Report on Science & Technology Indicators for Norway

2013

Human resources

Research and Development

Technology

Innovation

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The latest available figures and analyses of the Norwegian research and innovation system are presented in this abridged English version of the Report on Science and Technology indicators for Norway for 2013. The report also includes reflections and assessments of methodological challenges related to how the information is collected and used. Data in themselves are not sufficient for understanding - they must be put into context to make sense. In this respect the S&T indicator report is a valuable entry point. The full-length annual Norwegian version presents a larger set of indicators and analyses. The contributions from that report have been adapted and abridged to make up this biennial English version.

This year's edition has both a touch of renewal and tradition. The content is organized in such a way that it can be more easily accessible and function as a reference work. Great efforts have been put into ensuring comparability over time. Processes of developing new knowledge are time-consuming, which also applies to adoption and use of new knowledge. The report and it's figures and graphs can be downloaded on the report's WEB-page (http://www.forskningsradet.no/prognett-indikatorrapporten/Home_page/1224698172612). Figures are updated continuously online as new data become available.

Even with the high quality of the data, collection procedures and analyses there are still needs for improvements both for this report on S&T and the statistics on S&T in general. Actual use of the data for analytical purposes is the best approach to succeed in this. Therefore researchers are given access to the microdata to perform better and more detailed analysis of causality and data predictive power.

The report is produced in collaboration between NIFU, Statistics Norway (SSB) and The Research Council of Norway. In addition other experts are invited to contribute to the work where relevant. The editorial board for the report includes members from Innovation Norway and the Norwegian Association of Higher Education Institutions.

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!

Arvid Hallén
Director General
Research Council of Norway

Table of contents

This document presents a selection of science and technology (S&T) indicators from Norway. This abridged English report is based on the more comprehensive Norwegian text, and is designed to provide useful information and perspectives on a range of S&T issues. It aims to provide relevant and useful information for foreign audiences, who may not be familiar with the Norwegian S&T environment. It complements the full version which can be found online (in Norwegian).

This report is the latest of a regular series which goes back to 1997, although it also draws on certain measurements and indicators with a much longer history. It continues the serie's original aim of presenting a wide range of relevant statistics and indicators and of ensuring their ongoing development. Statistics on the resources devoted to research and experimental development (R&D) in Norway, in terms of expenditure and personnel, have been compiled since 1963. Those relating to patents, bibliometric analyses and advanced technology have been included since the 1980s. Innovation studies were first introduced in the 1990s and the range of innovation indicators has been considerably extended, i.e. following the revision of the Oslo Manual in 2005.

The full-length Norwegian report presents a larger set of indicators and commentary, divided into international, national and regional sections and a section on results, effects and cooperation on research and innovation. It also includes a separate section with detailed tables. The contributions of the authors from the original Norwegian report have been adapted in this abridged version to include more dicsussion and information on important features about the Norwegian research and innovation system. The highlights sections and tables on key indicators are taken from the original version of the report and may therefore include some topics which are not included in the text of this abridged version.

This English version of the report's structure should make it easy to find information across the wide range of topics covered. The report opens with an excecutive summary, followed by an overview of the Key Indicators presented. Chapter 1 presents the main results from R&D surveys based on international data from both UNESCO and the OECD; this chapter also includes results from the 2010 Innovation survey, and presents comparisons over time and between countries, for statistics on students, doctoral degrees, bibliometrics and patents. Chapter 2 draws on national R&D statitics 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 seperatly. Education statistics are included in order to establish the human resources availble in the country for science and technology. Chapter 2 also includes data on Norwegian participation in the EU Framwork Programme. Chapter 3 includes available indicators on the results, effects and cooperation on research and innovation avtivities. Chapter 4 presents regional indicators for R&D and innovation.

Not all sections of the original report are included here. The original Norwegian report includes more supplementary details on the Norwegian research and innovation system in a number of «fact boxes» and more short comment pieces from experts in «focus boxes» only a limited number of these are included in the abriged English report. Similarly, full references do not feature in this abridged report, but these can be found in the Norwegian report, available on Internet: http://www.forskningsradet.no/

Currency rates

As of 2011 (year average):
1 Euro = 7.8 NOK (Norwegian kroner)
1 US$ = 5.6 NOK

As of October 2013:
1 Euro = 8.1 NOK
1 US$ = 5.9 NOK

A more knowledge intensive world

Data presented in this report confirm the common assumption that society is becoming more knowledge intensive. The extent of research, education and innovation is increasing in many parts of the world. Expenditure on research and development (R&D) are still concentrated in a few «R&D super powers». The four largest R&D nations account for nearly two-thirds of the world's R&D and the United States alone accounts for nearly one-third.

At the same time there is a shift in the relative strength between the countries. Knowledge production is increasing more rapidly in countries that previously had little research and low levels of education. China, Korea and Brazil are examples of countries which quickly catch up with the more established knowledge nations. Asia is now the continent with the largest share of global R&D resources. Less than ten years ago, Asia was behind both North America and Europe.

The financial crisis in 2008 and the subsequent economic recession appears to have slowed down the growth in R&D expenditure. A majority of countries has experienced a lower R&D growth after the financial crisis than in the preceding period. The slowdown has been particularly noticeable for the business enterprise sector's R&D efforts, whereas public R&D expenditure until recently has been less affected. New figures show that the countries which have been most severely hit by the crisis, such as Spain, Italy, Greece and Portugal, implement real cuts in public R&D funding from 2008. Most other countries have managed to maintain some real growth in public spending on R&D after 2008. But growth flattened significantly compared with the period prior to the crisis. It is uncertain whether this is a passing trend or whether it is a sign that economic austerity will cause a more moderate growth in R&D spending.

A complex picture of Norway

International comparisons provide a mixed picture of Norway as research and innovation nation. Norway's total R&D expenditure accounted for 1.65 percent of gross domestic product (GDP) in 2011. This level has been relatively stable over the last 20 years. Norway is therefore behind the average for OECD countries, the EU and the world total. The modest position is partly due to the fact that Norway has a high level of GDP. GDP per capita places Norway in the upper echelon in the world.

The business enterprise sector in Norway accounts for a smaller share of R&D spending than in other countries. This is largely because the Norwegian business enterprise sector is characterized by industries with a low R&D intensity. Norway's public R&D efforts are however at a high level internationally.

In international comparisons of innovation, Norway is located in the lower echelon. Less than half of Norwegian companies report that they have had innovation activity in the period 2008–2010. This is significantly lower than the EU average and the other Nordic countries. Norway also is among the few countries with a decline in innovation rate compared with the previous survey. However, these results must be interpreted with caution. The industry structure and methodological factors may explain much of Norway's modest position in innovation statistics.

As for at human resources, Norway is at a consistently high level internationally. The level of education is high and increasing. Moreover, Norway has a high and rising share of researchers in the population. Nevertheless, Norway is slightly behind the Nordic average also on this dimension.

Decreasing growth for research in Norway

In 2011, more than 45 billion NOK (8 bill. $) were spent on research and development in Norway. Just under half of total expenditure were carried out in the industrial sector, while the higher education sector and research institutes accounted for about a quarter each. Looking back several decades, there has been a slight shift from research institutes to more research carried out at universities and in industry. Over the past ten years, however, the industrial sector's share has stagnated. At the same time, there has been a clear trend towards more research in service industries and less in industry. This main picture applies, even if the data for 2011 show an increase in research for both manufacturing and service industries.

Government budget appropriations or outlays for research and development (GBAORD) has had an overall real growth of 60 percent since 2000. However, it is not unique in an international context. The growth rate in Norway has shown some variation in the period after 2000. Growth was strongest in the period 2005–2009, while growth appears to have levelled off in subsequent years. From the mid 2000s, health related research in hospitals has increased the most in Norway.

Energy, ICT and health are important themes for Norwegian research

Nearly a quarter of the national R&D effort is included in the priority area of global challenges. This area comprises mainly energy-related research, primarily performed by businesses and research institutes. This bias towards energy and especially petroleum-related R&D largely reflect the industrial structure in Norway. The key priority areas of Health, Food and Marine research follows as other important areas. As for technology areas, ICT is by far the largest area, with 10 billion NOK in R&D expenditure, of which 80 per cent is performed in the industrial sector.

The national capital region dominate research, while innovation is less centralized

R&D activity is largely concentrated in big cities and strong university and technology environments. Norway's capital region (Oslo/Akershus) represents about half of all R&D in Norway. Compared to other countries, Norway still has a more even regional distribution of R&D expenditure. As an example, research activity in Denmark and Finland is more concentrated towards the capital region.

Innovation activity in Norway also shows a much more even regional distribution than R&D activity. However a number of more rural areas follow just behind. The relatively large regional spread of innovation is due to several factors. Among other things, innovation is about much more than R&D, and hence a lot of innovation does not require proximity to heavy R&D and technology environments. Another factor is that the national innovation agency (Innovation Norway) provides loans and grants which largely compensate for centralization in that much of the funding is related to regional concerns.

More women and foreign citizens are awarded their doctoral degree in Norway

The number of awarded doctorates in Norway has increased steadily over time. This level is more than twice as high as only ten years ago. Two key trends are important in this respect. Firstly, the proportion of women among doctoral candidates increased significantly. Around 1980, there were 10 per cent women among doctoral degrees, while women today account for about 50 per cent. Second, there is an increasing number of doctoral degrees awarded to foreigners. More than a third of doctoral degrees in 2012 were submitted by a researcher with a foreign citizenship.

What are the results and impacts from R&D and innovation activity?

In Norway as internationally, there is an increasing interest in measuring the results and impacts of research and innovation. However, reliable data on the outputs from R&D are lacking, and therefore this issue must be addressed with several indicators.

Measurement of publication and citation of scientific publications are among the most widely used indicators of R&D outputs. These indicators give a rather positive picture of Norway. In terms of scientific publications per capita, Norway ranks as the fourth country world wide, with only Switzerland, Sweden and Denmark ahead. Norway is also among the countries with the strongest growth in the number of publications in recent years. However, the Norwegian ranking is more modest in terms of impact measured by citations.

Compared to other countries, Norwegian companies have a weak tradition for protecting new products and services in the form of patents or trademark protection. This may be an indication of little innovation in Norwegian industry, but it can also be related to the fact that Norwegian companies have relatively little activity in industries where it is natural to seek patent or trademark protection.

Norwegian firms also score very low in terms of percentage of turnover from innovative products. This indicator is often used as an indicator of the results of innovation. However, if we look at the general indicators of growth and productivity, Norway scores very well. This apparent paradox is much discussed in the Norwegian debate. Two explanations can be derived from the analyses in this report. Firstly, Norwegian companies operate in industries with high profitability. Thus, efforts in terms of research and innovation are relatively small in relation to earnings. Secondly, growth and progress are often due to other factors than the research and innovation as measured by conventional indicators. Among these other factors, a high level of learning in the workplace can explain much of the growth and progress in Norway.

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 2005, 2007, 2009, 2010 og 2011

	2005	2007	2009	2010	2011
Resources for R&D and innovation					
R&D expenditure as a percentage of GDP	1.51	1.59	1.76	1.68	1.65
R&D expenditure per capita in constant 2010-prices (NOK)	8 058	9 011	9 049	8 746	8 838
R&D expenditure funded by government as a percentage of total R&D expenditure	43	45	46	..	46
R&D expenditure funded by industry as a percentage of total R&D expenditure	45	43	42	..	43
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	31	32	32	32	31
Human resources					
Percentage of the population with higher education	33	34	37	37	38
R&D full-time equivalents per 1 000 capita	6.5	7.1	7.5	7.4	7.5
R&D full-time equivalents per qualified researcher/scientist per 1 000 capita	4.6	5.2	5.4	5.4	5.5
Percentage doctoral degree holders among qualified researchers/scientists	27	27	30	31	32
Percentage women among qualified researchers/scientists	32	34	35	36	36
Cooperation in R&D and innovation					
Extramural R&D expenditure compared to intramural R&D expenditure in the industrial sector (%)	30	28	31	29	27
Companies involved in cooperation on R&D as a percentage of all R&D companies	52	39	39	..	34
Companies involved in cooperation on innovation as a percentage of all innovative companies	37[1]	39[2]	38[3,4]	34	..
Articles in international scientific journals co-authored by Norwegian and foreign researchers as a percentage of all articles by Norwegian researchers	50	54	56	54	56
Results of R&D and innovation					
Percentage innovative companies in the business enterprise sector	26[1]	25[2]	27[3,4]	23[3]	..
Percentage of turnover of new or substancially altered products in the industrial sector	5.9[1]	6.1[2]	4.5[3,4]	58[3]	..
Number of articles in international scientific journals per 100 000 capita	147	172	198	207	224
Number of patent applications to the European Patent Organization per million capita[5]	82	83	94	107	..

[1] 2004.
[2] 2006.
[3] Does not include enterprises with 10–19 employees in Construction and Transportation and storage.
[4] 2008.
[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 15
Resources for R&D and innovation							
R&D expenditure as a percentage of GDP	2011	1.65	3.37	3.09	3.78	2.3[1]	2.09
R&D expenditure per capita (NOK)	2011	9 174	12 720	11 517	12 889	7 581	6 811
R&D expenditure funded by the government as a percentage of total R&D expenditure	2011	46	28	28	25	31[1]	35[1]
R&D expenditure funded by the business enterprise sector as a percentage of total R&D expenditure	2011	43	58	60	67	60	54[1]
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	2011	31	26	30	20	19	24
Human resources							
Percentage of the population with higher education	2011	38	35	34	39	32	29[2]
R&D full-time equivalents per 1 000 capita	2011	7.5	8.3	10.3	10.1	..	5.7
R&D full-time equivalents per qualified researcher/scientist per 1 000 capita	2011	5.5	5.2	6.7	7.4	3.5[3]	3.5[1]
Cooperation in R&D and innovation							
Companies involved in cooperation on innovation as a percentage of all innovative companies	2010	31	39	40	40	..	24
Companies involved in cooperation on innovation as a percentage of innovative companies in manufacturing and mining	2010	34	45	39	43	..	25
Results of R&D and innovation							
Percentage of innovative companies in the business enterprise sector	2010	34	49	43	46	..	44
Percentage of innovative companies in manufacturing and mining	2010	39	52	47	54	..	50
Percentage of turnover of new or substancially altered products in the business enterprise sector	2010	6.1	8.4	15	15.3	..	13.5
Percentage of turnover of new or substancially altered products in Manufacturing or Mining	2010	12.8	9.8	23.8	27.0	..	20.1
Number of articles in international scientific journals per 100 000 capita	2012	230	246	267	208	78[4]	103[4]
Number of patent applications to the European Patent Organization per million capita[5]	2010	107	226	192	233	92	104[6]

[1] 2010.
[2] EU 21.
[3] 2007.
[4] 2011.
[5] By inventor address and by application date, European applications only (EP-A).
[6] EU 27.

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

1 Norwegian R&D and innovation in an international context

Hebe Gunnes, Kristine Langhoff, Lise Dalen Mc Mahon, Espen Solberg, Kaja Wendt, Lars Wilhelmsen

Norway and the main international trends

- In the wake of the economic downturn about half of the OECD states have reduced their growth in public R&D investment (after 2007), while the other half of the countries have increased growth in their public R&D investment.
- Business enterprise sector's own R&D investment has declined in almost all countries.
- USA's and Europe's share of world R&D resources are dwindling, while Asia's share especially is increasing rapidly.
- China is now the second largest R&D-performing country in the world, with a share of 15 per cent of the world total R&D expenditure. The USA is still the largest with 31 per cent of R&D expenditure. If growth continues at the same pace as the past decade, China will be the largest within a few years.
- Growth in total Norwegian R&D expenditures is slightly higher than the OECD average last year, but there is a clearly slower growth after the financial crisis also in Norway.
- The share of R&D expenditure performed in the business enterprise sector was 52 per cent in Norway in 2011. In the OECD area the corresponding share was 67 per cent, and this is also the level of the business enterprise sector among the largest R&D actors and the other Nordic countries.
- Countries with a high R&D share of Gross Domestic Product (GDP) have a high proportion of R&D performed in the business enterprise sector.
- Norway's R&D share of GDP was 1.65 per cent in 2011, while the OECD countries total was 2.37 per cent. This puts Norway in 24th place in the world, while the rest of the Nordic countries were placed among the world's top seven most R&D-intensive countries.
- In 2011, the share of R&D funding from the business enterprise sector in the higher education sector was 4 per cent. This was two percentage points lower than the average for OECD countries.

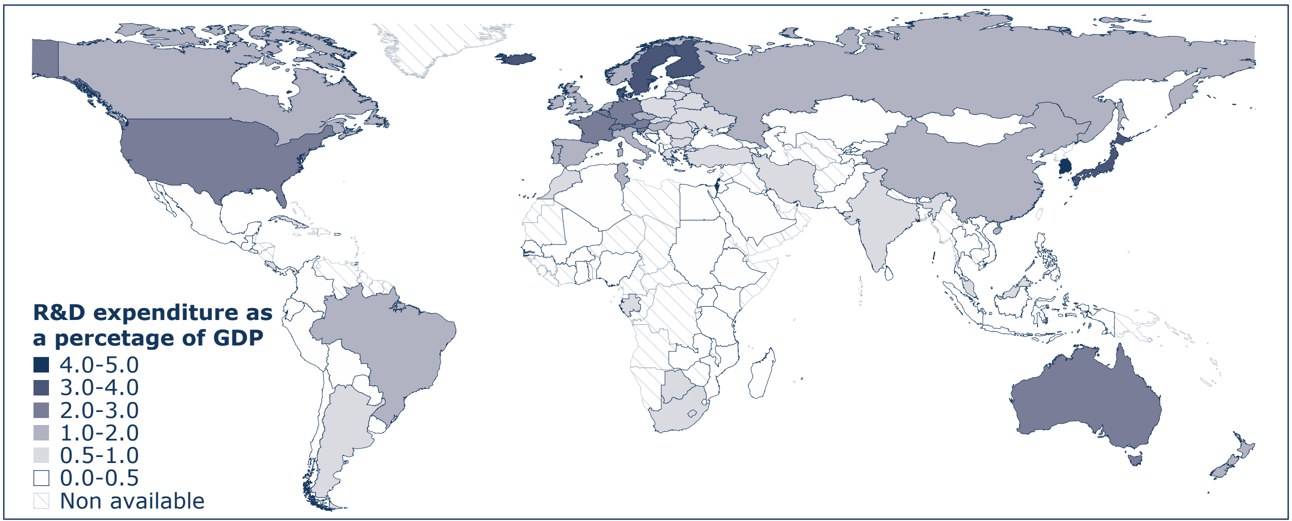
Innovation measurements

- On the EU's Innovation Union Scoreboard (IUS) 2012, Norway holds the 17th position, the same score as in 2011. Norway scores thus inferior to the other Nordic countries.
- Norway does quite well in human resources in the IUS, and is characterized by a high proportion of international co-authorship and public-private co-publication in scientific papers.
- Norwegian industry has the lowest share of innovative enterprises and weakest growth in innovation activities in the Nordic countries (CIS 2010).

Human resources

- The share of the population with higher education was 38 per cent in Norway in 2011, compared with 32 per cent in the OECD overall.
- Only Israel and Switzerland had higher public expenditure per student in higher education in 2010 than Norway.
- The production of doctoral degrees in Norway is increasing rapidly; the country has still fewest doctoral degrees in relation to the number of inhabitants in the Nordic region.
- The share of female students, at 62 per cent, is even higher than the 58 per cent average of OECD countries. Female professors had a proportion of 21 per cent (2010), which was slightly above the average for the EU countries (20 per cent).
- In Norway, R&D personnel with higher education represented 5.5 full time equivalents (FTE) per 1 000 inhabitants in 2011. This makes Norway one of the world top performers together with the other Nordic countries, Singapore, Korea and Taiwan.
- Figures from the European Social Survey shows that employment in Norway and other Scandinavian countries is more learning-intensive than other parts of Europe.

Figure 1.1
Total R&D expenditure as a percentage of GDP in the world: 2011 or latest available year.



