dominate

Figure 2.5 shows that the universities are the dominant R&D-performing institution type in the Norwegian higher education sector. The universities' share of the sector's R&D was 66 per cent in 1995, the proportion rose to 69 per cent in 2009 and remained 66 per cent in 2015.

The Norwegian higher education sector is going through a period of reorganisation and concentration. If the institutional affiliation after the last two years of merger processes is assumed, the universities' share of the sector will increase from 66 to 68 per cent, see the column of alternative section in 2015 in Figure 2.5. This will be at the expense of the share of state university colleges, which represented 11 per cent of R&D expenditure in 2015 and 8.5 per cent after the merger. In 1995, the proportion of R&D at state

Figure 2.5
R&D expenditure in the higher education sector by type of institution. 1995–2015.[1]



[1] Alternative 2015 distribution after mergers for NTNU, NU and UiT. UNIK and Bergen Academy of Art and Design are included in universities.

[2] 1995–2005 university hospitals include both pure hospital wards and units associated to universities. From 2007 until 2015 health trusts with university hospital function are included.

Source: NIFU, R&D statistics

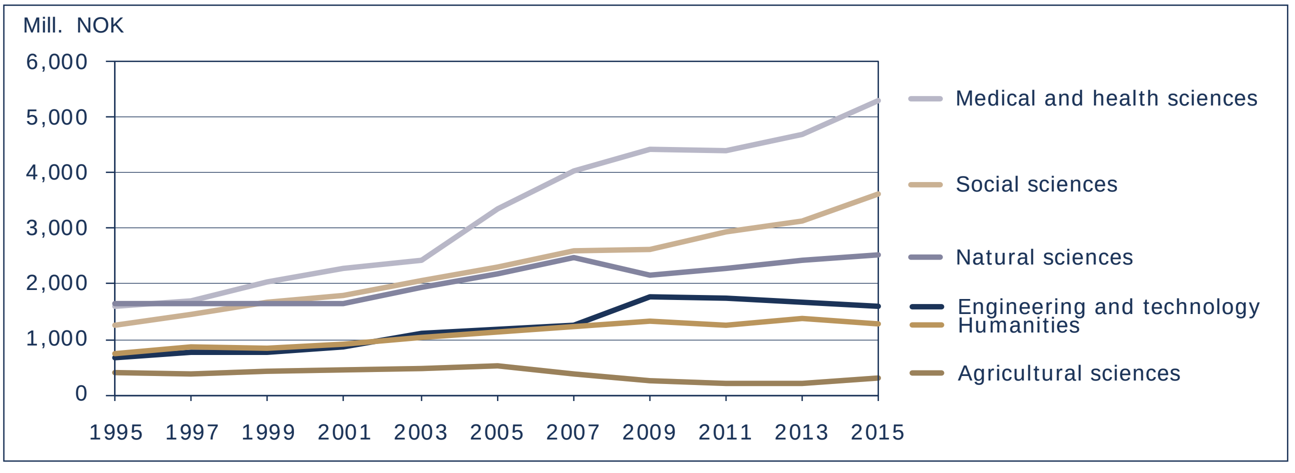
university colleges was also 11 per cent. The decline for specialised university institutions from 9 per cent in 2003 to 4 per cent in 2005 is primarily because the Norwegian College of Agriculture (now the Norwegian University of Life Sciences – NMBU) received university status that year.

More R&D at university hospitals

For university hospitals, there has been a major change in data collection from 2007, and their share of the sector's R&D over the period has increased quite slowly from 13 per cent in 1995 to 17 per cent by 2015. The R&D of the university hospitals is presented in Chapter 2.4 on the R&D of health trusts.

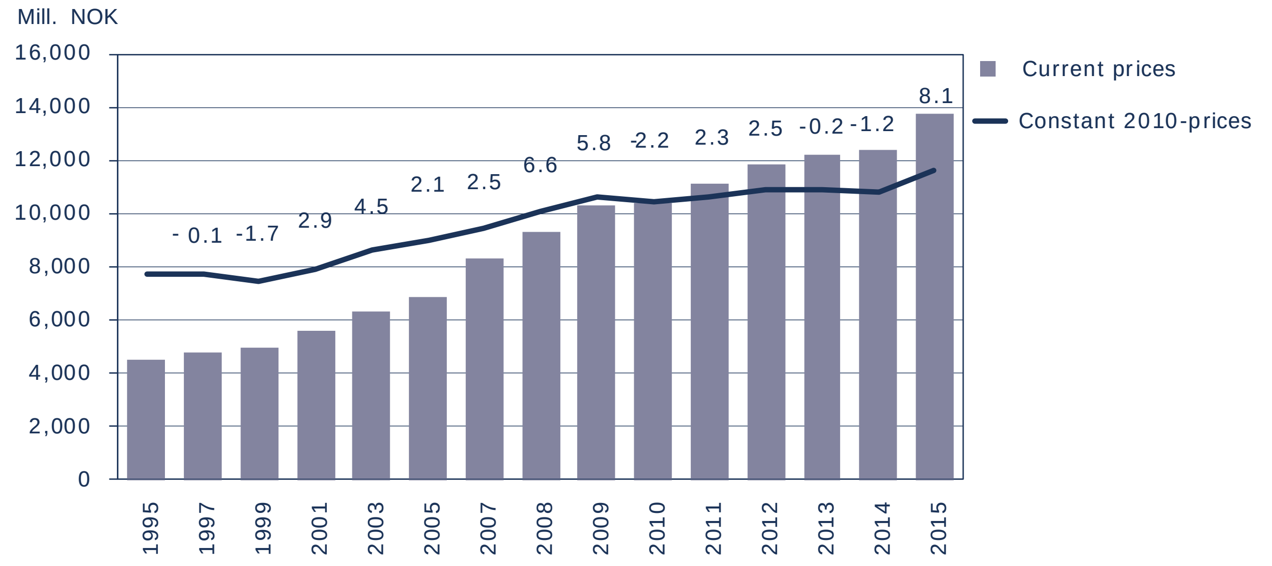
The most significant change in the development of the fields of science over the twenty-year period is the growth in R&D in medical and health sciences; the area had an average annual real growth rate of over 6 per cent, followed by social sciences with over 5 per cent annual real growth. The other fields of science had a growth of around 4 per cent, corresponding to total growth. For agricultural sciences, there has been a real decline of more than one per cent per year; some of the decline is due to mergers where the field of expertise was no longer the largest in any of the research environments.

Figure 2.6
Current costs for R&D by field of science. 1995–2015. Fixed 2010 prices.



Source: NIFU, R&D statistics

Figure 2.7
R&D expenditure in the institute sector. 1995–2015. Current and fixed 2010 prices. Average yearly real change in per cent.



Source: NIFU, R&D statistics

The institute sector is today the smallest of the three research-performing sectors in which the Norwegian research system traditionally is divided. The institute sector had 23 per cent of all R&D in Norway in 2015. The sector's share of the country's total R&D has decreased a lot compared with the situation 20 years ago, when 28 per cent of total R&D resources were used in this part of the research system.

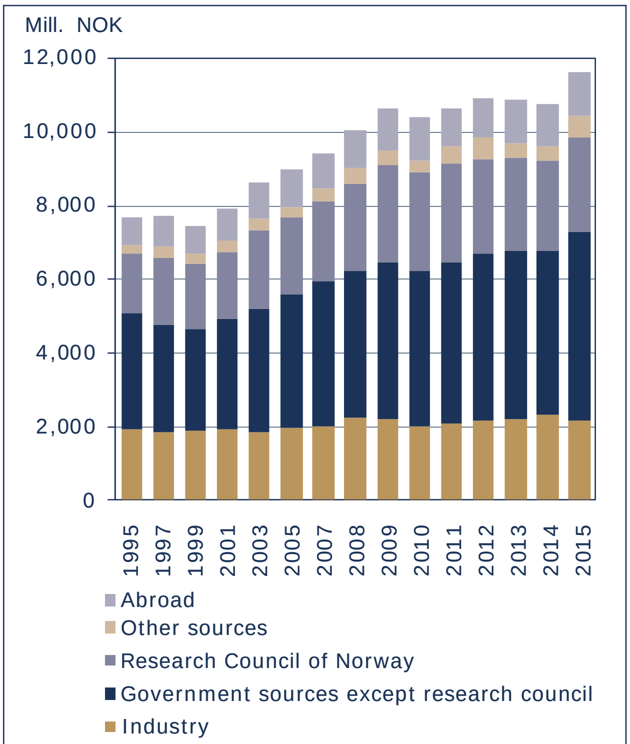
The institute sector consists of a heterogeneous group of institutions, many of which have R&D as core activity, but it also includes entities where R&D is often a more limited activity. Common features of the sector are that no dividend is paid, and that the organisation is not directly subject to an educational institution.

The R&D survey in the institute sector included in 2015 just under 100 research institutions, about half of which are commonly referred to as research institutes. This applies to institutes where R&D is considered being the core activity. The majority of these fall under the guidelines for government funding of research institutes. Some governmental research institutes receive their basic funding directly from the relevant ministry.

In addition to the research institutes, the sector comprises 40 institutions, both private and public, which to a greater or lesser extent perform R&D. Further added are museums, where the use of resources for R&D is largely estimated, as well as health trusts without university hospital functions and private, non-profit hospitals.

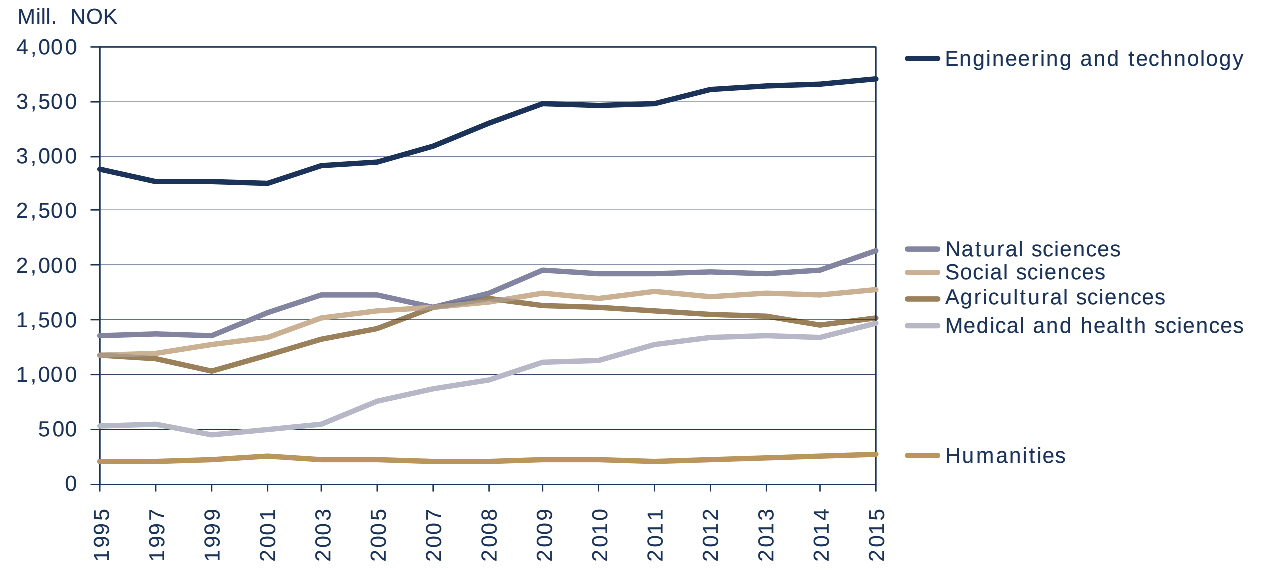
When R&D statistics for the Norwegian institute sector are reported to international organisations, the sector is divided into government-oriented and business-oriented institutes. The research institutes serving enterprises are added to the industrial sector and form the business enterprise sector. By 2015, research institutes serving government accounted for two

Figur 2.8
R&D expenditure in the institute sector by source of funds. 1995–2015. Fixed 2010 prices.



Source: NIFU, R&D statistics

Figure 2.9
Current R&D expenditure in the institute sector by field of science. 1995–2015. Fixed 2010 prices.



Source: NIFU, R&D statistics

thirds of the sector's R&D expenditure. The relative distribution between public-oriented and business-oriented institutions has been quite stable over the past 20 years.

Diverse funding profile

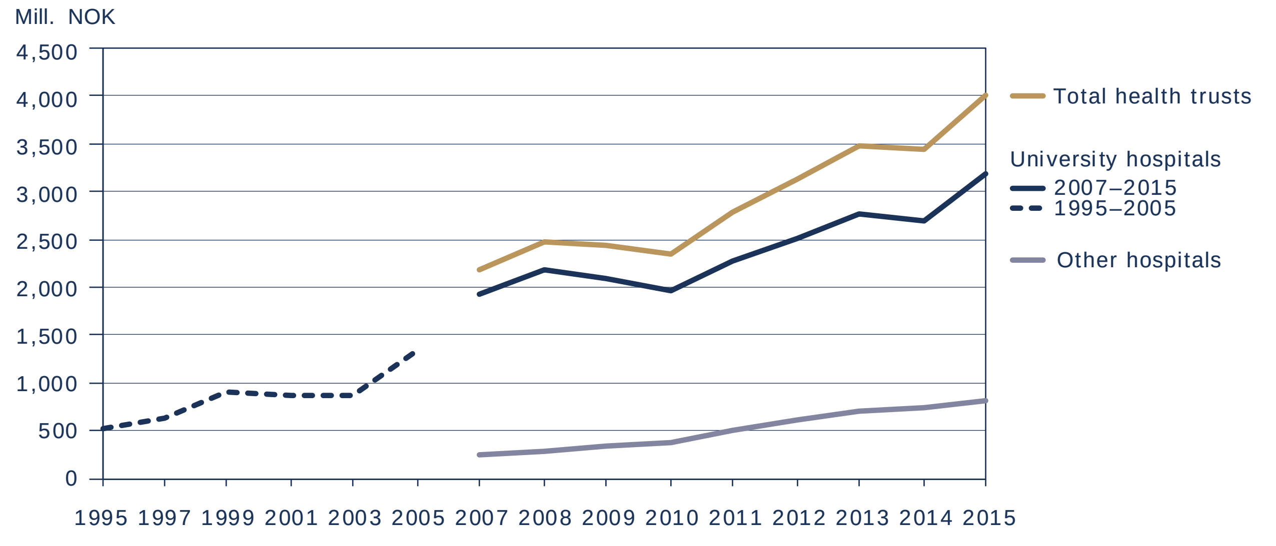
The institutie sector serves the private and public sector at home and abroad, and there is great diversity in its funding structure. Over the last 20 years, the distribution on main funding sources is stable.
Compared with the situation in the mid-1990s, industry today finances a somewhat smaller proportion of the institute sector's R&D. In 1995, industry financed 25 per cent, while the share of recent years has been around 20 per cent. Similarly, there has been growth in government funding of the same magnitude.
Funding from abroad has remained stable at around 10 per cent throughout the period.

Large academic variation, but engineering and technology and natural sciences (STEM) are strong

In the institute sector, R&D was carried out within all fields of science. Engineering and technology were the largest area with one third of the sector's R&D resources in 2015, while one-fifth of the expenses were classified as natural sciences. All in all, more than half of the sector's R&D resources were used in STEM sciences. Social sciences, agricultural sciences research and development amounted to 16 and 14 per cent respectively, while 13 per cent were used within medical and health sciences. Humanities are by far the smallest field with 3 per cent of the resources, see Figure 2.9.

Over the last 20 years, the allocation of R&D by fields of science has been relatively stable.
Engineering and technology fell somewhat in the latter half of the 1990s, while medicine and health increased more than other subjects after the turn of the millennium.

Figure 2.10
R&D expenditure in the health trusts. 1995–2015.[1]



[1] For university hospitals, from 1995 to 2005 only hospital wards and university-related institutes are included. From 2007 to 2015, health trusts with university hospital function were included in the system of assessment of resources for R&D in health trusts.

Source: NIFU, R&D statistics

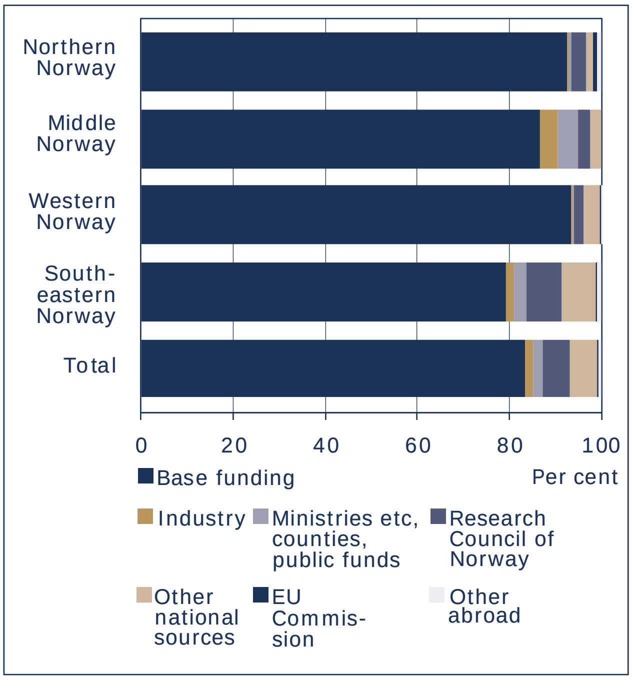
This chapter describes the main features of the R&D efforts in the specialist health services or health trusts. Specialist health services consist of public hospitals organised as health trusts and private, non-profit hospitals that have operating agreements with a regional health trust. In the following, we refer to them under the joint name of health trusts, and distinguish between health trusts with university hospital functions (university hospitals) and other health trusts and private non-profit hospitals. Measured in total current costs, including patient care, the two institutional groups are about the same size, but in the R&D context, university hospitals are clearly the larger with about 80 per cent of the R&D expenditure (Wiig 2016:16).

Ministry of Health and Care Services is the main source of funding

Medical and health-related R&D in Norway is largely financed by government, mainly by the Ministry of Health and Care Services (HOD) budget. Most of the funding is channelled as basic funding or as earmarked, strategic or other research funds via regional health trusts or regional cooperative bodies. The cooperative bodies' allocations are made upon application. In total, in 2015, NOK 3.3 billion or 84 per cent of health trusts' total R&D expenses were distributed through these mechanisms. The Research Council of Norway financed NOK 240 million, or 6 per cent. Other domestic sources accounted for a total of 10 per cent and include government agencies, medical funds and private organisations such as the Cancer Society, Extrastiftelsen and the National Association for Heart and Lung Disorders (LHL). Foreign sources accounted for about one per cent.

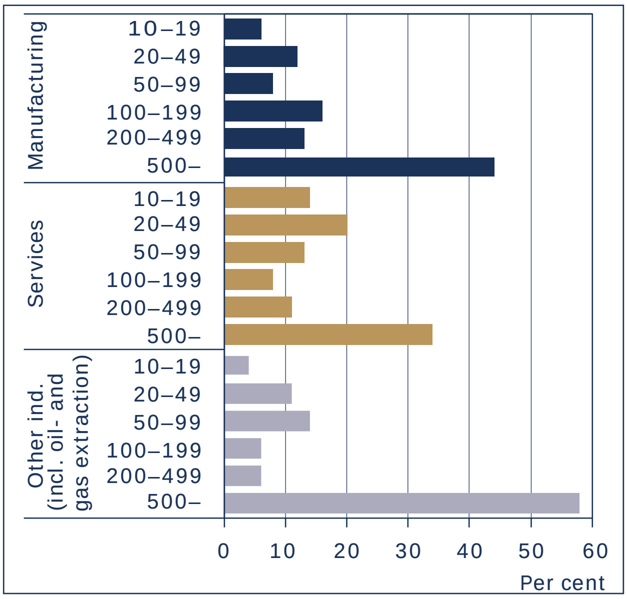
Government sources account for 90 per cent of health trusts' R&D. Over time, this funding pattern has been relatively stable. The basic financing share has varied between 83 and 85 per cent.

Figure 2.11
R&D expenditure in the health trusts in 2015 by health region and source of funds.



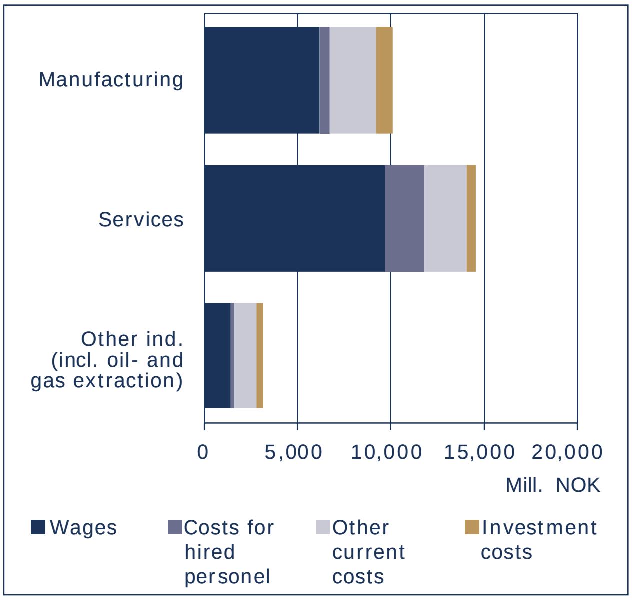
Source: NIFU, R&D statistics

Figure 2.12
R&D expenditure as a share of the main industry's total R&D expenditure in 2015 by size groups.



Source: Statistics Norway, R&D statistics

Figure 2.13
Expenditure for intramural R&D in the industrial sector in 2015 by type of cost and industry.



Source: Statistics Norway, R&D statistics

Strong growth in industrial sector R&D in 2015

The industrial sector carried out R&D of NOK 27.9 billion in 2015, an increase of 12 per cent from 2014. Measured in fixed prices, growth was 9 per cent. This is the second consecutive year in with a strong increase in R&D activity for the industrial sector. There has also been real growth in the remaining years after 2010, but to a lesser extent. The increase for 2015 took place during a period of moderate production development in general. GDP for Norway showed a decline in 2015, but the corresponding figure for mainland Norway showed an increase of about 3 per cent (nominal). This means that R&D expenditure in the industrial sector as a share of total GDP increased by 0.11 percentage point to 0.9 per cent.

The results for 2015 also show a clear increase in the proportion of enterprises performing R&D. The share has been stable at around 20 per cent for several years, but jumped to 25 per cent for all enterprises in 2015. In terms of the number of R&D enterprises, the growth is most remarkable for small enterprises with 10–50 employees. This group of enterprises also have the largest increase in expenditure for own R&D activity, 26 per cent more than in 2014. However, as we can see from Figure 2.12, it is the largest enterprises that contribute the most to total R&D.

The increase for the smaller enterprises may seem large, but matches the sharp increase in the use of the tax deduction scheme for R&D, SkatteFUNN[1] in the last two years. The scheme is widely used by small enterprises. The number of approved applications to SkatteFUNN has increased by 15 per cent in both 2014 and 2015. Budgeted R&D expenses increased by well over 30 per cent in both years.

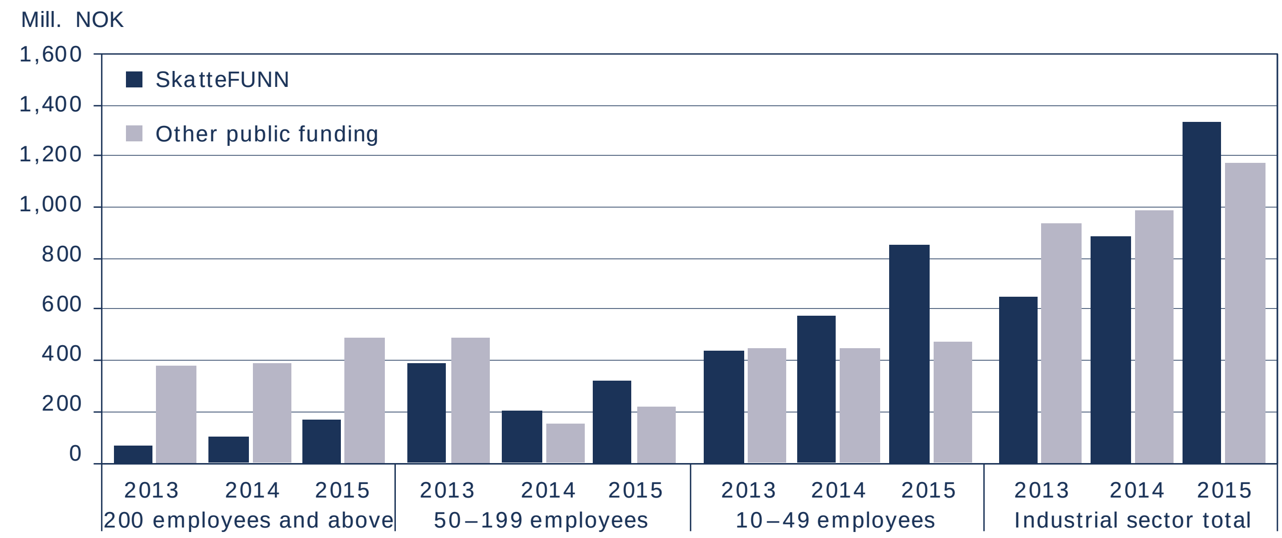
Figure 2.13 shows that R&D expenditure within services amounted to NOK 14.5 billion by 2015, 14 per cent higher than the year before. This amount accounted for 52 per cent of industry's total R&D expenditure in 2015. Manufacturing industry's R&D expenditure amounted to NOK 10.1 billion. Growth was only one percentage point lower than for services, while the development in manufacturing has been relatively weaker in preceding years. *Other industries*, including *crude oil and gas extraction*, performed R&D for NOK 3.2 billion, corresponding to a 10 per cent increase from 2014.

However, development for individual enterprises varies considerably, regardless of industry and size group, as many enterprises report increased R&D activity while others have lower activity.

R&D activity in industrial sector is mainly carried out by the enterprise's own employees. Compensation

[1] SkatteFUNN is a tax-deduction fund. The figures from the R&D survey differ in absolute values from figures from the tax authorities. This is primarily because the R&D survey 2014 covers only enterprises with at least 10 employees and only a sample of enterprises with 10–49 employees. The R&D survey does not cover all industries. In addition, for SkatteFUNN enterprises participating in the R&D survey, amounts may have been reported for different period, and other amounts may have been reported. The figures from the tax authorities show that the total tax-deduction for R&D amounted to a total of NOK 2.9 billion in 2015.

Figure 2.14
Funding of R&D from SkatteFUNN and other public funding by size group. 2013, 2014 og 2015.



Source: Statistics Norway, R&D statistics

of own R&D personnel amounted to NOK 17.7 billion in 2015, which corresponds to 63 per cent of total R&D expenditure. Nevertheless, hiring external personnel to perform R&D in enterprises is becoming more widespread. Industrial sector's expenses for extramural R&D personnel amounted to NOK 2.8 billion in 2015, NOK 700 million more than in 2014, a 36 per cent growth. In 2009, the cost of hired personnel was 6 per cent of total R&D expenditure, and in 2015 the share increased to 10 per cent. There has been a gradual change over time, but the increase was highest in 2015. This increase in the use of hired personnel is also follows SkatteFUNN. Purchased labour costs in approved SkatteFUNN applications increased to 20 per cent of total budgeted R&D for 2015.

Important purchase of R&D services from abroad

In addition to performing R&D with own employees or hired personnel, many enterprises purchase R&D services from other actors. Expenditure for purchased R&D in the industrial sector was NOK 6.8 billion in 2015, an increase of 7.5 per cent from 2014. The acquisition of R&D services from other Norwegian enterprises amounted to 25 per cent. Research institutes, universities and university colleges accounted for 20 per cent. Purchases from foreign actors accounted for 49 per cent, over half of which are deliveries from foreign enterprises in their own group (28%).

Strong growth in SkatteFUNN funding

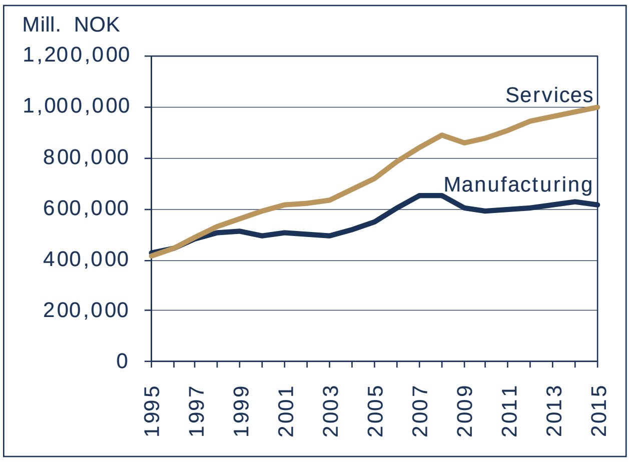
Enterprises largely finance R&D activity with their own funds, with more than 75 per cent of funding being sourced internally. When funding from other enterprises in the same group is included, the share is close to 90 per cent. Public funding, including SkatteFUNN, amounts to 9 per cent.

There has been a strong growth in the use of SkatteFUNN as a source of funding in the last two years, see Figure 2.14. The total tax deduction for R&D has more than doubled from 2013 to 2015. The increase must be related to the higher amount for R&D expenditure eligible for tax deductions; from a total of NOK 11 million in R&D spending in 2013 to NOK 33 million in 2015. However, only very few enterprises use this maximum amount. There are relatively few enterprises with such a high R&D activity.

Furthermore, the R&D statistics show that funding through SkatteFUNN was more extensive than other public funding in 2015; SkatteFUNN accounted for 13 per cent more than other public funding for R&D in the business enterprise sector. For enterprises with up to 200 employees, SkatteFUNN is clearly a more important source of funding than other public support, while for the largest enterprises, other public support is of greater importance. However, with the increased frames for tax deductions, it seems that larger enterprises are also starting to use SkatteFUNN more as funding for R&D.

Based on approved project applications for 2016, the growth in SkatteFUNN appears to continue. Budgeted costs increased by 30 per cent compared with 2015. Estimated tax deductions increase by 34 per cent to 4.6 billion. Actual costs usually account for 75–80 per cent of the budgeted costs. This will provide a tax deduction of just under NOK 4 billion.

Figure 2.15
Production in base value by main industry. 1995–2015. Fixed 2005 prices.



Source: Statistics Norway, National accounts

Sustained growth over a long period of time

There has been more or less sustained growth in industrial sector's R&D efforts in Norway since 1970. R&D spending peaked in 2008 but the impact of the financial crisis struck in 2009 and 2010. After 2010 there has been a clear growth in R&D expenses in the industrial sector. Annual real growth has been 3.2 per cent in the period 1995–2015.

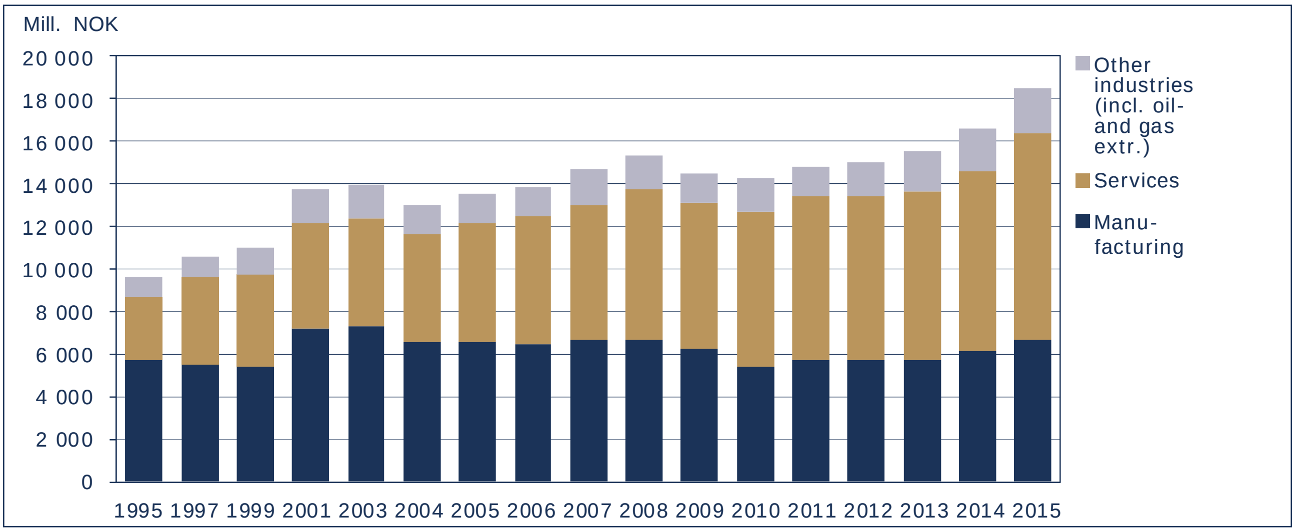
Manufacturing industry was the largest contributor to industrial sector R&D through the 1980s and 1990s and far into the 2000s. However, the share of the total has fallen gradually over a long period. For example, manufacturing industry accounted for 59 per cent of intramural R&D expenditure in 1995. In 2001, the corresponding share was reduced to 53 per cent and to 43 per cent in 2008. In 2015, the share was 36 per cent. Conversely, services have increased their share of the industrial sector's total R&D activity. In 1995, services accounted for 31 per cent of the total R&D activity and 37 per cent in 2001. In 2008, the proportion was for the first time higher than for manufacturing industry, 46 per cent. The share in 2015 was 52 per cent and has been relatively stable in recent years.

Stronger growth in service industries than in manufacturing

The shift from manufacturing industry to services in R&D activity must be seen in conjunction with development in overall activity in the industries. Figure 2.15 shows that the development in production in services has been clearly stronger than the trend in manufacturing. The figure includes the following industries within services: *Retail trade*, *Information and communication*, *finance and insurance*, *professional, scientific and technical services* and *business services*. This deviates somewhat from services included in the R&D survey, but does not change the overall picture.

A large part of the change between manufacturing and services is real, in the sense that activity in manufacturing is reduced or closed down, while new industries within services have grown. But part of the shift is also due to reclassification from manufacturing to services. This is because, among other things, support functions such as IT, have become outsourced to enterprises classified under services. The distinction between goods and services is also not as sharp as before, and the development of new products with new features can be reclassified as a service and not as a product. To quantify the extent of these changes is difficult.

Figure 2.16
R&D expenditure in the industrial sector by main industry. 1995–2015. Fixed 2005 prices.



Source: Statistics Norway, R&D statistics

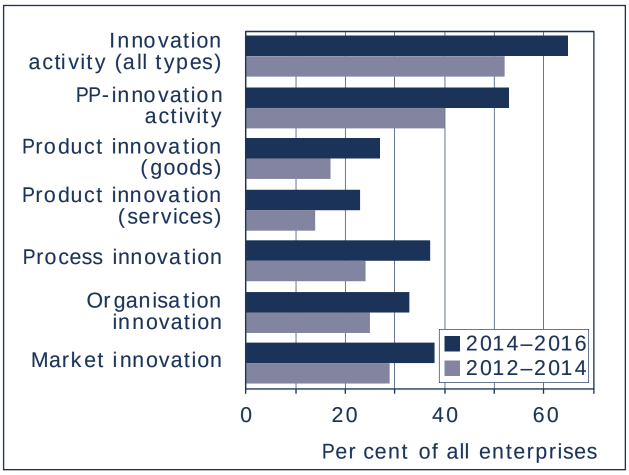
Table 2.3
Innovation activity by type. 2001–2016. Share of population.[1]

Year of survey	Product- and/or process innovation	Product innovation	Process innovation
2001	33	31	23
2004	31	25	19
2006	31	24	19
2008	27	21	17
2010	24	19	14
2012	21	17	11
2013	37	29	24
2014	39	30	26
2016	53	39	38

[1] Population is adjusted for comparability.

Source: Statistics Norway, Innovation survey

Figure 2.17
Types of innovation activity in the industrial sector. 2012–2014 and 2014–2016.



Source: Statistics Norway, Innovation survey

More Norwegian innovators after a changed survey design

For Norway's part, the results of the Innovation Survey have shown that the number of innovative enterprises gradually decreased in the 2000s to 2012, see Table 2.3. There is no simple explanation for this, but overall it is challenging to measure innovation. One possible reason for this decline may be that many enterprises went from dedicated internal R&D departments to integrating innovation activity in all parts of the enterprise. Thus, the innovation activity became more difficult to capture in such a survey. In 2013 and 2014, there was a positive shift in the proportion of innovative enterprises. However, this was a consequence of the fact that the innovation survey was made separately and thus more decoupled from the R&D concept. The survey thus includes several non-R&D innovators, who have a greater degree of «low technology» innovation, perhaps especially in services and processes. This has also improved Norway's position on international innovation indexes, where the innovation survey is one of the sources.

Almost two thirds of enterprises renew themselves

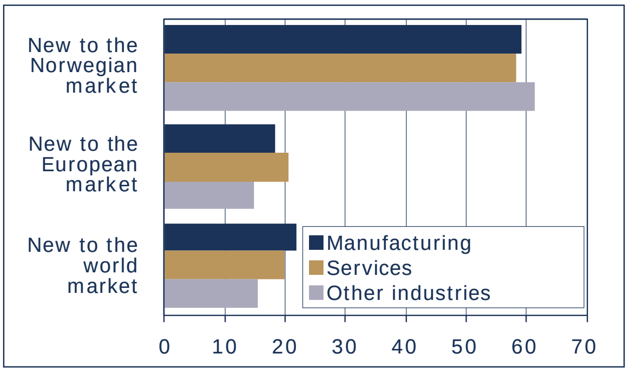
In the latest innovation survey, the results show that 65 per cent of Norwegian enterprises included in the survey reported innovation activity in the period 2014–2016. This is significantly higher than in the period 2012–2014, see Figure 2.17.

The main criterion for something to be considered as an innovation in the survey is that it is the «*introduction of new or considerably improved products or processes*», see definition at the beginning of Chapter 2. An innovation must be put into use at the enterprise or introduced in the enterprise's market. It is not a requirement that an innovation must be new as such, or new to the market. Neither does it need to be developed by the enterprise itself. For the industrial sector, the increase in the proportion of enterprises reporting innovations varies between 8 and 13 percentage points for the four main types of innovation; product, process, organisational and market innovation. The increased proportion of enterprises reporting to be innovative applies to the entire industrial sector, both by main industry and size group. On a more detailed level of industry, there are greater variations, but there also is a tendency for a higher proportion of innovative enterprises than before.

More innovators explain the shift of innovation activities

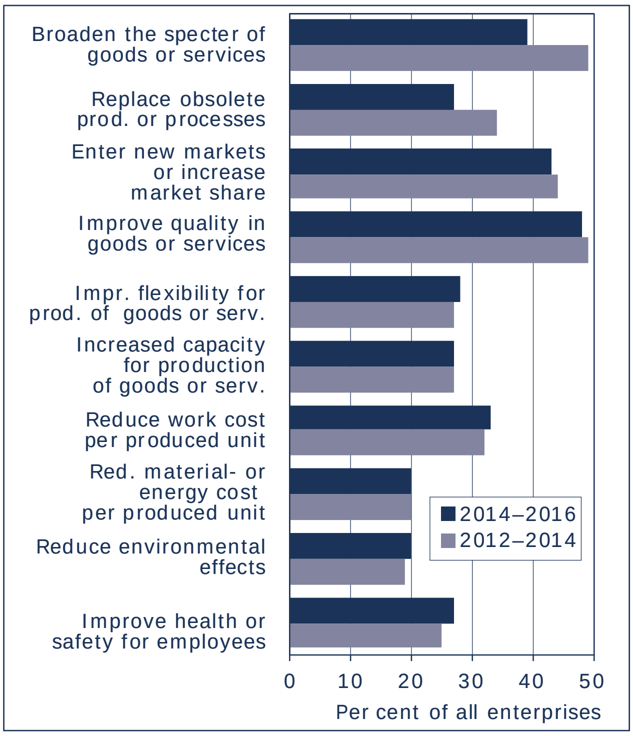
The before-mentioned increase in the number of innovative enterprises has also affected the composition of the various reported innovation activities. As a whole, a lower proportion of innovators reported

Figure 2.18
Product innovation new to the enterprise's market. 2014–2016.



Source: Statistics Norway, Innovation survey

Figure 2.19
Very important purposes with innovation activity in the industrial sector. 2014–2016.



Source: Statistics Norway, Innovation survey

knowledge-related activities such as intramural R&D, acquisition of R&D services and acquisition of other external knowledge. At the same time, the proportion of enterprises reporting activity in the purchase of machinery, equipment and software and other innovation activities, such as design and competence building among employees, has increased.

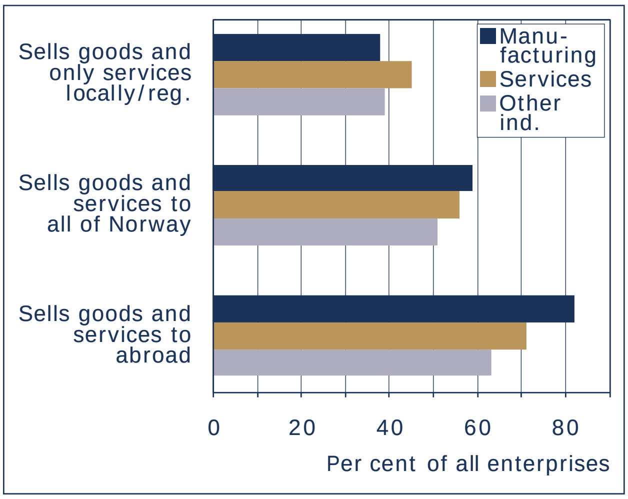
Unchanged for innovations new to the market

For product innovations, the increase in innovation activity is mainly due to innovations that are new only to the enterprise, but not new to the enterprise's market. Compared with the total population, there is a slight increase in product innovations that were new to the market, but as a share of the number of product innovators the proportion has decreased.

As in previous surveys, enterprises stating that they have developed at least one of their innovations themselves are the most common, followed by innovations developed in collaboration with other enterprises in their own corporate group. This applies to goods, services and processes. Cooperation on innovation development or the use of innovations mainly developed by others is, however, somewhat more common for process innovation.

For market innovations, it is primarily the use of new media or new ways of promotion that drive the

Figure 2.20
Enterprises' innovation activity and market orientation. 2014–2016.



Source: Statistics Norway, Innovation survey

increase in the proportion of innovators, while for organisational innovations there is a steeper increase for all types. The number of enterprises with organisational and market innovations increases for enterprises with and without PP innovation activity.

Purpose of innovation activities

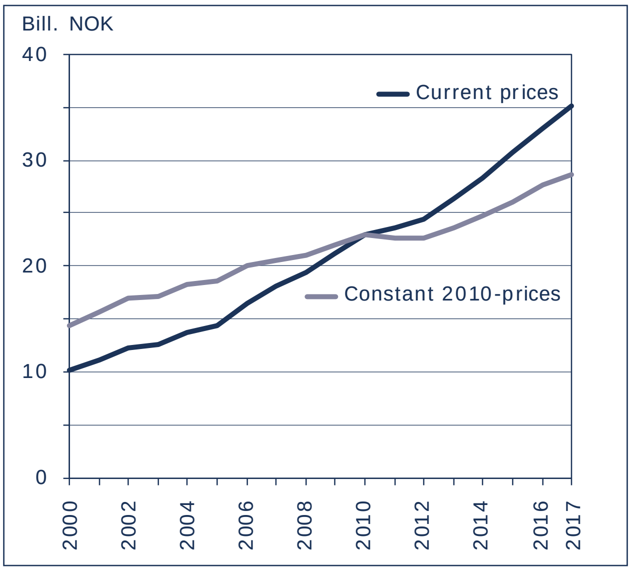
There are no major changes in the purpose of innovation activities, i.e. the effects the enterprises want to achieve with the innovation work (Figure 2.19). Most innovation goals increase steadily with the increase in the number of innovators.

For purposes that are stated to be very important, it is to enter new markets or increase market share, or to improve the quality of goods or services, which is most commonly reported by the companies. The least-reported goal is reducing material or energy costs per unit produced and reducing environmental impact, although these are important purposes in some industries.

Market orientation affects innovation flexibility

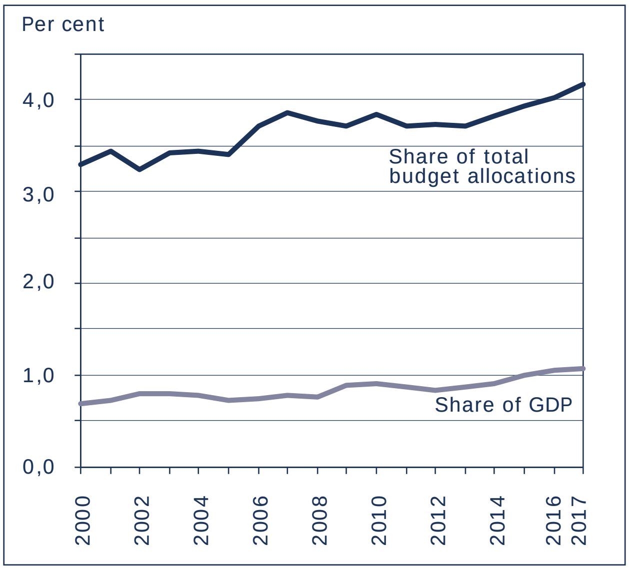
The larger the markets the enterprises operate in, the greater their chances of being innovative. Enterprises selling their goods or services throughout Norway have a significantly higher proportion of innovators than enterprises that operate only locally or regionally, see Figure 2.20. Enterprises selling goods or services (also) abroad have a higher innovation share than the enterprises with only a national market. This applies regardless of enterprise size and in all major industries, but the trend is strongest in manufacturing industry.

Figure 2.21
Government budget allocations for R&D. 2000–2017. Current and fixed 2010 prices.



Source: NIFU, GBARD

Figure 2.22
Government budget allocations for R&D as a share of GDP and as a share of total state budget allocations. 2000–2017.



Source: NIFU, GBARD

Five budgets in a row with high real growth

NIFU's analysis of the Norwegian state budget for 2017 identifies funding for research and development at NOK 35.1 billion, see Figure 2.21. This entails a growth of around NOK 2.1 billion compared with the adopted budget for 2016, which gives a nominal increase of 6.4 per cent. With the current assumptions of expected wage and price growth, the 2017 budget will lead to a real growth in government budget allocations for R&D of about 4 per cent.

2017 is the fifth fiscal year in a row with a significant real growth in GBARD. Since 2013, these R&D allocations have had an annual average real growth rate of just under 5 per cent.

Record high R&D relative to GDP

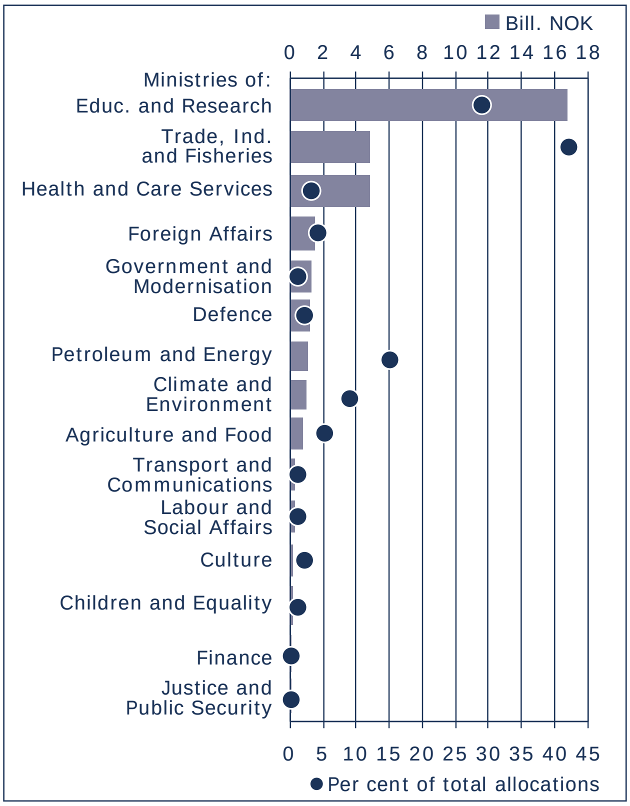
The development in R&D appropriations as a share of gross domestic product (GDP) expresses the relationship between public investment in R&D and society's total value added. The R&D appropriations in the adopted state budget for 2017 are estimated as 1.07 per cent of GDP, an increase from 1.06 per cent in 2016. The GDP ratio in 2017 is the highest ever.

Strong concentration on few departments

The state budget analysis calculates R&D on more than 130 spending chapters in the state budget. All ministries have R&D grants targeted at challenges in their sectors, but there are major differences in the size of the ministries' appropriations for the purpose.

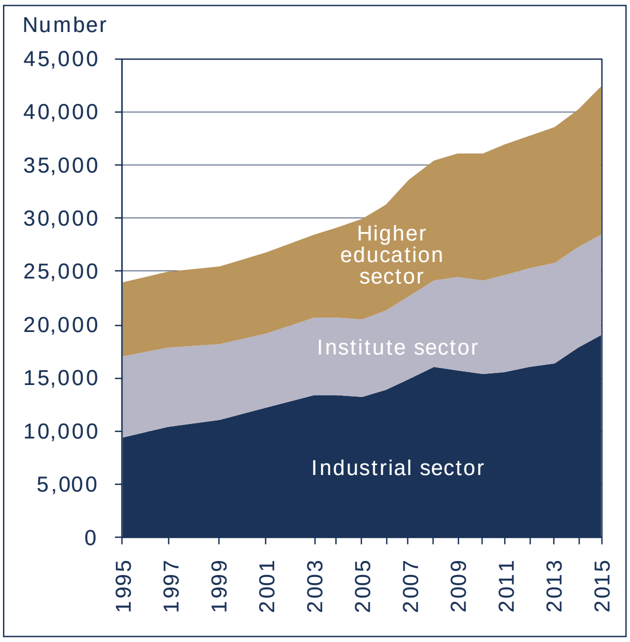
A significant part of R&D grants is channelled over the budgets of a few departments (see Figure 2.23).

Figure 2.23
Government budget allocations for R&D in 2017 by funding ministry. Billion NOK (upper axis) and as a percentage of the ministry's total allocations (bottom axis).



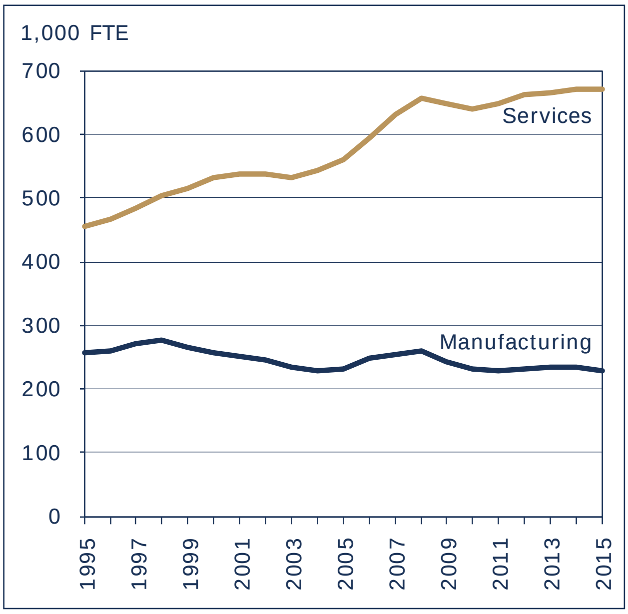
Source: NIFU, GBARD

Figure 2.24
R&D full time equivalents in Norway by performing sector. 1995–2015.



Source: Statistics Norway/NIFU, R&D statistics

Figure 2.25
Full time equivalents for employees and self-employed in services and industry. 1995–2015.



Source: Statistics Norway, National accounts

In total, over 42,000 R&D full time equivalents (FTE) in Norway were carried out in 2015. The number of FTE spent on R&D has increased by 2,000, or 5 per cent, from 2014. The growth in FTEs from 2014 to 2015 is highest in the industrial sector, with about 1,100 more R&D FTE, or just over 6 per cent. In the higher education sector, the growth in the number of R&D FTE is around 900 (7%). After a slight decline from 2013 to 2014 in the institute sector, due in part to organisational changes and mergers, there is a slight increase in the number of R&D FTE in this sector (0.2%).

In Norway, there has been a large increase in the number of R&D FTE in the last 20 years, see Figure 2.24, from just over 24,000 R&D FTE in 1995 to over 42,400 R&D FTE in 2015. At the same time, R&D expenditure had a real growth rate of 86 per cent. Comparing 2015 with 1995, both the industrial and the higher education sectors have more than doubled the number of R&D FTE, while the growth in the institute sector has been more moderate (23%).

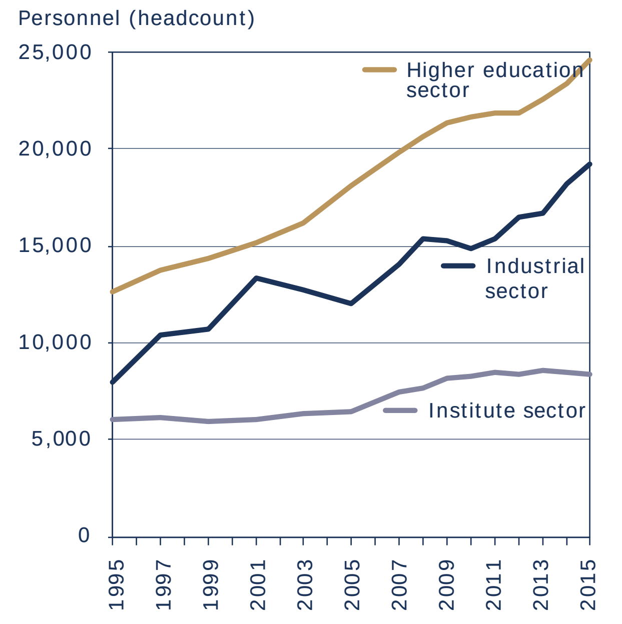
The industrial sector is the largest sector when measured in R&D FTE, with a share of nearly 40 per cent of the total R&D FTE in 1995, and 45 per cent by 2015. For the institute sector and the higher education sector, the picture has changed over the twenty-year period. In 1995, the institute sector was larger than the higher education sector, with 32 and 29 per cent of the total R&D FTE. However, from 1995, the proportion of R&D FTE in the institute sector fell, and in 1997 the higher education sector was for the first time larger than the institute sector. The growth in R&D FTE in the institute sector was relatively moderate until 2015, while the higher education sector experienced a somewhat larger increase. By 2015, 22 per cent of R&D FTE were carried out in the institute sector, while the higher education sector had a 33 per cent share.

In the industrial sector, there has been a clear shift in R&D activity in favour of services, which must be seen in conjunction with developments in overall activity in manufacturing. Figure 2.25 shows the development in total R&D FTE collected for these main industries.

The number of researchers in Norway almost doubled from 1995 to 2015

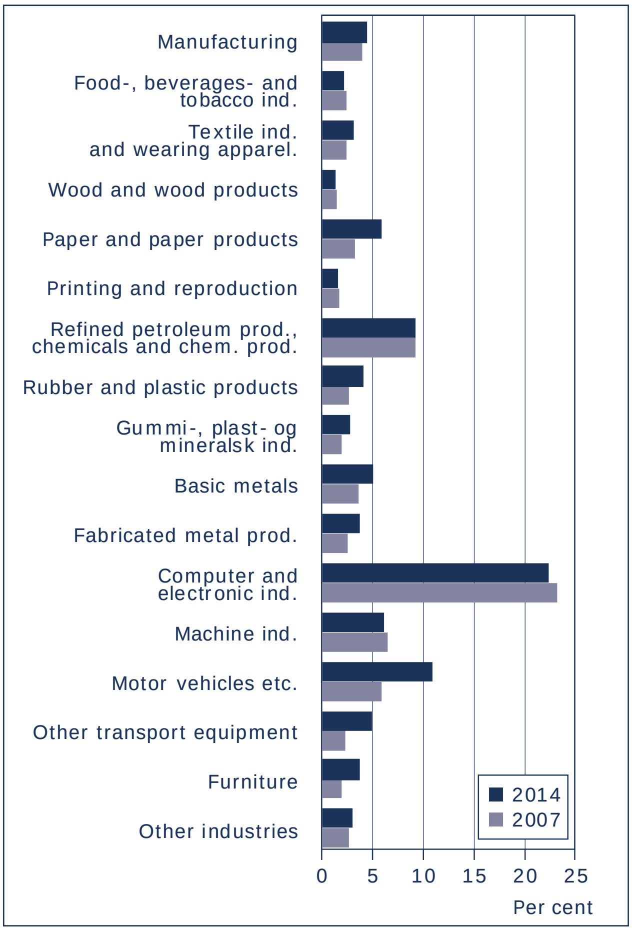
By 2015, more than 76,000 people participated in R&D in Norway. This includes both researchers and technical/administrative staff. Of these, 33,000 were employed in the higher education sector, 31,000 in the industrial sector, and about 12,000 in the institute sector. Overall, the number of participants in R&D increased by 35,000 since 1995, an increase of almost 90 per cent; this is somewhat higher than the growth in the number of R&D FTE, which is 75 per cent. This means that, on average, each person spent a smaller share of working time on R&D by 2015 than in 1995. Growth in R&D personnel has been highest in the industrial sector, with about 18,000 people. The higher education sector has grown by 15,000 people,

Figure 2.26
Number of researchers in Norway by performing sector. 1995–2015.



Source: Statistics Norway/NIFU, R&D statistics

Figure 2.27
Number of R&D personnel as a share of number of employees in selected manufacturing industries. 2007 and 2014.



Source: Statistics Norway, R&D statistics and Structural statistics for manufacturing industries

while the institute sector's increase is around 2,000 people in the period.

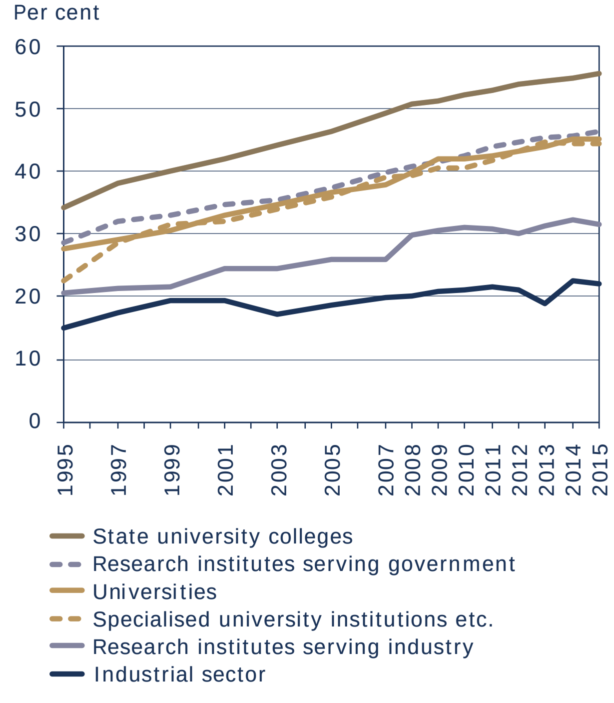
The number of researchers has increased from almost 27,000 in 1995 to over 52,000 in 2015. The highest growth is found in the industrial and higher education sectors, where the number of researchers has almost doubled in the period. At the same time, the institute sector has experienced a more moderate growth rate of almost 40 per cent. Over the twenty years from 1995 to 2015, the share of the technical/administrative R&D staff has decreased from 35 to 32 per cent, but there are major differences between the sectors. In the industrial sector, there were relatively more technical/administrative staff in 2015 than in 1995, while the other two sectors had a lower share of staff in this group at the end of the period than in the beginning.

Figure 2.26 shows the development of the number of researchers in the period 1995–2015. The growth curve for industrial sector is characterised by fluctuations. The government's commitment to recruitment positions in the early 2000s contributes to the increase in the higher education sector, but the highest percentage growth has been for the group of postdocs and researchers employed on projects. Research staff in the institute sector has remained relatively stable during the period, but the sector has had a slight decline in the number of researchers in recent years. This is partly due to mergers between research institutes and higher education institutions.

Computer and electronic industries have the highest proportion of R&D personnel

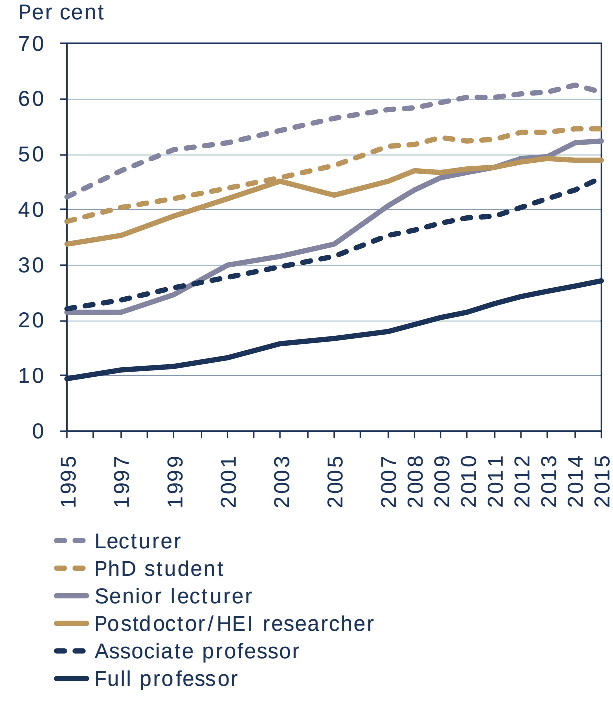
Figure 2.27 shows the ratio between the number of R&D personnel and the number of employees in total in important R&D industries in 2007 and 2014. The figure shows that there are significant variations in this ratio between industries from the average of 4–4.5 per cent. The highest proportion is *computer and electronic industry*, which is still one of the industries with a slight decline in R&D personnel in relation to total employment. Industries with by higher proportion of R&D personnel in relation to the total number of people are *motor vehicles etc*. The industry includes parts and equipment for motor vehicles, and the construction of ships and oil platforms. The number of R&D personnel has increased, while the total number of employed has been stable. In the *paper and paper products*- and *basic metals*, there has been a significant decline in the number of employed without a corresponding decrease in R&D personnel.

Figure 2.28
Share of female researchers by type of institution. 1995–2015.



Source: Statistics Norway/NIFU, R&D statistics

Figure 2.29
Share of women by selected tenured positions. 1995–2015.



Source: NIFU, Register of research personnel

In 2015, more than 52,000 researchers participated in R&D in Norway. Of these, 19,500, or 37 per cent, were women. The highest proportion of women were in the state university colleges (56%), the lowest in the industrial sector (22%), see Figure 2.28. Public-oriented research institutes, universities and university colleges all had around 45 per cent women by 2015. At the research institutes serving enterprises, women accounted for about one third of the research staff in 2015. Since 2008, the state university colleges are the only type of institution where women constitute more than half of the researchers.

Health trusts with university hospital functions are added to universities in Figure 2.28. Women accounted for 50 per cent of the research staff in university hospitals in 2015. In other health trusts (included in institutes serving government), the share of women was 51 per cent in 2015.

In 1995, the share of female researchers was 24 per cent, i.e. 13 percentage points less than in 2015. The state university colleges also had the highest share of women 20 years ago, by about one third, while both the universities and the public-oriented research institutes had less than 30 per cent women. The share of women has increased steadily over the past 20 years. In the industrial sector, the share of female researchers increased from 15 to 22 per cent between 1995 and 2015.

The women share increases at all positions at Norwegian higher education institutions

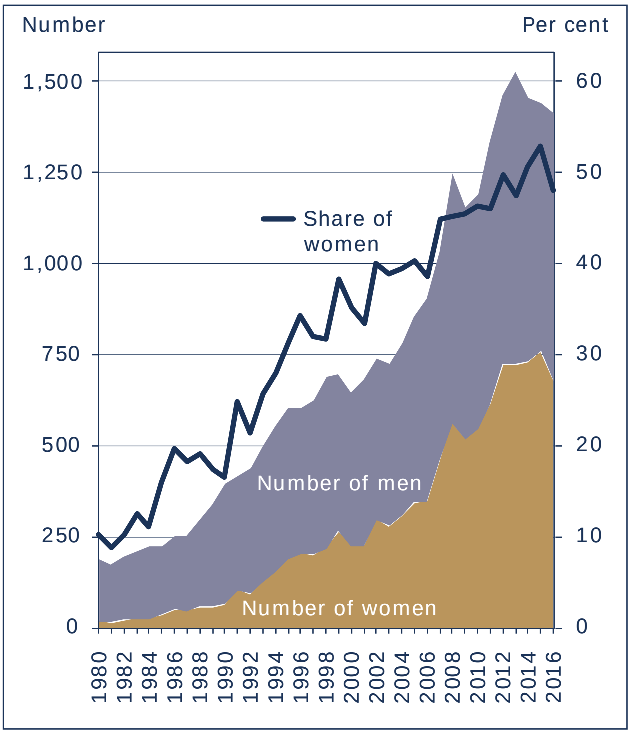
Between 1995 and 2015, the number of people holding academic and research positions at universities, university colleges and university hospitals has increased from 12,300 to 24,600, and in the same period, the number of women has increased from 3,600 to 11,700.

Professors have had the lowest share of women throughout the period, while lecturers have had the highest, see Figure 2.29. For both types of positions, the share of women has increased relatively evenly over the last 20 years; lecturers from 42 per cent to 61 per cent, and professors from 10 to 27 per cent.

Associate professors and senior lecturers had about the same female share in 1995, just over 20 per cent, but while there has been relatively stable growth among associate professors from 2005 to 2007, we see a significant growth for senior lecturers.

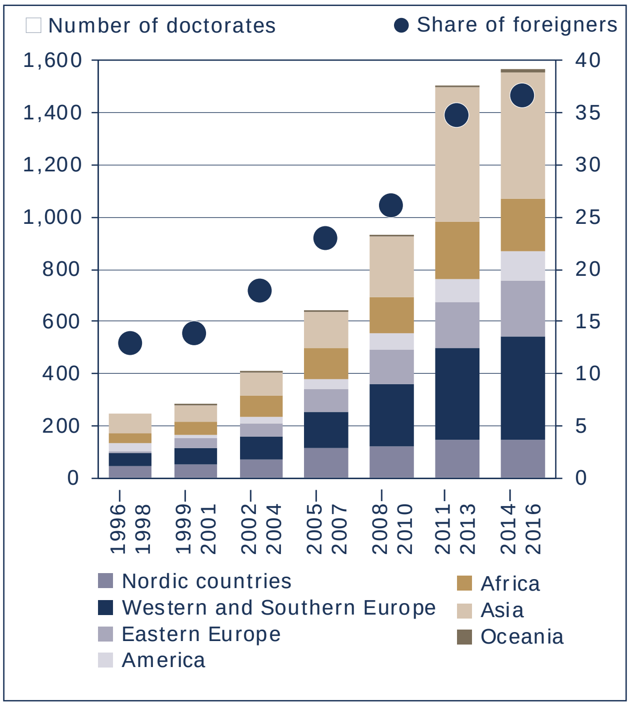
The share of women among research fellows has increased from 38 per cent in 1995 to 55 per cent in 2015. Most PhD students were women in 2007, but it was not until 2014 that there were more female than male PhD graduates. Every third postdoc and researcher employed on a project was a woman in 1995. 20 years later, women's share was 49 per cent in these positions.

Figure 2.30
Doctorates by gender. Share of women. 1980–2016.



Source: NIFU, Doctoral degree register

Figure 2.31
Number of doctoral degrees with foreign citizenship by world region. Percentage of foreign citizenship. 1996–2016.



Source: NIFU, Doctoral degree register

Over the past 20 years, major changes have been made in Norwegian doctoral education. The degree structure has been redesigned, several institutions are accredited to award doctorates, and the public commitment to recruitment positions has been successively increased. These are factors that contribute to a significant increase in the number of doctoral degrees.

In recent years, 1,400–1,500 doctoral degrees have been awarded at Norwegian higher education institutions, see Figure 2.9.11. The peak year for the number of graduates was 2013, when 1,524 people graduated as PhD. The number of doctorates has more than doubled since the latter half of the 1990s, when there were 600–700 PhD theses per year.

A third of women doctorates 20 years ago – even gender balance in recent years

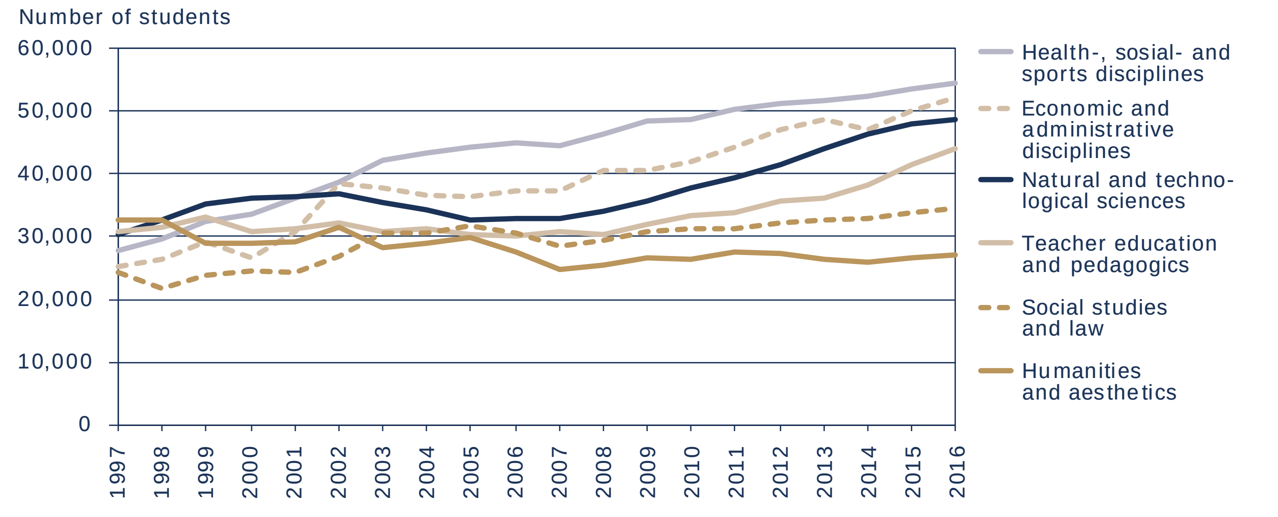
At the beginning of the 1980s nine out of ten doctoral students were men. During the 1980s and during the first half of the 1990s, more women took a doctoral degree, and in the middle of the 1990s about one third of the doctoral degrees were taken by women. The share was quite stable for some years before it continued to grow after the turn of the millennium. Since 2012, the proportion of women among PhD students is between 47 and 53 per cent annually, see Figure 2.30. However, there are still major differences in gender balance between fields of science.