Source: UNESCO, OECD – MSTI 2013:1 and Battelle, R&D Magazine

Research, development and innovation are regarded as increasingly important for social progress and economic growth. Over time, investments in research and development increased significantly in many parts of the world. The financial crisis in 2008 marked yet a trend shift in the global development of research and development investments. The economic downturn has affected countries worldwide. As a result, R&D expenditure in the business enterprise sector seems to stagnate or decrease in many key countries. China and other emerging economies however, have maintained the growth rate.

Public R&D investment has until recently been maintained and increased in many countries after the financial crisis. The latest figures for public R&D funding may indicate that public spending cuts gradually begin to be reflected also in the field of research.

International comparisons of R&D and innovation must be made with care. The level of R&D and innovation is dependent upon several factors, such as economic structure, favourable natural conditions, historical conditions, education and political priorities in a country.

The world's R&D expenditure remains concentrated. The three main research nations – the U.S., China and Japan – account for nearly 60 per cent of world R&D expenditure. The great importance of a few countries makes the international average distorted by some «research superpower». For example, the OECD average is largely dominated by the efforts of the United States, Japan and Germany. At the same time, there are changes in global power relations. The most obvious change is China's stronger position, while U.S. and European proportions weakened.

As this report shows, it is not enough to have just one measure of a country's efforts in R&D and innovation. Efforts should be measured in different ways and related to several dimensions. For Norway, for example, there is a very different outcome of efforts related to the country's value added (GDP), the number of researchers or the number of inhabitants. Different countries also have different composition in terms of performing sectors, industries and fields of science.

International comparisons over time provide interesting information about the countries and areas that are on the rise, where there is stagnation or decline, and the areas to which research is directed. International comparisons rely on good statistics. EU and OECD countries coordinated their collection of statistics in the 2000s, and the most updated statistics can be found within these countries. The latest figures on R&D will be from 2011, and the latest Innovation Survey covers 2008 to 2010, while the government budget appropriation of outlays for R&D (GBAORD) covers 2012. UNESCO identifies R&D statistics from about 150 countries; however, the statistics are not as frequently updated.

In this chapter we first present figures on main trends of global distribution and development of R&D. Then we present a comparison of innovation systems (Section 1.2), followed by a presentation of international statistics on innovation activity during the period 2008–2010. Section 1.4 presents the human resources, where we look at student numbers, Full-Time-Equivalents (FTE) in R&D, women in science and learning in the workplace.

1.1.1 International distribution of R&D expenditure

Table 1.1
R&D expenditure by continent and selected countries. Absolute numbers PPP$, nominal growth and share of world GDP and R&D. FTE per mill. capita, 2002 and 2011 or last available year.

Continent/ country	R&D (PPP$ bill.)[1]		Average annual growth	Share of World R&D		Share of World GDP		FTE per mill. capita[2]	
	2002	2011		2002	2011	2002	2011	2002	2011
North America	297	439	4.4	37.7	32.4	24.7	21.0	4 561	4 659
Latin America	22	40	6.9	2.8	3.0	8.1	8.2	326	453
Europe	236	372	5.2	30.0	27.4	31.1	28.6	2 353	2 691
Africa	7	10	3.5	0.9	0.7	3.6	4.0	150	144
Asia	214	473	9.2	27.2	34.9	31.0	36.8	544	660
Oceania	11	22	8.0	1.4	1.6	1.5	1.4	3 685	4 231
World total	788	1 356	6.2	100.0	100.0	100.0	100.0	922	1 027
USA	277	415	4.6	35.2	30.6	22.5	19.2	4 654	5 137
China	40	208	20.2	5.0	15.4	7.9	14.4	630	978
Japan	108	147	3.4	13.7	10.8	7.4	5.5	4 890	5 137
Korea	23	60	11.5	2.9	4.4	2.0	1.9	3 057	5 804
Nordic countries	23	33	4.3	2.9	2.5	1.6	1.5	5 478	6 100
Brazil	13	25	7.7	1.7	1.9	2.9	2.9	459	703
India	13	24	7.2	1.7	1.8	3.8	5.8	110	136
Norway	3	5	6.7	0.4	0.4	0.4	0.4	4 432	5 497

1 2009 for Latin America, Africa and Oceania.

2 Numbers for FTE in 2002 is an average of 2001 and 2003 for Denmark, Norway, Iceland and Sweden (Nordic countries). Last year of data for the USA and India is 2007. 2009 for continents and world total. 2010 for Brazil.

Source: UNESCO institute for Statistics, OECD MSTI 2013:1, calculations at NIFU

Asia has the largest share of R&D expenditure

Total global spending on research and experimental development (R&D) amounted to 1.4 trillion U.S. dollars in 2011. In current prices, this is almost twice as much as ten years ago. The resources are highly concentrated geographically. For example, the five largest R&D nations account for two thirds of all research in the world.

> ***International comparisons of R&D***
>
> Two main approaches are central to international comparisons of R&D. One implies a conversion of resources to a common device called PPP$ (purchasing power parity) to make various countries' R&D effort comparable with regard to the currency and purchasing power. The other way is to relate the R&D expenditure to countries' wealth creation, population and other indicators. Both procedures involve some challenges that have been discussed in previous editions of this report. Among other things, is the question of what is the best method of conversion. Moreover, fluctuations in GDP have implications for R&D as a share of GDP.

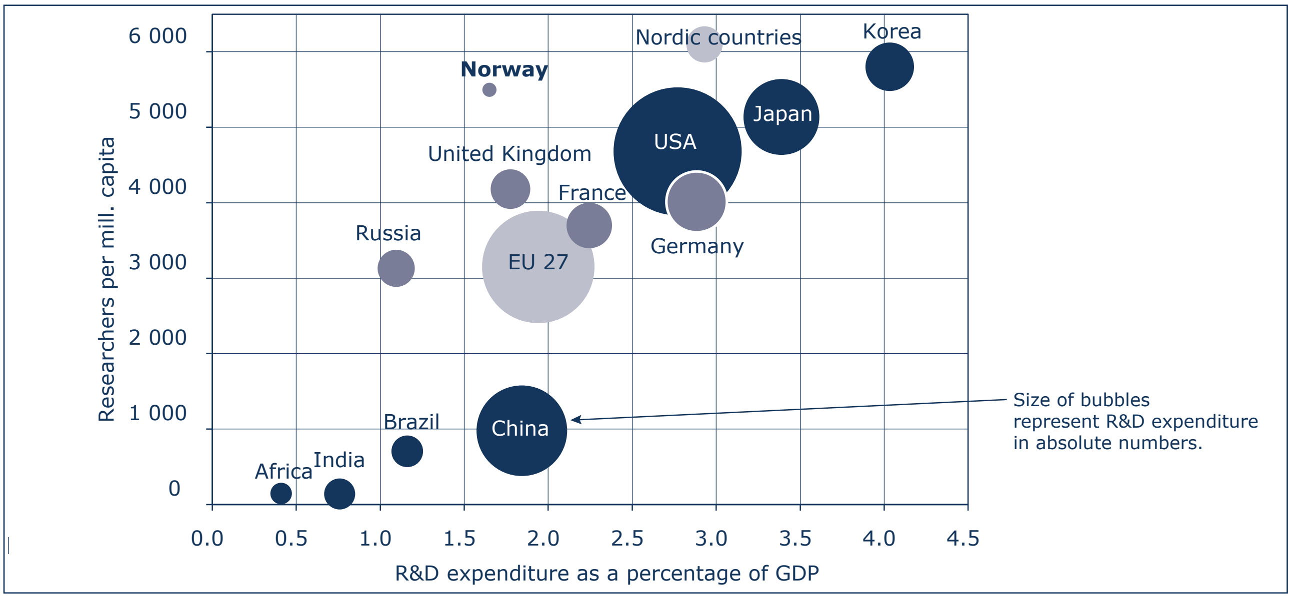
World distribution of R&D expenditure is concentrated in three continents: Asia (35 per cent), North America (32 per cent) and Europe (27 per cent). The remaining 6 per cent is distributed in South America (3 per cent), Oceania (2 per cent) and Africa (1 per cent), as shown in Table 1.1. In recent years there has been a shift in the distribution of world R&D expenditure: North America's and Europe's shares has been reduced, while Asia's share has been growing. The latest figures confirm these trends. These changes occur rapidly: while Asia's share of global R&D expenditure in 2002 was 10 percentage points less than the USA share, the situation was reversed in 2011, as more of the worlds R&D was performed in Asia than in any other continent.

The USA remains by far the world's largest R&D nation, with a share of 31 per cent of the world's total R&D expenditure: this is nevertheless a decline from 35 per cent in 2002. For years, China has experienced a real growth of around 20 per cent annually. If this trend continues, China will challenge the USA hegemony as the world's leading research nation within a few years. China is now the world's second largest research nation with 15 per cent of the world's R&D expenditure in 2011. In the next places follows Japan (11 per cent), Germany (7 per cent), Korea (4 per cent), France (4 per cent), United Kingdom (3 per cent) and Russia with 2.6 per cent. If the Nordic countries were one nation, it would have taken the 9th place with a share of 2.5 per cent of the world's R&D expenditure. Sweden alone holds number 15, while Norway holds the 28th position with a share of 0.4 per cent of world R&D expenditure.

Norway has lower R&D share of GDP than the world average

In relation to countries' GDP, the focus is much stronger on R&D in North America than in other parts of the world. While the USA accounted for 31 per cent of world R&D expenditure in 2011, its share global GDP accounted for 19 per cent as shown in Table 1.1. The Nordic countries and Korea is emerging as countries and regions with heavy investments in R&D in relation to their share of the world GDP. Europe's shares of global R&D and GDP are roughly equal with respectively 27 and 29 per cent. Also in Norway there is an equivalent relationship when it comes to share of world GDP and share of R&D. A similar distribution is also found in Asia, which accounts for 35 per cent of R&D expenditure and 37 per cent of GDP. In Brazil and India in particular, the relationship is the opposite: these countries have a higher share of global wealth creation than of R&D expenditure.

Figure 1.2
Global R&D investments. Full time equivalents performed by researchers per mill. capita, and R&D expenditure as a percentage of GDP: 2011 or latest available year.



Source: UNESCO og OECD – MSTI 2013:1

Figure 1.2 shows the researcher density (y-axis), R&D intensity (x-axis) and national R&D level in absolute terms (the size of the bubbles) for selected countries/regions.

R&D expenditure as a share of GDP shows for how much R&D accounts as a share of total value creation in the country. For most countries, there is a correlation between R&D as a share of GDP and the share of researchers in the population. However, Norway is one of the countries which is characterized by a relatively high density of researchers, but low in R&D expenditure as a share of GDP. China, on the other hand, is an example of the opposite. Here R&D intensity is much higher than the share of scientists per million population, which is due to the fact that China is the world's most populous country.

Norway holds 24th place in the world with regard to R&D as a share of GDP. Our Nordic neighbours are all among the world's seven most R&D-intensive countries. Globally, there has been stability in R&D intensity in recent years. In 2009, global R&D as a share of GDP was close to 1.8 per cent (UNESCO, 2013). The OECD average was 2.4 per cent in 2011. However, there are wide variations between countries and regions.

The EU countries have for years been committed to raise overall R&D efforts in the EU to 3 per cent of GDP. This goal was originally to be reached in 2010, but is now postponed until 2020. Since the 3 per cent target was adopted in 2001, R&D investment in the EU increased from 1.76 to 1.94 per cent of GDP. Romania has the lowest proportion with 0.5 per cent, while Finland has the highest proportion of 3.8 per cent.

The African Union has set a target for Africa as a whole to spend 1 per cent of GDP on R&D (UNESCO, 2013). Currently, the average for the region is 0.4 per cent.

In Asia, total R&D intensity is about 1.6 per cent. However, there are significant regional differences. In West Asia, Israel invests 4.4 per cent of its GDP on research and development. This includes probably a large share of military research. In East Asia, Korea is at the top with 4.0 per cent, Japan spends 3.4 per cent, Singapore 2.2 per cent and China 1.8 per cent. In Central Asia, the level is between 0.1 and 0.3 per cent. India invests about 0.8 per cent of GDP on R&D.[1]

In North America, the R&D intensity is about 2.8 per cent in the U.S. and 1.7 per cent in Canada.

In Latin America and the Caribbean, Brazil has the highest R&D intensity with 1.2 per cent. Mexico has an R&D intensity of 0.4 per cent.

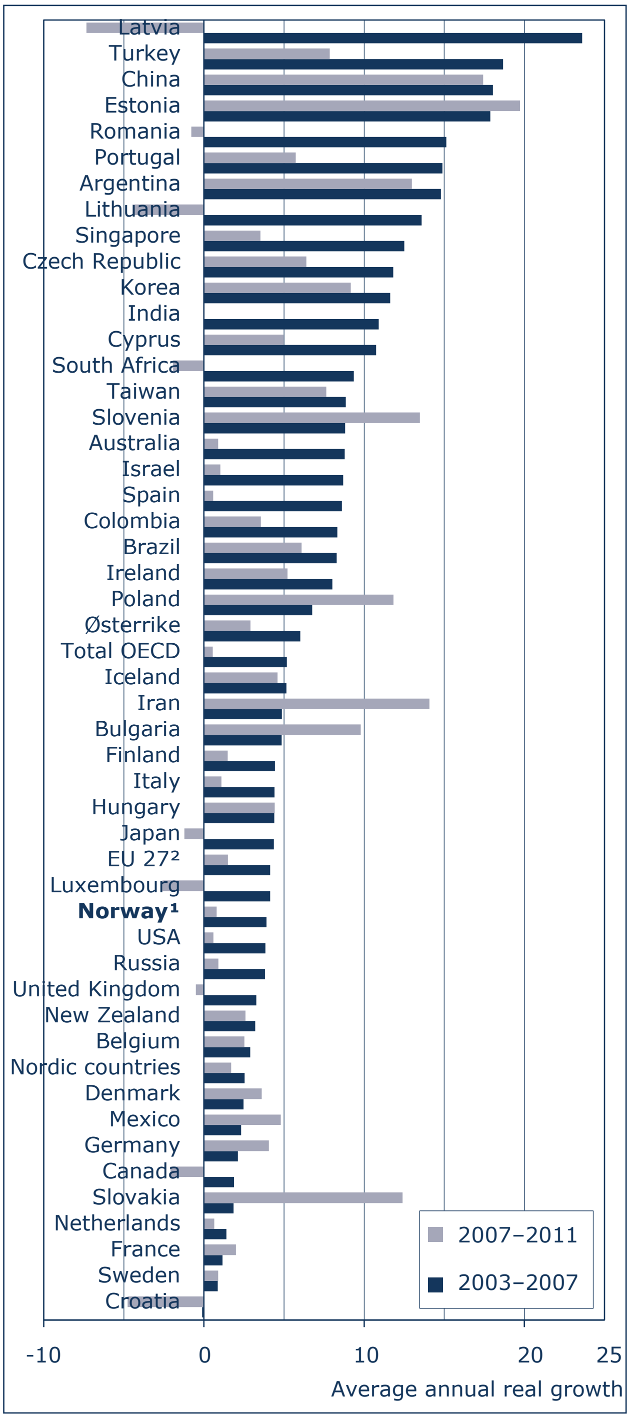
The Arab states also have a low R&D intensity. R&D expenditure as a share of GDP has remained stable at about 0.2 per cent in the recent years. In Oceania, Australia and New Zealand spend respectively 2.2 and 1.3 per cent.

The Nordic countries are also a significant research region. The Nordic region is the world's ninth largest «country» in terms of total R&D efforts, and the overall R&D intensity is about 2.9 per cent of total GDP in the region.

[1] Planning Commission Government of India (2012).

1.1.2 International trends in R&D expenditure

Figure 1.3
Average annual real growth in R&D expenditure. Selected countries: 2003–2007 and 2007–2011 or latest available year. Constant PPP$-prices.



[1] For calculations of growth for Norwegian R&D national price indexes have been used, see table C.1 in the tables of the Norwegian report. These are more detailed with respect to type of expenditure and sector of performance. The growth proves slightly weaker than in the OECD price index.

[2] EU 27 plus Croatia. OECD calculations.

Source: UNESCO and OECD – MSTI 2013:1, national R&D statistics for Norway

The financial crisis has slowed R&D spending in OECD countries

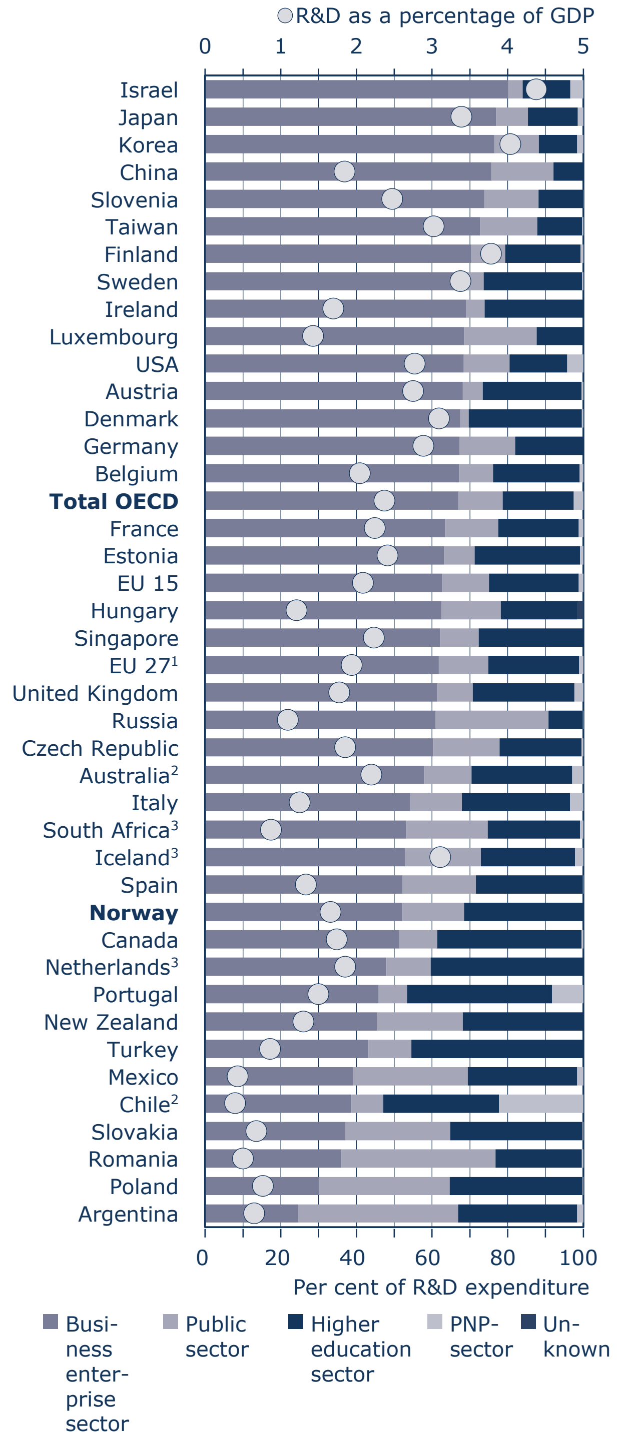
After the financial crisis of 2008 and subsequent turmoil in the world economy, industry's own R&D investments have been under pressure, while many countries have had to reduce public investment. Among other things, the United States and many European countries struggled to operate a high and rising government debt. Since R&D investments are characterized by long-term, multi-year contracts, it may take time before the cuts appear in this area. However, the first effects of the economic downturn is now appearing in the R&D statistics. Figure 1.3 shows the national average annual real growth in total R&D expenditures divided into two periods: before and after the financial crisis, from 2003 to 2007 and from 2007 to 2011.

Of the 47 countries included in the list, 34 had weaker growth the period after the financial crisis than the period before. Only 10 countries had higher growth in the period 2007–2011, while two of the countries had investment at the same level. Nine of the countries in Figure 1.3 had a real decline in R&D investment by 2007, including Canada, the UK and Japan. Having had the strongest growth before the financial crisis, Latvia had the strongest decline since the financial crisis.