Seven times as many foreign PhD students as 20 years ago

An increasing number of foreign nationals are taking their doctoral degree at Norwegian higher education institutions. Twenty years ago, there were about 80 awarded doctorates with a foreign background annually in Norway. In recent years, the number has passed 500 each year. This means that the proportion of foreign PhD students has increased, from just over 10 per cent in the last half of the 1990s to 38 per cent in 2016, see Figure 2.31.

The rate of foreigners is highest in engineering and technology, with two thirds of doctorates in recent years. Foreigners also constitute the majority within natural sciences, agricultural sciences, with just over half of the thesis defences. In other fields of science, foreign citizens account for about a quarter of the degrees.

Figure 2.32
Number of students by discipline. 1997–2016.



Source: Statistics Norway

One out of three young people study

By 2016, the total number of students in Norwegian higher education was 273,227, which means a 50 per cent increase compared with 1997 when the student number was 181,004. In the first half of the 20-year period, there was moderate growth in student numbers, while the second half of the period was characterised by a sharp increase. In the period, the share of students in the age group 19–24 years has increased from 28 per cent in 1997 to 35 per cent in 2016. However, it appears that the propensity to study in the age group 19–24 years was around 28–30 per cent until 2009, in other words relatively stable, while the increase has been in the last five to six years. Overall, one in three people aged 19–24 years old studies in a higher education institution.

Largest student growth at the universities

In the first half of the period 1997–2016, university colleges had the largest increase in the number of students, from about 96,500 students in 1997 to over 130,000 students in 2004. During this period, the number of students at universities and specialised university institutions was stable, at around 80,000. From 2005 there have been major changes; state university colleges have become universities and there have been mergers. This has consequences for student balance at universities/specialised university institutions and university colleges. From 2005 to 2016, the number of students at university colleges varied between 100,000 and 124,000, while the number of students at institutions with university status increased from 88,000 in 2005 to almost 173,000 in 2016 – just over double.

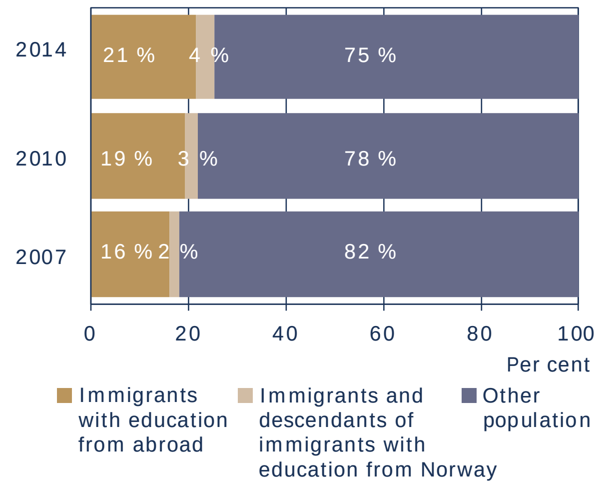
From majority to minority for students in the humanities

It is not only the distribution of students between universities and colleges that has changed in the twenty-year period, as there has also been a change in which subjects students choose, see Figure 2.32. In 1997, most students were in *humanities and aesthetics* subjects, and fewest students in *social science/law subjects and economics*. The relative variations between the various subjects were also quite small; the smallest disciplines had about 25,000 students, while the largest – *humanities and aesthetics* – had just under 33,000 students.

By 2016, the picture had changed completely. *Humanities and aesthetics* are now the smallest discipline, with only 26,000–27,000 students, while the health, social and sports subjects and economics are the two largest. The two latter subject areas both have more than 50,000 students. *Health, social and sports subjects* are the only subject areas that have experienced relatively strong growth throughout the period, but all disciplines, except *humanities and aesthetics*, have grown compared with 20 years earlier. Early in the period, around 2000, growth appeared particularly in economics and administrative subjects and social subjects/legal subjects, in addition to health, social and sports subjects, while all other subjects were stable.

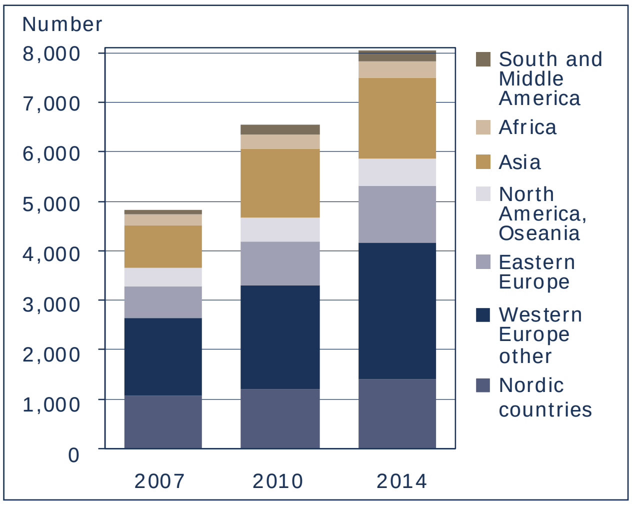
From 2008 onwards, especially in the field of economics, natural sciences and engineering, as well as *teacher education/pedagogy*, there is a strong increase in the number of students, while there is more moderate growth in social science/legal subjects.

Figure 2.33
Research personnel in Norway by immigration status and immigration background. 2007, 2010 and 2014.



Source: NIFU/Statistics Norway, Diversity statistics (Mangfoldstatistikk)

Figure 2.34
Research personnel in Norway by immigration background and country/region of origin. 2007, 2010 and 2014.



Source: NIFU/Statistics Norway, Diversity statistics (Mangfoldstatistikk)

In 2014, one quarter of the researchers at Norwegian universities, university colleges, research institutes and health trusts were immigrants or descendants of immigrants, see Figure 2.33. Immigrants with education from abroad, so-called mobile researchers, accounted for 21 per cent, while immigrants with education from Norway accounted for 3.4 per cent. Descendants of immigrants constituted 0.5 percentage points.

The proportion of immigrants among researchers has increased steadily from 18 per cent in 2007 and 22 per cent in 2010. The growth has been highest for immigrants with education from abroad; somewhat more moderate for immigrants with education from Norway, while the proportion of descendants of immigrants has remained unchanged during the period.

Growth in the proportion of researchers from non-western countries

The largest group of researchers with immigrant background at universities, university colleges, research institutes and health trusts have their background from Western Europe (outside the Nordic region). The share has been stable around 33 per cent from 2007 to 2014, see Figure 2.9.22. The largest group in 2014 had their background from Asian countries. Researchers from the other Nordic countries were the third largest group in 2014 with 17 per cent of immigrants in academia.

The proportion of researchers and academic staff from Eastern Europe has remained stable at 13 per cent, while the share from North America and Oceania has fallen slightly. Four per cent of the researchers and the academic staff had backgrounds from Africa, while the share from South and Central America increased from two to three per cent between 2007 and 2014. In total, the proportion of researchers from non-western countries increased from 38 per cent in 2007 to 41 per cent in 2014, while the proportion from other countries decreased accordingly.

The Diversity statistics (Mangfoldstatistikken)

The Diversity statistics provide an overview of immigrants and descendants from immigrants among researchers, as well as higher technical and administrative staff, within Norwegian research and higher education institutions for the years 2007, 2010 and 2014. The statistics include the higher education sector and the institute sector, including health trusts and private, non-profit hospitals.

The approach to diversity statistics is twofold. On the one hand, international mobility among researchers is monitored, i.e. those who come to Norway either with a doctorate or to take a doctoral degree. The second approach is to follow immigrants, as well as descendants of immigrants, whose entire education has been in Norway.

NIFU and Statistics Norway have prepared the diversity statistics on behalf of the Ministry of Education and Research, based on input from the Committee on Gender Balance and Diversity in Research (KIF Committee)

Diversity statistics are presented in NIFU's R&D statistics bank, see www.foustatistikkbanken.no - Diversity statistics.

3 Knowledge sharing and cooperation

Dag W. Aksnes, Fredrik Piro, Gunnar Sivertsen, Espen Solberg, Elisabeth Wiker, Lars Wilhelmsen

Foreign R&D funding and cooperation

- In 2015, almost 10 per cent of Norwegian research was financed from abroad. The proportion of foreign funding has doubled over the last 20 years and is on a par with the EU average.
- In most countries, between 5 and 15 per cent of the national R&D effort is funded by foreign sources. In general, large countries have low shares, while small countries have high shares.
- A large share of international research cooperation does not result in financing from abroad. Norwegian universities and university colleges state that more than 40 per cent of R&D activity involves international project cooperation, while only 3–4 per cent is funded from abroad.

R&D cooperation within the EU framework programmes for research

- Over the past 20 years, the EU framework programmes have evolved into a significant arena for European R&D cooperation. The total budget for the current programme (Horizon 2020) is close to €70 billion.
- Traditionally, Norwegian research institutes has thushave accounted for the largest proportion of Norway's EU funds. So far in Horizon 2020 the higher education sector has the highest share of such funding, with 34 per cent of Norway's funds.
- Norway's two main partner countries in Horizon 2020 are Germany and the United Kingdom. In total, 19 per cent of Norway's partners come from these two countries.

Cooperation on scientific publishing

- By 2016, 66 per cent of Norwegian scientific publications had international co-authors, a significant increase from from 17 per cent in 1981.
- The United States is still Norway's largest partner in scientific publishing, followed by United Kingdom and Sweden. But collaboration with United Kingdom is becoming more important than the United States.
- International co-authorship is most prevalent in medical and health sciences, natural sciences and engeneering and technology. In the humanities, the proportion is significantly lower, but in these disciplines a large share of publication activity is not captured in international bibliometric databases.
- Articles with international cooperation are noticeably more cited than articles with authors from one country. This applies to most countries, Norway included.

Cooperation between research institutions and the industrial sector

- More than one third of Norwegian enterprises participate in R&D cooperation projects. Collaboration with suppliers is most prevalent and is reported by 4 per cent of the enterprises with R&D cooperation. Customers (34%), universities or colleges (34%) and research institutes (27%) are also frequent partners.
- Small enterprises collaborate most with customers and suppliers, while large enterprises have more collaboration with researchers at higher education institutions and research institutes.
- A large share the research activities at higher education institutions and research institutes is reported to be relevant for industry. Universities state such relevance for around a quarter of their research, while the share of enterprise funding is only 3–4 per cent.
- The proportion of industry-relevant research is clearly highest among research institutes. Approximately 60 per cent of their research is reported to be of such relevance in 2015, while about 20 per cent of their funds came from business enterprises.

International student mobility

- International student mobility has increased significantly in recent decades. Previously, the number of Norwegian students travelling abroad was higher than the number of foreign students coming to Norway. Today, Norway has a more balanced student exchange.
- In the 1960s and 1970s countries on the European continent were popular, not least German-speaking countries. Today, nine out of ten graduate students choose countries where the language of teaching is English or Scandinavian. The United Kingdom, Denmark and the United States are the most popular countries among Norwegian students.

A well-functioning R&D and innovation system depends on collaboration and knowledge-sharing. Several factors indicate that there is substantial cooperation in the Norwegian system. In this chapter, we look at different indicators to provide a picture of the extent and patterns of cooperation and knowledge sharing.

More open research

In international and particularly in European research policy, there is increasing emphasis on the need for open research environments. New digital tools and solutions provide new opportunities for collaboration on the development of new knowledge, between researchers, between researchers and society, and between researchers and industry. The European Commission has summarised this in the so-called three Os: «Open Innovation», «Open Science» and «Open to the World». These openness dimensions are central to the design of the EU's next framework research programme, which Norway has supported. An important point in this context is that research should not only be communicated to society but be in contact with community actors and community needs throughout the research process.

Extensive international cooperation

Research increasingly involves international cooperation. This constitutes one of the most significant structural changes in the way research is conducted over the past decades. The development is universal and includes most countries. Not least, we see this as a clear trend in the Norwegian system. About one in every ten NOK spent on R&D in Norway is financed from abroad. This share has doubled over the past 20 years. Furthermore, participation in the EU research framework programmes has increased significantly over the same period. This year we also present new data which display extensive involvement in international project work among Norwegian R&D institutions. Much of this cooperation does not result in financial transactions, and thus often not captured by traditional indicators of cooperation.

Potential for more business cooperation

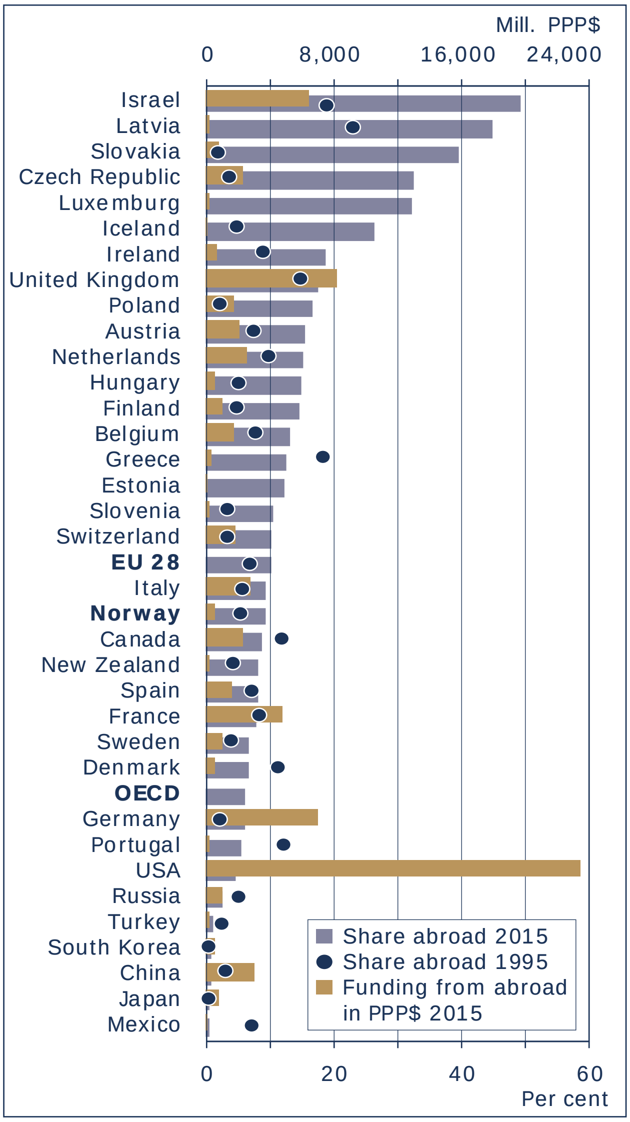
Cooperation between research institutions and industry is important for research to contribute to innovation, business development and value creation. Often, such cooperation is measured by looking at how much R&D industry buys from other sectors. This gives a narrow picture of cooperation. In this chapter, we also look at the institutions' own estimates of how much research they consider relevant to industry. Although these data are based on self-reported estimates, they may provide a broader and more adequate picture of research-industry relationships.

International co-authorship is the rule

In this chapter, we also illustrate research collaboration through scientific co-authorship and other publishing. The figures show that Norwegian researchers are increasingly publishing their research in cooperation with colleagues in other countries. Today this is the main rule, rather than the exception. The geographical cooperation profile is also changing. Although the United States and other Scandinavian countries remain important, cooperation with the UK and other European countries is increasing.

In addition, this chapter also contains figures for international student exchange.

Figure 3.1
R&D expenditure funded from abroad in selected countries in 2015 (upper x-axis) and share of total R&D expenditure 1995 and 2015 (lower x-axis).



Source: OECD – MSTI 2017:1

International cooperation is central to spreading and sharing knowledge. An expression of this is the share of the nationally-performed research funded by foreign sources. Although this is a narrow measure of such cooperation, but it may indicate the degree of international cooperation in the R&D system.

Increased foreign R&D-funding

As shown in Figure 3.1, most countries receive 5–15 per cent of the national R&D funding from foreign sources. The average for the EU 28 countries is 10 per cent. In a twenty-year perspective, shares of foreign funding have increased for most countries. This development reflects both internationalisation of research, and that this cooperation has become more formalised, notably through the expansion of the EU. Some countries, especially Russia and China, have reduced their share of foreign R&D funding. This may be due to the changed reporting and classification of funding, but may also reflect real changes.

In some western countries the share of international funding hav decreased (e.g. Canada, Denmark, Portugal and Greece). All these countries had a relatively high percentage of foreign funding twenty years ago. Among all countries with more than 10 per cent foreign funding in 1995, only the shares of United Kingdom and Israel have increased further.

Among the other Nordic countries, Finland has had the strongest growth in the share of international funding, which is partly due to Microsoft's acquisition of Nokia's mobile production. In Norway, the share has also increased, from around 5 per cent in 1995 to almost 10 per cent in 2015. In Norway, the growth has been particularly strong over the past two years, and this development has mainly been driven by increased foreign R&D funding in Norwegian enterprises.

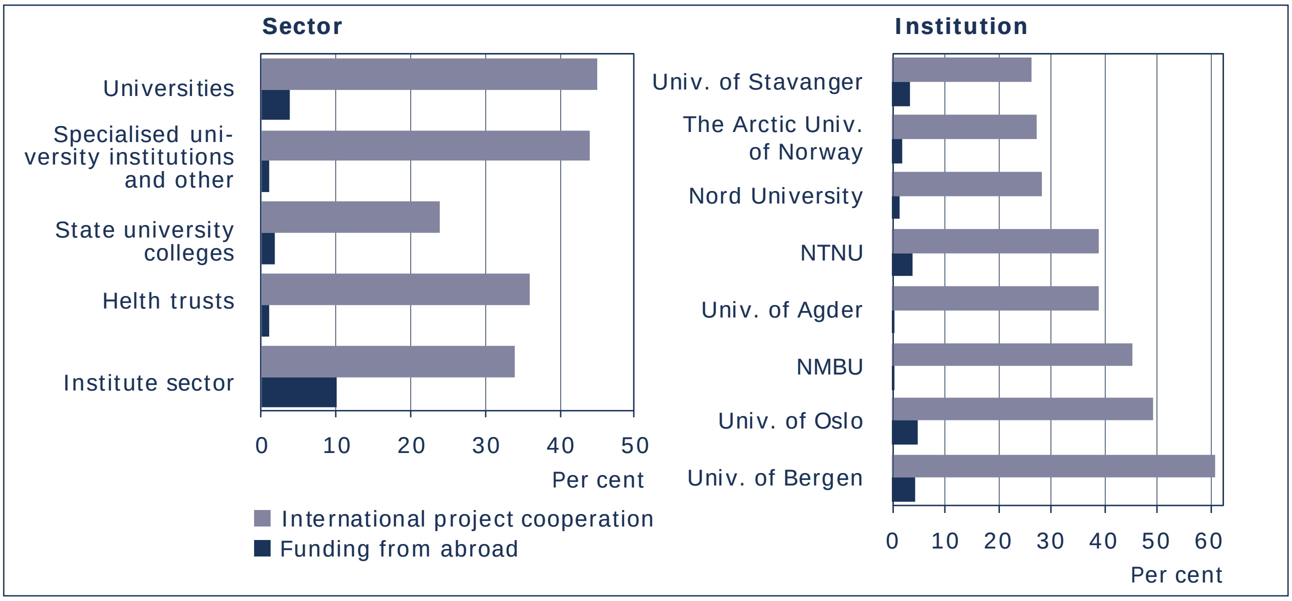
Large countries – low share of foreign funding

In general, we see that foreign R&D funding is less important for large countries. Both in the US, China, Japan, Korea and Germany, less than 5 per cent of the national R&D efforts are funded from abroad. However, as the figure also shows (upper x axis), the volume of foreign funding is clearly the largest among R&D superpowers like the United States, Germany, France and the United Kingdom. The UK has both a high proportion and a high volume of foreign funding. An explanation for this is that many multinational enterprises have put their R&D activity to the UK. The same is true for Ireland and especially Israel, where almost half of all R&D in the country is funded from abroad.

Foreign research funding most prominent in industry

In most countries, the largest share of foreign funds is found in the industry sector, while such funding accounts for a relatively small proportion of funding in the higher education sector. In some Eastern European countries however, higher education sector institutions draw a relatively large share of their research resources from international sources. This includes funds from the EU Structural Funds and, in part, EU framework programmes. In small R&D nations, such funding may be relatively important as access to national sources could be more limited.

Figure 3.2
R&D funding from abroad as a share of total R&D and share of international project cooperation as a share of total activity in 2015 by sector and university.



Source: NIFU, R&D statistics

R&D cooperation across national borders does not always result in international funding. To get a broader picture of international cooperation, the respondents to Norwegian R&D statistics surveys in recent years have been asked to discretely state the proportion of R&D activities involving international project cooperation. We compare these figures with the amount of international funding that year.

International cooperation involved in almost half the higher education sector projects

The highest proportion of international project cooperation is found in the higher education sector. At the eight Norwegian universities, the proportion has increased from around 40 per cent in 2011 to 45 per cent by 2015. In health trusts and in the institute sector, the shares are around one third, a relatively stable figure over the four-year period. The state colleges had the lowest rate of international project cooperation, but the proportion has increased somewhat.

Most of the international R&D cooperation is performed without foreign funding

By comparison, the higher education sector only received 3 per cent of its funding from international sources in 2015, while the institute sector received 10 per cent of its income from abroad. This shows that most of the international cooperation does not give rise to funding from abroad, especially in the higher education sector. For the institute sector, a larger part of international cooperation involves financing from abroad, which seems natural, as the institutes are mission-oriented units that are more prone to seeking projects that involve funding.

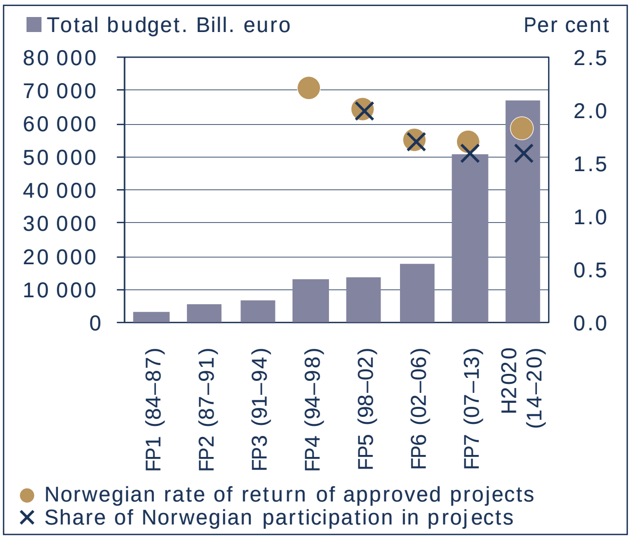
The University of Bergen has the highest proportion of internationalisation

A closer look at the statistics shows significant annual fluctuations at the largest Norwegian higher education institutions. As shown in Figure 3.2, we find the highest percentage of international project cooperation in 2015 at the University of Bergen (61 per cent), the University of Oslo (49 per cent) and NMBU (45 per cent), while the percentage was lowest at the Oslo and Akershus University College of Applied Sciences (20 per cent) and the University College in Southeast Norway (25 per cent).

Most international project collaboration within mathematics and science

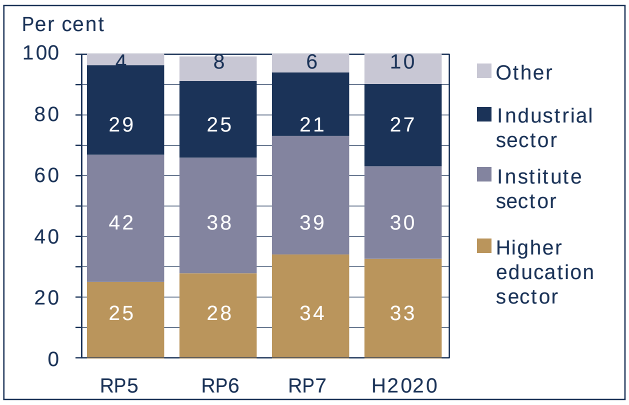
The proportion of researchers with international project collaboration also varies between disciplines. The highest degree of international project cooperation in the higher education sector is found in mathematics and natural sciences (56%) and in medicine and health (48%), and the lowest in the humanities (30%). In the institute sector, social sciences and humanities had the lowest levels of international cooperation (30%), while the highest proportion in this sector was found in mathematics and science.

Figure 3.3
Total budget for EU framework programmes. Norwegian rate of return and share of Norwegian participation in projects. EU FP4 to Horizon 2020.



Source: European Commission, Ecorda. Juni 2017.

Figure 3.4
Distribution of approved projects from the EU framework programmes to Norway in EU FP4 to Horizon 2020 by R&D sector. Per cent.



Source: European Commission, Ecorda. Juni 2017.

The EU framework programmes constitute the largest international cooperation arena for Norwegian research. Norway has participated in this cooperation since the first framework programme (FP1) in the mid-1980s. With the conclusion of the EEA Agreement, Norway gained full participation in FP4 (1994). It is therefore possible to follow Norwegian participation over the past 20 years.

Towards a broader framework programme

As Figure 3.3 shows, there has been significant budget growth throughout all programme periods, and with a special boost from FP7. The framework programmes have evolved from limited efforts to becoming a driving force for European research, and a significant source of funding.

The Norwegian participation has been relatively stable. Norway's total share of allocated project funds (return rate) was 2.2 per cent in FP4, but has since stayed below 2 per cent. Variations in the return rate should, however, be viewed within its context, i.e. the number of participating countries more than doubled from FP4 to Horizon 2020 (H2020). The Government's ambition is a total national return of 2 per cent for the entire H2020. Several measures have been taken to achieve this goal.

The Norwegian proportion of project participants in short-listed project applications shows a development similar to the financial return rate. The former has stabilised at about 1.6 per cent in H2020. Within the H2020 the tendency is a large application increase, partly due to smaller national R&D funds in several European countries. Stable Norwegian participation in approved project applications is therefore positive.

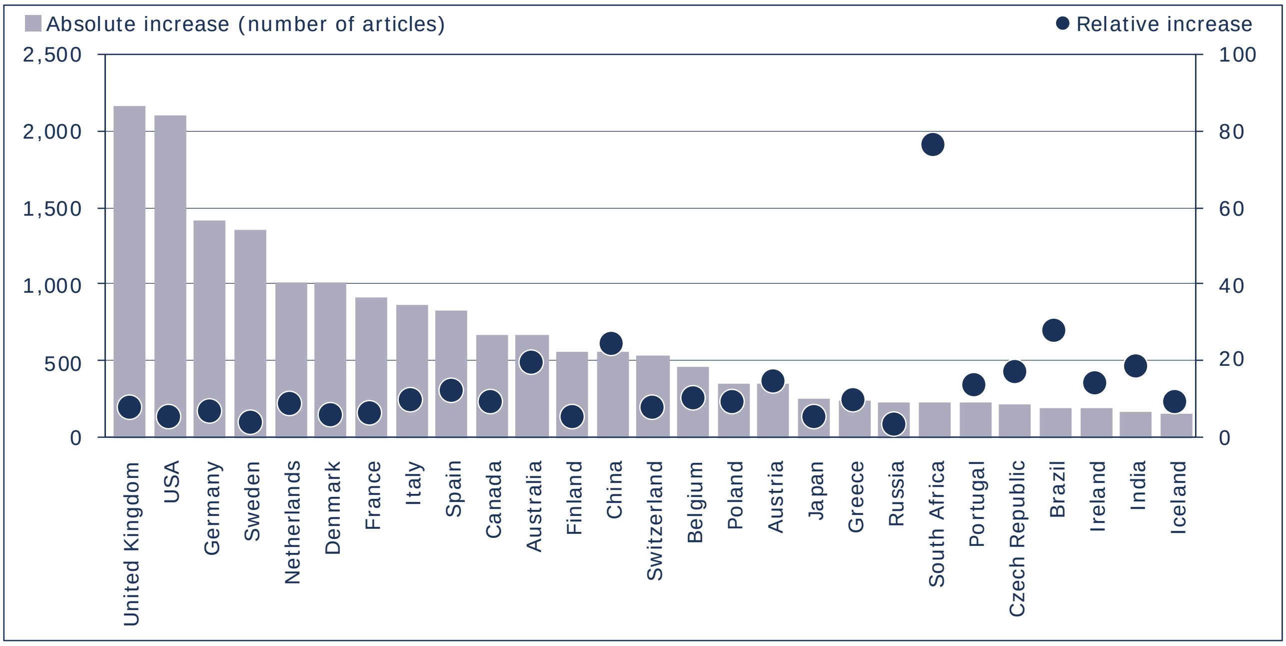
More emphasis on societal challenges

While the first framework programmes focused on applied and technology-based research, broad societal challenges have become increasingly important. Starting with FP7, basic research, through the creation of the ERC, has its own arena within Horizon 2020. At the same time, the priority of innovation has been greatly strengthened, partly because the former Competitiveness and Innovation Framework Programme (CIP) is now integrated into H2020. Thus, entrepreneurship and market-based innovation have become parts of Horizon 2020. As shown in Figure 3.4, these changes have so far led to more participation from enterprises and higher education institutions from Norway, while the institutes' share of Norwegian funds has fallen considerably.

Towards the 9th Framework Programme (FP9)

The preparations for the framework programme to follow H2020 (FP9) started in 2017. A high-level expert group (Lamy Group) recommends a continuation of the main structure of H2020, but with a doubling of the budget. The Lamy Group also recommends further strengthening of innovation efforts in the framework programme, including efforts through the establishment of a European Innovation Council (EIC) to further develop a common European innovation policy. An overall goal for FP9 should be to develop an eco-system for researchers, innovators, companies and government agencies to facilitate innovation and commercialisation.

Figure 3.5
Changes in the Norwegian geographical collaboration structure.[1] Increase in number of articles with collaboration and relative growth. 1996–2016.



[1] Only countries with an increase of more than 150 articles with collaboration during a period is presented in the figure.

Source: Data: Clarivate Analytics, Web of Science. Computations: NIFU.

Small countries have the most international co-publishing

The percentage of articles with international co-authorship is usually higher in small countries than in large countries. It is natural that large countries have more researcher cooperation opportunities within the country's borders, while researchers in small countries are more likely to seek research partners across national borders. Norway's share of international co-authorship is about the same as in the rest of the Nordic countries and other small European countries. This «small-scale effect» provides a positive outcome for these countries in international comparisons such as the European Innovation Scoreboard (EIS), see also chapter 1.3.

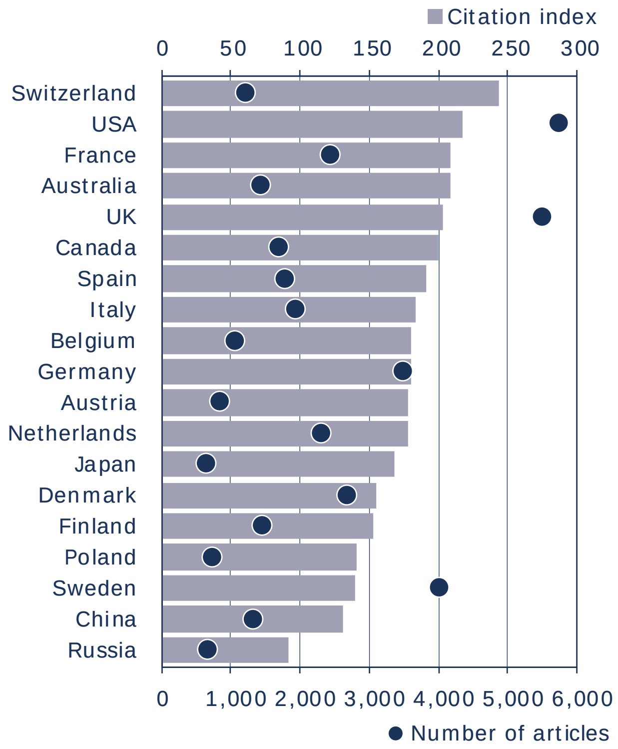
UK soon more important for Norway than the United States

The geographical collaboration profile has also changed during the last 20 years. Figure 3.5 shows the absolute and relative increase for the countries where collaboration has grown most in the twenty-year period 1996–2016. This analysis is limited to articles in international journals (Web of Science) since CRIStin data is not available for 1996. In absolute terms, the increase has naturally been the strongest for the countries that are Norway's most important partners. For both the United Kingdom and the United States, the number of collaborative articles has increased by over 2,000, but both the absolute and relative increase is stronger for the United kingdom. If this trend continues, the United Kingdom will, in a few years, will surpass the United States as Norway's most important cooperative country. For Norway's third largest partner country, Sweden, the number of co-authored articles increased by about 1,300, but relative growth is the second lowest of the countries included in the figure. This means that the importance of Norwegian-Swedish collaboration is reduced.

EU collaboration affects the collaboration profile

An important underlying factor for these changes is the Norwegian participation in the EU framework programmes for research. Among the EU countries, Norway has had the greatest relative increase in relations where there has traditionally been little collaboration, for example with the Czech Republic, Austria, Ireland, Portugal and Spain. Norwegian publishing collaboration with several of the so-called «BRICS countries» has increased relatively much. South Africa, Brazil, China and India are all among the five countries with the strongest relative growth. However, the bulk of Norwegian research collaboration still includes the United States and other Western countries.

Figure 3.6
Relative citation index for the Norwegian articles with international collaboration by country and number of articles with collaboration.[1] 2012–2014.



[1] Only countries with more than 600 collaboration articles with Norway are shown in the figure. Citation index is weighted by the different countries' relative contribution to the articles.

Source: Data: Clarivate Analytics, Web of Science. Computations: NIFU

In general, articles with international collaboration are noticeably more cited than articles that only have authors from one country. This also applies to Norway. Articles that only have authors from Norway are cited slightly below the world average for the entire period 1994–2014. The analysis is limited to the Norwegian articles indexed in the Web of Science since citation figures are not available for other publications.

Articles with international cooperation more cited

The articles with international collaboration are, on average, cited 47 per cent more than the world average. In other words, we see a positive link between international collaboration and citation frequency. Research with international collaboration increases the scientific influence, and the figures indicate that Norwegian research benefits greatly from participating in such collaboration projects. The figure also shows the proportion of articles with international collaboration. As mentioned above, this share has risen significantly. Since articles with international collaboration make up a much larger proportion of the articles than before, they have a greater impact on the national totals. This explains much of the general rise in Norway's total citation index (see chapter 1).

Several factors can explain why articles with international collaboration in general are more cited than articles without. First, collaboration may in itself increase the quality of research, as it would involve researchers with complementary scientific expertise, more technical resources and laboratory facilities, etc. Big multinational collaboration projects will consist of contributions from many researchers and funding from several countries. Such projects can result in major scientific results, hence much cited. Second, the «visibility» of the publications will increase through international co-authorship, partly because the publications will be part of research of more research groups. These groups will be able to build on the current research and cite it in subsequent publications.

Figure 3.6 shows that Norwegian researchers publish most of their articles (bullets) in collaboration with colleagues in the United States and the United Kingdom with over 5,000 articles.

Highest citation index for collaboration with Switzerland and the United States

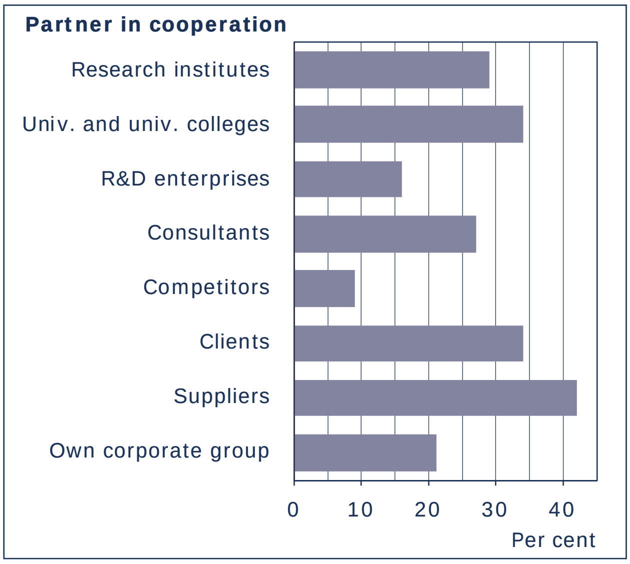
Although articles involving international collaboration are generally more cited than the average, there are significant differences between nations. Looking at the citation frequency of Norwegian co-publications by country (Figure 3.6), it appears that Norwegian articles in collaboration with Swiss and US researchers achieve the highest citation rate. These were cited respectively 143 and 117 per cent more than the world average (citation index 243–217). Articles involving Norwegian-Russian collaboration achieved the lowest citation rates among the largest Norwegian cooperative nations. These were also cited below the world average (citation index 92).

Co-authorship with developing countries less cited

The number of collaborative citations also varies according to the countries in which they collaborate. Articles co-publish with researchers in developing countries are generally low on the citation index.

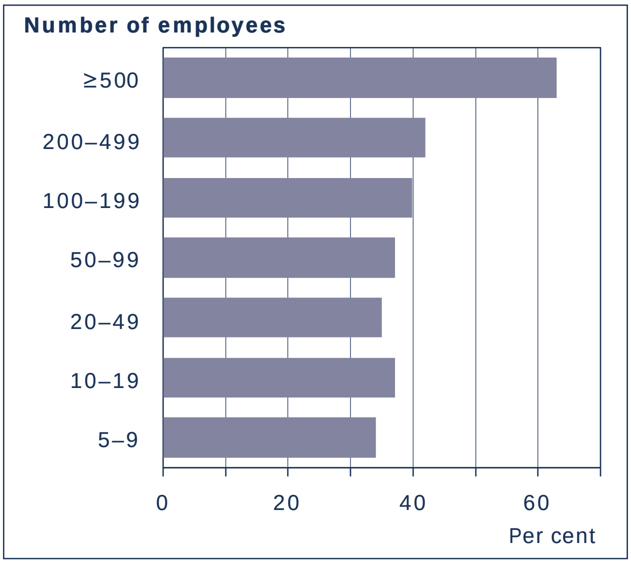
Although there is a certain correlation between the citation index shown in Figure 3.6 and the countries' total citation index (see Chapter 1), there are also interesting differences. Though Denmark has one of the highest citation index in total, Danish participation in Norwegian publications does not contribute to these articles achieving a particularly high citation index.

Figure 3.7
Share of enterprises with R&D cooperation in 2015 by type of partner.



Source: Statistics Norway, R&D statistics

Figure 3.8
Share of enterprises with R&D cooperation in 2015 by size group.



Source: Statistics Norway, R&D statistics

R&D activities in the industrial sector are carried out extensively in collaboration with other research communities. The frequency and patterns of such cooperation are mapped in the annual R&D surveys and discussed below.

Different forms of cooperation

The enterprises' R&D cooperation is usually carried out by enterprises purchasing R&D services from others or hiring researchers for a period. In addition, enterprises are asked if they have been actively involved in R&D cooperation with other enterprises or institutions other than purely contractual work (purchase or sale). This means active participation in joint R&D activities with other organisations, both other enterprises and non-commercial institutions. This does not necessarily mean that both parties achieve immediate financial gain from the collaboration. More informal contact in the form of an exchange of ideas and information, however, is not covered by the survey.

Most of R&D cooperation with suppliers

Based on the definition above, just over a third (37%) of Norwegian enterprises state that they participate in R&D cooperation projects. The most frequent type of partner is suppliers, as stated by 42 per cent of the enterprises with R&D cooperation. Subsequently, customers (34%) and higher education institutions (34%) and research institutes (27%) follow. For enterprises that are part of the same company group, cooperation with other enterprises in the group is very common.

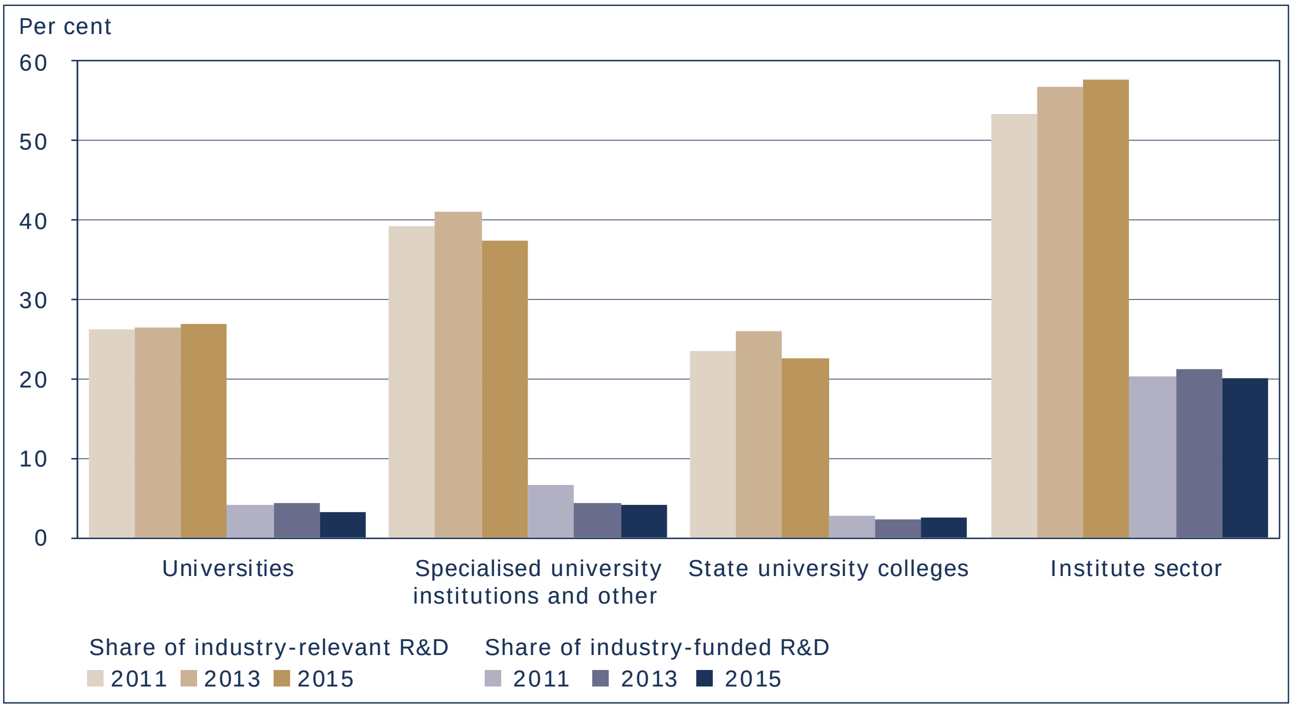
Cooperation with R&D institutions is most frequent among large enterprises

Among the smallest enterprises with 5–9 employees, 34 per cent say they cooperate. This proportion increases slightly according to the size of enterprises up to 200 employees, but is significantly higher among enterprises with at least 500 employees. Of these enterprises, 63 per cent report cooperation. This is because large enterprises are more prone to collaborate with higher education institutions, research institutes and R&D laboratories. For smaller enterprises, suppliers and clients or customers are the most frequent partners. Figure 3.8 shows the distribution of the most frequent partners by company size.

Small businesses typically cooperate locally

It is most common for the partner to be located locally or regionally elsewhere in Norway. However, there are many enterprises that have partners in the Nordic countries or in other EU countries. Also, in terms of regional distribution of partners, there are clear differences according to the size of the enterprises. The smallest enterprises cooperate locally to a much greater degree than large enterprises. Large enterprises cooperate both regionally and with partners in other parts of the country, but they also have more extensive cooperation with foreign partners, i.e. both in the Nordic countries, in other European countries and in the rest of the world. Ten per cent of the largest enterprises have R&D cooperation with China or India.

Figure 3.9
Share of industry relevance and share of funding from industry of R&D by type of institution. 2011–2015.



Source: NIFU, R&D statistics

Another widely used indicator of collaboration between R&D institutions and enterprises is the share of R&D institutions' research funded by industry. However, this only gives a limited picture. There is much industry-relevant research that are unknown to potential collaborating enterprises or that the enterprises in question are able to finance. In Figure 3.9, the R&D institutions' share of industry funding is compared with the R&D institutions' own perception of the industry relevance of their own research. Both aspects are captured through questions in R&D statistics survey, see fact box.

More than half of the institutes' research is considered of relevance to industry

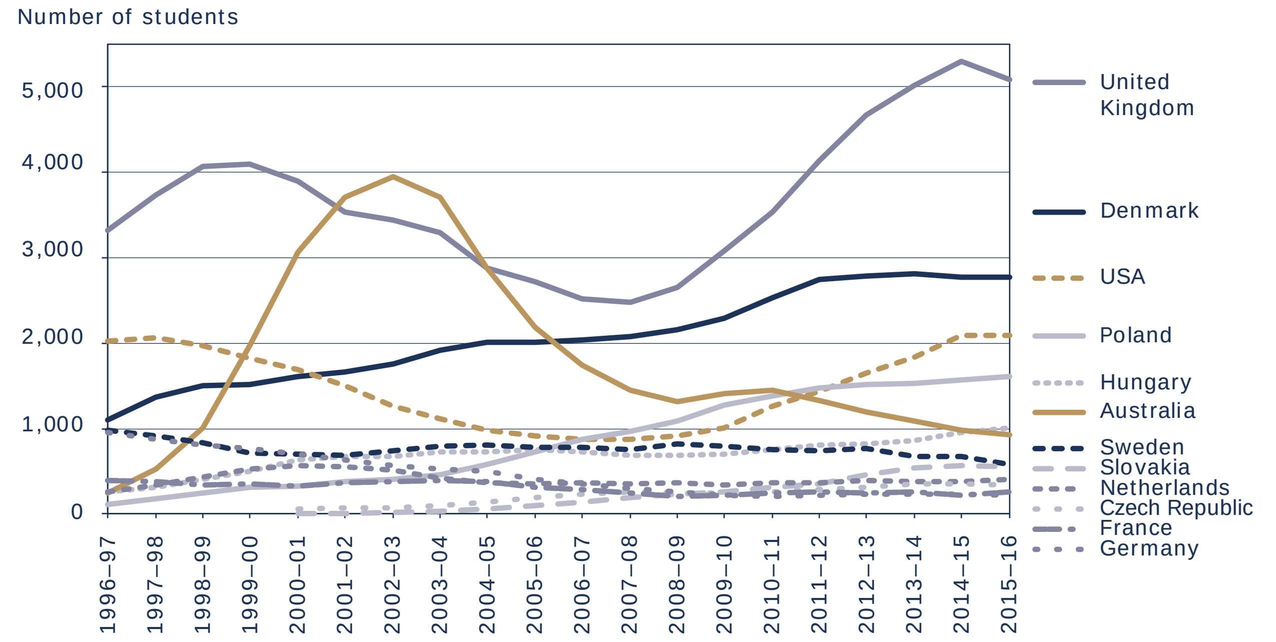
As shown in Figure 3.9, a large part of the various institutions' research is considered relevant to the industrial sector. For universities, about a quarter of their research is considered as industry-relevant, while the share of industry funding is only 3–4 per cent. Similar patterns are found among the state colleges, but the proportion of both industry relevance and industry funding is somewhat lower. For university colleges and other higher education institutions, the gap between industry relevance and funding is even greater. This is because much of the research at the NHH Norwegian School of Economics, which is a major contributor in this category, is considered to be industry-relevant, although industry funding is not achieved at an according level.

Not surprisingly, the proportion of industry-relevant research is clearly the largest among research institutes. Around 60 per cent of their research in 2015 was considered to be industry-relevant. A key explanation is that the group of technical-industrial institutes account for a large share of the research in the institute sector, and their main task is to serve Norwegian industrial sector by performing and delivering relevant applied research. Among the institutes, industry funding is also significantly higher, i.e. around 20 per cent in total for the sector and a total of 37 per cent for the technical-industrial institutes.

About industry relevance

Respondents to the R&D statistics survey have since 2009 been asked to estimate the proportion of the R&D effort of their enterprise that was of industry relevance. Industry relevance is defined as R&D activities of which the results are expected to have an immediate value for enterprises. Only units in the higher education sector and the institute sector are asked to make such estimates. Naturally, there is considerable uncertainty associated with such discretionary assessments, but the figures provide a broader picture of the scope of industry-relevant research than looking at industry funding alone.

Figure 3.10
Norwegian students taking part of their education abroad by country with the highest number of students. 1996/1997–2015/2016.



Source: The Norwegian State Educational Loan Fund (Lånekassen)

Number of Norwegian exchange students abroad nearly doubled

The majority of Norwegian foreign students take a full degree abroad (graduate mobility), but there are also a considerable number of students taking part of their education abroad (credit mobility). The latter group is often referred to as exchange students, and many of the students on these sojourns are enrolled in the ERASMUS programme and other exchange agreements. Exchange students have constituted a separate group in the State Educational Loan Fund's statistics since the millennium, and during this period the number of exchange students has almost doubled.

More Norwegians prefer English-language countries and studies

There have been significant changes in the preferred countries for Norwegian abroad. In the 1960s and 1970s continental Europe was popular, not least German-speaking countries. Today, most full degree students choose countries where the language of instruction is English or Nordic languages. The United Kingdom, Denmark and the United States are now the most popular host countries. Many also choose English-language programmes (mainly medical education) in Eastern Europe. Around the millennium, many Norwegians went to Australia to study, but this country is now receiving considerably fewer Norwegian students.

Also, fewer students choose to take a full degree in Germany and France. The decline has been particularly remarkable for Germany. Twenty years ago, there were about a thousand Norwegian graduate students in Germany, compared with only 221 in the academic year 2015/2016. The trend in the number of students in the most popular countries among Norwegian students is shown in Figure 3.10.

Wider geographical dispersion of exchange students

Those who take part of their degree abroad (exchange students) travel to a wider range of countries than those taking a full degree abroad. The United States, Australia and the United Kingdom are popular also among exchange students, but there are far more exchange students than full degree students choosing Germany and France. There are also significant numbers of students who go to countries like Tanzania, South Africa and China.

Business and administration is the most popular programme among students undertaking a full degree abroad. There are also many Norwegians who study medicine abroad, almost as many as in Norwegian universities. Further, students in veterinary education, physiotherapy, psychology, architecture, arts and journalism are overrepresented among internationally mobile students. These programmes are also highly selective in Norway.

4 Results and effects on R&D and innovation

Dag W. Aksnes, Frank Foyn, Eric Iversen, Rune Rambæk Schjølberg, Michael Spjelkavik Mark, Tore Sandven, Elisabeth Wiker, Lars Wilhelmsen

Scientific publication and citation

- Norway has had strong growth in the number of publications in the last 20 years compared with the EU 15 countries. However, there are large variations between the different fields of science. Norwegian publishing has a strong specialisation in geosciences, biology, special marine and fisheries biology and social sciences. This pattern is rooted in historical traditions.

- The University of Oslo and the Norwegian University of Science and Technology (NTNU) published the most in 2016, while the University of Oslo, University of Bergen and university hospitals score highest on the citation index for articles published in the period 2012–2014.

- Women are somewhat underrepresented in scientific publishing. They accounted for 42 per cent of all publishing researchers, but accounted for only 34 per cent of total publication points.

Norwegian participation in Horizon 2020 and the European Research Council (ERC)

- Norwegian researchers have obtained NOK 3.9 billion (or € 440 million) from the EU Horizon 2020 programme by June 2017.

- The Norwegian return rate is 1.81 per cent, still below the government's target of 2 per cent, and the return rate in the other Nordic countries is 2.15 per cent for Finland, 2.55 per cent for Denmark and 3.54 per cent for Sweden.

- Norway is represented in almost 5 per cent of approved projects so far in Horizon 2020. 14.4 per cent of Norwegian applications have been approved for funding, which is above the average of 12 per cent.

- Norway has a relatively low return rate in the ERC. While the grant rates were on average 12.9 per cent for all countries, the Norwegian grant rate was 8.3 per cent.

Patents

- In 2016, the Norwegian Intellectual Property Office (NIPO) received a total of 2,062 patent applications, an increase of 14 per cent from the previous year. Of these, 1 195 applications were submitted by Norwegian applicants, an increase of 6.5 per cent from the previous year.

- The total number of patent grants in Norway has increased sharply in recent years, while the allocation to Norwegian applicants has been stable. In the period 2012–2016, 16,837 patents were awarded in Norway, of which 2,239 were granted to Norwegian applicants.

Impact of innovation and instruments

- Development of new products, product innovation, is increasingly important for Norwegian companies. Norwegian companies report that 6.8 per cent of total sales were based on product innovations in 2014–2016. This is an increase from 2012-2014, when the share was 5.9 per cent.

- Two out of three SkatteFUNN projects lead to product innovation. One of three projects leads to a single product innovation, while the last third of the projects lead to more product innovations. At the same time, 14 per cent of the projects have been reported on filed patent applications. From 2009 to 2015, this represents a total of 2,300 patent applications.

- The past ten-year period shows a stable level in the proportion of new companies established by researchers formerly employed at research institutions.

Significant financial and human resources are used for research and innovation. The figures from Chapter 2 show that more than NOK 60 billion is invested in research and development (R&D), while 76,000 people are involved in R&D. The number of researchers in Norway has increased by 4.1 per cent from 2014 to 2015, which is the last measurement year. If we go a little further back in time, the increase is even more pronounced; from 2010 to 2015, the number of researchers in Norway increased by 15.8 per cent. This reflects that investment in research and development has also increased considerably, both in private and in public research budgets. In addition come innovation activities other than research and development.

With such large resources involved, it is relevant to study what comes out of the effort. What are the results and effects of research and innovation? In general, it is more challenging to find good measures for results and effects than for investments in R&D and innovation. In this chapter, we focus on indicators for measuring results and effects of research and innovation.

From measurement of results to effects

In R&D statistics, performance measurement has traditionally been in the form of counting publications, citations and patents. These indicators measure some of the results expected to come from investments in research. But there is also a broad consensus that they do not measure everything that comes from research and innovation activities. Therefore, there is increasing interest in including indicators and methods that can provide a broader perspective on results and effects. Inclusion of new indicators and methods applies to «hard numbers» as indicators of business growth, productivity or export. This is based on administrative and other data collected over long periods of time by national statistical agencies. Long time series open up the use of econometric methods to establish control groups, estimate counter-factual analyses and thus show effects of research effort.

Hard facts can nevertheless only reveal some of the effects. Several initiatives aim at looking at the wider societal effects of research. In the UK, higher education institutions systematically report on societal impacts, typically case studies organised under The Research Excellence Framework, focusing on various effects beyond academia. In Norway, these methods have also been used, for example, by evaluating the humanities departments and the social science institutes. If these exercises are routinely done, they provide rich material that can eventually be systematised and provide indications of the social impact of research.

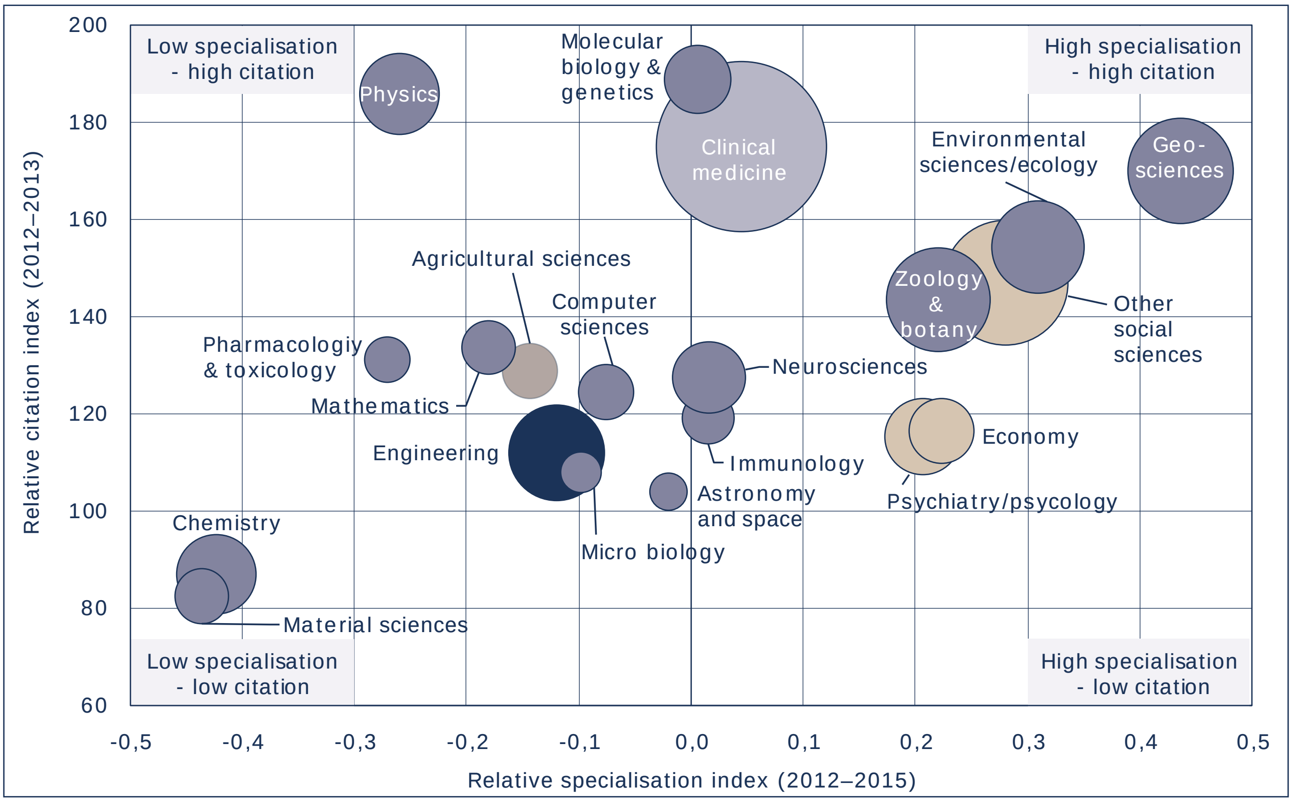
Indicators complementing each other

Chapter 4 looks at different types of indicators. In the first part, we look at publications and citations and map Norway's publishing profile in an international context, as well as citation frequencies at institution and sector level. Furthermore, the results of research and innovation effort, measured on industrial rights, covering patents, trademarks and design.

Norway accounts for a very limited part of the world's knowledge production. Therefore, it is crucial that Norwegian research institutions and Norwegian businesses participate in international cooperation, which gives the opportunity to tap into knowledge produced outside Norway. Horizon 2020 and the European Research Council are important venues for international R&D cooperation.

Central to Norwegian research policy is the impact of business and industry on research and innovation. Research must create growth and jobs, and Norwegian enterprises need to stay competitive. We therefore look at both the impact of internal innovation, but also at impact measures related to key instruments at Innovation Norway and at the Research Council of Norway. We also look at research collaboration in establishing new enterprises.

Figure 4.1
Relative specialisation index (2012–2015) and relative citation index (2012–2013) for Norway. Disciplines with natural sciences, medical and health sciences, engineering and technology, and social sciences. Size of the circles is proportional to the number of articles.



Source: Data: Clarivate Analytics, Web of Science. Computations: NIFU.

Norway's level of publishing activity and citation rates vary considerably between disciplines. Figure 4.1 shows the discipline profile based on publication and citation figures for the period 2012–2015. The figure uses Web of Science data, and thus includes publication in international journals. The system of classification of disciplines in Web of Science has been used, and the figure covers all subject areas. Due to the database's poor coverage of the humanities, this field is not included in this analysis.

Two types of indicators have been calculated. First, a specialisation index, which is an indicator that tells if a country has a higher or lower proportion of publications in a particular discipline than the average for all countries. Second, a citation index, which calculates the relative citation rate in different disciplines, see the fact box on the next page.

Much geosciences, biology and social sciences

As we can see from the figure, a strong specialisation in a discipline does not necessarily entail high citation rates in the same field, and vice versa. The Norwegian discipline profile deviates a lot from the average. In general, Norwegian research has a high relative activity in *geosciences*, *biology* and *social sciences*. In *biology*, Norway has a particularly high specialisation in *marine and fisheries biology* (not shown in the figure). Conversely, we find a low relative activity in physics, chemistry and materials science. This specialisation pattern is rooted in historical traditions.

At the same time, Norway has a discipline profile at the world average in many of the disciplines, including *clinical medicine* and several biomedical disciplines (*neuroscience*, *immunology*, *molecular biology & genetics* and *microbiology*).

High citation index in many disciplines

Norwegian scientific articles achieved a total citation index of 146 in the period 2012–2014. At an aggregate level, this is well above world average, but the citation index varies widely between disciplines and fields of science. From figure 4.1, we see that the relative citation index is below the world average in only two of the subject fields: *Material sciences* and *chemistry*.

In science, Norwegian research has the highest citation index in *physics* and *geosciences*. The articles from the period 2012–2013 were cited respectively 86 and 70 per cent above the international average in these subjects. *Geosciences* is also the field where Norwegian research has the strongest specialisation. *Environmental sciences/ecology* also shows relatively high scores on the citation index (154).

Within *medicine and health*, *clinical medicine* has high citation index, 175. *Clinical medicine* is also by far the largest discipline in terms of publishing volume and therefore contributes much to raising the toverall citing index. The rate of citation within bio-medical subjects varies. The publications in *molecular biology & genetics* are particularly cited (189), while the citation index is relatively low in microbiology (108). In *social sciences*, the citation index is 117 in economics, while it is 147 universities in general. However, it should be added that only a relatively small part of the publication in social sciences is indexed in the database.

Strong growth during the last 20 years

Table 4.1 shows how the volume of scientific publishing has evolved in the various disciplines during the past twenty-year period (1995–2015). Figures for the EU 15 countries and the world are included as reference values. For Norway, the EU 15 countries provide a more relevant comparative basis for Norway than the world average.

Norwegian article production has shown a considerable increase over the past twenty years. Most European countries have significantly lower growth rates than Norway. This pattern is also visible at the level of fields of science. However, there are large variations between the different fields of science.

To a large extent, this strong growth can be explained by a general expansion of total Norwegian R&D effort and a steady increase in the number of researchers. At the same time, scientific productivity has risen, as each researcher publishes on average more articles today than before.

Table 4.1
Relative change in publishing volume. Norway, the EU 15 countries and the World. 1995–2015.

Discipline	Norway	EU 15	World	N (Norway 2015)
Economy	578 %	365 %	186 %	400
Social sciences, other	478 %	326 %	196 %	1,440
Engineering	387 %	181 %	198 %	833
Computer sciences	366 %	211 %	239 %	284
Geosciences	340 %	204 %	173 %	1,003
Astronomy and aerospace	336 %	98 %	64 %	144
Psychiatry/psychology	308 %	268 %	141 %	551
Neuro sciences	262 %	108 %	102 %	471
Molecular biology & genetics	256 %	97 %	123 %	431
Environmental sciences/ecology	225 %	251 %	266 %	784
Micro biology	203 %	74 %	114 %	176
Agricultural sciences	198 %	148 %	173 %	262
Materials sciences	195 %	148 %	283 %	257
Mathematics	190 %	120 %	148 %	232
Pharmacology & toxicology	159 %	57 %	124 %	181
Clinical medicine	146 %	82 %	122 %	2,585
Immunology	131 %	69 %	77 %	256
Chemistry	116 %	65 %	143 %	604
Zoology & botany	115 %	66 %	88 %	867
Physics	87 %	37 %	70 %	488
Total	**208 %**	**104 %**	**134 %**	**12,717**

Source: Data: Clarivate Analytics, Web of Science. Computations: NIFU

Relative Specialisation Index (RSI)

RSI is an expression of whether a country has a higher or lower proportion of publications in a particular discipline compared to the average for all countries where RSI=0. That is, it characterises the internal balance between the disciplines, but says nothing about production in absolute terms. If RSI> 0, it indicates a relative positive specialisation (in the form of scientific publishing) in the relevant field. Note that the total score for a country will be 0. The fields of science are of very different size, which is important to be aware of when interpreting the results.

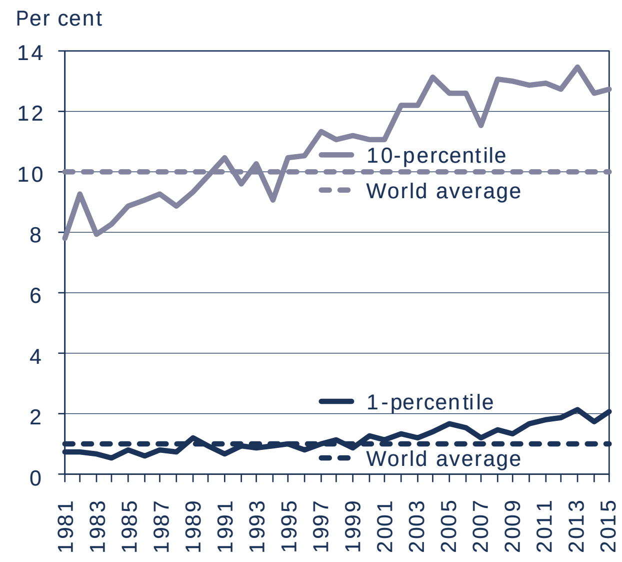
Relative citation index is an expression of whether a country's publications in a particular discipline are cited more or less than the world average in the discipline (which is normalised to 100).

Strong growth in social sciences

The *social sciences* stand out with a particularly strong increase during the period in question. In economics, the growth in Norwegian article production in (mainly) international scientific journals is more than sixfold. Here the EU 15 countries have also seen strong growth by 365 per cent. Also, Norwegian publication in other social sciences has very strong growth. Some of the increase can be explained by an extended coverage of social science journals in the database. Nevertheless, the figures show that Norwegian social scientists are increasingly publishing in international journals.

After social sciences, the relative increase has been highest in *engineering and computer science*, where Norwegian article production has increased by 387 and 366 per cent, respectively. The lowest increase is found within *physics*, *zoology and botany* and *chemistry* (87–116 per cent), but also in these subjects, the Norwegian growth rate is clearly above the average growth for the EU15 countries.

Figure 4.2
Citation index for Norway. 1981–2015. 1-percentile and 10-percentile.



Source: Data: Clarivate Analytics, Web of Science. Computations: NIFU.

Norway had a citation index of 146 in the period 2012–2014. With this, Norway ranked 9th of the world's 39 largest nations measured in publishing volume. The chapter provides a more detailed analysis of the citation frequency of Norwegian research based on indicators of highly-cited articles.

Skewed citation frequencies

Generally speaking, the citation rate of scientific articles is very skewed. Most articles are little cited or not at all, while a few get an extremely high number of citations. This is also the case for Norwegian scientific publication activities. About a quarter of the Norwegian articles published in 2011 have never been cited, or cited only once or twice, while 4 per cent of the articles have been cited more than 50 times five years after publication. A similar skewness is found in other countries.

In the last decade, there has been an increasing interest in using highly-cited articles as an indicator in the research policy context. One reason is the strong attention towards scientific excellence. In this context, highly-cited articles have been considered as a relevant indicator

In order to analyse how Norway scores on this citation indicator, we have identified articles from Norwegian researchers which are among the 1 per cent and 10 per cent most-cited articles in their field of study (most of which have also authors from other countries). The citation index for Norwegian research in total has increased much in recent decades. Also, the proportion of highly-cited articles shows a clear positive trend. In 1981, 0.76 per cent of the Norwegian articles were among the 1 per cent most-cited worldwide, that is, less than the average. In latter years (2013–2015) this share has been around 2.0 per cent, i.e. twice as high as expected from the world average. Similarly, 7.8 per cent of the Norwegian articles were among the 10 per cent most cited in 1981, while the proportion has been around 13 per cent in recent years.

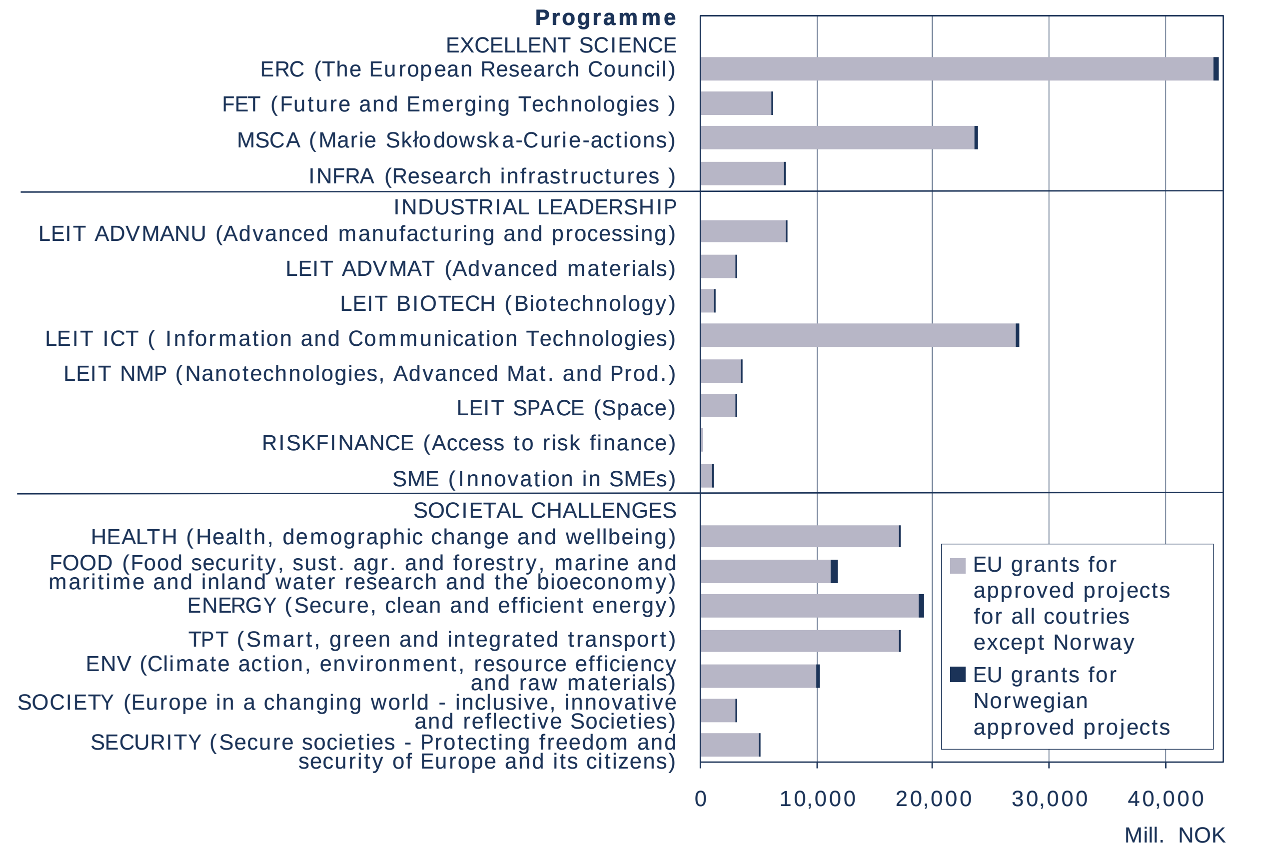
Several very highly cited articles

Figure 4.2 shows the development of the two indicators for the period 1981 to 2015. There are some annual fluctuations in the values, but in particular the 1-percentile has a strong relative growth throughout the period.