In the years prior to 2007, growth in the Nordic region was lower than for the OECD total, while in the years after the financial crisis, growth has been at a higher level. After 2007, Denmark had a real growth of 3.6 per cent annually in its R&D investments, while there was a slowdown in growth in Finland by 1.5 per cent. In Norway and Sweden, the average annual real growth remained slightly below 1 per cent in the years after 2007.

For the OECD countries, there was a clear decline in R&D growth after 2007, from 5 per cent average annual real growth in the years before 2007 to 0.5 per cent growth in the years after the financial crisis. The EU countries had a slightly lower growth in the years prior to 2007 with 4 per cent. At the same time, R&D expenditures in the EU have not declined as much as in the OECD area following the financial crisis. In the years after 2007, the EU had an average annual real growth in R&D expenditure of 1.5 per cent. So far, the numbers indicate that the economic downturn following the financial crisis has affected research in the United States and Japan more than in Europe. A major reason why Europe actually has an R&D growth after the financial crisis is that Germany has maintained an annual real growth rate of 4 per cent.

Figure 1.4
R&D expenditure for selected countries by sector of performance and total R&D as a percentage of GDP (upper axis): 2011 or latest available year.



[1] EU 27 pluss Kroatia. OECD calculations.
[2] 2010.
[3] 2009.
Source: OECD MSTI 2013:1

Large variations in where research is performed

The comparisons in previous sections show total R&D for all countries. However, there are large differences between countries in terms of the proportion of R&D conducted in the various sectors, see the fact box of sectoral classification in chapter 2.1. A key point is how much research is performed by the business enterprise sector and how much is carried out by universities, colleges, research institutes, hospitals and other stakeholders. The sectoral differences are related to industrial structure, historical development and different political priorities in the countries.

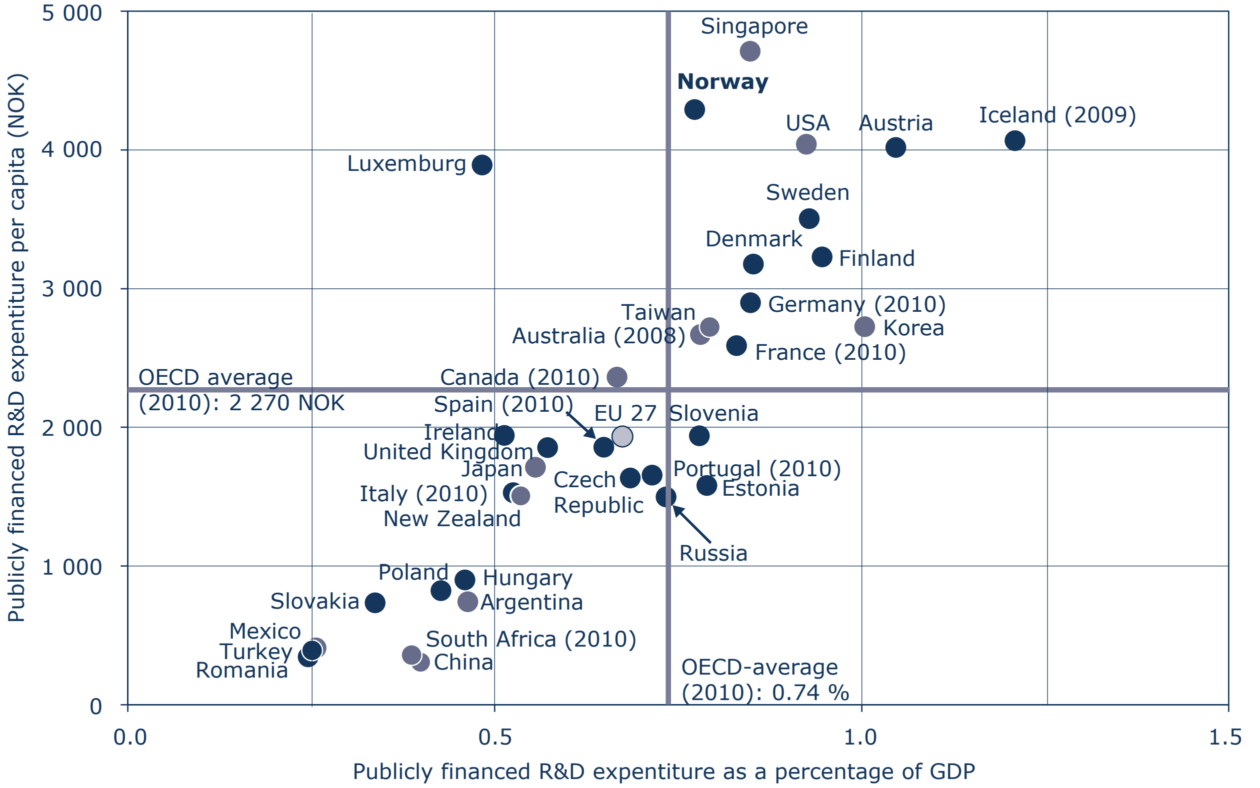
In most countries, the private sector dominates research performance. For OECD countries, average R&D expenditure performed in the business sector was 67 per cent, as shown in Figure 1.4. The average is strongly influenced by the business enterprise sector as the dominant sector in major R&D nations like the USA, Germany and France. In R&D-intensive countries such as Japan, Korea, Finland and Sweden, this sector accounts for somewhere between 70 and 80 per cent. At the other end of the scale, countries like Poland, Romania, Mexico and Turkey have a business enterprise sector that only accounts for 30–40 per cent of total R&D expenditure. The Norwegian business enterprise sector performs 52 per cent of the country's R&D investment. Since the mid-2000s, the Norwegian business enterprise sector's share remained about 15 percentage points below the level of the OECD total, and even lower than the other Nordic countries except Iceland.

Business enterprise sector is crucial for overall R&D

As shown in Figure 1.4, countries with high total of R&D expenditure as a share of GDP also consistently have a high proportion of R&D performed in the business enterprise sector. In virtually all countries that are above the OECD average in R&D as a share of GDP, more than two thirds of the research is carried out by the business enterprise sector. Conversely, most countries with low R&D in the business enterprise sector also have a relatively low overall R&D as a share of GDP. Norway follows this pattern. One exception is Iceland, which has both relatively little research in the business sector and a high overall R&D effort. However, that is one of the few international exceptions where the government fully compensates for a low private R&D effort.

1.1.2 International trends in R&D expenditure

Figure 1.5
R&D expenditure funded by public sources per capita and as a percentage of GDP for selected countries, 2011 or last available year¹.



¹ 2008 for Australia. 2009 numbers for Iceland and Israel. 2010-numbers for Canada, France, Italy, Portugal, Spain, South Africa, Germany, EU 27 and total OECD.

Source: UNESCO and OECD – MSTI 2013:1, national R&D statistics for Norway

High share of public funding in Norway

Government sources constitute the second major source of funding for research. Measured per capita, only Singapore has higher share of public R&D investment than Norway in 2011 as shown in Figure 1.5. With close to 4 300 NOK per capita, Norway invests almost 2 000 NOK more per capita than the average for the OECD countries. Other countries with a high share of public investment measured in this way are Iceland, USA, Austria, Luxembourg, the other Nordic countries and Germany.

However, the picture changes if public funding is measured as a share of GDP. Several countries have established national targets for public R&D efforts, including Norway, which since 2005 has had a target to raise public R&D spending to 1 per cent of GDP. In 2011, only Iceland, Austria and Korea had a public R&D effort over 1 per cent of GDP. USA, Germany, France and the Nordic countries also had a high share, and with a share of 0.77 per cent, Norway is just above the OECD average.

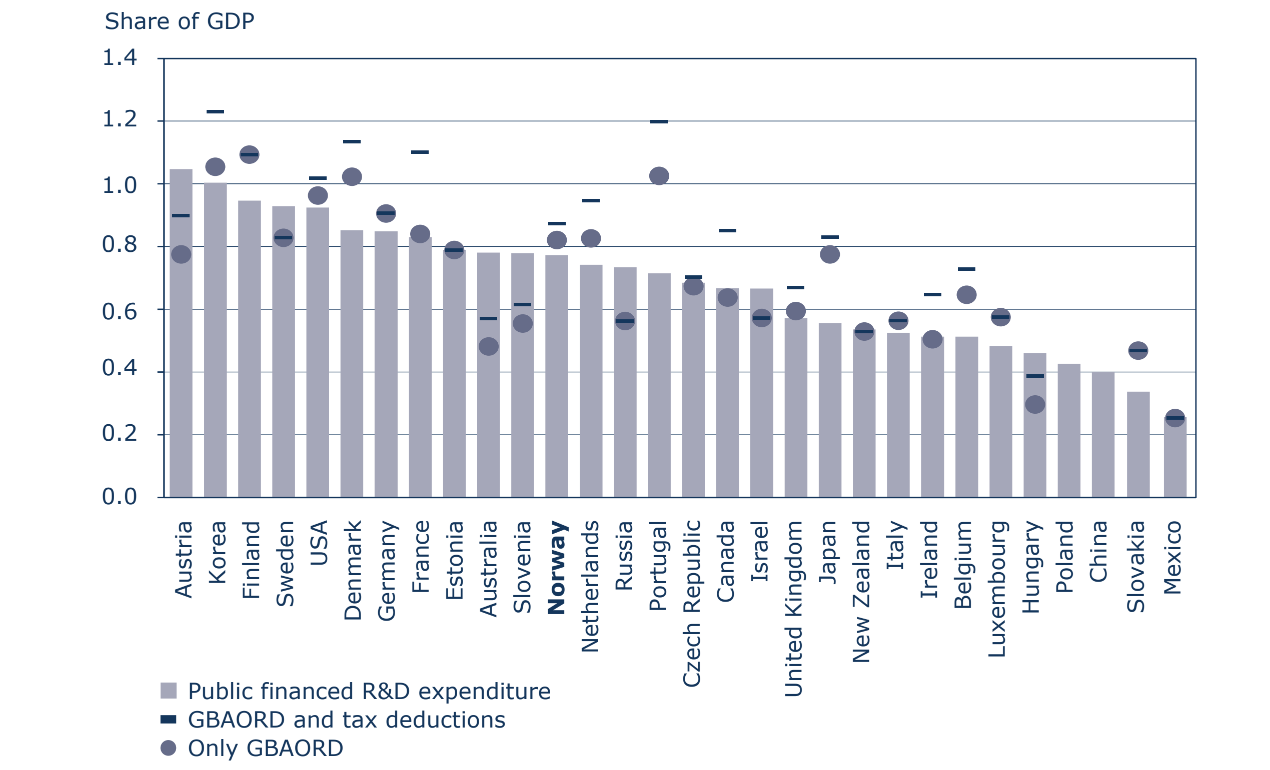
Varying growth in public R&D spending after 2007

Four countries had a real decline in public investment in recent years; Romania, Turkey, South Africa and Italy. Half of the countries (19 countries) have increased their average annual real growth after 2007 while the other half have reduced growth. For OECD countries overall, the average annual real growth in public R&D investment increased from 2.8 per cent in the years before 2007 to 3.4 per cent after 2007.

The vast majority of EU countries have also managed to increase growth in public R&D investment in the years after the financial crisis.

Prior to 2007, Norway had the highest growth in public R&D expenditure amongst their Nordic neighbours. Then followed Iceland, Finland, Sweden and Denmark. In 2007, Norway had a decline in growth in R&D investment. Finland also had a slight decline in growth, while Denmark, Sweden and Iceland (from 2007 to 2009) have actually increased annual growth. In the Nordic countries, Denmark now has the strongest growth.

Figure 1.6
R&D expenditure funded by public sources, Government budget appropriations or outlays for research and development (GBAORD) and GBAORD including tax-deductions as a share of GDP, 2011 or last available year.



Source: OECD – MSTI 2013:1, OECD/special survey

The above figures give the most accurate picture of public funding and rely on the annual R&D surveys. However, public R&D efforts can also be measured by looking at research grants in the government budget. This provides more recent figures, but these figures are also more uncertain and less suitable for international comparison. If measured by government budget appropriations or outlays for R&D, Norwegian public financing amounted to 0.82 per cent of GDP in 2011.

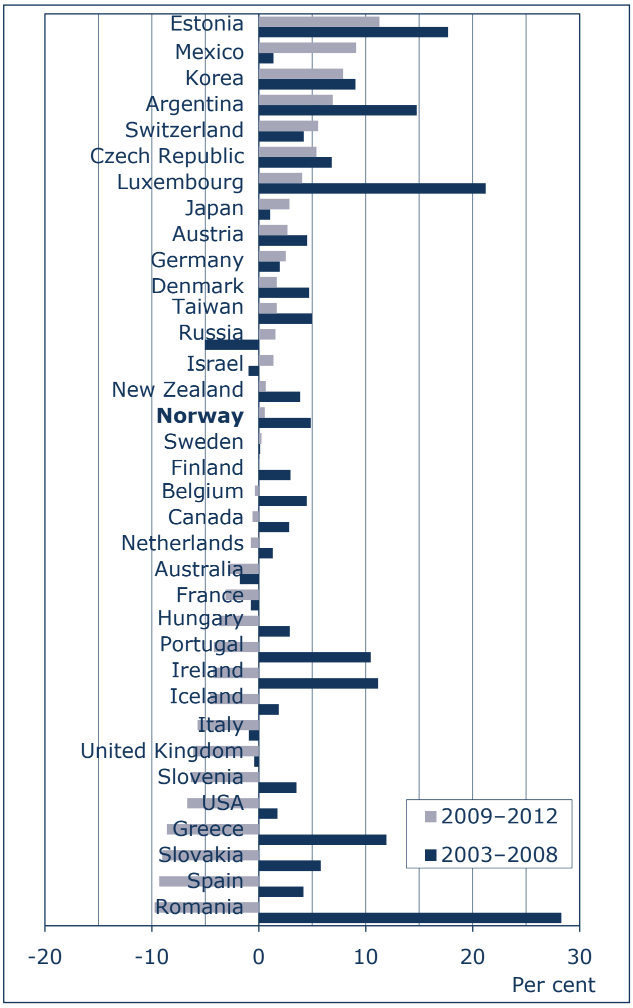
Many countries have higher R&D expenses when tax incentives are included

Tax refunds for corporate research expenditure also constitute a form of public research support. The use of such schemes has increased considerably, and according to the OECD, 26 countries have now introduced such a system. According to the OECD guidelines, the effect of such schemes are not to be included in the calculation of public funding. At the same time, tax refund arrangements can also be seen in the context of the overall public investment in research. Figure 1.6 shows public R&D expenditure as a share of GDP after three calculation methods, i.e. based on the official R&D survey, based on government budget appropriations of outlays for R&D (GBAORD), and based on GBAORD included tax schemes. Figures for public support in the form of tax schemes are based on experimental data from the OECD and must therefore be regarded as unofficial figures. The latter method gives the best result for Norway, but it is also the case for many other countries.

Should tax refund arrangements be regarded as R&D investments?

A relevant question is whether the effect of tax deductions for business R&D expenditures should be regarded as public research funding or not. According to the OECD's Frascati Manual, indirect support, in the form of tax credits, is in principle not supposed to be considered as public funding. However, the manual is open to include the effect of tax schemes if the current scheme is an integral part of public research policy, i.e. the scope of the scheme can be documented, and that it is part of the overall budget process R&D area. For international comparability, the effect of tax schemes should however always be stated separately.

Figure 1.7
Average annual real growth in GBAORD for selected countries: 2003–2008[1] and 2009–2012[2]. Fixed PPP$-prices.



[1] 2005 for Italy.

[2] 2010 for Canada. 2011 numbers for Spain, United Kingdom, France, Israel, Luxemburg, Korea, and Argentina.

Source: OECD – MSTI 2013:1

Government budget figures show real decrease in R&D funding for half of the countries

If we want to look at the latest developments in public R&D investment, we use the figures of R&D over national budgets (Government budget appropriation or outlays for R&D, GBAORD) that is collected by the OECD. These budget figures show intended allocations rather than actual use. The figures are in turn more up to date than accounting figures. Figure 1.7 shows that about half of the countries had average annual real growth in the years 2009–2012. As the figure shows, this is a significantly lower growth rate for the vast majority of states than for the years 2003–2008. At the same time, we can see that there are now as many as 17 countries that have experienced real decline in R&D funding after 2008. Among these are several countries that are deeply affected by the financial and debt crisis in the euro area after 2008.

Norway is among the countries with growth in R&D funding after 2008, but the growth rate is significantly lower than in the years before 2008; respectively, nearly 5 per cent before and 0.6 per cent average annual real growth after. Denmark has revised its growth down, but not as much as Norway. Growth in Finland was at a lower level than in Denmark and Norway in the years before the financial crisis, and after 2009 had zero growth. Sweden has had zero growth in both periods.

Future developments in R&D

Investment in R&D has become an increasingly competitive activity between countries. Estimates by R&D Magazine/Battelle suggest that global R&D share of GDP will remain steady at 1.77 per cent.[2] China's R&D is growing faster than that of the USA and is projected to overtake it within 10 years.

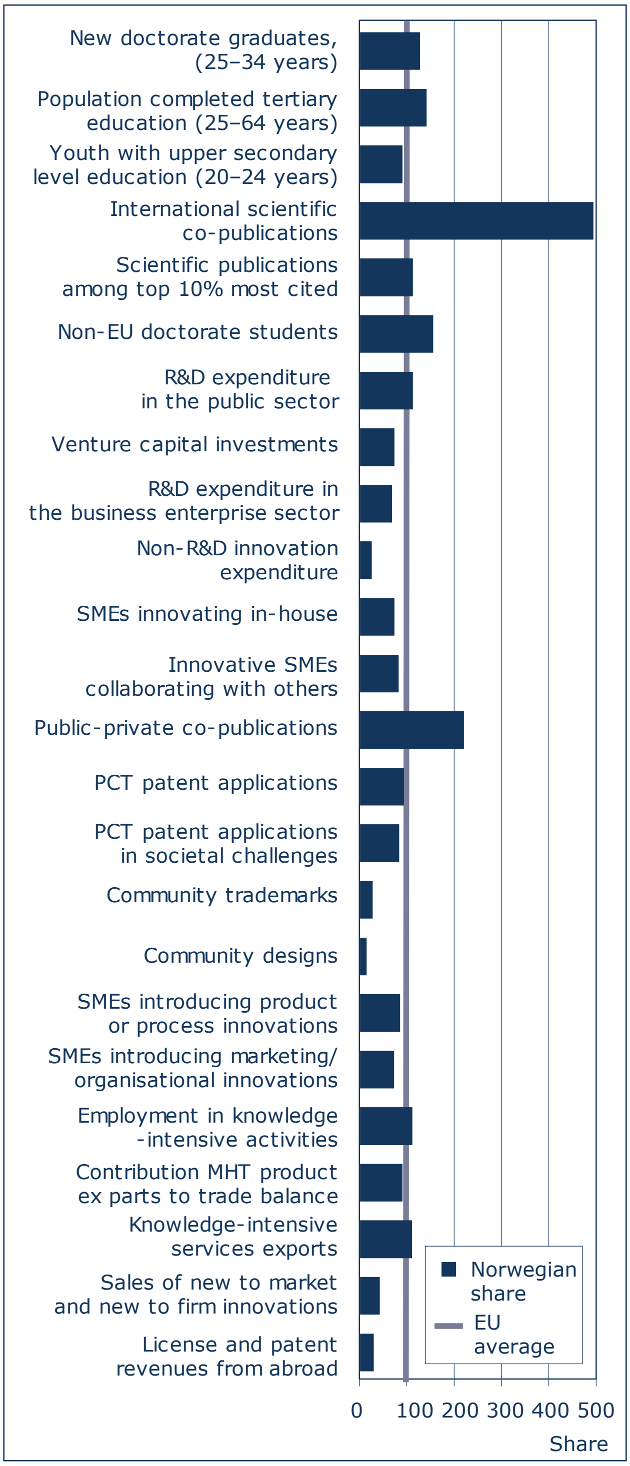
An annual survey of the global research community[3] identifies four critical areas of their R&D activity: lack of external funding; limited internal budgets; lack of long-term budgets; and lack of time to be creative and innovative. As many as 35 per cent of respondents reported these as the main challenges. Respondents were also asked what they considered to be the most important global research questions in the years ahead. 51 per cent responded that the most important thing is to improve the public understanding of science and technology. Over the three years the survey has been conducted, the importance of various «green» issues has been highlighted. More than 40 per cent mentioned the demand for renewable energy, sustainable development, and climate change/global warming as key issues for their research.