Also in the case of highly-cited research, Norway has made significant progress. NIFU does not have access to data that makes it possible to compare Norway with other countries. However, a previous analysis showed that, despite progress, in the period up to 2011 Norway was behind other countries such as Denmark, Switzerland, the Netherlands and Sweden in the 1-percentile index. The report concludes that Norway still scores as relatively poor in terms of research with high impact and that only a small proportion of Norwegian research is at the forefront of their respective areas.

The highly-cited Norwegian articles are distributed across all disciplines. An analysis of the years 2010–2013 shows that the share of highly-cited articles (1-percentile) is highest within Norwegian geoscience, while chemistry has the lowest share of such articles.

Figure 4.3
Approved projects in Horizon 2020 by programme. Total and for Norway.



Source: EU Commission. E-Corda. June 2017.

The EU Horizon 2020 Framework Programme (H2020) for the period 2014–2020, will allocate about € 70 billion over the whole period. Norway has participated as a full member of EU research programmes since 1994. The programme focuses on innovative research, innovative solutions and new technologies by providing support from idea to market and bridging across borders and sectors. Interdisciplinarity and collaboration between researchers, businesses and end users are central aspects in the programme.

The H2020 is part of the EU's Europe 2020 growth strategy:strengthen Europe's global competitiveness through innovation to create new and sustainable jobs and promote growth. H2020 is also be the financial instrument to implement the EU's flagship initiative: Innovation Union. The programme's three main parts are: *excellent science*, *industrial leadership* and *societal challenges*. In addition, it supports the programmes: *spreading excellence and widening participation* and *science with and for society*.

Most EU funds for societal challenges

Figure 4.3 shows funding per programme in H2020, for Norway and for the whole programme. Total EU support for approved projects by June 2017 amounted to NOK 215,412 million (or € 24,270 million). Of these, approved projects under the pillar *societal challenges* account for 38.1 per cent of total funds, while an almost equal share (37.6%) has gone to projects under the topic *excellent science*. For the latter type there has been a slight increase since June 2016. The third pillar, *industrial leadership*, has experienced a slight decline in its share of total approved budgets, from 23.1 per cent in June 2016 to 21.4 per cent in June 2017. The remaining almost 3 per cent are distributed on topics such as *spreading excellence and widening participation*, *science with and for society* as well as innovation (*fast track to innovation*).

Strong increase in approved Norwegian projects, declining total return rate

By June 2017 Norwegian applicants have collected a total funding of NOK 3.9 billion (or € 440 million) from the H2020. Norwegian EU grants increased by 53 per cent since June 2016. The status at June 2017 is that total EU support in approved applications has increased by 59 per cent in the same period.

So far, H2020 comprise a total of around 120,000 applications and 14,300 approved projects. Of these, 4,642 applications and 668 approved projects have Norwegian participants. Norwegian researchers are thus represented in almost five per cent of all approved applications. More than 14 per cent of Norwegian applications have been approved, while the average success rate for all countries is 12 per cent.

The Norwegian Government's overall target is that Norwegian researchers should be granted two per cent of the H2020 projects (return share). As of June 2017, the Norwegian return is 1.81 per cent, a decline from June 2016 (1.89%). However, large projects may explain these annual fluctuations. The mismatch between a declining return and a strong increase in the number of Norwegian approved projects can also be due to the increase of the total budget for the H2020.

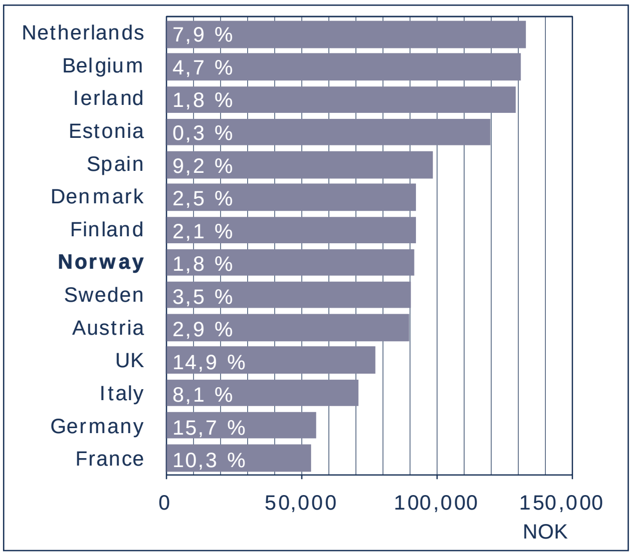
The Norwegian return rate is highest within *societal challenges*, with 2.6 per cent in total (June 2016: 2.6%), while the return rate within *industrial leadership* is 1.9 per cent (June 2016: 1.9%), and for *excellent science* 1.2 per cent (June 2016: 1.3%). The return rate is highest in the programmes for innovation in small and medium-sized enterprises at 5.4 per cent, as well as *FOOD* (food security, agriculture, forestry, marine, maritime etc.) with 5.3 per cent.

Allocated funds per R&D FTE are on par with other Nordic countries, but lower returns

The EEA agreement connects Norway to the EU's single market, giving Norwegian researchers opportunities to participate in the some of the best research networks in the world, accessing knowledge, infrastructure and markets. Comparing Norwegian success in this arena with other countries is a commonly used benchmark for international competitiveness in R&D (Figure 4.4).

So far, in H2020, Norway has collected about as much EU funding per R&D full time equivalents (FTE) as Denmark, Sweden and Finland. Among the countries in Figure 4.4, the Netherlands, Ireland and Belgium have obtained the most funding per R&D FTE. The amounts shown above are not purchasing power adjusted. There must also be reservations about the use of R&D FTE, because countries with a high proportion of R&D FTE in the business enterprise sector appear relatively weaker. This sector is allocated one third of the funds in H2020, while accounting for between 50 and 70 per cent of R&D FTE in many countries. Norway has a much lower number of R&D FTE in the business enterprise sector than, for example, Denmark. With a return of 1.81 per cent, Norway has obtained a smaller proportion of the announced funds than the other countries in the figure.

Figure 4.4
Allocated EU grants for approved projects in Horizon 2020 (exclusive EURATOM) by selected countries and per R&D FTE. Rates of return in per cent.



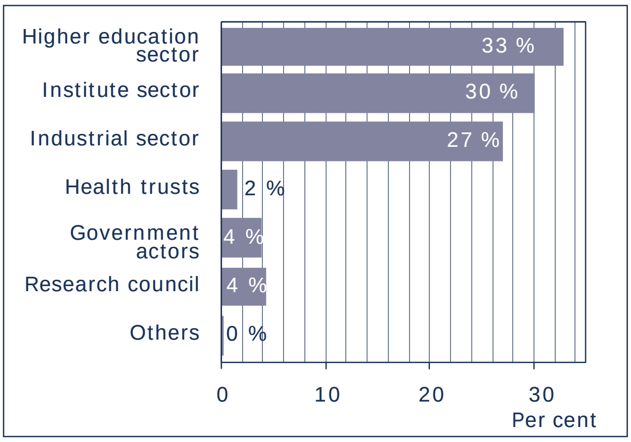
Source: EU Commission. E-Corda. June 2017. OECD – MSTI 2017:1

Even distribution of funding for the three R&D sectors in Norway

The higher education sector has received the highest level of funding in the H2020 so far, followed by the industrial sector and institute sector, both receiving approximately the same amount.

Just over half of the Norwegian higher education sector's EU funding has been obtained in the field of excellent research, with almost a third from the European Research Council (ERC) alone. Then, within the programmes for research career and research mobility (MSCA) and health, universities have received the most.

Figure 4.5
Distribution of approved EU grants in Horizon 2020 on R&D-performing sectors in Norway.



Source: EU Commission. E-Corda. June 2017. OECD – MSTI 2017:1

Table 4.2
Number of domestic patent applications. 2010–2016.

År	Patent applications-total	Applications by domestic entities	Applications by foreign entities	International applications via PCT	Share of all applications: Norwegian enterprises
2010	1,800	1,063	162	575	726
2011	1,743	1,053	186	504	738
2012	1,551	964	153	434	669
2013	1,744	1,060	146	538	768
2014	1,564	1,052	95	417	817
2015	1,805	1,122	127	556	860
2016	2,062	1,195	121	746	840

Source: Norwegian Intellectual Property Office (NIPO)

Patents have long been used as indicators of R&D performance and of innovation more generally. This section presents patent indicators for Norway. The focus is on patent applications that have been submitted to the Norwegian Patent Office, including those stemming from international applications.

Patent applications filed in Norway have an average processing time of 5.4 years. The Patent Office estimates that 43 per cent of the applications result in grants. Patent applications are filed in Norway through one of three main channels. An application can be delivered directly to the Patent Office. The patent application may (since 1978) also be delivered to Norway through the PCT system or (since 2008) through the EPC system (EPO application). Filings that designate Norway via PCT or EPO are processed only in the country where the application was first delivered. European patents (EPO) only emerge into the Norwegian patent record when it is granted in the country of origin.

Increase in patent applications in 2016

The Norwegian Intellectual Property Office (NIPO) received 2,062 patent applications in 2016, an increase of 14 per cent over the previous year (Table 4.2). This represents the highest level since Norway became a full member of the European Patent Office system (EPO) in 2008. The increase is largely due to international filings that arrive in Norway through the PCT system. PCT applications that had entered the national phase in Norway accounted for 36 per cent of total applications in 2016.

Domestic application counts underrepresent the degree of foreign patenting in Norway. Prior to Norwegian EPC/EPO membership, foreign applicants accounted for about 80 per cent of total domestic applications in Norway. Membership has had the expected effect that a large proportion of foreign patenting now comes to Norway through the EPO system. The consequence in terms of indicators is that patents by and large appear at the Norwegian office only after grant (not as applications).

Seven out of ten Norwegian applications stem from companies. Norwegian applicants accounted for 1,195 applications in 2016. The International Patent Classification (IPC) is used to categorise patents according to the specific technical field (s) the invention claims novelty for. Aggregating the IPC classes, the largest share of filings in Norway is found in the field of mechanical engineering, with a majority of these linked to oil and gas extraction.

Patent documents do not provide information about the applicant's business area. Norwegian applications filed by enterprises have therefore been linked to applicant information including employment and industrial classifications. This reveals how patent filings by domestic applicants varies by industry affiliation. The industry with the highest patent filings is technical service providers, such as architects and technical consultants. The industry accounted for 24 per cent of all patent applications in the three-year period 2014–2016. Other important industries were research and development, mechanical engineering, oil and gas services, and agency and wholesale trade.

Patents are most often filed by either very small enterprises or very large enterprises, with large enterprises averaging a greater number than small enterprises. Enterprises with at least 500 employees had an average of 5.8 applications per patenting enterprise, while the corresponding average for enterprises with fewer than 20 employees was 1.4 applications.

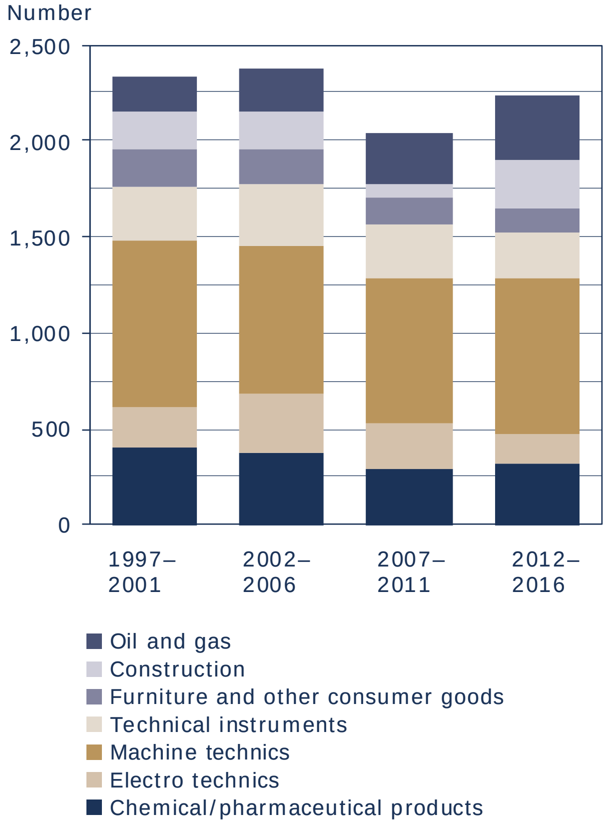
Table 4.3
Patents granted in Norway by application route, share granted to Norwegian entities by route.[1]

Period	Grants		Share granted to Norwegian entities		
	Total	Norwegians	Direct filings	PCT1 filings	EPO-filings
1987–1991	11,407	1,419	14.2 %	2.7 %	:
1992–1996	11,731	1,461	15.0 %	2.0 %	:
1997–2001	12,777	2,328	28.2 %	3.1 %	:
2002–2006	11,416	2,379	43.4 %	1.9 %	:
2007–2011	8,950	2,038	58.8 %	2.7 %	1.9 %
2012–2016	16,837	2,239	87.1 %	4.6 %	2.1 %

[1] The PCT (Patent Cooperation Treaty) provides a common international procedure for filing and granted patents across national borders. More than 150 countries are involved.

Source: NIPO og NIFU. Fractional counts of applicants.

Figure 4.6
Patents granted in Norway to Norwegian entities by year of grant and technical area.[1]



[1] The categorisation system uses the main IPC class as defined by NIPO. WIPO's Technology Correspondence Table is used (WIPO IPC/CE/41/5) and amended by NIPO to include 'Oil and gas'.

Source: NIFU, based on NIPO data (2017)

Patent grants constitute an important result-oriented innovation indicator. It is only when the application is granted that the patent enters into force and the proprietor can use the patent in competition with other actors. A weakness with this indicator is that it may take several years to process an application. Thus, the time of allocation is detached from the time of innovation. The presentation therefore compares patents awarded in Norway over several five-year periods.

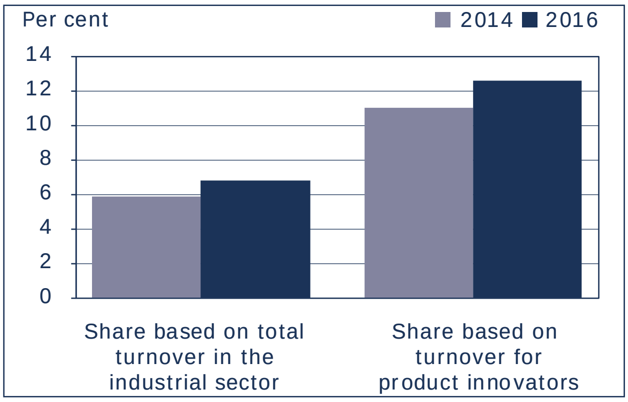
Norwegian entities most often file domestically, while foreigners increasingly use the EPO system to patent in Norway. This changed after Norway became a member of EPO in 2008. Table 4.3 presents patents granted in Norway over the past 20 years by application channel, distinguishing between Norwegian and foreign applicants for each channel.

The number of patents awarded to domestic applicants has remained relatively stable over the past 20 years. Roughly 2,200 patents were awarded to domestic entities in the period 2012–2016, the same level as in 1997–2001. Until 2006, the allocations totaled around 11,500. The exception was the increase in the run-up to the IT bubble (1997–2001). There is a break around 2008. The table shows that the total number of grants fell sharply (to about 9,000) in 2007–2011 before rising again to over 16,900. The decline for 2007–2011 is due to both the transition to the EPO (in 2008) and the effect of the financial crisis. The increase from 2012 stems mainly from foreign filings via the EPO system.

The table demonstrates the changing patterns. Patents granted in Norway to foreign entities increasingly stem from EPO filings and decreasingly stem from domestic direct filings at NIPO or via the PCT.

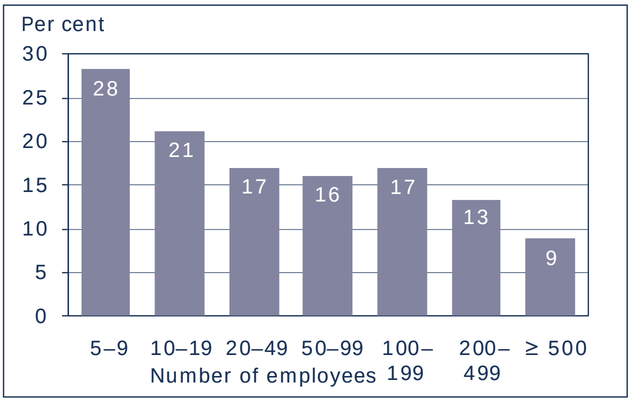
Norwegian actors now account for 87.1 per cent of the patents granted based on Norwegian applications, as against about 15 per cent in the early 1990s. Only 2 per cent of the EPC allocations and almost 5 per cent of the PCT grants originate from Norwegian applications that were first applied in another European country. The number of patents awarded to foreigners in Norway has increased significantly over the last 5 years, primarily thanks to Norwegian membership of EPO/EPC.

Figure 4.7
Share of turnover from product innovation for the industrial sector and for product innovating enterprises. 2014 and 2016.



Source: Statistics Norway

Figure 4.8
Share of turnover from product innovation for product innovative enterprises in 2016 by number of employees.



Source: Statistics Norway

Increased turnover from new products

In chapter 2.6, we looked at innovation investments. In this chapter, we look at what the enterprises has gained from their innovations. Process innovations can of course lead to reduced costs, increased efficiency, and other incremental benefits, but these are very difficult to quantify, and enterprises do not necessarily know which outcomes are attributable to innovation.

For product innovations, it is somewhat easier, and the innovation survey shows figures for the proportion of enterprises' turnover arising from goods and services introduced during the observation period. Turnover of the last year is reported, and distinguishes between products that were new to the enterprise's market and for products that were only new to the enterprise.

Compared with the previous innovation survey, the share of turnover from product innovations has increased from 5.9 to 6.8 per cent, that is for all Norwegian enterprises. If we only look at the product innovators' turnover, the increase is even slightly higher, from 11 to 12.6 per cent.

The increased impact of product innovation stems from innovations that are only new to the enterprise, but are not new to the enterprise's market. This is especially true for services, but for other industries we also see an increase. In manufacturing industry, the figures are stable for innovations that are new to the enterprise, while overall, there is a slight decline.

There are major differences between enterprises and industries, and the share of turnover reported to come from product innovations varies from almost 35 per cent to under 0.1 per cent. Both the economic life of a product in the market, and how long it takes from a product is introduced until it generates revenue varies. In addition, the figures are affected by the market cycles, both in terms of fluctuations in turnover and market sensitivity for new product launches.

Over time, we see that the same industries appear both in the upper and lower part of the scale. Any differences from one survey to the next are often so high that they can be attributed to individual observations in a specific year. This can make it difficult to describe developments of specific industries in general from one year of observation to the next.

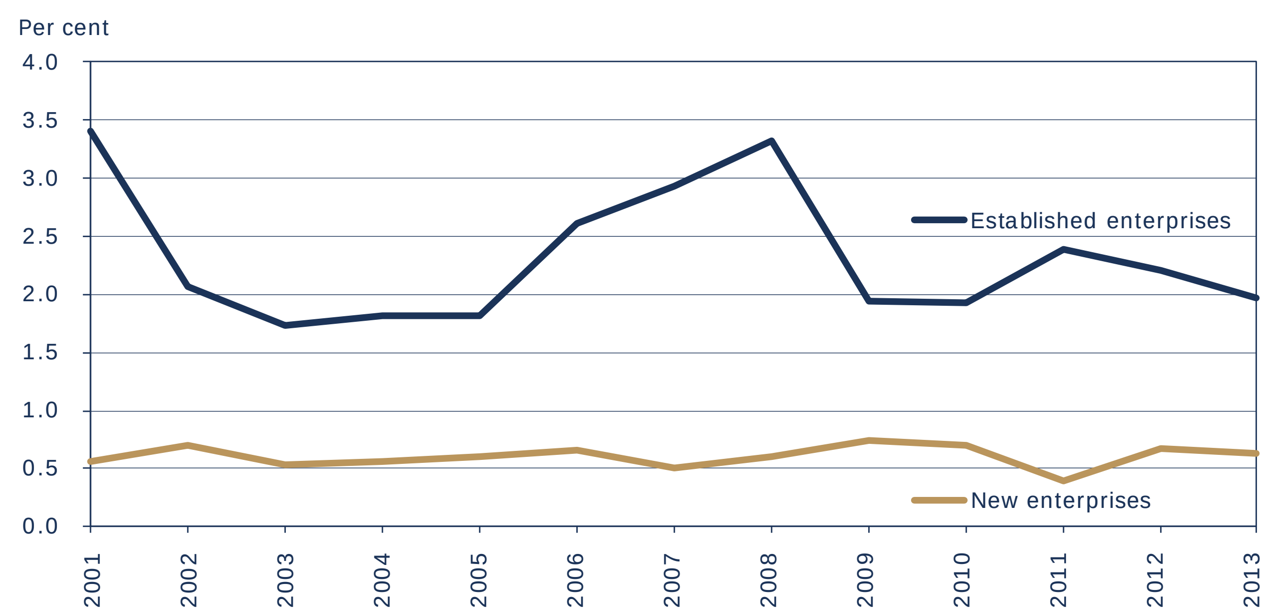
Small innovators more «innovation-dependent»

The survey shows that small innovators get a significantly higher share of their turnover from innovations than the large companies. Small innovators also invest relatively more of their turnover than the major ones in innovation.

The survey does not provide clear answers to the mechanisms that cause these observations, but it may be due to small entities relying on innovating to survive. In a growth phase, enterprises can have high investment relative to sales, and the same revenue may come from relatively few but innovative products. If innovators survive and grow, the same products will not necessarily be considered innovations, although they can significantly contribute to the turnover in the companies. New innovations introduced later may in the absolute sense be equally important, but since turnover then is larger, the innovative products contribute less to turnover.

In absolute terms, however, it is nonetheless the largest innovators who have the largest revenue return on their innovations, both because there is a higher proportion of product innovators among the large enterprises, and a higher turnover in general. In relation to the number of employees, there is no clear connection between turnover from product innovations and enterprise size; small product innovators have at least as much turnover per employee from their innovations as the largest enterprises.

Figure 4.9
Share of researchers who move to established or new enterprises from one year to the next. 2001–2013.



Source: Data: Statistics Norway. Computations: NIFU.

Entrepreneurship and the establishment of new enterprises is crucial for growth and renewal in the economy. This is the case no matter if newly-started enterprises survive, go bankrupt or are taken over by others. The number of new enterprises is therefore often used as an indicator for the dynamics of an economy.

Increased expectations of commercialisation

Traditionally, few enterprises are established based on universities or other research environments. Establishing new businesses is not the primary task of universities and colleges. Nevertheless, there are growing expectations that public funded research will lead to creation of new, innovative enterprises. There is an increasing focus on spin-offs and establishment of enterprises as important indicators of the commercialisation of universities and other research communities. At the same time, the creation of new businesses is central to the technology transfer offices (TTO).

We look at companies that are established with researcher involvement. Researcher involvement is defined as the case where the company at time of start-up employs at least one person who a) was registered as an employee at a university, college or research institute the year before the company was established and b) had higher education at the minimum master's level. This is a so-called trace analysis, which follows the employment status of the individual researcher from one year to the next.

Most of the researchers are still employed by a university, college or research institute from one year to the next. This applies to 89 per cent. About 4.5 per cent leave the labour market, either temporarily or permanently, while almost 4 per cent go to «Other public sector». Figure 4.9 shows that around 2 per cent have gone to existing companies. The number has been stable for the last 5 years, but varies more if we go further back in time.

No growth in the share of new enterprises with researcher involvement

The proportion of researchers involved in establishing new enterprises is quite stable at 0.6 per cent since the year 2000. In fact, the absolute number of new establishments with researcher participation is increasing, yet the proportion is kept constant because of an increase in the number of researchers in general. Researcher numbers have increased from around 17,500 researchers in the year 2001, to 29,000 in 2013. A stronger focus on new establishments from research environments has apparently not affected the entrepreneurship motivation of researchers.

New establishment with research collaboration occurs most often in the industry *knowledge-intensive business services*, which include consulting and consulting services. Second, researchers are involved in start-ups in the Health, social and education sector, which can be explained by increased privatisation in these industries.

FOKUS BOX NO. 4.1

How to measure impact?

Impact is a relatively new term in Norwegian research policy. It is generally used on broad and long-term effects of research, thus expressing a central objective with society's focus on research in various organisations and sectors. If the term is new, measurement of impact has nevertheless been done for almost 50 years. Despite major methodological problems, new methods are still being developed.

Quantitative methods

The most common approaches to impact measurement are about mapping the economic return on investment in research and development (R&D). Investigations have been carried out on both publicly financed and privately financed R&D and the effects they have had, especially on aspects such as innovation, growth and turnover in private companies. Often this has been used for so-called summative evaluations as the basis for deciding whether certain support schemes should be continued. This form of evaluation usually illustrates the relationship between input factors and results.

Two main approaches can be distinguished in such surveys. The first involves the use of different types of databases where one looks for links between indicators for research and indicators for effects. For example, studies have been conducted into the extent to which commercially successful patents are based on published research, and the extent to which companies receiving specific types of public support for R&D, have higher scores on different economic indicators than companies that do not receive such support. The second main approach is based on surveys, sometimes combined with databases, to look for experience with the implementation and use of research in enterprises or other organisations. The innovation survey conducted in Norway and many other countries (CIS) is an example of such an investigation. In many cases, databases and surveys are used both to say something about the benefit of the individual company and the further benefit to society in terms of the ripple effects of the research.

Common to both approaches is that they often find high returns, 20 per cent or more, for companies investing in or receiving research funding. Many studies, however, find an even higher return for society – it is not uncommon for quantitative studies to indicate numbers of 50 to 100 per cent. The figures are highly discussed, not least because of major methodological problems with such surveys.

Measurement Problems

Attribution is a central and complex method problem: research usually does not have an effect alone, it is research results along with many other factors that make a difference for a company or society as a whole. So how much of the credit should the research have in general, or the individuals and the research groups who have participated in specific projects and results? What else is needed to create impact – and should this be included in measurements so that impact doesn't becomes a responsibility for research alone?

Latency is another key issue – in many cases it may take a long time between research and measurable utility. Systematic surveys of agricultural research, which is probably the most frequently studied subject in terms of impact, indicate that average time from R&D to effect may be decades. This, of course, depends on what is measured, but it nevertheless creates major challenges for measurement systems and indicators – and for the assessment of attribution.

Causality is also controversial. Many have argued that the relationship between societal effects and research is more complicated than the latter leads to the former. In many cases there will be needs and challenges in society and industry that initiate or influence research efforts, and it is the mutual influence between research and those who use the one that creates impact. Although there are many examples that a scientific breakthrough or a research-based invention leads to a concrete product or other usefulness later, it is more common that impact is a more complex and indirect process.

Case based approaches

Understanding of impact, based on exploration of specific cases, has attempted to handle these problems in a slightly different way from the widely-established quantitative surveys. Often this has been a matter of evaluating a particular research environment or a particular research effort, and with the use of different data, one has attempted to map the breadth of what the research community or initiative has led to. This method tracks the impact in time.

Several of the latest measurement methods for impact are based on such an approach. This concerns among other things, the British Payback framework, used for medical research, and the French ASIRPA framework, designed to study how publicly-funded agricultural research benefits. Both approaches are aimed at mapping how research can lead to different types of impact for different groups and sectors in society. The method SIAMPI does something similar, especially by mapping the direct and indirect interactions between researchers and users. There are also methods that take into account values in society to which the research seeks to contribute. All these methods are most commonly used in so-called formative evaluations, where the purpose is to help research organisations and financiers to improve the way they work rather than finding a score. However, the relationship between input and output can still be central here, although attention is more directed to the often long-term process that leads to community benefits.

Alternatively, case-based mapping can start with certain products, such as drugs or new technologies, and try to track back in time to determine what research has been important to the product and in what way. Two of the most well-known and oldest systematic impact assessments are of the latter type. The United States Department of Defense wanted in the 1960s to map the productivity of different types of research based on 20 of its most important and most advanced military innovations. The results of this project, called Hindsight, showed that only a half per cent of hundreds of «key events» in the processes that led to the innovations could be classified as basic research. The driving force in the processes was, in almost all cases, an identified practical need. As a response to this, the US Research Council NSF had its own project, called Traces, which, based on some other innovations, found that around 70 per cent of key events were about basic research. The main difference was that NSF chose to go 100 years back in time, while the US Department of Defense's Hindsight project looked over the last 20 years.

The examples show that the measurement problems do not disappear using case-based methods, and that some different practical choices can have very big effects on the results. Clarity and transparency about such choices are thus important for the quality of the measurements. Measurement of impact also has a clear research policy side and can be used by different actors to argue for more funding or freedom for the research they are particularly concerned with. Traces and Hindsight – through their methodological choices – express a distinction between actors who primarily wish for basic research, and actors who primarily want more applied or user-driven research. Both project reports were referred to in the Norwegian Productivity Commission's second report in 2016.

Towards a broader impact concept

The most comprehensive impact assessment is now taking place in the UK in conjunction with the National Evaluation of Research, called the Research Excellence Framework (REF), which was carried out in 2014 and will be repeated in 2021. Here, all research communities must submit one or more so-called impact cases – short descriptions where a linkage of a concrete example of benefit to a concrete research result, must be documented. This is copied in many other countries, also in evaluations in Norway. The method is weak, among other things, because it covers only a few ways that research is beneficial, but it may be that it has other effects, such as increased awareness of community benefit in research environments. Many environments have used impact cases to communicate the value of their own research to the outside world.

The research policy most interesting with REF is the broad definition of impact: an impact on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life beyond the academy (REF 2011: 26). These are effects that are not only economic but related to health, environment, culture and public services. The impact concept thus becomes a challenge to all disciplines and sectors of research, formulated so that it also has the potential to meet those who do not recognise language usage around returns and productivity. It opens without the fact that the effects of research are not necessarily positive, without this being a significant aspect in the measurements so far. The definition of impact is in line with that used in many of the case-based approaches.

Although this newer and broad understanding of impact captures much more of the research's social impact than a purely economic understanding of utility, the breadth in many ways helps increase the measurement problems. Ratings of attribution and causality become rather difficult than simpler when there are many different types of effects in different areas of society. There are more and in many ways better measurement methods, but there are few signs of standardisation and still major problems comparing across different impact measurements.

Broad measurements of impact based on indicators or cases with both quantitative data and qualitative assessments are very expensive. Here, however, interesting experiments are taking place. Some seek to create new links between large and partly new databases, others want to develop new indicators under names like StarMetrics or AltMetrics. There are also a number of major research projects that primarily seek to understand the research system and the research process, while at the same time helping to create tools that can be used in research policy and in evaluations. Some of the most important discussion on these topics takes place in social media and on the impact blog of the London School of Economics.

Read more:

Bornmann, L. (2013): «What Is Societal Impact of Research and How Can It Be Assessed? A Literature Review.» *Journal of the American Society for Information Science and Technology* 64(2): 217–33.
Bozeman, B. and D. Sarewitz (2011): «Public Value Mapping and Science Policy Evaluation.» *Minerva* 49(1): 1–23.
Donovan, C. and S. Hanney (2011): «The 'Payback Framework' Explained.» *Research Evaluation* 20(3): 181–83.
Griliches, Z. (1995): «R&D and Productivity.» Pp. 52–89 in *Handbook of Industrial Innovation*, edited by P. Stoneman. London: Blackwell.
Joly, P. B. et al. (2015): «ASIRPA: A Comprehensive Theory-Based Approach to Assessing the Societal Impacts of a Research Organization.» *Research Evaluation* 24(4): 440–53.
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LSE impact blog: *http://blogs.lse.ac.uk/impactofsocialsciences/*, Twitter: @LSEImpactBlog
Oslo Institute for Research on the Impact of Science (OSIRIS): *http://blogs.lse.ac.uk/impactofsocialsciences/*, Twitter: @ OSIRIS_TIK

Magnus Gulbrandsen, TIK/University of Oslo and NIFU

5 Regional comparisons of R&D and innovation

Hebe Gunnes, Tore Sandven, Olav R. Spilling

Strong concentration of R&D activity in Norway

- Oslo alone accounted for 28 per cent of the total expenditure of R&D in Norway in 2015, followed by Sør-Trøndelag, Akershus and Hordaland. These four counties constituted 70 per cent of total national R&D expenditure.
- Within the various disciplines we find a strong concentration of R&D in engineering technology in Sør-Trøndelag; in medical and health sciences, humanities and social sciences in Oslo; and in agricultural sciences in Akershus.
- Industrial sector R&D activity is strongly concentrated in Oslo and Akershus. In 2015, the proportion of the two counties was 41 per cent of R&D, a slight decline from 43 per cent in 2008.

Regional allocation of government's instruments

- The Research Council of Norway has had significant growth in funding since the 1990s, but the distribution in the counties has been fairly stable. Oslo received around 29 per cent of the funding over the period. Sør-Trøndelag grew significantly, receiving 24 per cent in 2015, while Akershus experienced a decline, receiving 14 per cent in 2015.
- The SkatteFUNN tax deduction scheme expanded significantly over recent years. Oslo especially has grown strongly and is the largest county measured in budgeted activity. However, in relative terms Rogaland shows the strongest growth with a tripling of activity since 2002, and the county is now second largest in budgeted funds – after Oslo and ahead of Akershus and Sør-Trøndelag.
- Funding from Innovation Norway was stable during the period 2008–2016, except for 2009, when extraordinary funds were implemented due to the financial crisis. There is a fairly good distribution of grants across the country, and there has been a tendency for the innovative tools to gain greater weight.

The regional perspective on research, innovation and economic development is important, and over the last 20 years there has been an increased interest in the importance of the regional level. This is reflected, among other things, in the international interest in regional innovation systems and in European monitors such as the Regional Innovation Scoreboard and European Cluster Panorama. In line with this, regional content in the Report on Science and Technology Indicators for Norway, as of 2010, has been given a separate chapter, which has gradually expanded.

One main trend is, on the one hand, that industrialised countries are characterised by strong regional differences, and research and innovation activity is largely concentrated in certain regions. As shown in previous editions of the this report, the capital region appears in many cases to be the most important region. On the other hand, it is also an important perspective that each country consists of different regions with different advantages, and that it is crucial to facilitate the development of robust regions that specialise in different areas. A country's total strength is based on the interaction between the regions. It is therefore important to develop the understanding of the role of the different regions, and to assess regional R&D and innovation in a wider systemic perspective.

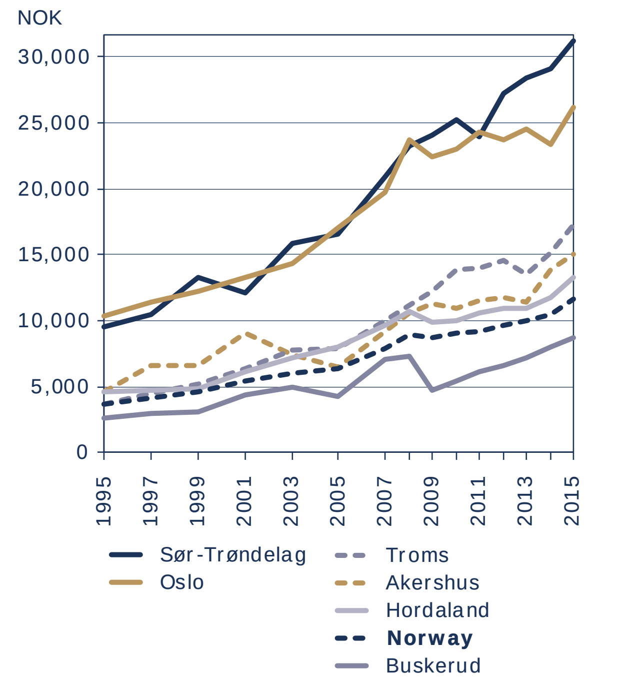
A regional innovation system can be defined as all parts and aspects of the economic structure and institutional conditions in a region that are important for innovation activity, knowledge development and learning. In the innovation literature, it is common to consider a regional innovation system as being composed of two sub-systems:

- The knowledge-developing system, which applies to all institutions that contribute to developing new knowledge, such as universities and colleges, research institutes, health trusts and business enterprises performing R&D activity.
- The knowledge-utilising system, i.e. institutions which put the knowledge to use and exploit it for different economic purposes. This applies to both the industrial and the public sectors. Traditionally, focus has been mainly on the industrial sector, but the utilisation of knowledge, of course, is equally central to the public sector.