When asked which five countries should be considered the most influential in 10 different research areas, the answers have remained very stable , with the United States among the top 5 in all 10 priority areas and placed top in 8 of them. China was among the top 5 in 8 of 10 areas. Germany peaked in 2 areas, and Japan and South Korea score highly.

[2] R&D Magazine was established in 1959 (under the name Industrial Research), incl. articles on industrial R&D, with 79 000 readers. Battalle is the world's greatest non-profit S&T company established in 1929. The company has today more than 22 000 employees at 130 places with headquarters in Ohio. The estimates in the projection are based on academic research.

[3] Global R&D Funding Forecast 2013: 32 914 answers from 70 countries.

Figure 1.8
The Norwegian score in Innovation Union Scoreboard 2012, compared with average score for EU 27 (=100).



Source: Eurostat

The European Commission publishes an annual index called the Innovation Union Scoreboard (IUS). This is a collection of 24 indicators, which in different ways reflect innovation and conditions for innovation in 40 countries in and outside the EU. The aim is both to raise awareness and debate on innovation and to provide member countries with a view of the strengths and weaknesses of their national innovation systems. IUS also ranks countries according to a composite indicator that merges the results of all the 24 indicators.

Norway is characterized as a «moderate innovator»

Norway has consistently been placed relatively low overall in these comparisons. The latest edition of the IUS puts Norway as number 17 and in the group of so-called «moderate innovators». Switzerland is at the top of the list, with Sweden, Finland and Denmark in the following places. Norway's modest position has been stable over time. The question that is often raised is whether the 17th position is representative of Norway's innovation capacity.

Several factors give reason to question the present rank in the IUS. Figure 1.8 shows how Norway scores on the various indicators compared to the EU 27 average. On several indicators, Norway is at, or well above, the EU average. Norway scores consistently high in terms of human resources, with the exception of completion of secondary education. Norway has its highest score on the two indicators concerning cooperation on scientific publishing. Although it must be noted that a high degree of international co-authorship is natural for a small country like Norway.

Norway scores, as expected, poorly on indicators of R&D and innovation in business. This can be largely explained by the Norwegian industrial structure, which is explained later in this report. Norway scores very poorly on so-called «soft indicators» such as design, trademarks and innovation without research. In this case, the business structure is less relevant as an explanation.

As many as seven of the indicators are measured in terms of countries' GDP. This means that Norway's high GDP is negative to the outcome on these indicators. Moreover, six of the indicators derive from the innovation surveys. As described in previous issues of this report, there are major preconditions regarding the international comparability of the figures. Overall, the IUS gives a useful overview of factors that affect innovation. However, the composite indicator for countries' innovation ability should be used carefully.

FOCUS BOX NO. 1

«Innovation Grand Prix» - Norwegian innovation in international rankings

It is often claimed that Norway scores poorly in international rankings of innovation. However, this is not quite the case. International rankings of innovation are in fact composed of a wide range of indicators. The actual indicators used are of great importance for how the different countries score. Besides, most rankings use a so-called composite indicator that merges all the indicators into one overall score for the country as a whole. The ranking of countries therefore also depends on how the different indicators are weighted when they are merged.

Deutsche Telekom Stiftung has, in collaboration with the Fraunhofer Institute in Germany, made an analysis and compilation of the most widely used scoreboards for national innovation and competitiveness. In addition to the Foundation's own «innovation indicators» the list below includes seven international rankings, and the EU's Innovation Union Scoreboard.

The Norwegian score varies greatly, from the aforementioned 17th position of 40 countries in the Innovation Union Scoreboard to a 6th position of 60 countries in the World Competitiveness Scoreboard. In the German «Innovation Indicator» Norway ranks 11th out of 26 countries, a small drop compared to the year before. The latter ranking is constructed similarly to the EU's Innovation Union Scoreboard, but has some additional indicators, including the productivity and framework conditions for innovation. In this ranking, Norway gets a relatively high score in terms of direct and indirect support to R&D in the business sector. Consequently, Norway was at position 14 in 1995, position 7 in 2010 and position 11 in 2012.

Despite relatively similar methods and areas of indicators, rankings give quite different results for individual countries. With some exceptions, Switzerland, Sweden and Singapore are almost always at the top level. BRIC countries (Brazil. Russia, India and China) are often clearly behind the developed industrialized countries. As in Norway, the results vary for major economies such as Japan, France and the United States. The German study cites four factors that explain the differences:

Table 1
Systems of measurement of innovation and competitiveness. Norwegian ranking.

Study	Type of indicators	Number of indicators	Number of countries	Top 3 countries	Norwegian position
Innovationsindikator (2012) (BDI Deutsche Telekom Stiftung)	Hard (74 %) Soft (26 %)	38	26	1. Switzerland 2. Singapore 3. Sweden	11
Innovation Union Scoreboard (2013) (EU)	Hard	25	40	1. Switzerland 2. Sweden 3. Germany	17
Global Competitiveness Report (2012–13) World Economic Forum	Hard 39 % Soft 61 %	113	142	1. Switzerland 2. Singapore 3. Finland	15
World Competitiveness Scoreboard (2012) World Competitiveness Yearbook, IMD	Hard 67 % Soft 33 %	329	60	1. USA 2. Switzerland 3. Hong Kong	6
Global Innovation Index (2011) INSEAD Business School of the World, WIPO	Hard 48 % Soft 52 %	60	142	1. Switzerland 2. Sweden 3. United Kingdom	16
Economist Intelligence Unit Innovation Ranking (2008)	Hard 27 % Soft 73 %	22	25	1. Japan 2. Switzerland 3. Finland	17
Global Innovation Policy Index (2012) Information Technology and Innovation Foundation (ITIF) and Ewing Marion Kauffman Foundation	Hard	84	55	1. Canada 2. Singapore 3. USA	At the top level among 1–18

Source: Innovationsindikator 2010, internet site for different scoreboards.

1) Selection of Indicators: some scoreboards focus only on research, bibliometrics, patents and technology, while others also take into account the wider economic and political conditions (tax, labour market, bureaucracy, etc.).
2) Use of «soft indicators»: indicators based on expert assessments provide valuable additional information about conditions, but can be difficult to compare across countries, partly because of cultural differences. Problems with strategic responses are also present.
3) How the indicators are weighted and standardized when calculated in a total index/composite indicator will affect the rankings.
4) Selection of the comparison countries, if one chooses to look at many countries with different preconditions, or only developed countries and emerging economies.

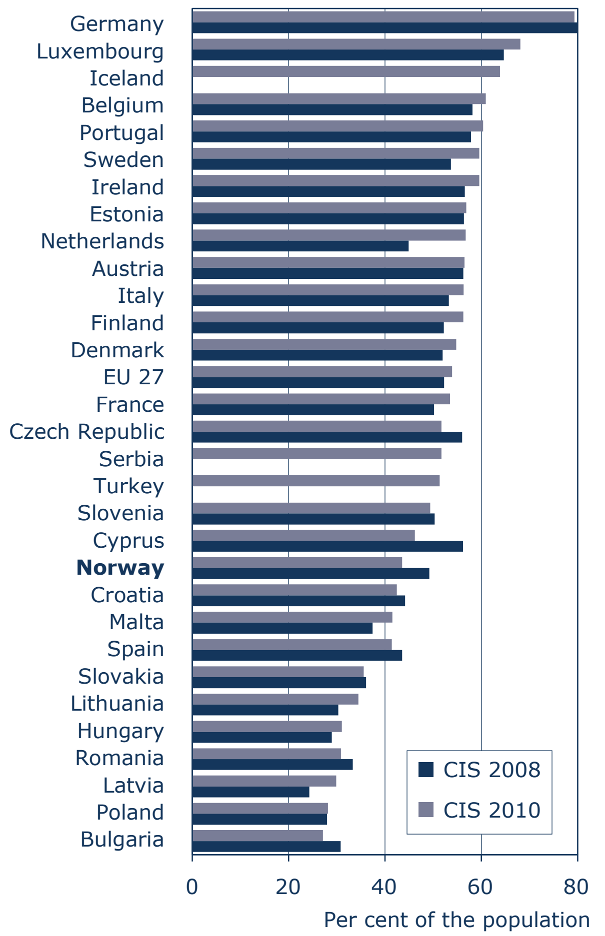
In many ways, it is appropriate to use a broad set of indicators when comparing innovation across countries. Innovation is an extensive and complex field that should be considered along many dimensions. The use of scoreboards might provide insight into the strengths and weaknesses of various countries' innovation systems. However, it is inappropriate to put too much emphasis on the ranking of countries according to one total score. The list above shows how differently this might turn out when indicators are selected and weighted in different ways.

There is no doubt that the rankings on total score creates valuable attention on innovation and innovation policy. However, analysis of the Norwegian innovation should be determined based on a more nuanced basis than our overall position in various scoreboards.

The focus box is an updated version of a box published in the Norwegian S&T report from 2012, p. 30.

Kaja Wendt og Espen Solberg, both NIFU

Figure 1.9
Proportion of companies with innovation activity. EU 27 and associated countries, 2008 and 2010.



Source: Eurostat

The coordination of the European countries' innovation surveys through the EU statistics agency Eurostat, provides opportunities to compare innovation activity in Norway and other countries. Such a comparison is important, because a priori it is not possible to set up an exact measure of how large innovation efforts should be or at what level one should expect or want to see the results. Innovation takes place as part of businesses competing in the markets, and this means that the appropriate level of innovation effort – and innovation results – are largely determined by what the competitors are doing. Since large parts of Norwegian industry is exposed to international competition, it is therefore a relevant basis for comparison how similar businesses abroad are rated and how much they achieve.

About innovation

Innovation activities by companies are defined as one or more of the following: the introduction of new products or new processes; the introduction of new organizational changes or changes in the way the company markets itself or its products; cancelled or postponed activity with a view to introducing new products or processes or ongoing activity not yet finalized by the end of a three year period. (See also the Fact box in the beginning of Chapter 2).

Figures from the European Innovation Survey, CIS 2010

The Norwegian industrial enterprise sector was below the EU average for innovation in the period 2008–2010, both when we look at the share of businesses with innovation activity as a whole and in terms of the proportion of businesses that have introduced new products or processes (PP-innovation), as shown in Figure 1.9. The Norwegian results are well below the corresponding figures from our Nordic neighbours: Sweden, Denmark, and Finland.

Reported total resources devoted to innovation, except R&D expenditure[4], are also very low. Norway, with other innovation costs of 0.6 per cent of total revenue, ends at the bottom among the countries participating in the survey. Compared to the EU average of 0.9 per cent, this is still a significant improvement compared to the previous survey. Sweden, Denmark and Finland for comparison, have respectively 1.6, 0.9 and 1.0 per cent.

Innovation activity and PP-innovation activity

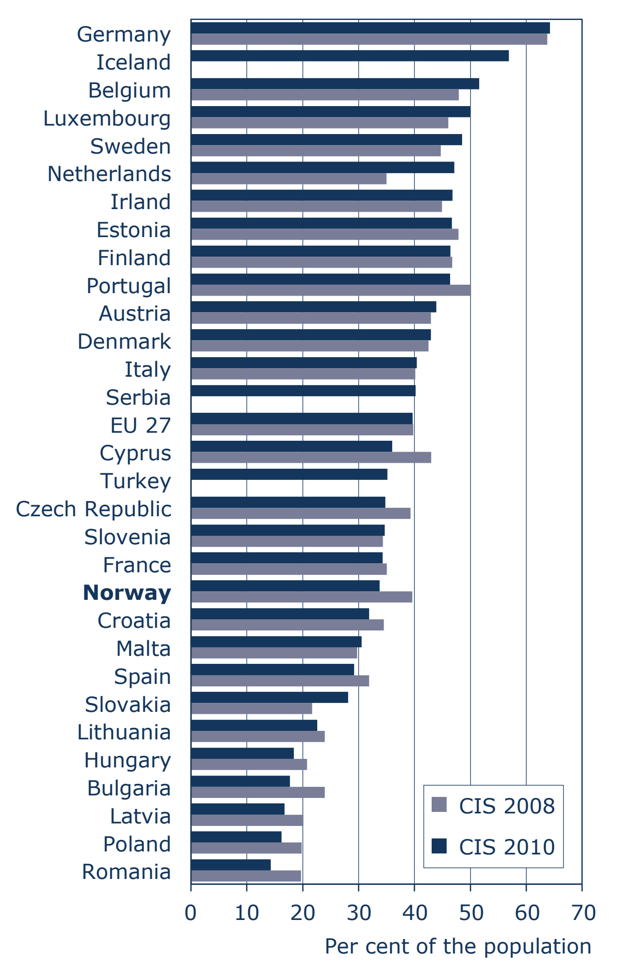
The survey shows that 44 per cent, almost half of the Norwegian firms included in the mandatory sample in CIS 2008, had innovation activity in the period 2008–2010. This was 10 percentage points below the EU average, and five percentage points lower than for the period 2006–2008. The EU average has increased by two percentage points since the last survey.

Ranked in descending order, Norway is number 20 of the 30 countries. Sweden, Finland and Denmark are ranked as number 6, 12 and 13, with respectively 60, 56 and 55 per cent of firms with innovation activities, and all of them with an increase since the previous survey. The innovation density among the countries that conducted this survey is evenly distributed. Germany with a reported share of 79 per cent of innovative enterprises, is ranked as number one.

[4] EU-average (EU 27) is based on accessible data for each indicator. I.e. data for the UK is missing for most variables that are not mandatory and UK is therefore not included in the totals. Greece has not provided data for CIS 2010 and is not included in the calculations.

1.3.1 International comparisons of innovation activity

Figure 1.10
Share of companies with PP-innovation activity in EU 27 and associated countries: 2008 and 2010.



Source: Eurostat

It may be noted that Germany had the lowest response rate of all countries participating in the survey, with only about 25 per cent in 2008. In addition, the method deviates from the standardized survey approach. It may therefore be appropriate to treat the results with some scepticism. Especially considering that Germany represents over 19 per cent of the businesses surveyed and over 28 per cent of the units reporting innovation activity. This provides a noticeable impact on the average figures for the EU as a whole, and if the German figures are excluded, the EU average drops by six percentage points.

The proportion of companies that have introduced exclusively organizational and/or marketing innovations – without any activity aimed at new products or processes – varies between the countries. Norway does not differ substantially, and ends with 10 per cent, which is about three percentage points below the EU average.

Apart from organizational and marketing innovations, the big picture for Norway is more or less the same as it was for all types of innovation activity as a whole. After a decrease by 6 percentage points since 2008, Norway end up with 34 per cent, which is also 6 percentage points below the EU average. The EU average has however remained flat at 40 per cent since the last survey.

For Norway, part of the decline in performance since the CIS 2008 can be explained by a change in the calculation basis for businesses that have introduced innovations in the period, and have registered interrupted innovation activity or ongoing activity that has not yet led to any innovation. The figures for 2008 showed that Norway clearly was an outlier on this variable with 10 per cent, compared with an EU average of only three per cent. In the figures of CIS 2010, the proportion of businesses with innovation activity in Norway is reduced to 1 per cent, the same as the EU average.

The reason for the high level of incomplete innovation reported in 2008 for Norway, was the inclusion of information from the previous survey. Firms reporting ongoing innovation activities aimed at introducing new products or processes by the end of 2006, but reported no innovation activity in the period 2006–2008, were recorded as having been cancelled or not completed innovation activity in CIS 2008. This is not unreasonable as such, but deviated from how this was registered in the other EU countries.

If the results are broken down by main industry[5], the picture is not significantly changed. The Norwegian businesses in the service industries score 31 per cent, three percentage points lower than the EU average, which is less than for all industries. Norway ends up somewhere on the middle of the scale if the countries are ranked by services alone, and there is still a long way up to the other Nordic countries. For manufacturing firms, the difference is even greater between the EU average, with 37 per cent, and Norway with a share of 44 per cent.

Part of the explanation for Norway's poor ranking is due to the Norwegian industrial structure. A joint Nordic study (Bloch et al., 2008) has previously corrected for the effect of varying industry structure in different countries, and the results of this gave a significant increase in relative innovation activity of Norway. This means that Norwegian companies are performing relatively better when compared with other Nordic companies in comparable industries. However it does not change the fact that on average they are less innovative than in the other Nordic countries in total.

[5] Industry includes the industrial codes B05–09, C10–33, D35 and E3–39. Services include G46, H49–53, J58, J61–63, K64–66 and M71. Together these two groups constitute the mandatory industrial coverage for CIS 2010.

FOCUS BOX NO. 2

A question of context: Assessing the impact of combined data collection strategies and of response rate on the measurement of innovation activity in Norway

International comparisons based on the Community Innovation Survey (CIS) have shown that Norway is scoring relatively poorly compared with the other European countries. For example, in the Innovation Union Scoreboard 2013 Norway is ranked below the EU average and is categorized as a «moderate innovator», the third lowest of four groups. Comparatively, the other Nordic countries, Denmark, Sweden, and Finland are all in the top group of «leading innovators». Additionally, Norway is also categorized as a «slow growing innovator».

Yet, Norway does very well on core economic indicators such as high GDP per capita growth, a high overall trade balance surplus, low unemployment, etc. If we expect a positive relationship between innovation scores and economic success, this may suggest that the Norwegian innovation results are lower than they reasonably should be when comparing the Norwegian economy to those of other countries. The OECD has termed this phenomenon «the Norwegian Puzzle».

Trying to resolve this apparent paradox, Statistics Norway carried out a project in conjunction with the R&D and innovation survey for 2010 to explore whether there are methodological factors that may have affected the Norwegian results. In particular, we wanted to answer two separate – but nevertheless related – questions:

First: Can the presence of detailed questions on R&D influence the reported incidence of innovation? Most countries have separate R&D and innovation surveys, while some – including Norway – have integrated them in a single combined survey. Initially, technology and R&D were considered to be the primary drivers for innovation, and the first surveys covered only the manufacturing industries. However, the concept and measurement of innovation has been evolving rapidly over the years, and the target population has widened in scope. Combining the surveys may inadvertently limit the respondents' understanding of what constitutes a «reportable» innovative activity by maintaining too strong a link between R&D and innovation.

Second: Can we identify an effect of an enforced mandatory innovation survey on reported incidence rates of innovation? Norway has traditionally had among the highest response rates of countries carrying out the CIS due to mandatory reporting with enforcement. Most other countries employ either a mandatory strategy with no enforcement or even a voluntary strategy, leading to – sometimes drastically – lower response rates. This could bias levels of reported innovation due to self-selection, and some countries have seen a drop in their innovation rates after making their innovation surveys mandatory.

The results from the project show that both these concerns are valid. We observe a significantly higher reporting of product and/or process innovation in an extra sample that received a mandatory innovation-only questionnaire compared to the corresponding groups in the regular combined survey. We also find that the reported innovation rates increase even further in a second innovation-only sample where responding to the survey was made voluntary. Overall, the measured incidence of product and/or process innovation is approximately doubled when going from a mandatory combined R&D and innovation survey to a voluntary innovation-only one.

The reported incidence of marketing and organisational innovations also increased between the regular combined survey and the mandatory innovation-only sample, but these effects were smaller than for product and/or process innovation.

Relationships with other explanatory variables have not been explored in depth. However, preliminary tests indicate that industries with a low R&D intensity observe a larger relative increase in their innovation rates compared to high-R&D industries when receiving the innovation-only survey.

Overall, our data show that there are clear and significant differences in the results of carrying out the CIS separately or integrated with the business enterprise R&D survey. However, the data do not provide unambiguous information as to which of the two sets of data are most accurate with respect to the measured innovation rates.