In Norway, there is a long tradition of strengthening the regional knowledge infrastructure through a decentralised development of the higher education sector. Currently, we are seeing an upgrade of this, so that most regions now have their own universities, or are in the process of getting one. Similarly, the development of regional industrial sector communities has long been a priority. This is expressed in particular by focusing on industrial clusters, and an important part of this development is to seek to strengthen the interaction between knowledge institutions and business enterprises at the regional level. At the same time, globalisation and increased international competition mean that regional systems, to the extent they exist, are under pressure.

The purpose of this chapter is to provide a broad overview of regional variations in R&D and innovation activities and the associated human resources, as we concentrate on the R&D performance of Norwegian regions.

Figure 5.1
R&D expenditure per capita in the six highest R&D performing counties. 1995–2015.



Source: NIFU/Statistics Norway, R&D statistics

In 2015, NOK 60.2 billion was spent on R&D in Norway. Oslo was by far the largest county in 2015 with 28 per cent of R&D effort. The second largest county was Sør-Trøndelag, followed by Akershus and Hordaland. The four largest counties accounted for 70 per cent of R&D effort in Norway in 2015. R&D effort in Norway tripled between 1995 and 2015, but the county distribution pattern is almost unchanged.

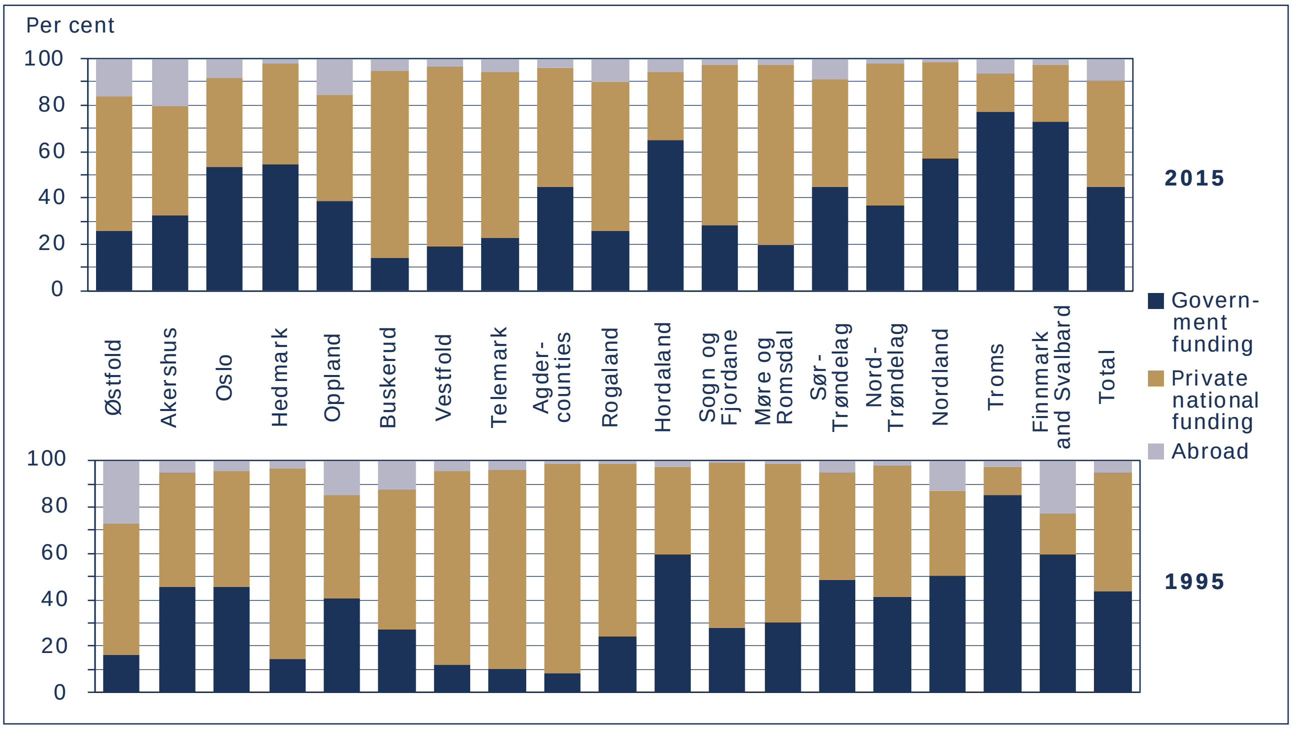
R&D effort per capita highest in Sør-Trøndelag and Oslo

Measured in R&D expenditure per capita, two counties stand out: Sør-Trøndelag and Oslo, see Figure 5.1. In 1995, R&D effort per capita amounted to NOK 10,000 in both counties, while in 2005 it increased to NOK 17,000 per capita. After 2008, growth stagnated somewhat in Oslo and was at NOK 26,000 per capita by 2015. In Sør-Trøndelag, growth continued and amounted to NOK 31,000 per capita by 2015. On average, NOK 3,700 was spent per capita for R&D in Norway in 1995, compared with 6,400 in 2005 and 11,700 in 2015. Five counties had above average R&D efforts in the period: Sør-Trøndelag, Oslo, Troms, Akershus and Hordaland.

High proportion of public funding of R&D in the northernmost counties

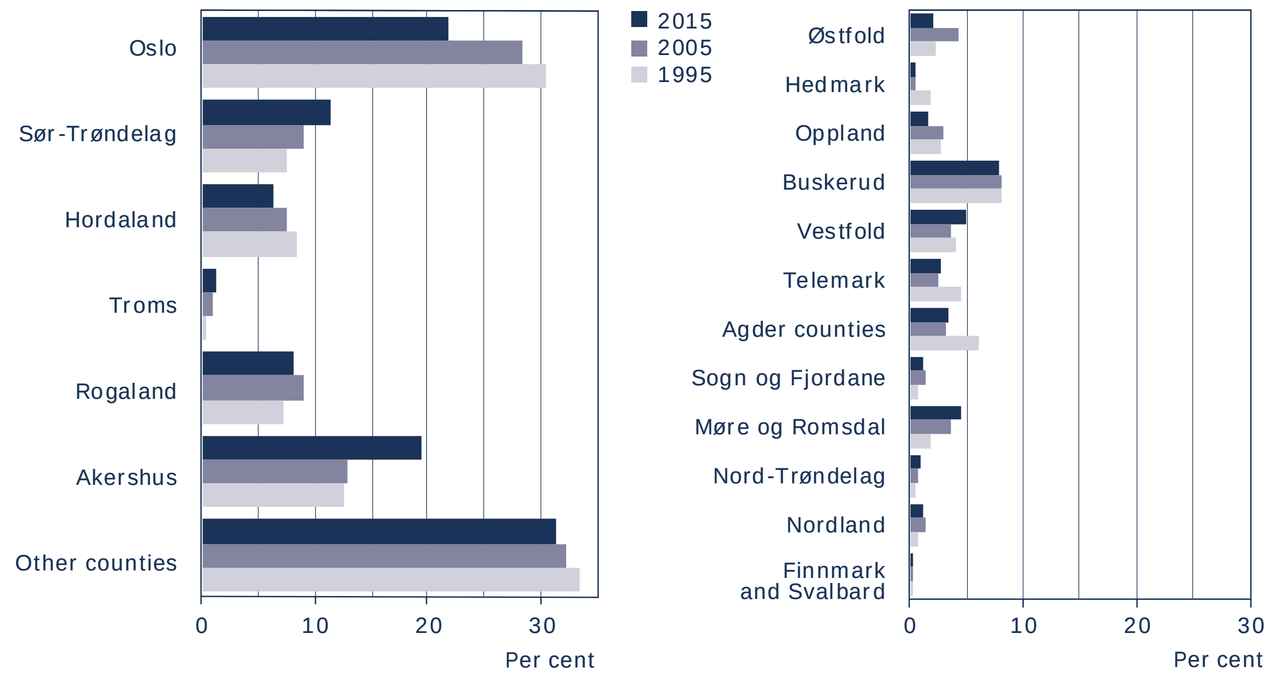
In the following, we look at funding of R&D activities, and we distinguish between private and public

Figure 5.2
Funding of R&D in 2015 (top) og 1995 (bottom), by main source of funds and county.



Source: NIFU/Statistics Norway, R&D statistics

Figure 5.3
Relative distribution of industrial sector R&D performance, by county. 1995, 2005 and 2015.



Source: NIFU/Statistics Norway, R&D statistics

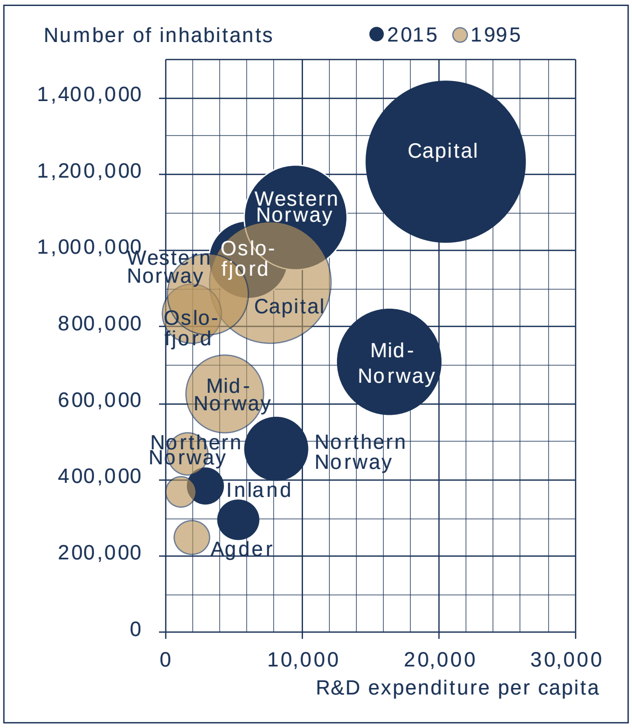
funding and funds from abroad. As shown in Figure 5.2, the funding pattern varies between the counties. Counties with a greater part of their R&D activity in the industrial sector, such as Buskerud, Vestfold, Telemark and Møre og Romsdal, also have a high amount of funding from this sector. Finnmark, including Svalbard, and Troms have a particularly high proportion of public sector funding. There is little R&D effort in the industrial sector, while the higher education sector accounted for nearly 60 per cent of R&D activity in 2015 in both counties. Other counties with a high proportion of public funding were Hordaland and Oslo, both of which have large institutions in the higher education sector, and also large university hospitals. The proportion of funding from abroad was highest in Akershus, Østfold, Oppland and Agderfylkene in 2015, while there were only marginal contributions from abroad in Hedmark, Nord-Trøndelag, Nordland and Finnmark.

Figure 5.2 shows changes in R&D funding in the counties from 1995 to 2015. In particular, four counties have major changes in the funding pattern: Hedmark, the two Agder counties, Buskerud and Finnmark, including Svalbard. In Hedmark, the industrial sector funded 82 per cent of R&D expenditure in 1995, and industry was the largest sector, while government funded 15 per cent. By 2015, public funding accounted for more than 50 per cent of R&D expenditure in this county. In the Agder counties there has also been a shift from privately to publicly funded R&D. In Buskerud, developments have been the opposite. The proportion of R&D funded by industry increased from 60 per cent in 1995 to 81 per cent in 2015.

R&D in industrial sector: High concentration in Oslo and Akershus

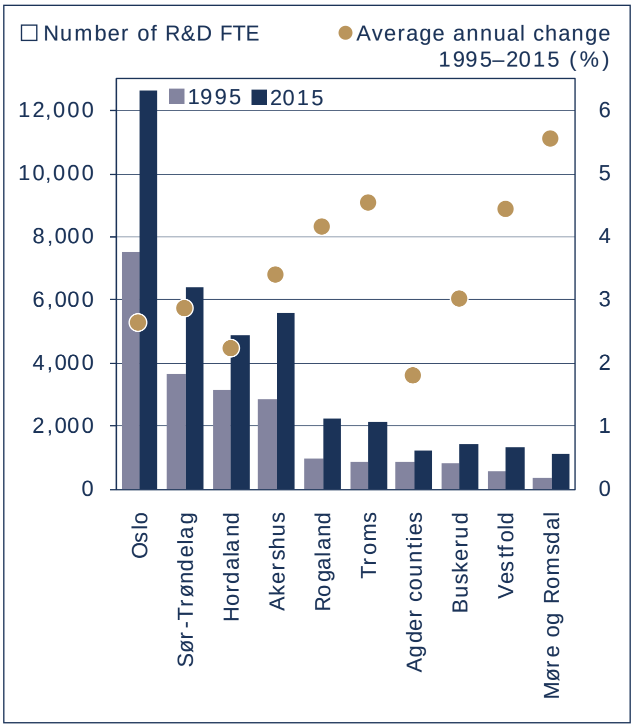
The industrial sector accounted for 46 per cent of R&D effort in Norway in 2015; over 40 per cent of this was carried out in Oslo and Akershus. Sør-Trøndelag accounted for 11 per cent, and Rogaland, Buskerud and Hordaland for between 6 and 8 per cent. As shown in Figure 5.3, Oslo has reduced its share of R&D performed in the industrial sector between 1995 and 2015. At the same time, the share has grown in Akershus, so the Oslo/Akershus region has retained its high share. There has also been significant growth in Sør-Trøndelag, while Hordaland has had a reduced share. Of the other counties, especially Buskerud stands out with relatively high R&D activity, largely due to the county's R&D-intensive industrial sector in Kongsberg. In Norway's four northernmost counties, R&D efforts in industrial sector have been marginal throughout the period, reflecting that these counties have industrial sectors of little R&D-intensive character.

Figure 5.4
Number of R&D personnel, inhabitants and R&D full-time equivalents in 1995 and 2015, by funding region.



Source: NIFU/SSB, R&D statistics

Figure 5.5
Number of R&D full-time equivalents in 1995 and 2015, and average annual growth from 1995 to 2015, by county.



Source: NIFU/SSB, R&D statistics

In 2015, 76,000 people performed a total of 42,000 R&D full-time equivalents (FTE) at Norwegian research institutions. The capital region, i.e. Oslo and Akershus, was the largest region. Here, a total of 30,000 people performed R&D, of which 21,500 were researchers.

In total, 18,200 R&D FTE were carried out in the capital region. The runner-up region in 2015, measured in the number of R&D FTE performed, was Mid-Norway, closely followed by Western Norway. The number of R&D FTE almost doubled from 1995 to 2015. The growth in the number of R&D FTE has been highest in the capital region, Western Norway and Mid-Norway. However, the largest percentage growth is found in Northern Norway and Mid-Norway.

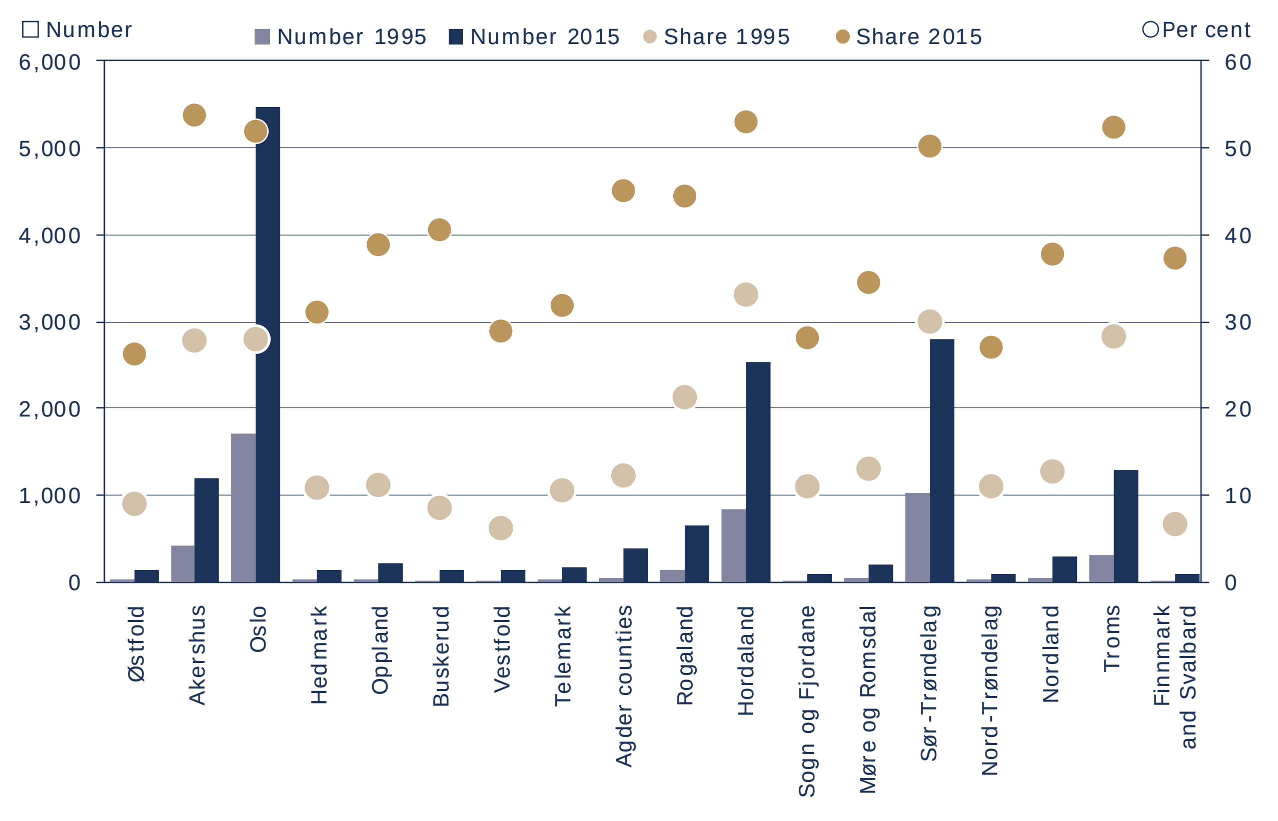
Figure 5.4 shows the relationship between the number of inhabitants, R&D expenditure per capita and the number of R&D FTE performed in each region in 1995 and 2015 respectively. The bubbles in the figure show the relative size of R&D FTE in the regions, and the figure reflects the growth in numbers R&D FTE from 1995 to 2015. The figure shows that the capital region scored highest both in 1995 and 2015, measured on all three criteria in the figure; residents, R&D expenditure per capita, and R&D FTE. The second largest region, in both years, was Western Norway, followed by the Oslofjord region and Mid-Norway. At the same time, Mid-Norway had the second highest R&D expenditure per capita. Inland and Agder were the two smallest regions.

Both in 1995 and in 2015, the capital region was the largest in all areas. The number of inhabitants has increased somewhat in all regions of the period, but the interdependence between the regions is the same. However, there has been a significant increase in R&D performance during the period, both in terms of R&D expenditure per capita and R&D FTE. The growth in R&D FTE in R&D has been highest in the capital region and Mid-Norway, which is also where R&D expenditure per capita has grown the most. However, the largest percentage growth from 1995 to 2015 in R&D FTE is found for Northern Norway, where the number of R&D FTE has more than doubled.

Highest average annual growth in R&D FTE in the smaller counties

Most of the R&D FTE were performed in Oslo both in 1995 and 2015, and the county accounted for about 30 per cent of R&D FTE both years. Average annual growth in the number of R&D FTE in Oslo in the period was 2.6 per cent, while at the national level the average growth rate was 2.9 per cent. Figure 5.5 shows that the counties with the highest growth in the

Figure 5.6
Doctorates among researchers / academic staff in the higher education sector and institute sector, by county, 1995 and 2015.



Source: NIFU, Doctoral Degrees Register

number of R&D FTE, Møre og Romsdal, Troms and Vestfold, all had a relatively low number of R&D FTE in 1995. Counties with major educational institutions such as Oslo, Sør-Trøndelag, Akershus and Hordaland, on the other hand, had the lowest average growth in R&D FTE.

Highest growth in the proportion of researchers/ academic staff with a doctorate in Agder

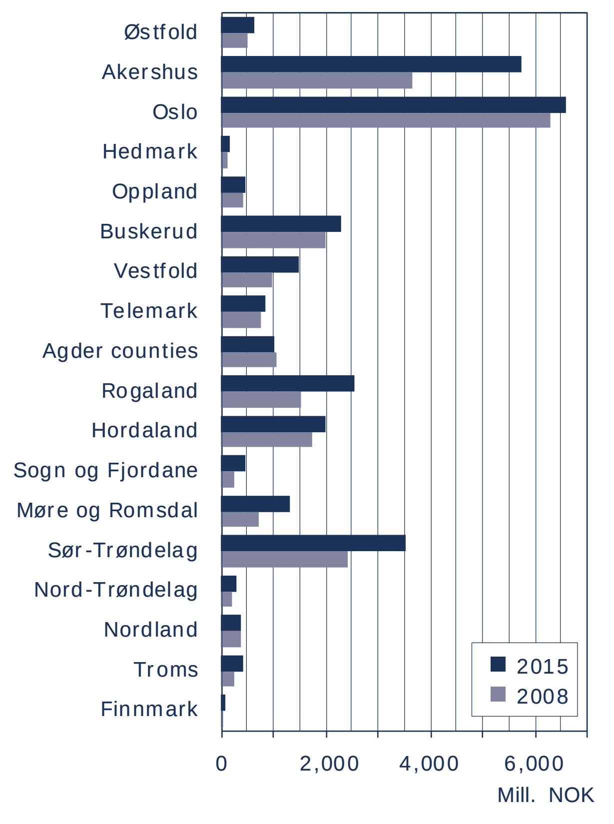
In 2015, 49 per cent of the researchers and the academic staff at the country's universities, colleges, health trusts and research institutes had a doctoral degree. In 1995, the proportion was 26 per cent. This means that the PhD degree in the higher education sector and the institute sector has increased by 23 percentage points during the period. The number of people with a doctoral degree in the two sectors has increased from almost 4,700 in 1995 to 16,000 in 2015. During the same period, 21,800 doctoral students defended their theses, but there are also many foreign PhD researchers who have come to Norway.

The counties with the oldest universities had the highest proportion of researchers/academic staff with a doctorate in both 1995 and 2015. The highest proportion in 2015 is found for Akershus, closely followed by Hordaland, Troms, Oslo and Sør-Trøndelag. The lowest PhD rate that year is found in Østfold, Nord-Trøndelag and Sogn og Fjordane. In 1995 Hordaland, Sør-Trøndelag, Troms, Oslo and Akershus had the highest doctorate proportions, while Vestfold, Finnmark and Buskerud had the lowest.

The largest growth in the doctorate share between 1995 and 2015 is found in Agder counties, Buskerud and Vestfold, all of which had a growth in the proportion of doctorates among researchers/academic staff of about 30 percentage points. Agder University College gained university status in 2008, which is a contributing factor to the county's increased doctorate share. The former colleges in Buskerud and Vestfold, now part of the University College of South-East Norway, have also worked to strengthen their research competence, with the aim of becoming a university.

The lowest growth in the doctorate share is found in Nord-Trøndelag, Sogn og Fjordane and Østfold. All these counties have medium-sized state colleges specialising in areas with low doctorate shares, such as teacher education and health care education. Østfold is the only county of these three which has research institutes of a certain size.

Figure 5.7
Industrial sector R&D expenditure by county. 2008 and 2015. Fixed 2015 prices.



Source: Statistics Norway, R&D statistics

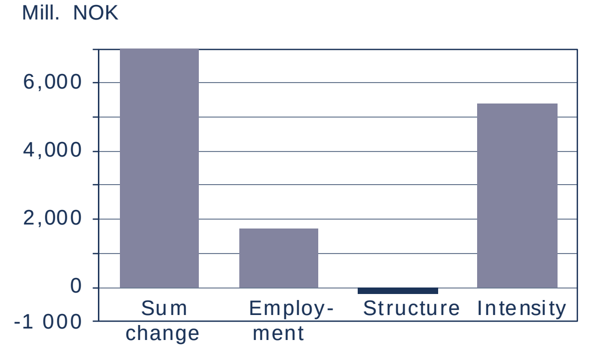
As shown in Chapter 5.1.1 on R&D expenditure in the counties, there is a strong concentration of industrial sector R&D activity in some areas of the Norway. By 2015, 41 per cent of the total activity was concentrated in Oslo and Akershus, while the three counties with the least R&D activity, Finnmark, Hedmark and Nord-Trøndelag, did not total more than 1.8 per cent. In this sub-chapter we will look at how R&D activity has developed in the counties in the period 2008–2015, the period for which we have data.

Overall, R&D activity in the industrial sector increased from NOK 18.1 billion in 2008 to NOK 30.2 billion by 2015, corresponding to a 30 per cent real growth. As shown in Figure 5.7, real growth occurred in most counties during the period. The regions with decline were the two Agder counties (4%) and Nordland (2%). In absolute terms, Akershus has had the strongest growth, followed by Sør-Trøndelag and Rogaland.

This development confirms the strong concentration of R&D activity in the Oslo and Akershus region. However, it is Akershus that has grown substantially, while Oslo's growth has been more limited. This has led to a decline in the overall share of industrial sector R&D in Oslo and Akershus, from 43 per cent in 2008 to 41 in 2015.

There has also been strong growth in Rogaland. While the county in 2008 was ranked sixth in terms of industrial sector R&D, in 2015 it moved to fourth place after Oslo, Akershus and Sør-Trøndelag.

Figure 5.8.
Decomposition of changes in R&D in industrial sector. 2008–2015.



Source: Statistics Norway. Computations: NIFU

Increased R&D intensity main explanation for growth in R&D expenditure

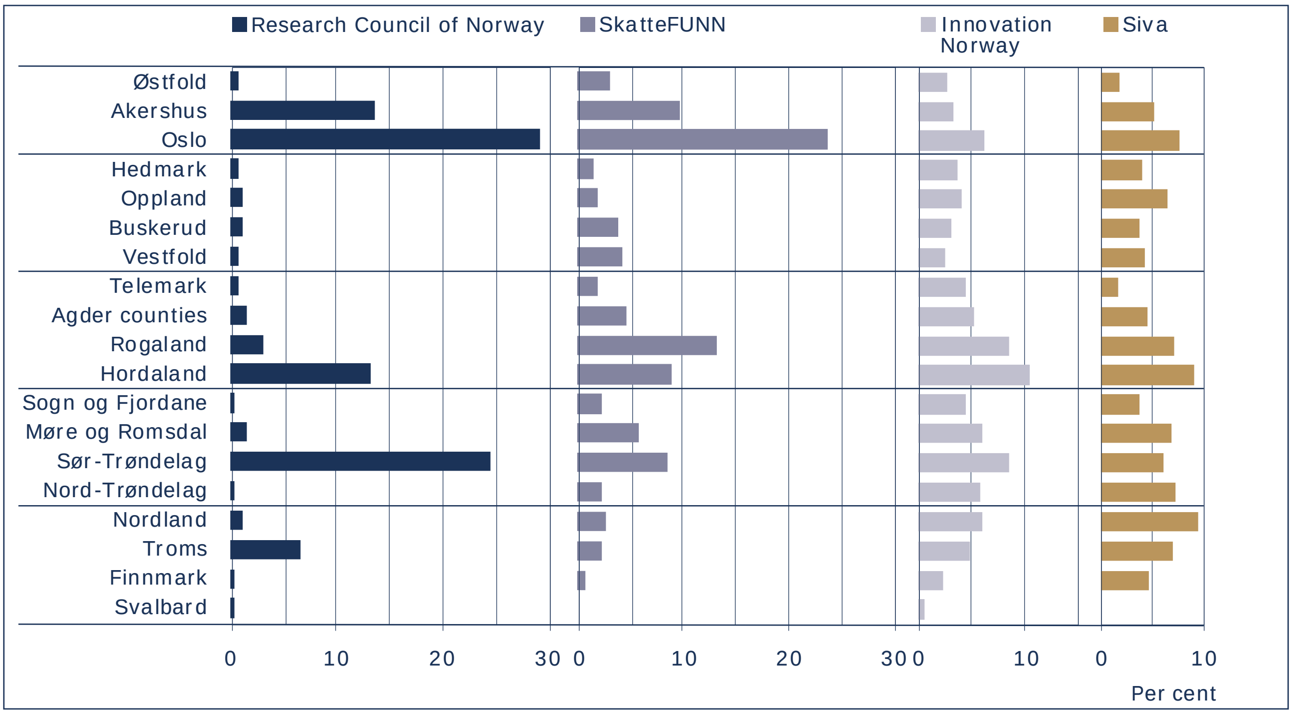
Growth in industrial sector R&D activity may occur due to several factors, and we have isolated growth in three such factors – employment, structure and intensity (see fact box). As shown in Figure 5.8, the growth in R&D activity is largely attributable to the fact that R&D intensity in industrial sector has increased, as a whole; 77 per cent of the increase is due to this. Part of the growth (nearly 25%) is due to general growth in the industrial sector. In addition, the R&D survey shows that structural changes have a negative component, that is, there has been a quite marginal change towards smaller R&D intensive industries.

Explanation of growth in business R&D

The growth in industrial sector R&D activity may be due to several factors, and in the analysis we have distinguished between the following three categories:

- General growth in the industrial sector; if the industrial sector's R&D activity is constant per employed, growth in employment will lead to increased growth in R&D.
- Change in industry sector structure; if different industries (with different R&D intensities) develop differently, this will lead to changes in the overall R&D activity.
- Change in R&D intensity in individual industries.

Figure 5.9
Regional distribution of funds from the Research Council of Norway, Innovation Norway, tax deduction (SkatteFUNN) and Siva in 2016.



Source: Research Council of Norway, Innovation Norway and Siva

In this sub-chapter we provide an overview of the county-wide distribution of the most important instruments that are applied to stimulate research and innovation in Norway, and this applies to:

- Grants for research through the Research Council of Norway
- Budgeted tax deductions in SkatteFUNN[1] projects with planned activity
- Grants awarded by Innovation Norway
- Grants for innovation infrastructure through Siva

In this overview, we only provide data for 2016: in that year the Research Council granted a total of NOK 8.9 billion for research, based on more than 2,200 projects. In the SkatteFUNN scheme, a total of 6,900 projects with planned activity were approved in 2016. The total cost budget for these projects was NOK 26.4 billion and the estimated tax deduction was 4.9 billion. Innovation Norway committed a total of NOK 6.2 billion in loans and grants to more than 5,600 projects in 2016. Of this total funding, grants (net commitments) amounted to NOK 2.9 billion.

In total, funding for research and innovation through the Research Council, Innovation Norway and SkatteFUNN (tax deduction) amounted to NOK 16.7 billion in 2016, which is NOK 2.1 billion higher than in 2015 and NOK 4.1 billion higher than in 2014.

[1] See more about SkatteFUNN in chapter 2.5.1.

The strong growth is due to a particular increase in the expected revenue loss through the SkatteFUNN scheme, which has increased by almost NOK 2 billion over the past two years. The funding through the Research Council of Norway has grown, while the allocations through Innovation Norway have decreased slightly over the past year.

Siva's main role is to develop infrastructure for innovation by organising a number of innovation companies. As part of this, Siva also provides grants to business parks and incubators, totalling NOK 151 million in 2016, representing an increase of NOK 66 million compared to 2015.

Figure 5.9 shows how the instruments are distributed among the counties. Grants from the Research Council are strongly concentrated in the counties with the oldest universities, which is where the larger research institutes are located, too. The distribution of SkatteFUNN is determined by the location of research-oriented enterprises, i.e. largely following the distribution of R&D expenditure in the industrial sector. It is, however, somewhat more decentralised because the most central regions, especially Oslo and Akershus, receive a smaller proportion of these funds.

In contrast, the grants from Innovation Norway and Siva have a completely different geographical pattern. Both institutions have important regional policy tasks, which lead to a more decentralised distribution of their funds.

6 Structural change and transition

Lisa Scordato, Espen Solberg

Structural changes in the Norwegian economy

- Over the past 50 years, the industry structure in Norway has changed significantly. Today, only 2 per cent of Norwegians work in primary industries compared with 12 per cent in 1970. Secondary industries have decreased from 28 to 20 per cent, while service industries have increased from 56 per cent to 77 per cent.

- While shipping was Norway's largest export industry in the early 1970s, the petroleum industry has taken over this role. In 2012, more than half of Norway's total export revenue came from the sale of crude oil and natural gas and related services and products.

- In 2016, more than 60,000 new enterprises were established in Norway, while an almost equal number were closed down. This indicates that around 15 per cent of enterprises are being replaced annually. Nevertheless, changes in existing enterprises have by far the strongest impact on total employment.

R&D for green transition

- Petroleum-related research and development is important in Norway. In 2015, a total of NOK 5.7 billion was reported as related to such research, compared with NOK 1.7 billion to renewable energy. Petroleum research increased significantly up to 2014, but declined after the fall in oil prices.

- The industrial sector clearly has the largest share of petroleum research, but it also dominates research on energy efficiency and environmental technologies. The institute sector is the largest contributor in the field of renewable energy and has significant activity on all topics in energy and environmental research in Norway.

- There has been a strong growth in Norway's public grants to R&D and demonstration in the energy and environmental field. Total allocations are now highest among the Nordic countries. Norway stands out with high allocations to fossil energy, but has also increased its commitment to renewable energy and energy efficiency, especially after the so-called Climate Agreement 2008.

Digitisation and use of ICT

- By 2016, 45 per cent of Norwegians between 16 and 74 years had digital skills «above the basic level». Thus, Norway is number 3 in Europe, only behind Denmark and Luxembourg.

- Norwegian companies are generally prominent regarding the use of ICT and broadband access, but are lagging slightly behind the leading countries when it comes to access to high-speed broadband.

- Many state-owned enterprises in Norway expect and experience changes because of new ICT systems. The introduction of new ICT solutions hardly contributes to reduced staffing. In 2015, 25 per cent of enterprises expected the introduction of ICT to reduce their staff over the next two years. Two years later, only 7 per cent say they have experienced downsizing.

Changes in working life

- New calculations from the OECD show that 10 per cent of Norwegian jobs are highly likely to be automated. This is lower than previous estimates and on par with most OECD countries.

- Most international comparisons indicate that Norway has a learning-intensive work environment: Norway generally holds a high score in terms of the proportion of employees involved in education and training. In Norway, nine out of ten workers also say that they learn new things through their daily work.

The need for transition is high on the political agenda. In this chapter, we present some additional indicators which shed light on past patterns of change and indicate how Norway is positioned for future transition.

Research on transition

«Transition» is not just a political term. It is also subject to academic discussions, with various definitions and approaches. Some theories emphasise the long-term, gradual and complex nature of transition processes (Rotmans et al., 2001), while others have suggested that transition requires a distinct break and a clear identification of a «before and after» (Latour, 1993). The scholarly literature also shows mixed evidence as to whether transition processes can or should be steered. In innovation research, there has been an increasing awareness that the state should play an active role as a driving force for transition (Mazzucato, 2013). Closely related is also the movement towards so-called third generation innovation policy, where transition processes are understood as broad societal processes and are linked to the solution of major societal challenges (Schot and Steinmueller, 2016).

Transition as the normal mode

Transition is not a new phenomenon. The society and the economy are constantly changing, sometimes in the form of brand new phenomena that create changes from a certain point of time, such as when Norway started oil extraction in the early 1970s. But just as often, transition is a gradual process that can hardly be linked to one event. An example of the latter is the increased participation of women in Norwegian working life, which has taken place gradually throughout the post-war period. Both examples represent changes that have had a significant impact on the Norwegian economy and society.

A special need for transition

Several factors indicate that Norway has a special need for transition in a number of areas. The Government's latest Perspective Report highlights the following:

While much of the prosperity increase has previously built on increased productivity, productivity growth in Norway has been significantly lower over the past ten years. This is not unique to Norway, but poses a challenge for future prosperity.

The large revenues from the oil and gas industry are based on limited resources and cannot be expected to be a major driver of growth in the long run. The recent drop in oil prices has revealed and reinforced the need to develop new sources of export and value creation in Norway.

Climate and environmental challenges require a fundamental reorganisation of production and consumption in a more sustainable direction. This will require transition processes on many levels. For Norway's part, this also reinforces the need to develop alternatives to oil and gas activities.

The outlook for lower transfers from the Government Pension Fund Global[1] makes public spending unlikely to increase as much as has been the case during the past decades. If welfare levels are to be maintained and further improved, new solutions and more efficient use of resources in the public sector are needed.

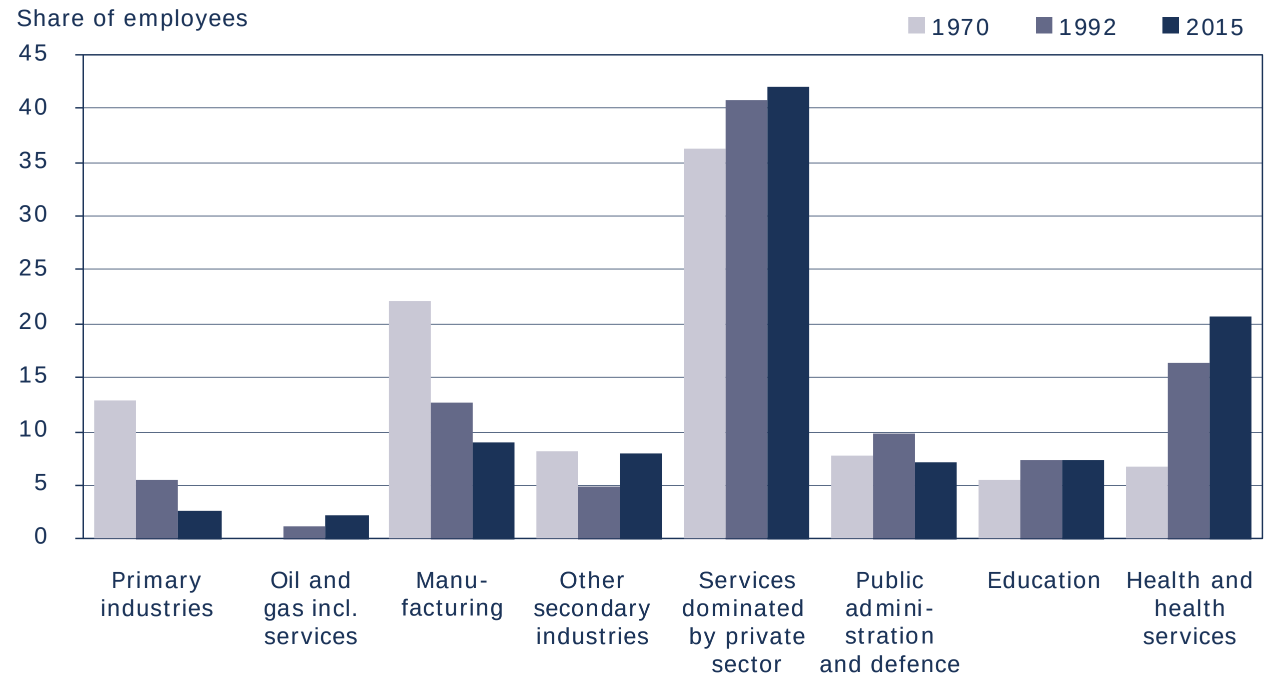
Digitisation and automation are changing large parts of working life. For Norway, it may mean fewer jobs in some areas, but also that new jobs may be created, for example, by moving production back from low-cost countries. But a positive use of digitisation and automation requires that society has the ability and willingness to use new technology and allocate resources to new areas.

Measurement of transition

Since transition is such a complex and multi-faceted term, it is also difficult to measure transition in an unambiguous way. In this chapter, we focus on transition in a Norwegian context and first describe some key economic trends over time. Then we look at some indicators that may say something about the prerequisites for future transition in Norway, particularly ICT, digitisation and automation, learning in the workplace and transition from fossil to renewable energy.

[1] The Government Pension Fund Global was set up in 1990 to underpin long-term considerations when phasing petroleum revenues into the Norwegian economy. Norges Bank Investment Management manages the fund on behalf of the Ministry of Finance.

Figure 6.1
Employment by main industry in Norway. Industries' share of total employment. 1970, 1992 and 2015.



Source: Statistics Norway, National Accounts

The economy is not static, but in constant change. New activities emerge while others become less important or obsolete. The way we produce goods and services has also changed over time. One way to grasp this is to follow changes in the business structure over time, that is, where people work and where value is created.

From agriculture and products to services

During the last 50 years, the industry structure in Norway has changed significantly. Primary industries now represent only 2 per cent of the employed, compared with 12 per cent in 1970. Secondary industries have decreased from 28 to about 20 per cent. This decline has mainly taken place in manufacturing. Services currently account for 77 per cent of total employment against 56 per cent in 1970. Some of this is due to reclassification of enterprises between industries, but the figures also reflect real changes. In other words, Norwegians work less often in fields and factories, and more and more in shops, offices and institutions.

[2] This chapter is based on Statistics Norway's publication «This is Norway 2017».

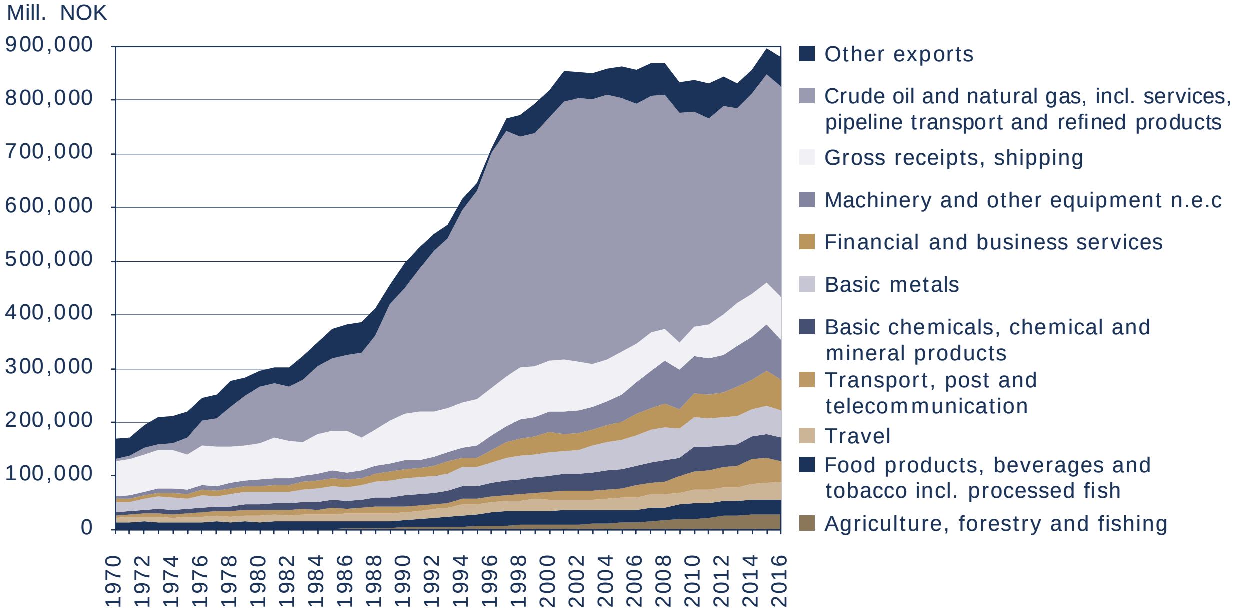
High value output per employee in secondary industries

The relative importance of industries can also be highlighted by looking at their contribution to gross domestic product (GDP). Then the picture changes slightly: secondary industry's share is today 33 per cent, compared with 20 per cent for the share of employees. This is mainly due to the high revenues per employee in the oil and gas industry. Primary industries' contribution to GDP is about the same as the rate of employment, i.e. 2 per cent. Tertiary industry's contribution to GDP is 65 per cent, which means that service industries generally have less value added per employee than the other main industries.

Fivefold increase in the number of employed in health and healthcare

Services, however, is very diverse. As shown in Figure 6.1, *health and healthcare services* have accounted for the strongest growth in service industries. Since 1970 the number of employees in in the health and care sector has increased fivefold. During the same period the number of employees in market-oriented services, public administration and education, has approximately doubled.

Figure 6.2
Revenues from Norway's 10 most important export goods and services in 2016. 1970–2016. Constant 2005 prices.



Source: Statistics Norway, National Accounts

Much of the transition debate in Norway is related to the need to develop new sources of export revenue. Norwegian exports have long been dominated by raw materials and fewer high-tech products. This can represent both a strength and a risk: trade in commodities can be very profitable at times of high commodity prices, a situation that Norway has benefited from over the last ten years. At the same time, decline in commodity prices can cause major losses of export revenues. But high-tech exports can also be vulnerable to changes in market needs and technological development.

Oil and gas dominate

Figure 6.2 shows the real growth in Norwegian income from exports of goods and services since 1970. Only the ten largest commodity and service groups in 2016 are included. These ten export categories accounted for 94 per cent of Norwegian exports in 2016 and 77 per cent in 1970. However, although the main export products and services have remained stable over time, there have been major changes. While shipping was Norway's largest export industry in the early 1970s, the petroleum industry has taken over this role. In 2012, more than half of Norway's total export revenues came from the sale of crude oil and natural gas and associated services. In addition, the supply industry, which also exports products and services related to the oil and gas business, is in other product and service categories.

Total exports follow the decline in oil and gas

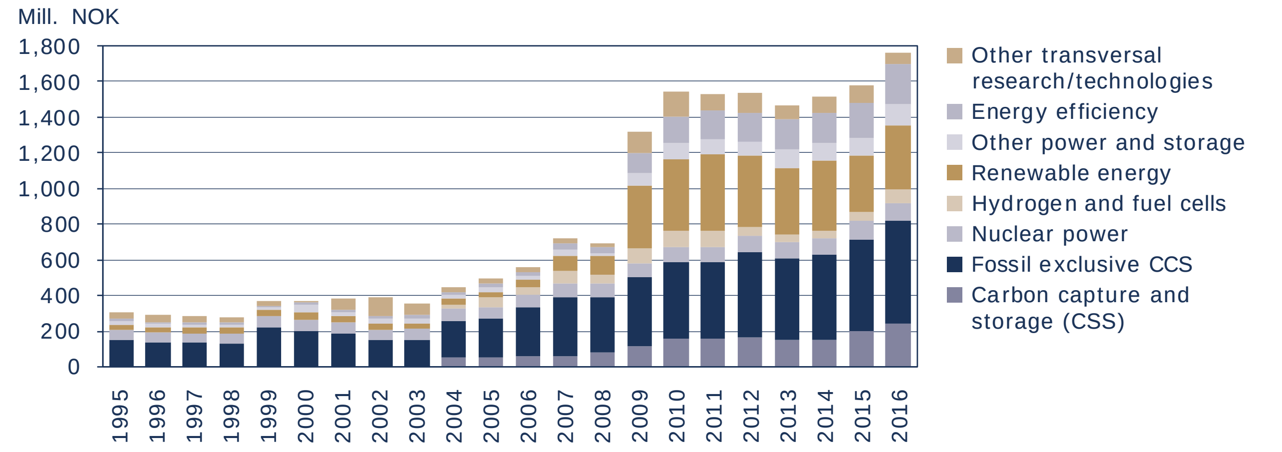
After 2012, and especially after 2014, the share of oil-related export revenues has declined, as a direct consequence of the oil price decline from 2014. Although more than half of Norwegian exports in 2016 originate from goods and services other than oil and gas, total exports have flattened. Norway still has a positive trade balance, but in 2016 the export surplus was the lowest in 17 years. In addition to the decline in oil and gas revenues, there was also a fall in export value for industrial machinery, where a large proportion goes to petroleum and gas-related businesses abroad. In contrast, fish exports increased, with a sharp rise in prices yielding record export values in 2016.

A commodity and service-based export profile

The chart also shows that about half of all exports in 2016 were linked to commodities, where metals and fish constitute the most important products after oil and gas. Furthermore, we see that services account for two of the four main export revenues, namely *shipping services* and *financial and business services*. Both service categories are considered «knowledge-intensive services» and are a major reason for Norway's high scores in international comparisons of knowledge-based services. On the other hand, Norway has a small degree of high-tech exports, as can be seen from this overview.

Figure 6.3

Norwegian government budget appropriations for R&D[1] by energy field. 1996–2016.



[1] Excluding expenditure for demonstration or own government R&D.

Source: OECD, IEA R&D Budgets database 2017

The importance of energy-related issues, and the need for more environmentally friendly energy, is also reflected in the profile of public funding. Here we use data from the International Energy Agency (IEA) to illustrate public funding for energy-related R&D and demonstration. The figures show developments over the past twenty years. We also compare with data for the other Nordic countries in the same period.

Increase of Norwegian public R&D in the energy field after the Climate Agreement in 2008

During the last two decades, Norwegian government R&D investments in the energy field have increased gradually. Between 1996 and 2016, the Norwegian allocations were NOK 18.2 billion. Expenditure increased especially from 2009 because of the climate agreement adopted in the Norwegian Parliament in 2008. R&D allocations for *renewable energy*, *energy efficiency* and *carbon capture and storage* (CCS) account for a large part of the increase.

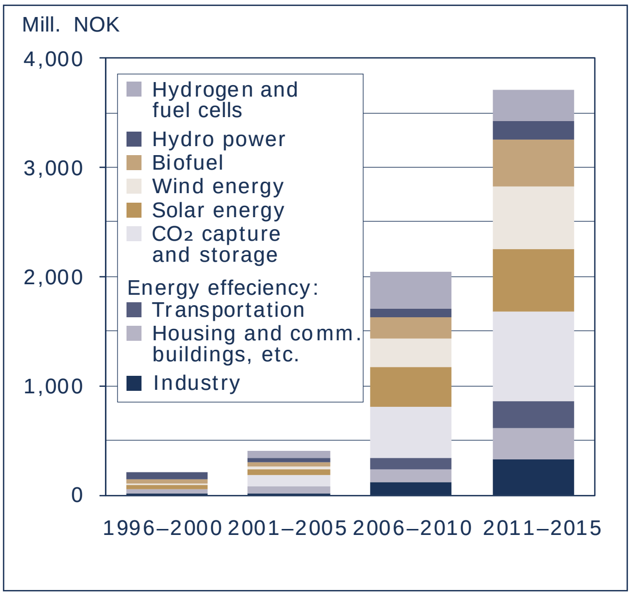
Public funding for demonstration in the period 2009–2016 was around NOK 12 billion. Compared with the period 2003–2008, the cost of demonstration was a total of NOK 436 million (demonstration expenses are missing before 2003).

For renewable energy, the allocated R&D expenditure was approximately NOK 3.6 billion in the period 1995–2016. Of this total, almost 90 per cent were invested in the last ten-year period. Within the renewable field, the cost of *solar energy* was 32 per cent of the total expenditure, followed by *wind* (27%), *biofuel* (22%) and *hydropower* (11%). For *carbon capture and storage*, R&D grants were just over NOK 1.6 billion. For energy efficiency, R&D appropriations were NOK 1.5 billion.

The Energi 21 strategy is Norway's national strategy for research, development, demonstration and commercialisation of new energy technology, which was established by the Ministry of Petroleum and Energy in 2008. In 2009, the scheme for environmentally friendly energy (FME) research centres was established, and in 2016 the Research Council allocated funding for eight new FMEs. The centres cover the areas of hydropower, smart power grids, energy efficient industry, environmentally friendly transport, CO2 management, solar cells, biofuels and zero-emission areas in the cities.

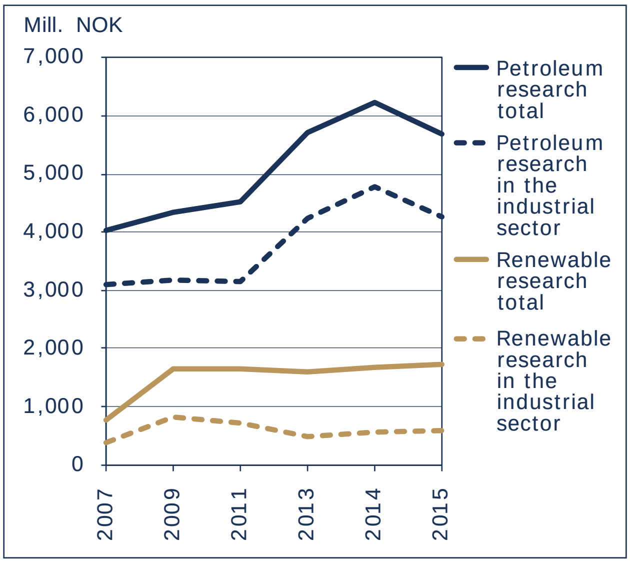
Figure 6.4

Norwegian government budget appropriations for R&D for environmental related energy fields. 1996–2015.



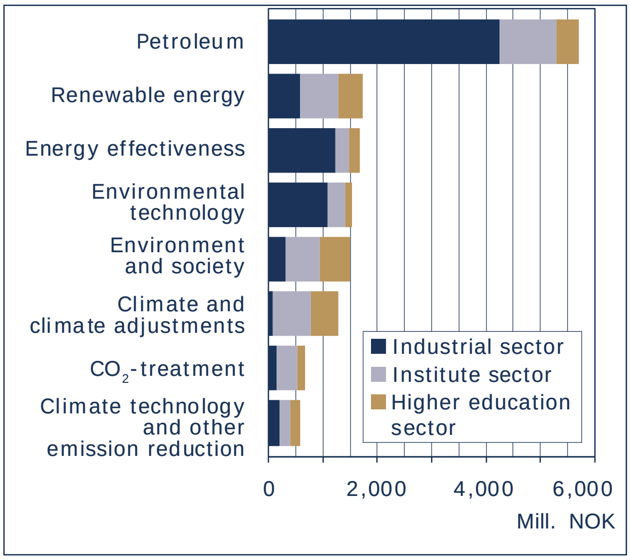
Source: OECD, IECD R&D budgets database 2017

Figure 6.5
R&D expenditure geared towards petroleum activity and renewable energy. Total and for the industrial sector. 2007–2015.



Source: Statistics Norway/NIFU, R&D statistics

Figure 6.6
R&D expenditure geared towards different energy and environmental purposes in 2015 by sector.



Source: Statistics Norway/NIFU, R&D statistics

R&D for green transition

Although there are different opinions about future oil extraction, there is broad consensus that more of Norwegian value added must come from sources other than oil and gas, and that the process must be facilitated for more sustainable value creation. Research and development are considered as important factors in such a transition. Therefore, we look at indicators for petroleum-based R&D and various forms of environment-related R&D. These dimensions have been mapped in R&D statistics since 2007.

Growth and decline in petroleum research

Figure 6.5 shows that Norwegian research communities report three to four times more petroleum-related R&D than R&D targeting renewable energy. From 2007, petroleum research has risen steadily and with a sharp increase in the period from 2011 to 2014. By 2015, we see that petroleum research decreased, which is most probably due to oil prices and reduced investments in the sector. This indicates that much of the petroleum related R&D activity is directly linked to new investments and exploration projects in the sector.

Few indicators of a green transition

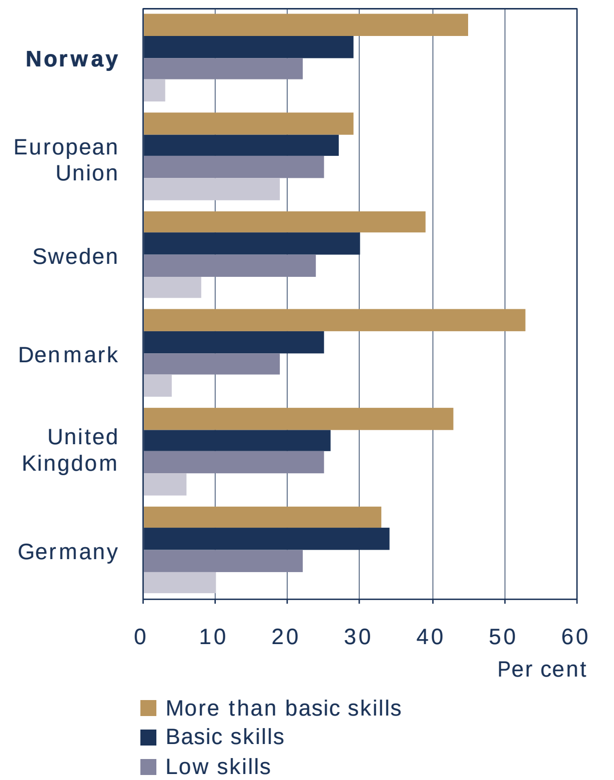
R&D efforts aimed at renewable energy show a slightly different development. Here we see a strong increase in the R&D effort after the agreement on climate policy from 2008[3]. Thereafter, growth has slowed down, both in total and for the industrial sector. Although research on renewable energy sources shows a certain increase, while petroleum research is declining, it is difficult to see signs of a green transition in the overall R&D effort in these areas.

The institute sector combines petroleum research and environmental research

Figure 6.6 shows the amounts of R&D devoted to petroleum activities and various environmental purposes in 2015. Several environmental categories are new in 2015, and cannot be measured over time. Petroleum-oriented R&D appears to be the largest category, with a total of NOK 5.7 billion in reported R&D. Most of this takes place in the industrial sector, not only in the oil and gas industry, but also in the supply industry and in ICT services. R&D in *energy efficiency* and *environmental technology* are also frequently reported in industrial sector. *energy efficiency* is particularly widespread in *oil and gas*, *metal industry*, *electrical engineering* and *technical consultancy*. Furthermore, we see that the institute sector reports a lot of R&D activity in both *oil and Gas*, *renewable energy*, *environment and climate*.

3 Norway's climate policy is based on agreements reached in the Storting in 2008 and 2012 between all the political parties (except the Progress Party). The agreements are a result of the broad political consensus that Norway shall take responsibility for a reduction in greenhouse gas emissions through an active national policy. The agreement contains targets for emission reductions in 2020, including ambitions for national emission reductions and a long-term goal of restructuring Norway to a low-emission society

Figure 6.7
General digital skills in Norway, EU and selected countries in 2016. 16–74 years.



Source: Statistics Norway/Digital Skills Indicator

The use of ICT and new digital solutions is considered important for transition in different parts of society. The population's digital skills therefore provide a relevant indication of a country's ability to handle and reap the benefits of new technology.

High digital skills among Norwegians

According to the most recent European survey on digital skills, Norwegians score relatively high. By 2016, 45 per cent of Norwegians between 16 and 74 years had digital skills «above basic level». Another 29 per cent had «basic skills». As shown in Figure 6.7, this is well above the EU average and also above the level in many neighbouring countries. In general, the countries of Northern Europe are better off than countries in southern and eastern Europe. Luxembourg is at the top with 54 per cent of the population having good skills. Then comes Denmark with Norway as number three in the EU measured by the proportion of people with digital skills above the basic level.

In Norway, there is also a very small percentage, only 3 per cent, who report that they have not used the Internet. This share is significantly lower than in the EU overall. At the same time, we see that every fifth citizen in Norway has low digital skills, which reveals a significant digital skills gap.

Most Norwegians master digital information search

In addition to the general skills indicator, the *Digital Skills Indicator* describes the population's digital experience and competencies in four different fields. Of the four fields, Norwegians fares best on Digital information search, with 87 per cent between 16 and 74 years above the basic level. Only Denmark and Luxembourg show higher skills here.

Norwegians also display high experience in digital communication and task-solving. 80 and 72 per cent respectively have good skills in these areas, compared with 58 and 54 per cent for the EU total.

Fewer are highly skilled in using software

Experience with using software is somewhat less prevalent than the three other categories. In Norway, 54 per cent have good skills in this area, while 22 per cent have inadequate or no mastery. Those over 65 especially have little experience with software. But here too, the level in the EU is overall lower, with an average of 40 per cent with good skills. A likely explanation for poor skills in using software is that few people need to use master computer programmes in their daily lives and work. The indicator does not distinguish between the lack of the needs and the lack of skills.

About «Use of ICT in households»

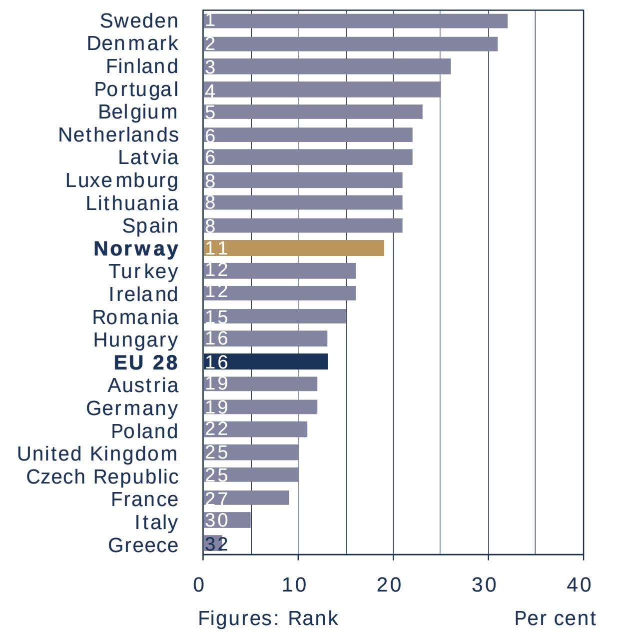
The survey forms the basis for the indicator Digital Skills Indicator, one of the tools the European Commission uses to measure digital skills in the population of Europe.

The indicator groups the population into four skill levels and consists of:

- I) Digital Information Search
- II) Communication
- III) Task Solution
- IV) Software Skills.

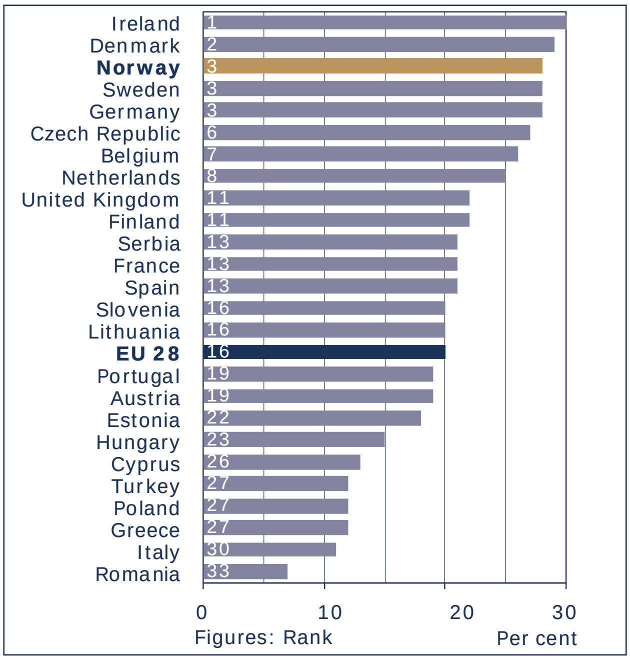
People who score «above the basic level» in all four areas of competence are considered to have good overall digital skills

Figure 6.8
Access to high-speed broadband (100 MB/s) in European enterprises. Share of all enterprises which use Internet in 2016.



Source: Statistics Norway, Employment of ICT in enterprises/Eurostat

Figure 6.9
Share of enterprises which have received orders via electronic networks in 2015 by country.



Source: Statistics Norway, Employment of ICT in enterprises/Eurostat

The use of new ICT solutions is important for competitiveness and transition in large parts of the business community. Eurostat conducts regular surveys on the use and dissemination of ICT in European business. This allows for international comparisons. In Norway, Statistics Norway conducts the survey among Norwegian enterprises.

Norwegian enterprises advanced in the use of ICT

In general, most indicators show that Norwegian enterprises are far ahead when it comes to access to and use of ICT solutions. Among other things, almost half of Norwegian enterprises now report that they use cloud services, which is a clear growth from previous years and is among the highest shares in Europe. The survey also shows that technological advances are moving rapidly and that several of the questions are becoming less relevant. For example, the proportion of enterprises with Internet access is now close to 100 per cent in most European countries.

Access to high-speed broadband across the EU, but behind Nordic neighbouring countries

Broadband access is also becoming increasingly widespread. The fact that broadband access is important for innovation and renewal is also emphasised by the fact that the European Commission has included enterprises' access to high-speed broadband as a new indicator in the annual European Innovation Scoreboard, see also section 1.3. Norwegian enterprises have a high score in broadband access, but are somewhat behind the leading countries when it comes to high speed broadband access with over 100 MB per second, see Figure 6.8.

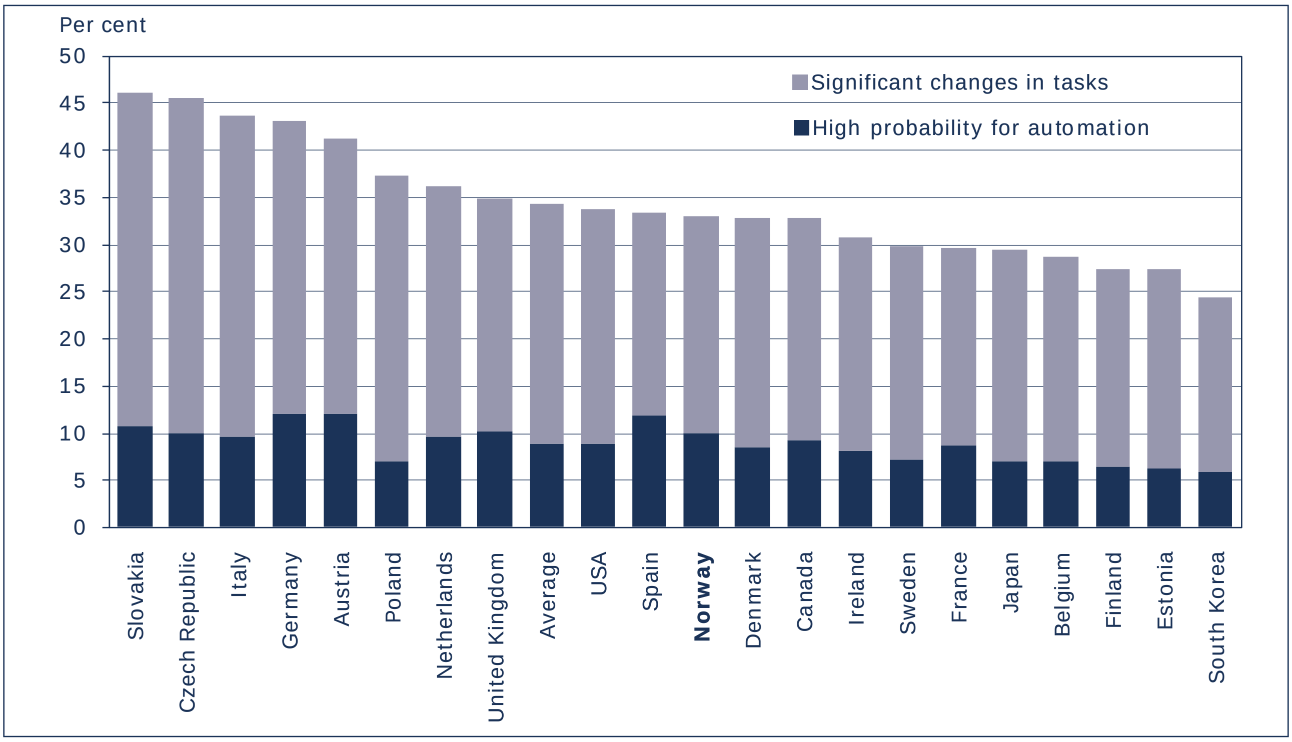
More than every fourth enterprise engaged in online sales

The ICT survey also shows that 28 per cent of Norwegian enterprises have received orders for goods or services through websites in 2015. As shown in Figure 6.9, only enterprises in Ireland and Denmark have a higher share in Europe. Most online sales among Norwegian enterprises are on the Norwegian market. By 2015, only 5 per cent of the enterprises were selling to other countries via the internet.

About «Use of ICT in enterprises»

The survey is published annually, and is a sample survey with Norwegian enterprises with at least 10 employees in selected industries. The survey asks, among other things, about internet access, e-commerce, ICT specialists, use of cloud services, social media and websites. The statistics are developed in cooperation with other European countries through Eurostat.

Figure 6.10
Share of jobs with a high probability for automation and significant changes in tasks in 2012 by selected OECD-countries.



Source: OECD, based on PIAAC and Arntz et al (2016)

The introduction of new technology has always resulted in major changes in working life. In recent years, there has been a lot of focus that advanced algorithms and new robotics can make many jobs redundant. But new technology can also create new jobs and, not least, change the content of existing jobs.

Exaggerated fear of automation

A much-discussed study by Oxford researchers Frey and Osborne (2013) has suggested that automation can make 47 per cent of all jobs in the United States redundant in the next 10–20 years. The same method has been applied to many other countries, including Norway, where 33 per cent of jobs were found to be likely to disappear soon (SSB, 2015). A weakness of these studies is that they estimate the likelihood of automation for all occupational groups but without considering that each profession and job often contains different tasks that are more or less automatable. Based on data from the Programme for the International Assessment of Adult Competencies (PIAAC), the OECD has made an alternative calculation based on the tasks of the employees, regardless of occupation. As shown in Figure 6.10, this gives far lower estimates of redundancies due to automation. Over all, about 10 per cent of employees are estimated to have jobs that can be automated, which is also the level in Norway.