While it is clear that we are capturing new information in the extra samples, we still do not have a complete understanding of the mechanisms involved. There are probably several different factors at play, and we have evidence to suggest that no single explanation is sufficient.

Another caveat is that the project only covered small enterprises in selected industries, and we do not presently know for sure how these findings will extend to the complete population. It will therefore be followed up by a full scale innovation-only survey for 2013. These results will then be contrasted against the regular 2012-survey which is being carried out as a combined survey.

While the CIS surveys in general are comparatively well coordinated, these results indicate that the comparability of data across countries cannot necessarily be assumed. For that reason, the main conclusion we draw from this exercise is that context does matter. As such, these results should be taken into account when comparing results from the Norwegian R&D and innovation survey against CIS-data from other countries. And finally, while the «Norwegian Puzzle» is yet to be fully solved; we do believe that this work has added an additional piece towards its solution.

More:

Wilhelmsen, Lars (2012): A question of context – Assessing the impact of a separate innovation survey and of response rate on the measurement of innovation activity in Norway, Documents 2012/51, Statistics Norway.

Lars Wilhelmsen, Statistics Norway

1.4.1 Students

Human resources are both the basis and the most important factor of all R&D and innovation. Government estimates that human capital accounts for 80 per cent of the national wealth (White paper to the Storting 2012–2013: p. 6).

High level of education in Norway

In 1991, 25 per cent of the Norwegian population had higher education. In 2001, the share had risen to 31 per cent, and in 2011 the proportion had risen to 38 per cent. This has made Norway one of the countries with the highest level of education in the world. For the average of OECD countries, the proportion of higher education is at 32 per cent. As of today, there are only 10 countries in the world that have a higher level of education than Norway.

Norway has a good system of financial support for students and a well-developed, free education service. However, this costs: Norway spent 7.6 per cent of GDP (for mainland Norway) on the educational system in 2010, while the OECD average was 6.3 per cent of GDP. Measured as a percentage of public funding, higher education in Norway accounts for 15.2 per cent of total public spending, compared with 13.0 per cent for the OECD total.

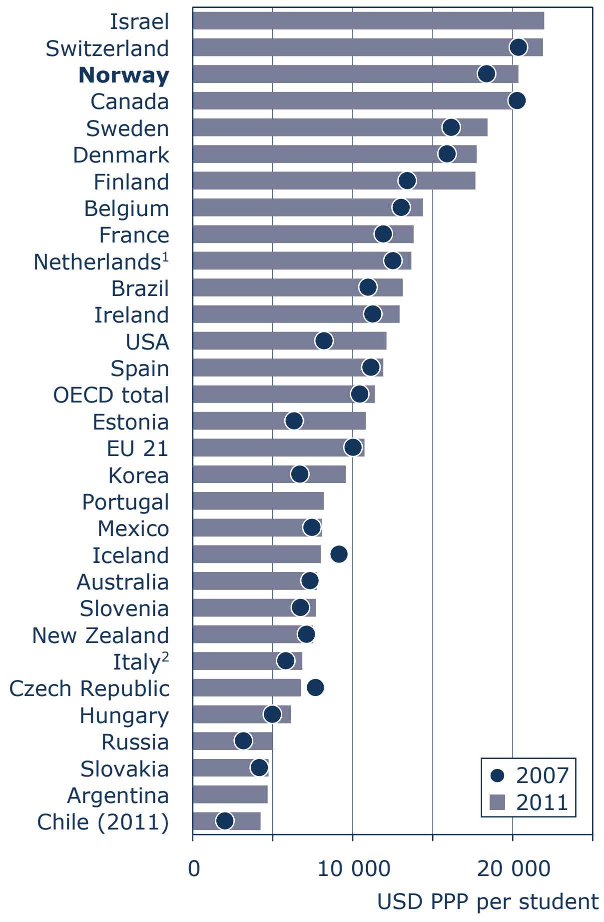
Norway has high public investment in education

Norway is among the countries with the highest public expenditure per student in higher education. As Figure 1.11 shows, only Israel and Switzerland spent more in 2011. Since 2007, Norway has had a nominal increase in spending of nearly 11 per cent, almost two percentage points higher than the average for OECD countries. Other countries with large growth from 2007 to 2011 are Chile, Estonia, Russia and Finland Two countries have experienced a decline in investment: Iceland and the Czech Republic. Measured in this way, it seems that many countries have managed to keep investment in higher education outside the major cuts of the economic downturn that began in 2008.

Private investment in higher education is low in Norway compared with other countries. In Norway, public investment accounted for more than 96 per cent of the costs of higher education. Denmark and Finland are also at high levels, while the proportion is lower in Sweden. For the OECD in total, the share is just under 70 per cent, and for the USA, public funding covers only 36 per cent of the costs of higher education.

Figure 1.11

Public expenditure on higher education institutions per student, 2007 and 2010. USD PPP.



[1] Private research institutes serving government sector are included in public institutes.

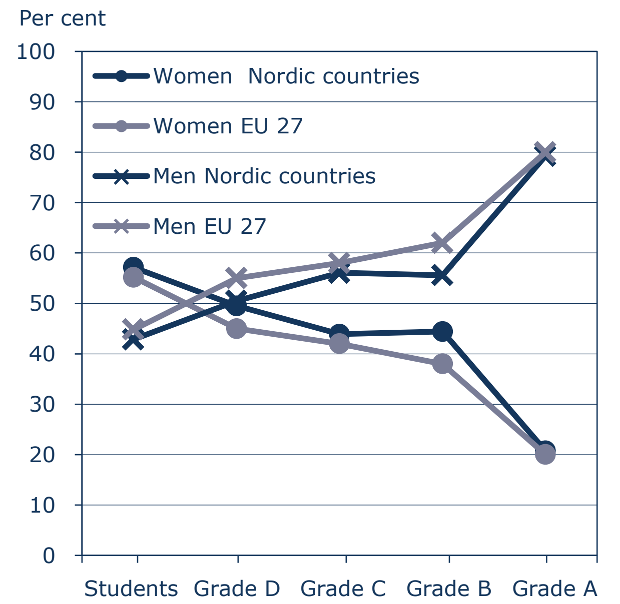
[2] Excl. vocational education.

Source: OECD – Education at a glance 2013

Age and gender

For OECD countries in total, it is estimated that about 40 per cent of the young adults today will take a higher degree examination. The share in Norway is even higher at 43 per cent. A characteristic of Norwegian students is that they are on average a little older (27.5 years) than the average for OECD countries (26.6 years) when preparing first graduate degrees. In the other Nordic countries, students are even a little bit older when they complete. It is also worth noting that the percentage of women who complete a higher education exam is now an impressive 58 per cent in the OECD area as a whole. For Norway, the proportion of women even higher by 62 per cent.

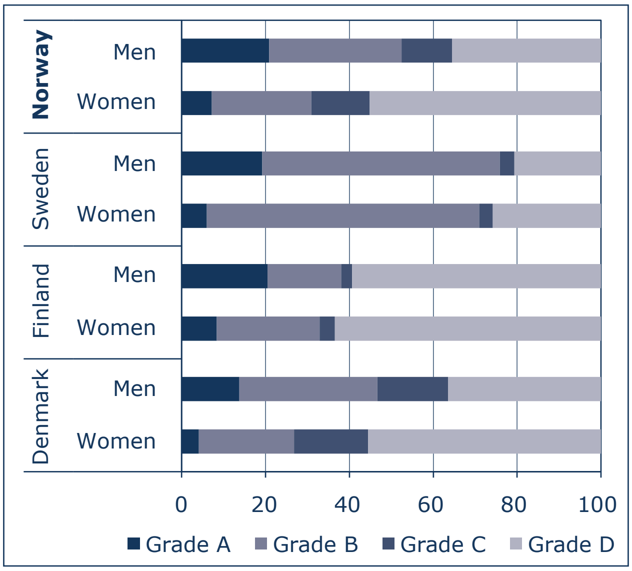
Figure 1.12
Share of women and men on different academic career levels in the Nordic countries and the EU 27, 2010.[1]



[1] Grade D:lowest position in the academic hierarchy, without the requirement of doctoral qualifications. In Norway this means doctoral fellows, research assistants and university and college lecturers. Grade C: first job after degree completion, typically postdoctoral and research positions. Grade B: more established research and teaching staff (in Norway: Professor, Associate Professor, Academic Director and Lecturer). Grade A: top position in the academic hierarchy (Professor).

Source: She Figures 2012

Figure 1.13
Share of women and men in a typical academic career in Denmark, Finland, Norway and Sweden, 2010.



Source: She Figures 2012

There is a total of 762 000 women in science in Europe in 2009. This gives a share among all scientific researchers of 33 per cent women (EU 27). The proportion of women among research staff was highest in the higher education sector and the public sector, both at 40 per cent, and lowest in the corporate sector at 19 per cent. There has been a higher percentage increase among women than men, with an average annual growth of 5.4 and 3.1 per cent respectively from 2002 until 2009.

The Nordic countries are often considered more equal regarding gender balance than other countries in Western Europe. The publication «She Figures 2012» shows that this is only partly true for women in science.

The Nordic region had a slightly higher percentage of female students at master's level than in the EU 27, as shown in Figure 1.12 and the proportion of women in the Nordic countries was higher in both Grade D, Grade C and Grade B. In particular, within Grade B, associate professor level, the proportion of women was significantly higher in the Nordic countries. However, at the professor level, Grade A, there are no differences between the Nordic countries and EU 27.

The proportion of female researchers is lower than the share of male researchers at the top level (Grade A) in all four Nordic countries, see Figure 1.13. In addition, the proportion of researchers at Grade A level is significantly higher in Norway, Sweden and Finland than in Denmark for both genders. It has traditionally been more difficult to become professor in Denmark than in the other three countries.

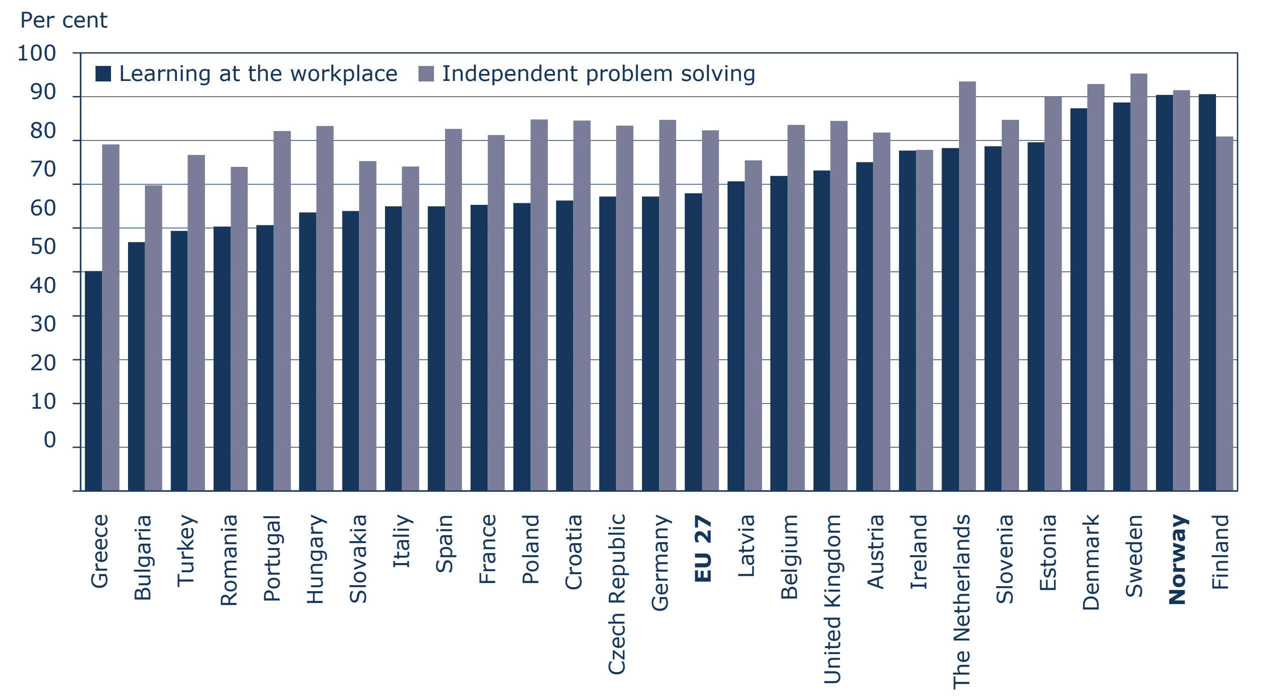
The proportion of women at grade D is high in Denmark, Finland and Norway. It separates Sweden out, and one of the reasons for this is that Sweden (and Finland) have not reported their PhD students in Grade D, as Norway and Denmark. Sweden has included many people in Grade B, in the metadata described as containing «Residual grade». It is challenging to adapt national employment structures to a frame that makes them comparable.

About She Figures

The She Figures of the EU Commission is a collection of statistics on women in science and research in Europe. It is published every third year, and the 2012 edition is the fourth publication in the series. It presents statistics along four main areas: 1) Overall level, i.e. the total number of researchers, students and the development of female representation over time. 2) Distribution of female researchers by scientific fields. 3) Seniority and 4) Setting the scientific agenda, that is, share of women among principals and directors of academic institutions and national funding.

1.4.3 Learning in the workplace

Figure 1.14
Share of employees who say their job involves learning at the workplace and independent problem solving, in selected countries: 2010.



Source: NIFU based on European Working Conditions Survey (ECWF) 2010

Internationally, there is a broad agreement in society that innovation is about more than research and technological development. The concept of innovation includes a variety of activities that require different types of expertise. This recognition has led to increasing interest in studying innovation in the context of the culture and organization in the workplace. The latest innovation survey (CIS 2010) includes a module of questions on business strategies to stimulate creativity among employees.

Several researchers have studied national differences regarding culture and systems of learning at the workplace in general. Based on data from the European Working Conditions Survey (EWCS) countries are divided into four categories of work systems: 1) countries with «learning-intensive work», 2) countries with a high degree of «routine problem solving» (lean production), 3) countries with «industrial production work» (taylorism) and 4) countries with much «traditional work».

The division of workers in these categories shows surprisingly large differences between countries. Learning-intensive work is most widespread in Scandinavia and the Netherlands, while countries in southern Europe are characterized by a higher degree of «taylorism» and «traditional work».

Figure 1.14 shows that it is particularly the Nordic and Duch workers who feel that their job involves learning and independent problem solving. These are two key elements in what is known as learning-intensive work. This work is believed to promote the most innovation. Work characterized by «routine problem solving», also known as «lean production», is also associated with innovative business, but is often more systematic and characterized by hierarchical structures. Such organizations are often linked to more incremental innovations and process innovations. Work systems characterized by «industrial production work» (taylorism) and «traditional work» is believed to be less conducive to innovation.

About the European working conditions survey

The European Working Conditions Survey (EWCS) is conducted by Eurofound every five years. The latest survey was conducted in 2010. It encompasses 40 countries with about 1 000 respondents in each country. The questions revolve around working conditions in general, but leading innovation researchers have identified 15 issues related to innovation and creativity in the workplace. Based on these, the countries have been classified according to the degree of learning in the workplace.

Chapter 2

2 The Norwegian system of R&D and innovation

Harald Fondevik, Hebe Gunnes, Elisabeth Hovdhaugen, Kristine Langhoff, Lise Dalen Mc Mahon, Terje Bruen Olsen, Bo Sarpebakken, Espen Solberg, Susanne L. Sundnes, Kaja Wendt, Jannecke Wiers-Jenssen, Ole Wiig, Elisabeth Wiker, Lars Wilhelmsen

Resources for R&D

- In 2011, the total Norwegian expenditure on R&D amounted to 45.5 billion NOK. This gives a nominal increase of 2.7 billion or real growth of 2.4 per cent from 2010. In comparison, there was a decrease in R&D expenditure from 2009 to 2010 of 0.7 per cent.
- R&D expenditure constituted 1.65 per cent of GDP in 2011, a decline from 1.68 per cent in 2010 and 1.76 in 2009.
- From 2010 to 2011, it is the industrial sector that has experienced the largest real growth in R&D expenditure (more than 4 per cent), followed by the institute sector (almost 3 per cent).
- The higher education sector is surveyed biennially. The average annual real decline from 2009 to 2011 was 0.7 per cent. The decline in the sector is primarily due to reduced capital expenditure, while there was an average annual real growth of 1.3 per cent in current expenditure. For the university hospitals alone there was no growth in this period.
- Total R&D expenditure in the Norwegian health trusts amounted to 6.1 per cent of total R&D expenditure in Norway in 2011, while the corresponding figure for 2010 was 5.5 per cent.
- The institute sector consists of about 100 units (plus museums). A large part of R&D expenditure in the sector is concentrated in a few units; in 2011, 15 institutions accounted for three-quarters of R&D expenditure in the sector.
- There is considerable variation in R&D intensity across the different industries. If the R&D expenditure are measured as a share of the value added, the R&D intensity was higher in the manufacturing industry than in services and other industries (including oil and gas). Especially engineering and computer and electronic industries had high R&D intensity.
- Divided into the technology areas of Government priority the highest R&D expenditure was within the ICT area, while the area of biotechnology has shown the largest relative increase since 2005.

Government budget appropriations or outlays for R&D (GBAORD)

- Grants for R&D in the approved budget for 2013 are estimated to 25.9 billion NOK. This will give a real growth of nearly 3 per cent. In fixed prices, there has been a flattening in the R&D funding after 2010.

Participation in international R&D cooperation

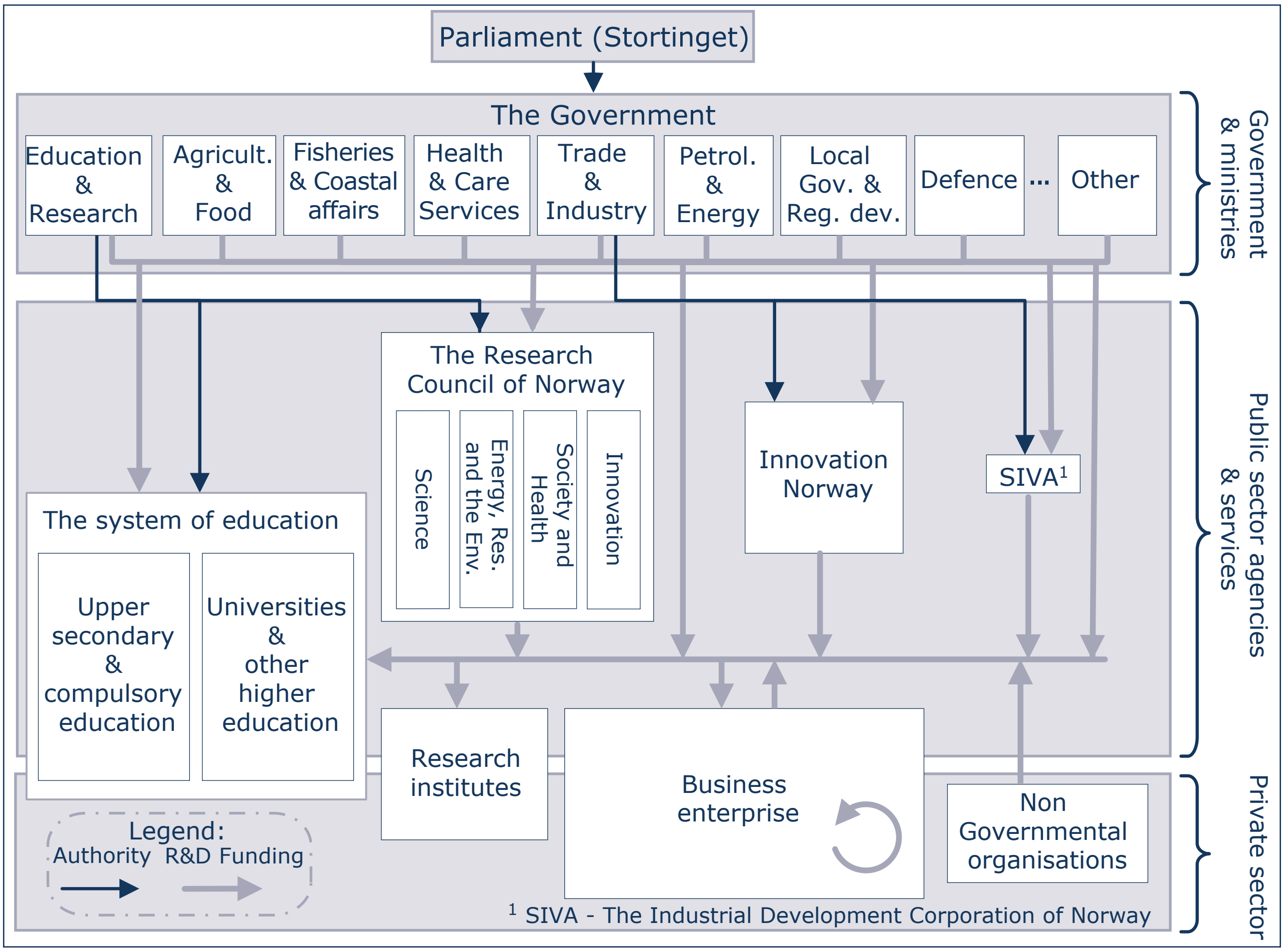
- Norway has strong research environments within marine and maritime areas, as well as within energy, and these areas have also given a high count within the 7th framework programme for research and technological development.
- More research funding goes abroad than to Norway.

Human resources

- The number of new PhD awards has skyrocketed in the 2000s. In 2012 1 461 degrees were awarded in Norway, half of the degrees by women and 35 per cent by foreigners.
- 6–7 per cent of Norwegian students complete their entire degree abroad; in addition 3–4 per cent complete parts of their education abroad. Traditionally, Norway has had few incoming students, but during the last decade, the number of foreign students at Norwegian higher education institutions has doubled, and amounted to nearly 8 per cent in 2012.
- In 2011, nearly 65 000 people participated in R&D activity in Norway. 46 000 of these were researchers, while 19 000 were in technical or administrative positions. More than 29 000 people participated in R&D activity in the higher education sector, while the corresponding numbers for the industrial sector and the institute sector were just above 23 000 and 12 000 respectively.

Chapter 2

Figure 2.1
The Norwegian system of education, research and innovation.



Source: NIFU

The Norwegian research and innovation system includes a large number of institutions with different roles. It is common to distinguish between the political, the strategic and the executive level. The international dimension should also be taken into consideration. Foreign actors are important to all parts of the Norwegian R&D system. Figure 2.1 provides a simplified picture of some of the key players. The description is limited to those involved in research and research-based innovation.

The Norwegian system can be characterized by pluralism at the operational level, with a great diversity of higher education institutions and research institutes. Even though the industrial sector accounts for nearly half of all R&D expenditure in Norway, there is little research performed in this sector compared with other countries. In return, the institute sector is of great importance for Norwegian research, although the trend is that an increasing part of the research is performed at the universities and colleges. In addition, the health trusts have become increasingly important research actors in Norway.

At the strategic level, Norway has fewer actors and stronger coordination. The establishment of one unified Research Council is unique in an international context. Also Innovation Norway fulfills functions which in other countries are divided among several actors.

Again, at the political level there is more pluralism. The Ministry of Education and Research is the largest funder and has a responsibility for coordination, but each ministry has a responsibility to fund research within and for its own sector, the so-called sector principle. The majority of public research is funded by the ministries, but in recent years more of the responsibility for the management and funding of research and innovation has been placed at the regional level.

In the following sections, we describe the system in more detail. We review the status and development of the overall R&D expenditure, both by source of funding and within the various performing sectors and we look at international cooperation as part of the Norwegian system. Finally, we look at the human resources involved in research and development in Norway.

The OECD's 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.

OECD (2002): Frascati Manual. Proposed Standard Practice for Surveys on Research and Experimental Development, OECD, 2002.

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 processes*** 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.

Norwegian performing sectors for R&D

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

- ***The industrial sector:*** Firms, organisations and institutions whose primary activity is the commercial production of goods and services for sale to the general public at an economically significant price.
- ***The institute sector:*** Private non-profit institutes mainly serving industry (incl. in the business enterprise sector in OECD's classification); research institutes and other R&D performing institutions (other than higher education) mainly controlled by and funded by the government (Government sector in OECD's classification); non-market, private non-profit institutions serving the general public (Private non-profit sector (PNP) in OECD's classification); and other health trusts not conducting education and PNP hospitals.

  The higher education sector: Universities, governmental and private university institutions, national institutes of the arts, state university colleges and university hospitals.

Based on these categories, the business enterprise sector encompasses the private business sector and research units that mainly serve that sector. The government sector in Norway encompass units in the institute sector linked to government and other public and semi-public institutions and public mission-oriented institutes. There are few PNP research institutions in Norway. In international statistics, PNP-institutions are therefor included in the Government sector. National and international statistics are identical for the higher education sector.

FOCUS BOX NO. 3

Revision of the Frascati manual

The Frascati Manual, the «bible» for definitions and collections of data on research and development, is being revised. This was decided by the OECD/National Experts on Science and Technology Indicators (NESTI) in April 2013, and the process is expected to take just over two years if all proceeds as planned. This is the sixth revision of the manual. The current edition is unchanged since 2002. In the meantime, much has happened that requires evaluation of existing advice and recommendations on new areas.

Still, many will ask why such a well-regarded and central manual needs to change. Is not it risky to change something that works well - «never change a winning team» as it is said? There are good reasons to maintain a considerable degree of stability, both for the sake of time series and references to laws and regulations, as well as references to related manuals, such as the Oslo Manual on innovation.

It is paradoxical that one of the main reasons for this new review is the extended use of the manual. The use of and interest in R&D statistics is increasing, and the requirements for comparability over time and between countries, institutions and industries increases proportionally. The main definition of R&D is not likely to be changed, but the practical advice on how to collect and refine information will be tightened and updated. The reason for this is that the recommendations in the manual allow for different methods, and thus existing practices in different countries have been found to result in data that are less comparable than desired. Questions that arise in this context are whether clearer recommendations related to selection procedures and specific examples of the design of questions, as well as questionnaires, should be prepared. There are also changes in methods of data collection that affect both the quality and cost of collection. Most countries experience some questionnaire fatigue. At the same time, access to administrative data has allowed a more efficient use of existing information.

Also, new uses of R&D data require supplemental information to what exists now. The most important information is that R&D is included as an investment in the national accounts. More detailed information about the capital cost component and about the expected lifetime of knowledge generated by R&D investment is required. Different public funding schemes, especially tax incentives for R&D, have increased their impact and thus require that funding sources are treated and categorized in the statistics. This is a factor that intervenes directly in determining how central research political goals are realized.

It is also important to take into consideration that new user groups will use R&D statistics without being experts on this type of information. This includes the use of data and statistics in, for instance, policy development and analysis. Similarly, there is a need to introduce users in countries that are new to the preparation of R&D statistics. To date, the Frascati Manual has primarily given technical guidance to those who collect statistics. Adequate guidance for the users of the statistics is a new need which must be addressed. It is still an open question whether, and how, this can be done inside or outside the scope of the manual.

The revision process is organized around a number of key issues, and there are groups that review the different challenges and opportunities. Each group has participants from a limited number of countries. The countries are represented by their delegates to NESTI or other experts who have the needed resources. Norway is involved in several groups and has also agreed to participate in the management of two of the groups. The groups are assisted by the OECD Secretariat and external academic experts when needed. The different themes will inevitably overlap to some degree, thus there is no direct correlation between what the groups are working on and the existing chapters. The final structure of the new manual will be prepared based on the groups' results.

In order to illustrate the themes dealt with, we have listed the working groups according to how they probably will be established. New needs and challenges may be revealed along the way. An actual revision of the current manual must not only be based on a perceived problem or need, but also ensure that the revised recommendations are better than the old ones. The work must be based on knowledge and experience already available, or which can be obtained within the limited time frame that is available.

The groups that have been established will initially address the following topics:

- The R&D definition
- R&D personnel
- R&D in the higher education sector (led by Norway/NIFU, Germany and France)
- Public funding of R&D
- Capitalization of R&D in the national accounts
- Costs of R&D, intramural versus purchased (led by Norway/Statistics Norway)
- Product and industry classification
- Results of R&D
- Industries versus product classification
- Internationalisation of R&D
- Extended operating instructions for R&D statistics
- Common themes for all groups:
    - Links to other statistical areas and manuals, laws and regulations
    - Classifications in general
    - Special considerations for developing countries
    - Data from the financing versus the performing parts and
    - The relationship between surveys versus administrative data

Svein Olav Nås, Research Council of Norway

Chapter 2

2.1.1 R&D expenditure by performing sector

Total expenditure on research and development (R&D) in Norway amounted to 45.4 billion NOK in 2011.This represents an increase in R&D expenditure of 3.6 billion NOK from 2009 and 2.7 billion NOK from 2010. In fixed 2010 prices, there was a total real growth in Norwegian R&D of 2.4 per cent from 2010 to 2011, see Table 2.1. The health trusts have had the highest real growth from 2010 to 2011. Without the university hospitals the higher education sector has had a decrease, while the institute sector and in particular the industrial sector have experienced some real growth.

In a ten-year perspective (2001–2011) the annual real development is at the same level as from 2010 to 2011, but the distribution between the sectors is different. During the last ten years it has been the higher education sector which has experienced the highest growth in R&D expenditure, followed by the institute sector, while the industrial sector had the lowest growth in this period.

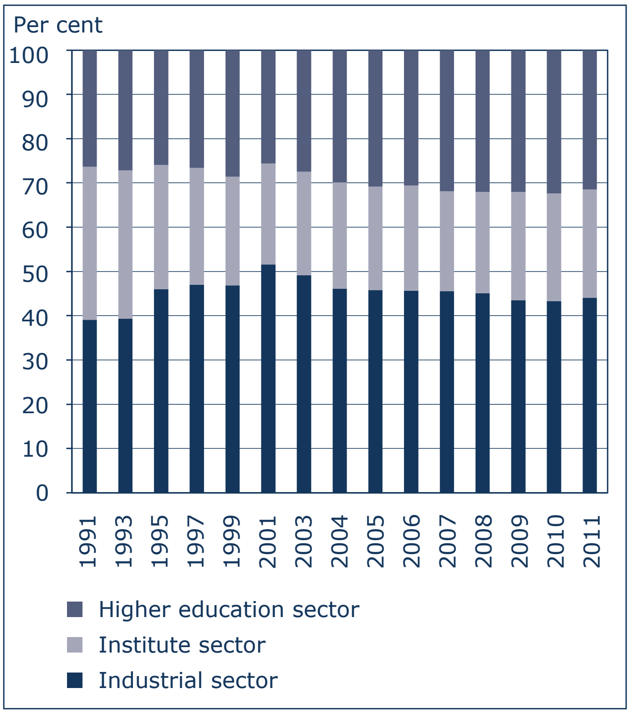
If we look at the distribution of R&D expenses in the R&D performing sectors in a longer perspective, Figure 2.2 shows that during the twenty years from 1991 to 2011 the higher education sector's share of R&D expenditure has increased slightly. Since 2007 it has remained at 31–32 per cent of R&D expenditure in Norway.

The institute sector's share of R&D expenditure has decreased from 35 per cent in 1991 to 23–24 per cent in 2001 and has since remained at this level.

The industrial sector's share has decreased since 2001, and in 2011 it amounted to 44 per cent of R&D expenditure in Norway.

In addition to R&D expenditure used in Norway, 5 billion NOK was used to finance R&D abroad.

Figure 2.2
Total R&D expenditure in Norway by sector of performance: 1991–2011.



Source: Statistics Norway/NIFU, R&D statistics

To improve the visualization of R&D in the health trusts the report provides an overall presentation of the health trusts where this is appropriate and possible (data from 2007 and onwards). The higher education sector and the institute sector are thus presented without the health trusts later in this chapter.

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Table 2.1
Total R&D expenditure in Norway by sector of performance/type of institution: 2009, 2010 and 2011.

Sector/type of institution	2009	2010	2011	Per cent of total R&D FoU 2011	Real growth 2010–2011 (%)	Average annual real growth[1] 2001–2011 (%)
Industrial sector	18 202	18 514	20 066	44	4.3	0.9
Higher education sector	11 324	11 870	11 989	26	-1.5	4.7
Institute sector	9 925	10 036	10 610	23	1.9	2.6
Health trusts	2 434	2 339	2 776	6	14.4	:
Total Norway	**41 885**	**42 759**	**45 440**	**100**	**2.4**	**2.5**

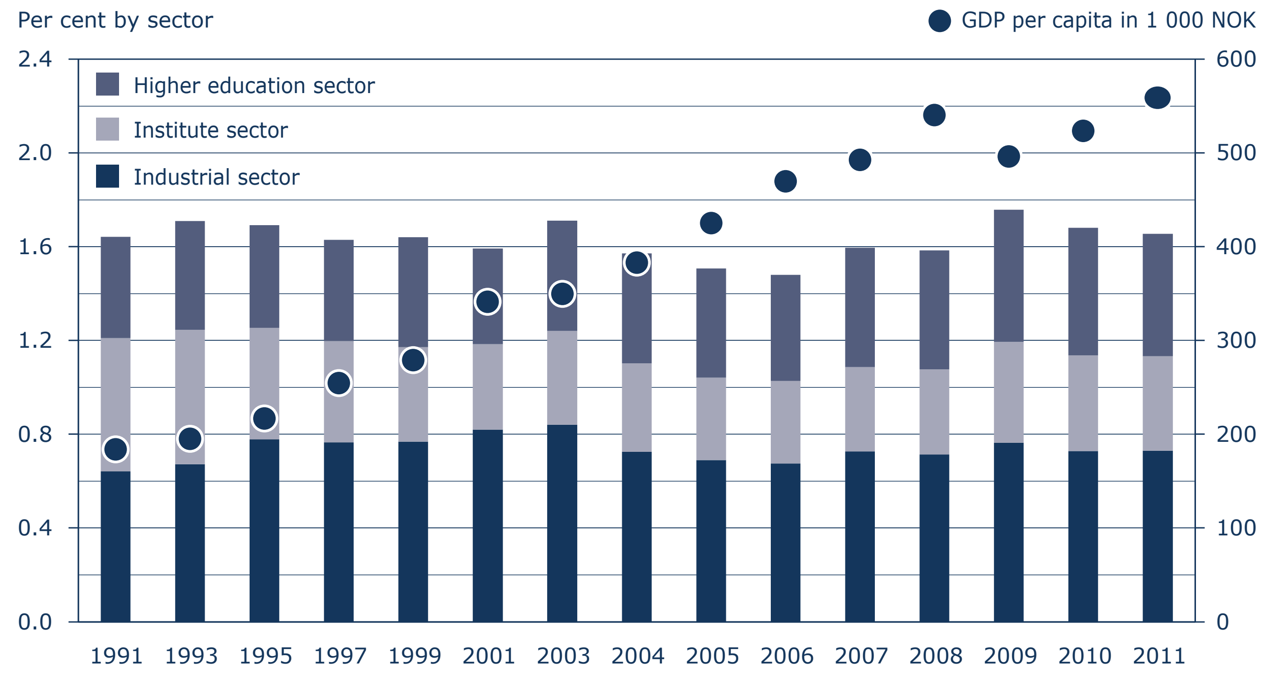
[1] Data for the health trusts before 2007 are missing. For the calculation of growth 2001–2011 the traditional sector classification has been used, i.e. the university hospitals are included in the higher education sector while other health trusts and private, nonprofit hospitals are included in the institute sector.

Source: Statistics Norway/NIFU, R&D statistics

Chapter 2

Figure 2.3

Total R&D expenditure in Norway by sector of performance and GDP per capita: 1991–2011.



Source: Statistics Norway/NIFU, R&D statistics

R&D expenditure as a share of gross domestic product (GDP) amounted to 1.65 per cent in 2011. The growth in R&D expenditure has in recent years not resulted in an increased R&D share of GDP, as shown in Figure 2.3. The right axis of the figure shows the scale for GDP per capita. It is evident how a high GDP per capita results in a lower R&D share of GDP (2008 and 2011) and vice versa (2009). Measuring the R&D expenditure relative to GDP is thus very sensitive to fluctuations in GDP. Measurements of R&D efforts should be complemented by additional indicators such as R&D per capita, per employee or per R&D full time equivalent (FTE/R&D-person years).

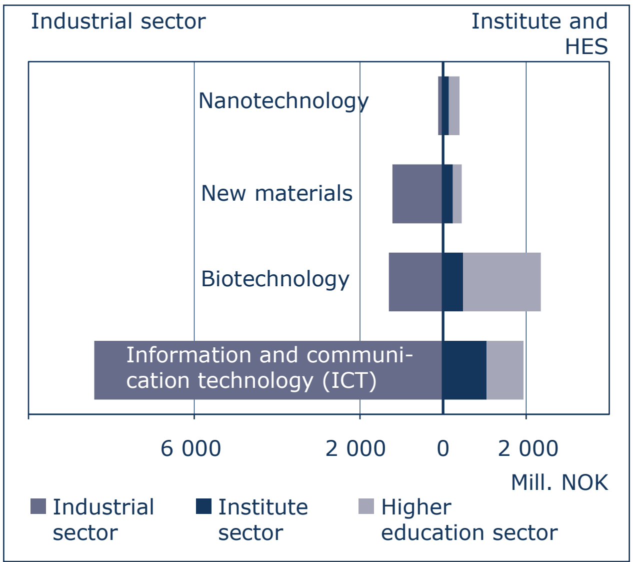
R&D expenditure as a percentage of GDP has in Norway remained at relatively stable 2011-level for the past 20 years. The contributions from the various sectors have not changed much either. Since the mid-2000s, the industrial sectors' share has amounted to about 0.7 per cent. The institute sector has since the mid-1990s accounted for about 0.4 per cent, while since 2003 the higher education sector has amounted to 0.5 per cent of R&D expenditure as a share of GDP. See Chapter 1 for an international comparison of the level of R&D as percentage of GDP.

About R&D as a percentage of GDP

R&D share of GDP is a popular but controversial indicator. The popularity is because it provides an easy and clear comparison of different countries' investment in R&D as a share of the value added. The use of the indicator was not lessened when the EU in 2002 decided that a R&D share of GDP of 3 per cent was going to be the so-called Barcelona target for the member states. In Norway, the White paper on Research 2012–2013 has upheld that this should be the long term objective also for the R&D efforts of Norway. At the same time the indicator is criticized for being a very rough measure of R&D efforts which does not reflect fluctuations in the denominator (GDP) or the number of inhabitants. In Norway there has also been a discussion about whether the mainland GDP rather should be used as the denominator to avoid the huge influence of the oil industry.

2.1.3 Technological priorities

Figure 2.4
Current expenditure on R&D by technology area and sector of performance, 2011.



Source: Statistics Norway/NIFU, R&D statistics

The national R&D survey maps the alternating governments' priorities. R&D investments in ICT, biotechnology and new materials have been mapped since the 1990s, nanotechnology since 2005.