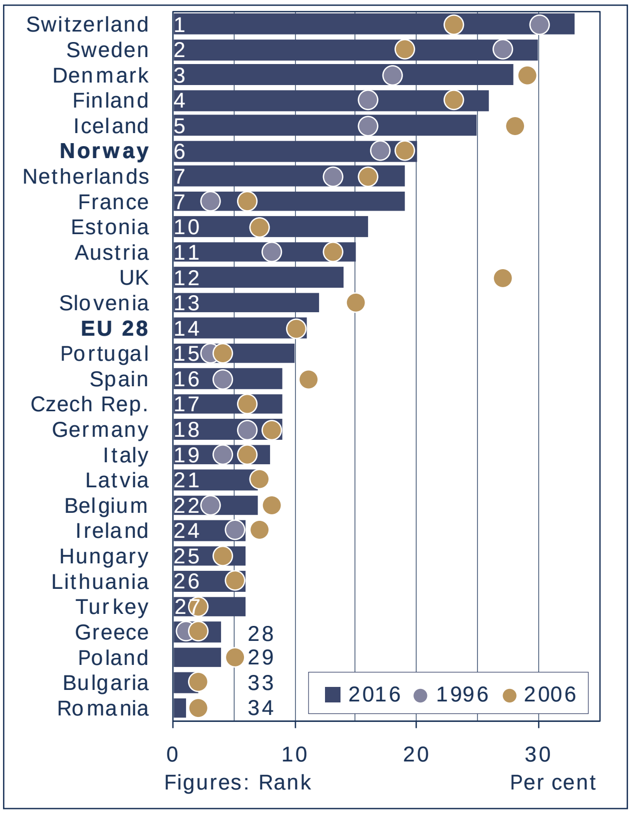
About PIAAC

The PIAAC (Programme for the International Assessment of Adult Competencies) is the world's largest survey of adult skills. It was conducted by OECD in 2011–2012 and includes testing adult skills in reading, numerical understanding and problem solving in the ICT environment. The skills are measured by respondents having answered tests in the form of exercises on PC or paper form. In total, the survey included 166,000 people aged 16-65 in 24 countries. Statistics Norway has completed all parts of the survey, and in Norway nearly 5,000 people participated in the test.

But major changes in work tasks

At the same time, the OECD calculations show that a large proportion of the workers in the countries concerned are in jobs where there is a high likelihood that the tasks will change. In many Eastern and Southern European countries, it is estimated that one third of the workers will experience significant changes in tasks. For Norway, the share is almost a quarter, which may indicate that Norwegian employment has already completed many of these changes.

Figure 6.11
Share of employees (25–64 years) who have participated in education or training in the last 4 weeks. Responses from the years 1996, 2006, and 2016.



Source: Eurostat/European Labour Force Survey (LFS)

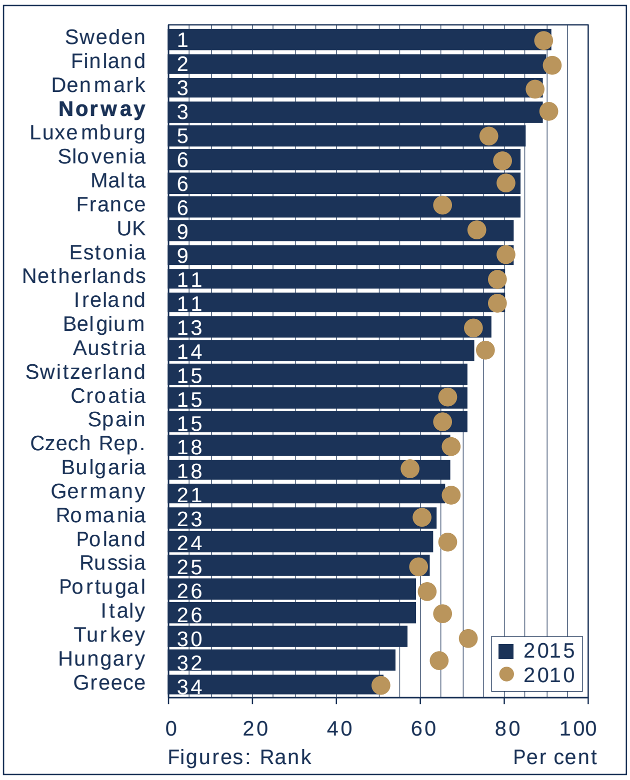
Societal transformations require that employees can develop their skills throughout their lives, and continue their education for new tasks. Several European studies include questions about employee participation in different forms of learning. Data from the surveys have been used as a new indicator of lifelong learning in the latest edition of the European Innovation Scoreboard (see chapter l.3).

High participation in lifelong learning in Norway

Compared with other European countries, Norwegian employees seem to have high participation in lifelong learning. Figure 6.11 shows the proportion of workers who report having participated in some form of education or training during the last 4 weeks. Here Norway is among the foremost countries, but noticeably behind Switzerland and the other Nordic countries.

The question has been the same since 1992. The main picture has been quite like the last 20 years, see Figure 6.12, confirming that high learning intensity is a structural and cultural feature of Norwegians and, not least, Nordic working life. This is also evident in other international studies on lifelong learning in working life.

Figure 6.12
Share of employees who state to learn new things in their daily work in 2015 and 2010.



Source: Eurofund/European Workings Conditions Survey

Most Norwegians learn through their job

In addition to formal and informal training, much learning takes place through daily work. Such learning is difficult to measure. However, one indication is given through Eurofund's regular working conditions surveys, where a selection of workers in all European countries are asked about different conditions at the workplace. One of the questions is whether the employee learns new things through his/her daily work. As shown in the figure, it is particularly the employees from the Nordic countries who state that they learn through daily work. In these countries, nine out of ten workers state that they learn through their work.

These findings have also been used in recent innovation research on the links between labour cultures and innovation capabilities. Here the conclusion is largely the same, namely that workplaces in Scandinavian countries and the Netherlands are characterised by large flexibility and incentives to learning, while, for example, the United Kingdom, France and Germany have more hierarchical and less learning-intensive systems (see, for example, Lorenz and Lundvall, 2010).[4]

[4] Eurostat/Adult Education Survey 2011, Eurostat/Continuing Vocational Training Survey 2010, and OECD/PIAAC 2012.

Appendix

Tables

Table 1

Total R&D expenditure in Norway by sector of performance and source of funds: 2015. Million NOK.

Sector of performance	Total	Industry		Government		Other sources[1]	Abroad	
		Total	Oil companies	Totalt	Research Council of Norway		Total	Of which: EU-com-mission
Business enterprise sector	32,445	23,585	..	2,805	1,676	1,812	4,244	356
Of which: Industrial sector[1]	27,782	21,690	..	1,171	553	1,315	3,607	118
Institutions serving enterprises[2]	4,663	1,895	317	1,634	1,124	497	637	237
Government sector	9,055	668	99	7,406	1,886	244	737	195
Of which: Institutions serving government	8,235	644	99	6,651	1,864	206	735	194
Health trusts without university functions	821	24	..	756	22	39	2	1
Higher education sector	18,709	586	157	16 674	2,782	887	561	409
Of which: Universities and university colleges	15,523	549	157	13,759	2,565	690	525	397
University hospitals	3,186	38	-	2,915	217	197	36	12
Total Norway	**60,209**	**24,839**	**..**	**26,885**	**6,345**	**2,943**	**5,542**	**960**

[1] Includes private funding, gifts and SkatteFUNN in the industrial sector.

[2] Includes private, non-profit hospitals operating on behalf of a regional health trust.

Source: NIFU/Statistics Norway, R&D Statistics

Table 2

Current expenditure on R&D by sector of performance and field of research and development: 2015. Million NOK.

Field of research and development	Total	Industrial sector	Institute sector	Higher education sector
Humanities	1,840	..	323	1,517
Social scienes	6,361	..	2,092	4,269
Natural sciences	5,497	..	2,516	2,981
Engineering and technology	6,248	..	4,362	1,886
Medical and health sciences	7,957	..	1,725	6,232
Agricultural sciences	2,150	..	1,794	356
Not elsewhere classified	26,035	26,035	..	..
Total	**56,087**	**26,035**	**12,812**	**17,241**

Source: NIFU/Statistics Norway, R&D Statistics

Table 3

Current expenditure on R&D by type of R&D and sector of performance: 2015. Million NOK and per cent.

Sector of performance		Total	Basic research	Applied research	Experimental development
Industrial sector	Million NOK	26,035	925	5,269	19,840
	Per cent	100	4	20	76
Institute sector	Million NOK	12,812	1,859	8,614	2,339
	Per cent	100	15	67	18
Higher education sector	Million NOK	17,241	7,612	7,483	2,146
	Per cent	100	44	43	13
Total	**Million NOK**	**56,087**	**10,396**	**21,366**	**24,325**
	Per cent	**100**	**19**	**38**	**43**

Source: NIFU/Statistics Norway, R&D Statistics

Table 4
R&D expenditure in Norway by sector of performance and type of cost: 1970–2015. Million NOK. Current prices.

	Total			Industrial sector[1]			Institute sector			Higher education sector		
Year	Total	Current expenditure	Investments	Total	Current expenditure	Investments	Total	Current expenditure	Investments	Total	Current expenditure	Investments
1970	891.0	774.1	116.9	275.6	255.5	20.1	329.3	295.3	34.0	286.1	223.3	62.8
1972	1,236.0	1,094.5	141.5	355.4	335.3	20.1	459.3	417.3	42.0	421.3	341.9	79.4
1974	1,633.1	1,467.3	165.8	478.6	434.4	44.2	629.5	578.8	50.7	525.0	454.1	70.9
1977	2,716.2	2,356.1	360.1	850.0	747.4	102.6	958.8	859.6	99.2	907.4	749.1	158.3
1979	3,265.2	2,951.9	313.3	1,026.5	941.6	84.9	1,229.9	1,134.6	95.3	1,008.8	875.7	133.1
1981	4,267.7	3,865.2	402.5	1,334.4	1,209.8	124.6	1,713.3	1,569.5	143.8	1,220.0	1,085.9	134.1
1983	5,764.6	5,207.2	557.4	1,886.4	1,737.6	148.8	2,404.6	2,142.1	262.5	1,473.6	1,327.5	146.1
1985	8,202.9	7,361.7	841.2	3,574.0	3,248.7	325.3	2,826.4	2,493.8	332.6	1,802.5	1,619.2	183.3
1987	10,319.4	9,216.1	1,103.3	4,548.5	4,036.7	511.8	3,605.1	3,232.2	372.9	2,165.8	1,947.2	218.6
1989	11,662.2	10,313.7	1,348.5	4,590.3	4,056.6	533.7	4,300.5	3,839.3	461.2	2,771.4	2,417.8	353.6
1991	12,744.0	11,285.2	1,458.8	4,979.8	4,463.2	516.6	4,405.2	4,024.3	380.9	3,359.0	2,797.7	561.3
1993	14,335.6	12,667.5	1,668.1	5,631.2	4,906.8	724.4	4,810.7	4,338.2	472.5	3,893.7	3,422.5	471.2
1995[2]	15,970.4	14,389.2	1,581.2	7,340.6	6,437.6	903.0	4,490.7	4,271.5	219.2	4,139.1	3,680.1	459.0
1997	18,243.9	16,485.2	1,758.7	8,571.5	7,742.0	829.5	4,826.6	4,518.6	308.0	4,845.8	4,224.6	621.2
1999	20,346.5	18,441.4	1,905.1	9,540.0	8,772.3	767.7	4,987.1	4,752.8	234.3	5,819.4	4,916.3	903.1
2001	24,469.4	22,305.3	2,164.1	12,613.7	11,348.5	1,265.2	5,581.5	5,337.4	244.1	6,274.2	5,619.4	654.8
2003	27,245.8	24,813.3	2,432.5	13,390.7	12,077.1	1,313.6	6,360.0	6,075.3	284.7	7,495.1	6,660.9	834.2
2004	27,552.7	25,280.5	2,272.2	12,707.7	11,735.5	972.2	6,620.0	6,320.0	300.0	8,225.0	7,225.0	1,000.0
2005	29,514.8	27,442.6	2,072.2	13,511.7	12,591.3	920.4	6,906.8	6,660.9	245.9	9,096.3	8,190.4	905.9
2006	32,274.8	29,844.9	2,429.9	14,734.8	13,614.9	1,119.9	7,650.0	7,350.0	300.0	9,890.0	8,880.0	1,010.0
2007	36,788.2	33,955.8	2,832.4	16,755.4	15,481.6	1,273.8	8,309.9	7,941.7	368.2	11,722.9	10,532.5	1,190.4
2008	40,545.3	37,354.4	3,190.9	18,294.7	16,928.9	1,365.8	9,266.6	8,812.5	454.1	12,984.0	11,613.0	1,371.0
2009[3]	41,884.5	39,061.7	2,822.8	18,201.9	17,180.2	1,021.7	10,262.4	9,794.2	468.2	13,420.2	12,087.3	1,332.9
2010	42,759.1	40,000.6	2,758.6	18,513.8	17,264.4	1,249.5	10,415.3	10,051.2	364.1	13,830.0	12,685.0	1,145.0
2011	45,440.4	42,577.5	2,862.9	20,065.9	18,532.5	1,533.4	11,115.1	10,657.4	457.7	14,259.4	13,387.6	871.8
2012	48,043.5	45,140.2	2,903.3	21,176.3	19,718.3	1,458.0	11,828.2	11,237.9	590.3	15,039.0	14,184.0	855.0
2013	50,748.2	47,817.7	2,930.5	22,556.9	21,059.1	1,497.8	12,190.1	11,689.0	501.1	16,001.2	15,069.6	931.6
2014	53,867.0	50,894.7	2,972.3	24,801.9	23,336.0	1,465.9	12,345.1	11,910.7	434.4	16,720.0	15,648.0	1,072.0
2015	60,209.3	56,087.1	4,122.2	27,782.4	26,034.5	1,748.0	13,718.1	12,811.7	906.4	18,708.7	17,240.9	1,467.8

[1] Due to new information from important R&D units in the industrial sector, R&D statistics from 2001 till 2007 have been corrected.

[2] Data from 1995 is not directly comparable with the previous years due to an extension in the data coverage in the industrial sector, as well as the transfer of state commercial enterprises from the institute sector to the industrial sector.

[3] In 2009, some research units were reclassified, mainly from the higher education sector to the institute sector.

Source: NIFU/Statistics Norway, R&D Statistics

Table 5
R&D personnel (head count) in Norway by sector of performance and gender: 1974–2015.

Year	Total			Industrial sector[1]			Institute sector			Higher education sector		
	Total	Researchers[2]	Women (%)	Total	Researchers[2]	Women (%)	Total	Researchers[2]	Women (%)	Total	Researchers[2]	Women (%)
1974	21,820	9,756	..	5,152	1,419	..	7,599	3,286	9	9,069	5,051	12
1977	23,952	10,818	..	5,851	1,688	..	8,108	3,517	9	9,993	5,613	14
1979	25,154	11,851	..	6,402	2,017	..	8,605	3,982	9	10,147	5,852	14
1981	26,297	12,939	..	6,473	2,316	..	9,138	4,376	12	10,686	6,247	15
1983	27,930	14,002	..	7,254	2,909	..	9,793	4,663	11	10,883	6,430	16
1985	30,979	15,923	..	10,041	4,475	..	9,818	4,792	13	11,120	6,656	18
1987	31,898	18,128	..	10,332	5,897	..	10,077	5,343	16	11,489	6,888	19
1989	32,871	19,515	18	9,734	5,861	13	10,639	5,882	19	12,498	7,772	22
1991	31,473	20,118	20	8,634	5,671	14	10,094	5,909	20	12,745	8,538	24
1993	33,979	21,879	22	9,402	6,192	16	10,514	6,339	24	14,063	9,348	25
1995	40,915	26,712	23	12,631	8,012	15	10,092	6,048	26	18,192	12,652	29
1997	43,972	30,280	26	14,326	10,377	18	9,998	6,118	28	19,648	13,785	32
1999	43,893	30,994	28	14,545	10,710	19	9,279	5,920	29	20,069	14,364	34
2001	48,394	34,549	29	17,995	13,308	19	9,285	6,077	31	21,114	15,164	36
2003	50,728	35,307	29	19,356	12,741	17	9,411	6,350	32	21,961	16,216	38
2005	53,845	36,570	32	20,215	11,999	19	9,425	6,484	34	24,205	18,087	39
2007	59,156	41,347	34	21,464	14,068	20	10,618	7,467	37	27,074	19,812	42
2008	62,675	43,715	34	23,472	15,412	20	11,111	7,713	38	28,092	20,590	43
2009[4]	64,126	44,762	35	23,468	15,249	21	11,716	8,198	39	28,942	21,315	44
2010	63,876	44,774	36	22,939	14,854	21	11,854	8,277	40	29,083	21,643	44
2011	64,717	45,578	36	23,317	15,332	22	12,106	8,434	41	29,294	21,812	45
2012	66,085	46,747	..	24,730	16,460	..	12,079	8,386	41	29,276	21,901	46
2013	68,204	47,795	36	25,324	16,667	19	12,297	8,540	42	30,583	22,588	47
2014	71,947	50,024	37	28,153	18,180	22	12,265	8,440	42	31,529	23,404	47
2015	76,557	52,181	37	31,068	19,236	22	12,323	8,341	43	33,166	24,604	48

[1] Due to new information from important R&D units in the industrial sector, R&D statistics from 2001 till 2007 have been corrected.

[2] Personnel with a higher education degree (ISCED-level 5A and 6). Only academic staff are included in the higher education sector.

[3] Data from 1995 is not directly comparable with the previous years due to an extension in the data coverage in the industrial sector, as well as the transfer of state commercial enterprises from the Institute sector to the Industrial sector.

[4] In 2009, some research units were reclassified, mainly from the higher education sector to the institute sector.

Source: Statistics Norway/NIFU, R&D statistics

Table 6
R&D personnel (FTE) in Norway by sector of performance: 1970–2015.

Year	Total			Industrial sector[1]			Institute sector			Higher education sector		
	Total	Researchers[2]	Others	Total	Researchers[2]	Others	Total	Researchers[2]	Others	Total	Researchers[2]	Others
1970	9,857	4,317	5,540	3,067	867	2,200	3,820	1,663	2,157	2,970	1,787	1,183
1972	11,395	5,115	6,280	3,395	976	2,419	4,400	1,992	2,408	3,600	2,147	1,453
1974	12,459	5,630	6,829	3,460	1,011	2,449	5,007	2,309	2,698	3,992	2,310	1,682
1977	13,860	6,358	7,502	4,003	1,202	2,801	5,333	2,556	2,777	4,524	2,600	1,924
1979	14,810	7,112	7,698	4,390	1,390	3,000	5,638	2,906	2,732	4,782	2,816	1,966
1981	15,025	7,548	7,477	4,201	1,524	2,677	5,885	3,125	2,760	4,939	2,899	2,040
1983	16,188	8,350	7,838	4,409	1,821	2,588	6,801	3,544	3,257	4,978	2,985	1,993
1985	19,036	9,767	9,269	6,687	2,995	3,692	7,095	3,605	3,490	5,254	3,167	2,087
1987	20,140	11,557	8,583	7,187	4,102	3,085	7,619	4,181	3,438	5,334	3,274	2,060
1989	20,471	12,256	8,215	6,579	3,862	2,717	8,108	4,725	3,383	5,784	3,669	2,115
1991	20,530	13,570	6,960	6,747	4,599	2,148	7,810	4,817	2,993	5,973	4,154	1,819
1993	22,166	14,803	7,363	7,482	5,021	2,461	8,026	5,045	2,981	6,658	4,737	1,921
1995[3]	24,003	15,964	8,039	9,437	6,169	3,268	7,611	4,802	2,809	6,955	4,993	1,962
1997	24,935	17,520	7,415	10,410	7,662	2,748	7,463	4,767	2,696	7,062	5,091	1,971
1999	25,444	18,319	7,125	10,995	8,080	2,915	7,136	4,718	2,418	7,313	5,521	1,792
2001	26,745	19,714	7,031	12,273	9,321	2,952	6,988	4,723	2,265	7,484	5,670	1,814
2003	28,546	20,581	7,965	13,390	9,368	4,022	7,238	4,962	2,276	7,918	6,251	1,667
2005	29,984	21,216	8,768	13,288	8,617	4,671	7,276	5,088	2,188	9,420	7,511	1,909
2006	31,251	22,600	8,651	13,881	9,530	4,351	7,500	5,200	2,300	9,870	7,870	2,000
2007	33,655	24,369	9,286	14,848	10,372	4,476	7,796	5,523	2,273	11,011	8,474	2,537
2008	35,502	25,593	9,909	15,996	11,027	4,969	8,165	5,796	2,369	11,341	8,770	2,571
2009[4]	36,091	26,273	9,818	15,673	10,783	4,890	8,763	6,328	2,435	11,655	9,162	2,493
2010	36,121	26,450	9,671	15,321	10,622	4,699	8,832	6,360	2,472	11,968	9,468	2,500
2011	36,950	27,228	9,722	15,545	10,925	4,620	9,123	6,543	2,580	12,282	9,760	2,522
2012	37,707	27,841	9,866	16,062	11,375	4,687	9,232	6,611	2,621	12,413	9,855	2,558
2013	38,534	28,311	10,223	16,371	11,508	4,863	9,449	6,749	2,700	12,714	10,054	2,660
2014	40,297	29,237	11,060	17,932	12,284	5,648	9,355	6,657	2,698	13,010	10,296	2,714
2015	42,409	30,632	11,778	19,087	13,000	6,087	9,370	6,656	2,715	13,952	10,976	2,976

[1] Due to new information from important R&D units in the industrial sector, R&D statistics from 2001 till 2007 have been corrected.

[2] Personnel with a higher education degree (ISCED-level 5A and 6). Only academic staff are included in the higher education sector.

[3] Data from 1995 is not directly comparable with the previous years due to an extension in the data coverage in the industrial sector, as well as the transfer of state commercial enterprises from the Institute sector to the Industrial sector.

[4] In 2009, some research units were reclassified, mainly from the higher education sector to the institute sector.

Source: Statistics Norway/NIFU, R&D statistics

Table 7
R&D and innovation indicators per county: 2015 or latest year for available data.

County	Percentage of employees with a higher education	R&D expenditure in the higer education sector per capita (NOK)	Percentage of R&D expenditure in the industrial sector	Innovation activity financed by Innovation Norway Per cent[1]	Percentage of publicly financed R&D	Percentage of funding from Research council of Norway
Norway	**10**	**3,605**	**46**	**100**	**45**	**100**
Østfold	6	294	59	2.7	26	0.8
Akershus	13	1,933	63	3.3	32	13.5
Oslo	21	10,599	36	6.1	53	29.3
Hedmark	6	583	45	3.6	55	0.6
Oppland	6	863	58	4.0	38	1.1
Buskerud	8	416	93	3.1	14	0.9
Vestfold	7	539	81	2.4	19	0.6
Telemark	6	627	80	4.4	23	0.6
Agder counties	7	1,160	60	5.2	45	1.3
Rogaland	10	1,432	70	8.5	26	3.2
Hordaland	11	5,672	27	10.4	65	13.0
Sogn og Fjordane	6	573	76	4.5	28	0.3
Møre og Romsdal	6	564	80	5.9	20	1.4
Sør-Trøndelag	13	11,354	33	8.6	45	24.3
Nord-Trøndelag	6	545	65	5.7	37	0.2
Nordland	6	1,305	44	6.0	57	0.9
Troms	10	10,208	14	4.8	77	6.4
Finnmark	6	1,057	34	2.3	62	0.1

[1] 2016.

Source: Statistics Norway/NIFU, Innovation Norway

Table 8
EU indicators for science, technology and innovation. Indicators for benchmarking in selected countries: 2015 or latest year for available data.

	EU innovation scoreboard 2015	EU 28	Belgium	Den-mark	Estonia	Finland	France	Ger-many	Iceland	Ireland	Italy	The Nether-lands	**Norway**	Poland	Portu-gal	Slove-nia	Spain	Sweden	Swit-zerland	Czech Rep.	United King-dom
	Composite Innovation-index1	0.503	0.597	0.675	0.393	0.646	0.539	0.609	0.600	0.571	0.371	0.639	**0.571**	0.270	0.409	0.482	0.386	0.708	0.812	0.416	0.618
	EU=100 (SI)	100	119	134	78	128	107	121	119	114	74	127	**114**	54	81	96	77	141	161	83	123
1	**ENABLERS**																				
1.1	**Human resources**																				
1.1.1	New doctorate graduates	1.8	1.8	3.2	1.1	2.9	1.7	2.9	0.9	2.5	1.5	2.3	**2.0**	0.6	1.9	3.5	1.9	2.9	3.4	1.7	3.0
1.1.2	Population completed tertiary education	38.2	44.3	45.3	41.2	40.7	44.0	30.5	43.4	51.8	25.6	45.2	**49.2**	43.5	35.0	43.0	41.0	47.3	50.9	32.6	47.2
1.1.3	Youth with upper secondary level education	10.8	7.0	27.7	15.7	26.4	18.8	8.5	24.7	6.4	8.3	18.8	**19.6**	3.7	9.6	11.6	9.4	29.6	32.9	8.8	14.4
1.2	**Attractive research systems**																				
1.2.1	International scientific co-publications	494	1,408	2,229	1,030	1,576	700	778	2,911	1,197	596	1,569	**1,760**	277	873	1128	701	1,939	2,798	688	1,151
1.2.2	Scientific publications among top 10% most cited	10.56	12.63	13.44	8.04	10.82	11.24	11.40	9.94	12.14	10.19	14.35	**11.11**	5.04	9.02	8.61	9.67	11.73	15.16	7.05	14.49
1.2.3	Foreign doctorate students	25.57	42.31	32.06	8.30	19.88	40.05	9.12	33.40	23.10	13.16	36.62	**20.53**	1.92	21.23	8.51	11.92	32.69	54.25	14.76	42.95
1.3	**Innovation-friendly environment**																				
1.3.1	Broadband penetration	13	23	31	12	26	9	12	n/a	15	5	22	**19**	11	25	16	20	32	n/a	10	10
1.3.2	Opportunity-driven entrepreneurship	3.14	1.51	11.09	3.40	5.98	5.31	2.92	10.00	2.28	2.72	3.89	**12.88**	1.64	1.99	2.12	1.61	8.20	5.23	2.65	3.34
2	**INVESTMENTS**																				
2.1	**Finance and support**																				
2.1.1	Public R&D expenditure as apercentage of GDP (%)	0.71	0.68	1.15	0.78	0.95	0.74	0.93	0.78	0.33	0.56	0.90	**0.88**	0.54	0.66	0.53	0.57	0.99	0.91	0.88	0.56
2.1.2	Venture capital as apercentage of GDP (%)	0.063	0.072	0.059	0.136	0.107	0.083	0.049	n/a	0.086	0.022	0.096	**0.077**	0.029	0.069	0.007	0.043	0.081	0.067	0.013	0.103
2.1	**Firm investments**																				
2.2.1	R&D expenditure in the business sector	1.30	1.77	1.87	0.69	1.94	1.45	1.95	1.42	1.09	0.74	1.12	**1.05**	0.47	0.60	1.69	0.64	2.27	2.06	1.06	1.12
2.2.2	Non-R&D innovation expenditure	0.76	0.56	0.29	0.85	0.32	0.50	1.26	n/a	0.47	0.57	0.16	**0.63**	1.24	0.64	0.81	0.36	1.12	2.01	0.94	0.67
2.2.3	Enterprises providing ICT training	22	34	28	13	34	20	29	25	30	12	22	**42**	12	23	27	23	25	n/a	22	28
3	**INNOVATION ACTIVITIES**																				
3.1	Innovators																				
3.1.1	SMEs with product or process innovations	30.90	48.26	34.65	17.36	44.10	35.47	41.56	44.30	45.72	32.67	42.93	**41.06**	13.27	42.08	28.67	18.60	40.41	48.15	30.83	32.58
3.1.2	SMEs with marketing or organisational innovations	34.89	45.14	39.98	15.03	37.26	41.62	49.09	43.02	52.52	34.60	32.51	**43.25**	11.39	37.81	33.19	25.52	35.10	61.96	25.74	45.45
3.1.3	SMEs innovating in-house	28.77	39.75	28.22	15.80	38.32	31.55	37.90	n/a	41.33	30.52	35.05	**35.23**	8.34	25.59	26.07	14.47	35.08	42.48	27.98	19.03
3.2	**Linkages**																				
3.2.1	**Innovative SMEs collaborating with others**	**11.22**	**28.59**	**13.23**	**10.76**	**16.77**	**13.21**	**10.10**	**20.61**	**13.95**	**6.72**	17.46	**19.04**	**3.50**	**7.75**	**13.15**	**6.68**	**13.51**	**8.75**	**10.03**	**24.70**
3.2.2	Public-private co-publications	28.67	61.05	131.99	1.52	63.05	32.20	45.30	170.16	23.55	15.20	72.66	**37.55**	3.68	6.65	41.20	11.37	88.74	183.06	10.25	43.19
3.2.3	Private co-funding of public R&D expenditures	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
3.3	Intellectual Assets																				
3.3.1	**PCT patent applications**	**3.70**	**3.35**	**6.14**	**1.36**	**8.29**	**4.17**	**6.35**	**3.24**	**2.49**	**2.17**	5.91	**2.71**	**0.58**	**0.70**	**3.00**	**1.57**	**9.58**	**6.68**	**1.08**	**3.25**
3.3.2	Trademark applications	7.60	7.75	11.60	14.97	11.44	5.85	9.34	9.32	5.40	8.14	9.58	**2.93**	5.25	7.21	10.21	9.13	10.75	17.76	5.14	7.32
3.3.3	Design applications	4.33	2.75	7.93	3.74	4.50	2.88	6.18	0.13	1.02	6.41	3.65	**0.37**	5.90	4.47	2.97	3.08	4.71	6.15	2.62	3.03
4	IMPACTS																				

	EU innovation scoreboard 2015	EU 28	Belgium	Den-mark	Estonia	Finland	France	Ger-many	Iceland	Ireland	Italy	The Nether-lands	**Norway**	Poland	Portu-gal	Slove-nia	Spain	Sweden	Swit-zerland	Czech Rep.	United King-dom
4.1	Employment impacts																				
4.1.1	Employment in knowledge-intensive activities	14.10	15.20	15.80	12.70	15.70	14.20	14.80	19.80	19.80	13.90	17.50	**15.20**	10.00	10.90	13.70	12.30	18.40	22.10	12.80	18.40
4.1.2	Employment fast-growing firms innovative sectors	4.77	2.46	4.31	3.03	2.84	4.26	4.52	n/a	8.76	2.65	5.48	**4.79**	5.54	3.74	2.95	3.52	5.98	3.25	4.95	6.94
4.2	Economic effects																				
4.2.1	Medium and high-tech product exports	56.18	48.53	47.84	42.72	44.64	58.61	67.65	10.55	52.52	52.07	48.47	**17.02**	49.44	36.70	56.00	47.79	54.72	48.65	64.08	54.75
4.2.2	Knowledge-intensive services exports	69.29	67.86	74.79	45.35	62.40	67.05	74.69	66.60	93.98	50.36	76.92	**76.80**	39.59	44.40	34.77	43.30	75.16	66.10	41.96	82.90
4.2.3	Sales of new to market and new to firm inno-vations	13.37	7.60	6.96	10.49	9.27	15.02	13.34	6.07	18.07	10.06	10.81	**6.16**	6.45	6.27	12.44	15.94	6.89	19.62	14.57	20.81

Source: DG Enterprise

Acronyms

List of acronyms

BES	Business enterprise sector
CIS	Community Innovation Survey (of the European Union)
EC	European Commission
EEA	European Economic Area
EFTA	European Free Trade Association
EPC	European Patent Convention
EPO	European Patent Organization
EU	European Union
EURATOM	Euratom Supply Agency
EUROSTAT	Statistical Office of the European Communities
FTE	Full-Time Equivalent
GBARD	Government Budget Allocations for R&D
GDP	Gross Domestic Product
GUF	General University Funds
HES	Higher education sector
ICT	Information and Communication Technology
ISCED	International Standard Classification of Education (of UNESCO)
ISI	Institute of Scientific Information
NIFU	Nordic Institute for Studies in Innovation, Research and Education
NOK	Norwegian Kroner (the Norwegian currency)
NPI	Non-profit institutions
NSI	National Science Indicators
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PhD	Philosophiae Doctor
PNP	Private Non-Profit
R&D	Research and Experimental Development
RCN	Research Council of Norway
RTD	Research and Technological Development
S&T	Science and Technology
SCI	Science Citation Index
UNESCO	United Nations Educational, Scientific and Cultural Organization

Nowegian Ministries and their Acronyms

English name	Norwegian name	Acronym
The Office of the Prime Minister	Statsministerens kontor	SMK
Ministry of Agriculture and Food	Landbruks- og matdepartementet	LMD
Ministry of Children, Equality and Social Inclusion	Barne-, likestillings- og inkluderingsdepartementet	BLD
Ministry of Culture	Kulturdepartementet	KUD
Ministry of Defence	Forsvarsdepartementet	FD
Ministry of Education and Research	Kunnskapsdepartementet	KD
Ministry of Climate and Environment	Klima- og miljødepartementet	KLD
Ministry of Finance	Finansdepartementet	FIN
Ministry of Trade, Industry and Fisheries	Nærings- og fiskeridepartementet	NFD
Ministry of Foreign Affairs	Utenriksdepartementet	UD
Ministry of Health and Care Services	Helse- og omsorgsdepartementet	HOD
Ministry of Justice and Public Security	Justis- og beredskapsdepartementet	JD
Ministry of Labour and Social Affairs	Arbeids- og sosialdepartementet	ASD
Ministry of Local Government and Modernisation	Kommunal- og moderniseringsdepartementet	KMD
Ministry of Petroleum and Energy	Olje- og energidepartementet	OED
Ministry of Transport and Communications	Samferdselsdepartementet	SD

The Research Council of Norway (RCN) (Norges forskningsråd)

The Research Council of Norway plays a vital role in developing and implementing the national research strategy. The Council acts as an advisory body to the government, identifying present and future needs for knowledge and research. In addition it is a funding agency for independent research programmes and projects, strategic programmes at research institutes, and Norwegian participation in international research programmes; it is also a co-ordinator, initiating networks and promoting co-operation between R&D institutions, ministries, business and industry, public agencies and enterprises, other sources of funding, and users of research.

The RCN's role as an adviser includes strengthening the knowledge basis for the research and innovation policy. The national R&D and innovation statistics are a part of this responsibility.

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NIFU Norwegian Institute for Studies in Innovation, Research and Education

NIFU is the leading Norwegian research institute for studies in innovation, research and education. NIFU provides analyses, reports, evaluations and data for Norwegian policy makers, ministries, the Research Council of Norway and others. The activities of the institute comprise R&D statistics and indicators, policy studies and studies on research and innovation policies and systems, and studies of education at all levels.

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Statistics Norway (SSB)

Statistics Norway is the national agency for collection, processing and dissemination of official Norwegian statistics. Statistics Norway has a special responsibility to identify and place in order of priority the needs for official statistics, for coordination, for development of statistical methods, and for providing the statistics for the benefit of analysis and research. Official statistics shall meet the needs of the general public, businesses and the authorities for information about the structure, the development and the functioning of the Norwegian society.

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Report on Science & Technology Indicators for Norway 2017

The report describes and documents the Norwegian research and innovation system. It is based upon the results from the national 2015 statistical survey on resources devoted to research and experimental development (R&D) and Innovation survey (2016 for Norway) as well as other statistics and studies. Time-series and international data are also included.

The purpose of the report is to present an overall description for non-Norwegian readers of Norway's performance and activity within science, technology and innovation. The data and analysis are structured around six chapters: The first chapter covers Norwegian research and innovation in international comparisons. The second chapter describes the Norwegian research and innovation system and presents data on i.e. expenditure and funding of R&D, human resources and innovation statistics. The third chapter includes indicators on knowledge sharing and cooperation in research and innovation. The fourth chapter presents results of R&D as measured by publications and citations, patents and innovation in Norwegian industry. The fifth chapter presents indicators for R&D and innovation in a regional perspective, while the sixth chapter examines transition and change in relation to research and innovation. Main figures and indicators are also included in an appendix.

The internet version of the report is available on www.forskningsradet.no/indikatorrapporten www.forskningsradet.no/publikasjoner–

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