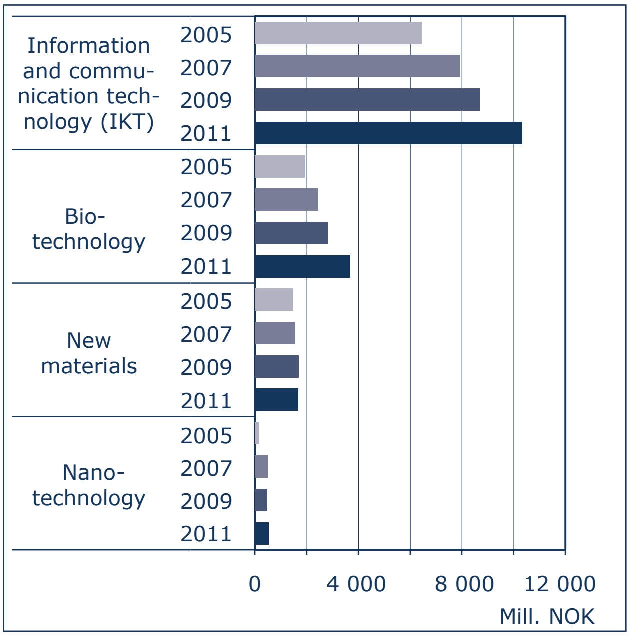
ICT is the largest technology area

In those years that the technology areas have been mapped by the R&D survey it has been the information and communication technology (ICT) area that has been the largest area of technology in terms of current expenditure on R&D, followed by biotechnology, new materials and nanotechnology. In 2011, the ICT area amounted to over 10 billion NOK in current prices, see Figure 2.4. The industrial sector accounted for over 80 per cent of expenditure within ICT.

The second largest technology area was biotechnology where the current R&D expenditure amounted to nearly 3.8 billion NOK. Within this area the higher education sector was the largest performing sector, with R&D expenditure of nearly 2 billion NOK while the industrial sector accounted for 1.3 billion NOK and institute sector 500 million NOK. The university hospitals accounted for almost one third of the R&D expenditure within biotechnology in 2011.

Within the new materials technology area the current R&D expenditure amounted to 1.2 billion NOK in the industrial sector, while the institute sector and the higher education sector both conducted research within this area for over 200 million NOK. The smallest technology area, nanotechnology, had a current expenditure on R&D of 0.5 billion NOK, the higher education sector accounted for over half of this, while

Figure 2.5
Current expenditure on R&D by technology areas: 2005–2011.



[1] In 2005 nanotechnology was included in the figures for new materials in the higher education sector and research institutes.

Source: Statistics Norway/NIFU, R&D statistics

the institute sector and the industrial sector accounted for about a quarter each.

Highest growth within biotechnology

Over time, it is the expenditure on R&D within biotechnology that has had the strongest relative growth among the prioritized technology areas, see Figure 2.5. The growth has been stronger than the development of total R&D in Norway. The average annual real growth within biotechnological R&D has been above 6 per cent from 2005 to 2011, while the corresponding growth for ICT was 3 per cent. There has however, been a slight real decrease in this period for the other technology areas.

Thematic and technological priorities

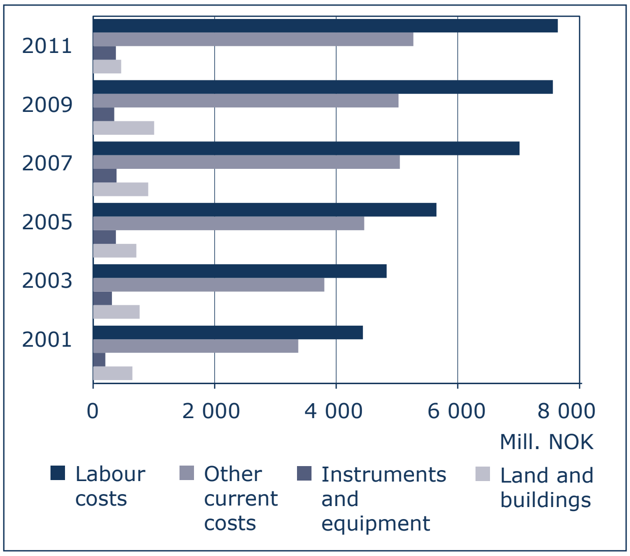
In the Norwegian government's latest white paper on research St. 18 (2012–2013), the priorities from the previous white paper on research are maintained: Global challenges, better health and health care, welfare and research-based professional practice, knowledge-based industry throughout the country and industry-relevant research on strategic areas. Several of these priorities are mapped by the R&D surveys. As a result of changes in the categories, it is difficult to show long time series for some the areas.

R&D expenditure at Norwegian universities (including university hospitals) and colleges totalled 14.3 billion NOK in 2011, see Table 2.2. There has been a nominal increase in R&D expenditure of 7 per cent from 2009 to 2011. Adjusted for wage and price inflation, this resulted in an annual real decrease of nearly 1 per cent in two-year-period and about zero growth from 2010 to 2011. The real decrease was primarily due to reduced investment in land and buildings. Several major construction projects in the sector were completed in 2011. If we look only at the current expenses, there was a real growth of about 3 per cent in the two-year-period.

The main figures for the higher education sector are prepared annually. The units at universities and colleges receive questionnaires only every second year, while the university hospitals are mapped annually. In line with international guidelines for R&D statistics the university hospitals are included in the higher education sector, see section 2.1. Initially in this chapter, we show the results for the entire sector including the university hospitals, while later in the review of this sector we only include the universities and colleges. The university hospitals, which in 2011 had R&D expenditure of nearly 2.3 billion NOK and accounted for 17 per cent of R&D expenditure in the higher education sector, is described in section 2.4.

In the decade from 2001 to 2011, R&D expenditure in the higher education sector has had a significant real growth, far higher than the institute sector and in particular higher than the R&D expenditure in the industrial sector. As a share of total R&D expenditure in Norway the higher education sector has increased from 26 per cent in 2001 to 32 per cent in 2011. The largest growth has been for wages related to R&D, as shown in Figure 2.6. The R&D expenses related to land and buildings varies quite a lot from one year to another, which was particularly visible in 2011.

Figure 2.6
Total R&D expenditure in the higher education sector by type of cost: 2001–2011. Fixed 2010-prices.



Source: NIFU, R&D statistics

Table 2.2
Total R&D expenditure in the higher education sector by group of institution and type of cost. Mill. NOK: 2009 and 2011. Current prices and growth in fixed 2010-prices.

	2009			2011			Average real growth per year. 2009–2011 (%)		
Type of institution	Total	Current expenditure	Capital expenditure	Total	Current expenditure	Capital expenditurs	Total	Current expenditure	Capital expenditure
Universities and university colleges	11 324	10 096	1 228	11 989	11 120	869	-0,9	1,0	-18,1
University hospitals	2 096	1 991	105	2 270	2 267	3	0,2	2,7	-83,3
Total	**13 420**	**12 087**	**1 333**	**14 259**	**13 387**	**872**	**-0,7**	**1,3**	**-21,3**

Source: NIFU, R&D statistics

R&D expenditure and categories of cost

Current expenditure on R&D include:

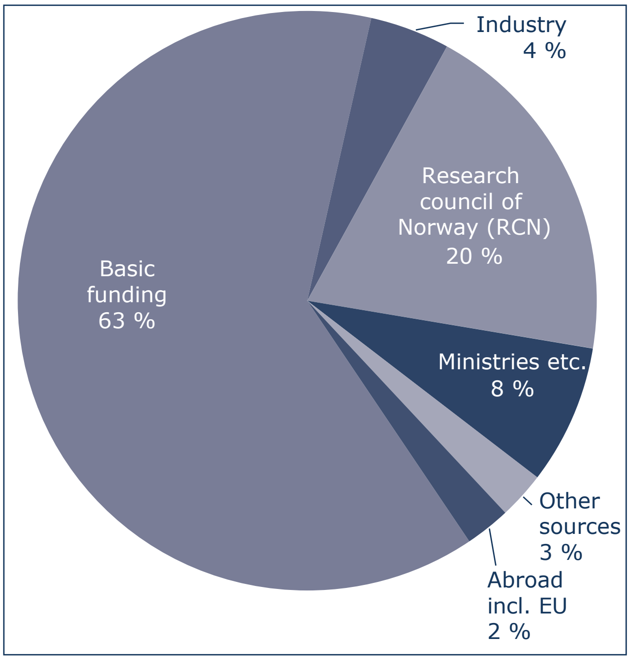
- Wages and social costs (pensions etc.).
- Other expenses which includes rent, electricity, cleaning, technical/administrative support and direct research operations, e.g. conference travel, journal subscriptions and minor investment in infrastructure, for example laboratory equipment.
  The share of R&D expenditure via GUF is based on time-use surveys, for expenditure funded by external sources the R&D share is provided by the different units (questionnaire).

Capital expenditure for R&D includes:

- Expenditure for investments in scientific equipment.
- Expenditure for new buildings and construction.
  The share of R&D is estimated based upon the purpose of the equipment or building.

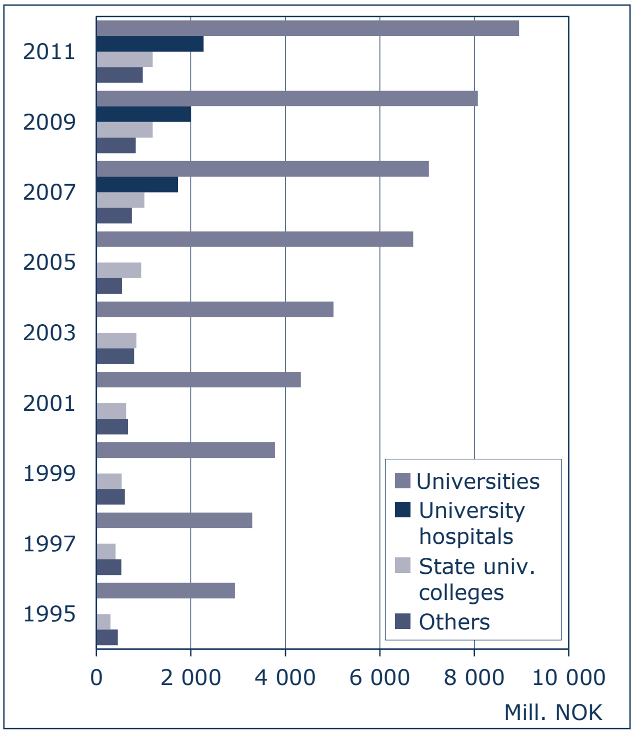
2.2.1 R&D expenditure – distribution and funding

Figure 2.7
Total R&D expenditure at universities and colleges by source of funding, 2011.



Source: NIFU, R&D statistics

Figure 2.8
Current expenditure on R&D in the higher education sector by institution type: 1995–2011.



Source: NIFU, R&D statistics

Just over a third of R&D funding in the higher education sector, excluding university hospitals, came from sources other than general university funds (GUF) in 2011, see Figure 2.7. The Research Council contributed 2.2 billion NOK, or almost one-fifth of R&D funding in the higher education institutions. Just less than 1 billion NOK came from other public sources, where project funding from ministries and agencies and funding from local and regional public authorities have been the main contributors.

Zero growth in external funds from 2009 to 2011

Current expenditure on R&D funded by GUF had a real increase of 3 per cent from 2009 to 2011, while external funding at the same time showed a weaker development with about zero growth. Funding from the Research Council, funding from other sources (private donations and funds, own income) and funding from abroad, which includes funding from the European Commission, all experienced a real decrease in the two-year-period. Funding of R&D at universities and colleges from the industrial sector saw, however, a small real growth. The largest increase was in public funding other than GUF and the Research Council. This funding had a real growth of over 15 per cent from 2009 to 2011.

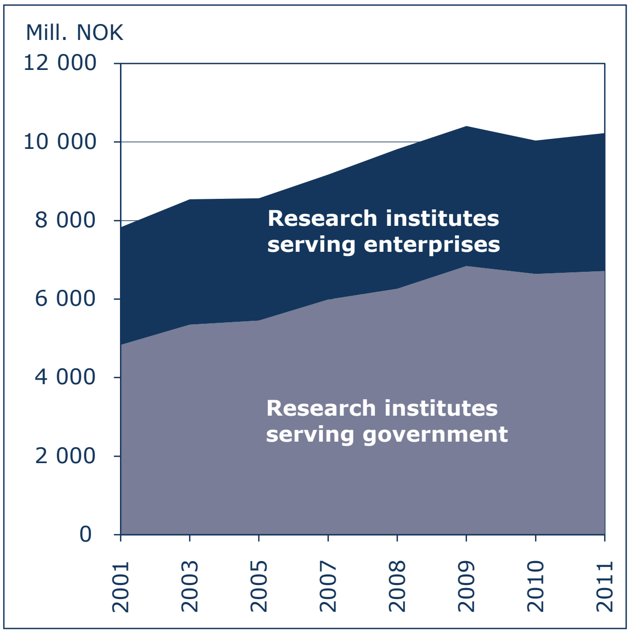
Changes in the institutional landscape

The relationship between the higher education sector's institution types has changed over time, see Figure 2.8. There are both methodological and actual changes that underlie these figures. From 2007 the R&D expenditure at the university hospitals have been investigated in a different way from before, as part of the health trusts' resource measurement system, see section 2.4. Today, the university hospitals constitute about 17 per cent of the higher education sector's R&D expenditure. It is difficult to identify the precise allocation of research funds in cooperative clinical research between universities and university hospitals: for statistical purposes funds are normally linked to the majority partner.

In 1995 the district schools converted into so-called state university colleges. For the state university colleges the R&D expenditure in 2011 was 1.2 billion NOK, nearly 9 per cent of the total R&D expenditure in the sector. In 2009 this share amounted to 10 per cent as it did in 2007. The decrease is not great considering the delayering as a result of the academic drift in the sector.

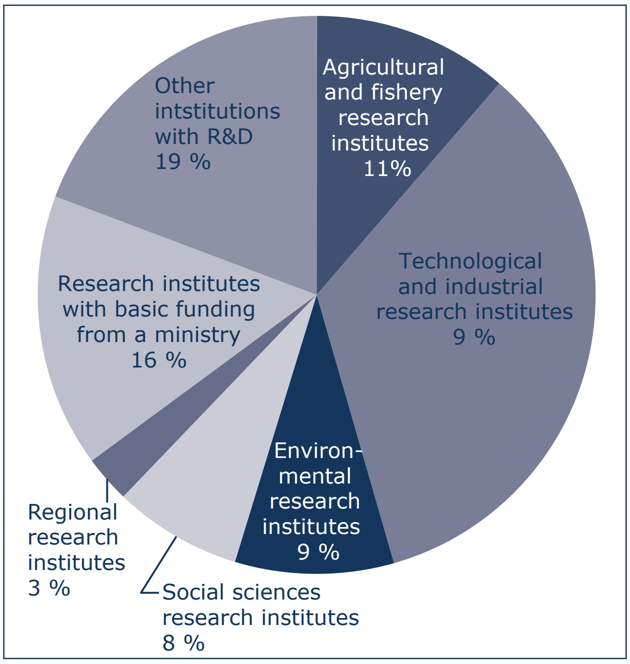
The universities' share of the sector's R&D expenditure in the period has declined marginally, from just above to just below 70 per cent. The R&D expenditure in the group of others institutions has varied somewhat and amounted to nearly 8 per cent in 2011.

Figure 2.9
R&D expenditure in the institute sector by type of institute: 2001–2011. Fixed 2010-prices.



Source: NIFU, R&D statistics

Figure 2.10
R&D expenditure in the institute sector by institute group: 2011.



Source: NIFU, R&D statistics

In 2011, R&D expenditure in the institute sector amounted to 11.1 billion NOK. The total R&D expenditure in Norway that year was 45.5 billion NOK. Hospitals without university functions accounted for about 0.5 billion NOK of the institute sectors' R&D expenditure in 2011. R&D within health trusts are discussed in section 2.4, and so the health trusts are excluded from the further description of the institute sector.

In the late 1970s, the three performing research sectors, the higher education sector, the industrial sector and the institute sector, were roughly equal in terms of R&D expenditure. Today the institute sector is the smallest. Both the higher education sector, and especially the industrial sector, have had a significantly larger increase in R&D resources, evaluating the period as a whole.

Since the turn of the millennium, R&D expenditure in the institute sector has had an annual real growth of just below three per cent. The increase has been somewhat higher in institutes that primarily serve the government or governmental bodies than for the institutes that particularly cover the R&D needs of businesses in the industrial sector. Some of the growth, particularly for the institutes serving governmental bodies, can be attributed to organizational changes that have resulted in change of sectoral belonging for some units in the R&D statistics.

The institute sector in the R&D statistics

Research groups in the institute sector are similar in that they do not pay dividends, and organizationally they are not directly under a higher education institution. Beyond that, the institute sector comprises a heterogeneous group of institutions.

The sector includes institutions that have R&D as a core activity; units that have a primary purpose other than R&D, but where R&D activity can still be significant; and institutions where research represents only a small part of the overall business.

The institutes serve a wide range of clients, which contributes to considerable variation in their disciplinary and thematic orientation.

The units that have research as their primary activity can be divided into two groups:

1) Institutes that are covered by the current guidelines for state funding of research, which was introduced in 2009. The scheme, which is partly performance-based, includes institutes that receive basic funding channelled through the Research Council of Norway. In 2011, this group included 51 legal entities.

2) Institutes that receive basic state grant directly from a sector ministry. In 2011, there were 6 such institutes.

The remainder include other institutions with R&D, and many museums, most with little R&D. Without the museums, the sector comprises almost 100 units.

2.3.1 The distribution and funding of R&D expenditure

High concentration of R&D the institute sector

As outlined above several large research institutes are included in the institute sector. The overall picture of the sector is however that the size of research units varies widely. Although the sector consists of about 100 units, a large part of the R&D activity is concentrated in the largest research institutes. In 2011, a total of nine institutes had R&D expenditure of over 300 million NOK, which accounted for half of the sector's total R&D resources. If the 15 institutes which had R&D expenditure of between 100 and 300 million NOK are also included, three-quarters of the sector's R&D resources are accounted for.

Among the smallest research units there are 12 institutes, where R&D expenditure amounted to less than 10 million NOK. Their R&D expenditure adds up to well below 1 per cent of the sector's total R&D.

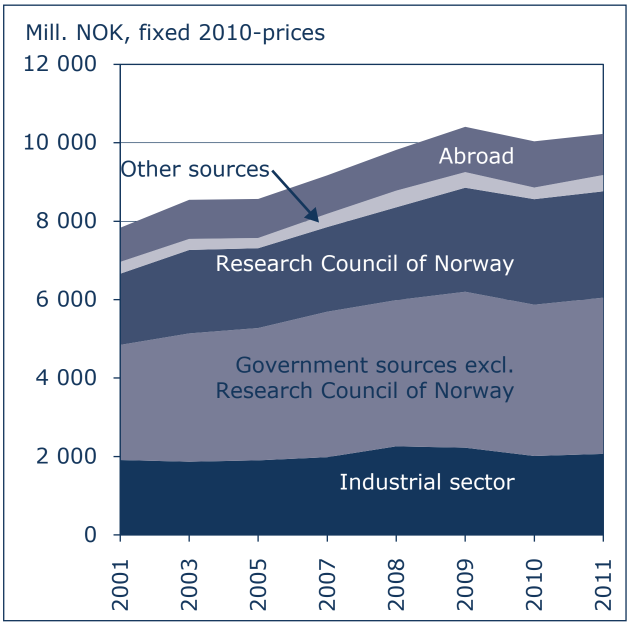
Who funds the R&D expenditure?

Funding of the institute sector is more complex than for other R&D performing sectors. The sector serves both the public and private sectors at home and abroad. The main picture shows that the relative distribution of funding sources have been quite stable since 2001. Going even further back, one will find that in particular funding from abroad has increased. Relatively speaking funding from abroad is twice as high today than at the beginning of the 1990s.

In 2011, two-thirds of the R&D expenditure was financed by national government sources, while the industrial sector accounted for one-fifth. Financing from abroad, which in 2011 also declined for the first time in many years, accounted for one-tenth.

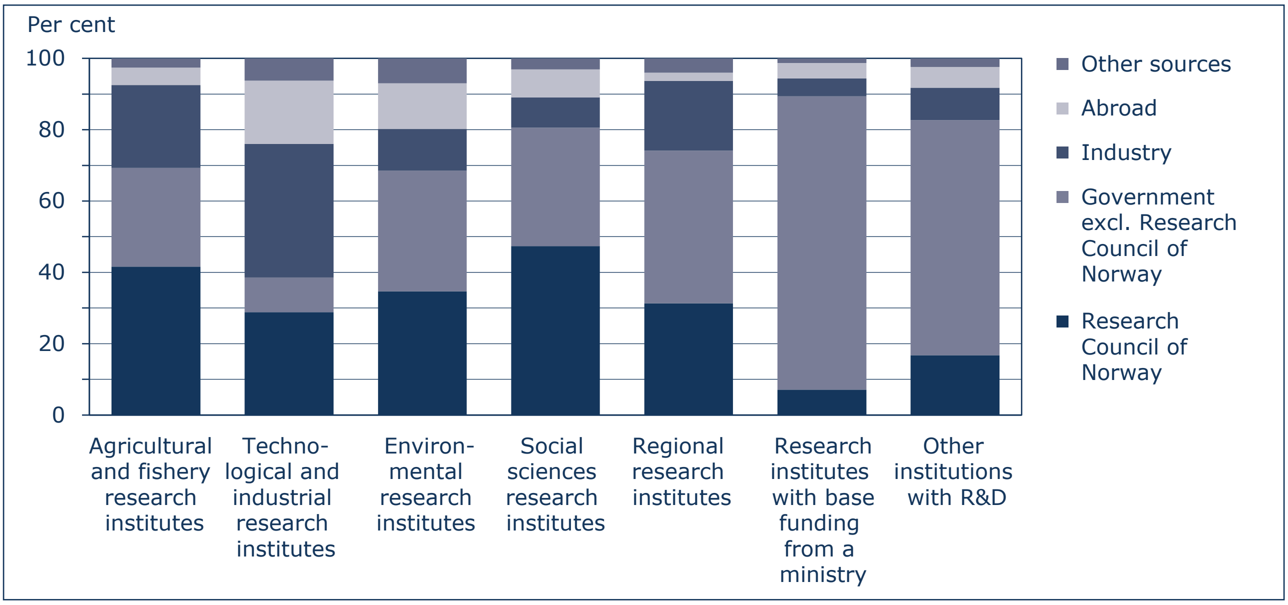
Nevertheless there are still major differences, both between the individual institutes and the arenas of distribution, in how the R&D activities are funded. The technical industrial institute group stands out with the highest funding from industry and abroad. For these institutes public funding amounted to under two-fifths, while public funding amounted to more than two-thirds for the primary- and environmental institutes.

Figure 2.11
R&D expenditure in the institute sector by source of funds: 2001–2011. Fixed prices.



Source: NIFU, R&D statistics

Figure 2.12
R&D expenditure in the institute sector[1] by source of funds and type of institution, 2011.



[1] Excl. health trusts.
Source: NIFU, R&D statistics

Health trusts: 6 per cent of the R&D expenditure

Total R&D expenditure in Norwegian health trusts and private, non-profit hospitals amounted to nearly 2.8 billion NOK in 2011, about 6 per cent of the total R&D expenditure in Norway this year. Thus, this share was about half a percentage point higher than for the previous year.

The R&D expenditure had an increase of 437 million NOK or 19 per cent from 2010. Changes in the reporting procedures for one of the largest health trusts are one contributing explanation for this. The figures from 2010 and 2011 are therefore not directly comparable.[1]

The South-East health trust is the largest

Norway is divided into four health regions: the Northern health region, the Mid-Norway health region, the Western health region and South-East health region. The largest of them is the South-East health region, where the total current R&D expenditure amounted to nearly 1.8 billion NOK in 2011. This accounted for almost two-thirds of the specialist health service overall expenditure on R&D. This is mainly due to Oslo University Hospital (OUS) which is a significant R&D actor regionally as well as within the specialist health service. Also, looking at the national level, OUS is among the largest R&D actors. Looking at the R&D expenditure in the specialist health service alone OUS accounted about half.

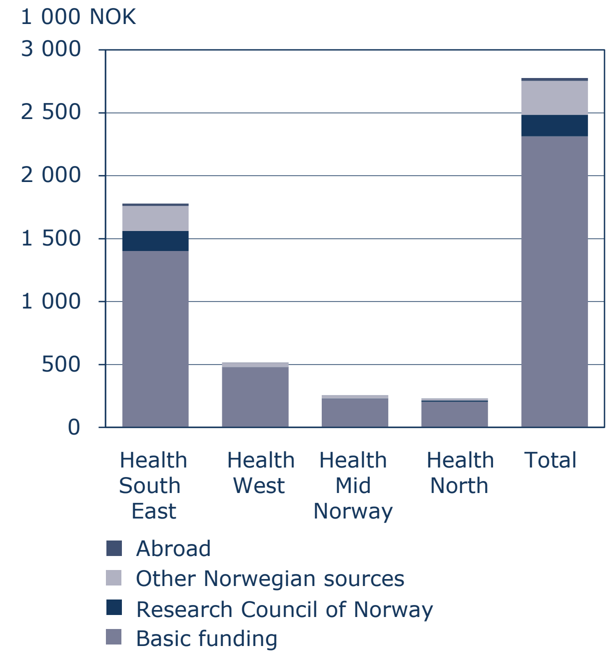
Second largest is the Western health region. With just over 0.5 billion NOK this region accounted for less than one-fifth of the resources devoted to R&D. The Northern health region and the Mid-Norway health region accounted for respectively 8 and 9 per cent.

University hospitals spent 2.3 billion NOK on R&D

Usually we distinguish between the university hospitals on the one hand and other health trusts and private, non-profit hospitals on the other. Comparing the resources of all specialist health service tasks, the two groups are roughly equal in size. However, for the R&D area the university hospitals accounted for nearly 2.3 billion NOK or 82 per cent of the specialist health services overall efforts in 2011. Other health trusts and private, nonprofit hospitals accounted for just over 0.5 billion NOK in R&D expenditure.

[1] If technical conditions and an estimated inflation of about 3 per cent are taken into account, the real growth in R&D expenditure is around 7 per cent.

Figure 2.13
R&D expenditure in the health trusts by health region and source of funding, 2011.



Source: NIFU, R&D statistics

The ministry of health is main funding source

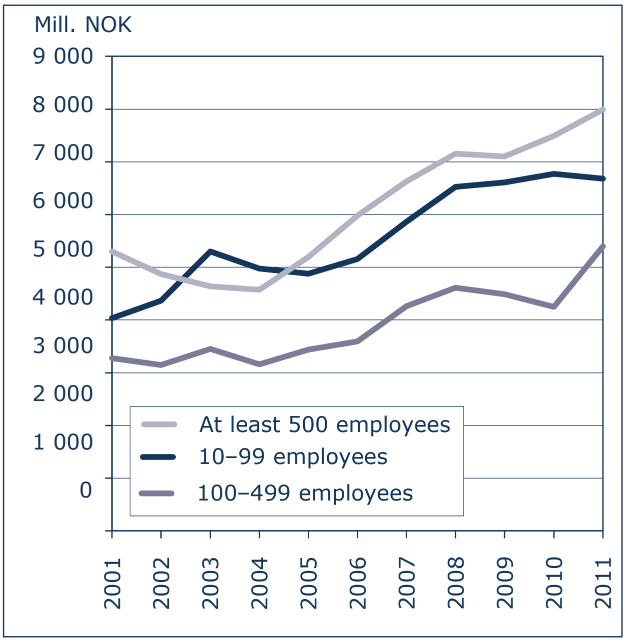
The R&D activity is mainly financed from the Ministry of health and care services' budget. Most of this is channeled as basic funding via the regional health trusts, or as earmarked, or other research funding that is allocated through the regional health trusts or regional cooperation bodies.

Those last mentioned allocations are awarded based on applications or granted as strategic assets for special measures, such as infrastructure. A total of over 2.3 billion NOK was distributed through these mechanisms in 2011, which on average accounted for 83 per cent of the total R&D expenditure in health trusts and private, nonprofit hospitals. The share of basic funding varies however, from less than 80 per cent in the South-East health region to 90 per cent in the Western health region. The external funding is consequently larger in the South-East health region.

On average, externally funded R&D amounted to 17 per cent, or 464 million NOK in 2011. The single, most significant source among these was the Research Council of Norway which contributed just over 170 million NOK. Funding from other domestic sources, i.e. ministries, government agencies, medical foundations and private organizations (e.g. the Norwegian Cancer Society and The Norwegian Heart and Lung Patient Organization) amounted to 270 million NOK or 10 per cent of the total funding. Registered funding from abroad is marginal in the health trusts.

2.5.1 The industrial sectors' expenditure on intramural R&D

Figure 2.14
Intramural R&D expenditures in the industrial sector by enterprise size: 2001–2011.



Source: Statistics Norway, R&D statistics

For the industrial sector, R&D expenditure amounted to 20.1 billion NOK in 2011. This represented an increase of 1.5 billion NOK, or 8 per cent, compared with the previous year. Measured in fixed prices, the increase was 4 per cent. After a couple of years of stagnation, the industrial sector again experienced real growth in R&D expenditure.

The largest growth for the larger enterprises

Large enterprises accounted for most of the increase in R&D expenditures in 2011, see Figure 2.14. In current prices there was an increase of 27 per cent in the group of enterprises with 100–499 employees. There was also growth for the group of enterprises with at least 500 employees in 2011, but this was a minor increase. Enterprises with 10–99 employees experienced a decline of 1 per cent in 2011, after two years of a weak growth. Enterprises with at least 500 employees did also have an increase in 2010, while enterprises with 100–499 employees had a decline in both 2009 and 2010.

As for the last five years the enterprises with at least 500 employees accounted for 40 per cent of the R&D expenditure in 2011.

Growth in both the manufacturing industries and service industries

Both the manufacturing and service industries had a significant growth in R&D expenditure from 2010 to 2011. The percentage growth is 10–11 per cent in both the main industries. In the manufacturing industries, it is particularly *pharmaceuticals*, *metal products*, *computer and electronic industry* and *hardware industries* that contribute to this growth. Within the service industries it is the *computer programming* and *finance and insurance industries* which experiences the strongest growth.

Just above half of the R&D in the industrial sector in 2011 was carried out within the service industries, while the manufacturing industries accounted for 39 per cent. It has for many years been a tendency that more and more of R&D in the industrial sector is performed within the service industries. There are several service industries that have had significant growth in R&D investment over the past five years. The largest growth has been for *architects and technical consultants*, with an increase of 930 million NOK from 2007 to 2011. R&D activity in this industry is mainly within *technical consultancy, technical testing and analysis*.

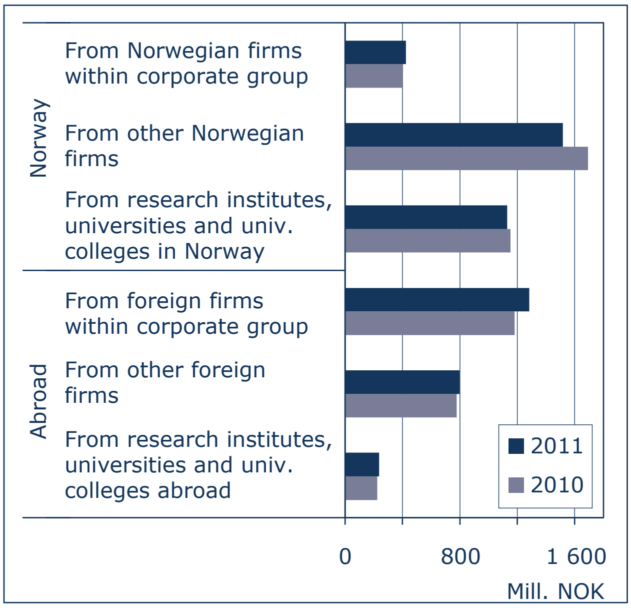
Extraction of Oil and natural gas has had weak development in recent years, and from 2010 to 2011 R&D expenditure declined by 7 per cent. Since 2007, the R&D expenditure has remained at 1.2–1.3 billion NOK. *Fishing, catch and aquaculture* (fish farming) did also experience a decline in 2011.

The industrial sector in R&D statistics

The industrial sector includes enterprises which are aimed at financial gain. In 2011, the survey covered enterprises with more than 10 employees. In even-numbered years enterprises with 5–9 employees are also covered. The following industries are covered by the survey: manufacturing, services and other industries (extraction of oil and gas, mining, fishing, catch and aquaculture, power supply, water, sewage and sanitation, and building and construction activities).

Standard Industrial Classification (SN2007) is used to classify the enterprises in the various industries. The survey is sent out to enterprises, which are also the legal entities. The enterprises can be divided into several businesses by activity in different industries/different locations. The businesses are used to group activities by industry and region, while the enterprises are used to group them by size.

Figure 2.15
The industrial sectors' purchase of R&D services by performing unit, 2010 and 2011.



Source: Statistics Norway, R&D statistics

No growth in the purchase of R&D services

Norwegian enterprises purchased R&D services from others for 5.4 billion NOK in addition to the intramural R&D activities in 2011. In 2008 the manufacturing and service industries purchased R&D services for approximately the same amount. But this relationship of strength has changed. Almost all manufacturing industries have had a decline in, or unchanged expenditure for, purchased R&D in 2011. Together the manufacturing industries purchased R&D services for 1.3 billion NOK in 2011, 12 per cent less than in 2010. The service industries purchased R&D for 2.1 billion NOK, which represents an increase of 11 per cent. Several service industries have experienced growth, especially *software publishing* and *architectural and engineering activities* (consulting). *Extraction of crude petroleum and natural gas* accounted for 30 per cent of all purchases of R&D services in the industrial sector. This industry purchased for 1.6 billion NOK, a decrease of 3 per cent from 2010.

Foreign providers of R&D service are important

R&D service providers from abroad are almost as important as Norwegian providers of R&D services for Norwegian enterprises. 43 per cent of purchased R&D in 2011 came from abroad, 6 per cent more than the year before. Just above half of these services comes from units within their own enterprise group. But R&D is also purchased from other foreign enterprises or research institutes and universities. From other Norwegian enterprises R&D was purchased for 1.5 billion NOK, which is 10 per cent less than in 2010. From research institutes, universities and colleges in Norway R&D was purchased for 1.1 billion NOK and accounted for 21 per cent of total purchases. 8 per cent of the R&D services came from Norwegian units in their own enterprise group.

Increased use of temporary personnel

Enterprises are mainly using their own personnel in R&D activities. Wages accounted for 63 per cent of the R&D expenditure or 12.6 billion NOK. This is 5 per cent more than in 2010 and corresponded with the development of full-time equivalents (FTE). Other current expenditure, which is the second largest expenditure item, amounted to 4.2 billion NOK.

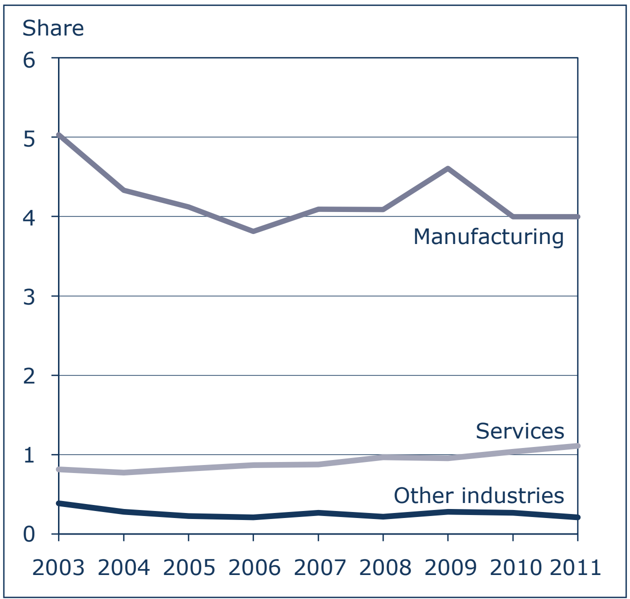
Contract personnel are external consultants who participate in the R&D activity of an enterprise. The use of temporary R&D personnel is slightly more common within the service industry than for the manufacturing industries. For the service industries the costs of temporary personnel accounted for 1.2 billion NOK, or 11 per cent of the total R&D expenditure, while the corresponding share in the manufacturing industry was 5 per cent. Especially in the service industry, there has been an increase in temporary personnel in recent years. *Computer programming* and *finance and insurance* stand out with particularly high use of temporary personnel. In *finance and insurance* the costs of temporary personnel accounted for almost a third of total R&D expenditure in 2011.

Enterprises with a lot of R&D activities use temporary personnel to a much greater extent than enterprises with less R&D activity, and also the use of temporary personnel is more prevalent in larger enterprises. 28 per cent of enterprises with 10–19 employees with R&D activity reported expenditure on temporary personnel. Among companies with at least 500 employees the corresponding share was 41 per cent.

Purchased R&D
Parts of the R&D in the industrial sector take place through the use of external resources. Partly through purchase of R&D services from other enterprises, research institutes, universities and colleges. Partly through enterprises hiring specialist expertise which performs R&D in the enterprise. This is reported as intramural R&D, while purchased R&D is a separate category which is reported in addition to the intramural R&D activity. It can be difficult to distinguish, and this can cause variations in how such expenditure is reported.

2.5.3 R&D intensity in the industrial sector

Figure 2.16
Intramural R&D in the industrial sector as a share of GDP by main industries: 2003–2011.



Source: Statistics Norway, R&D statistics

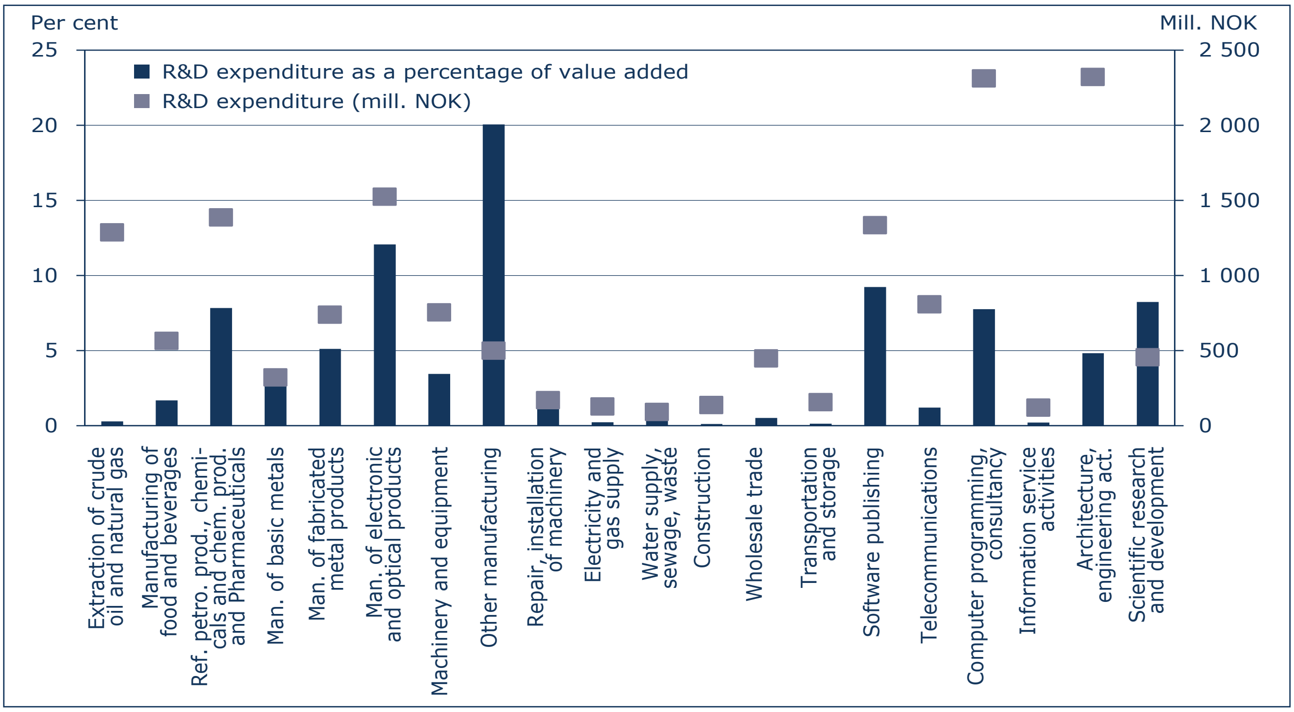
R&D intensity can be measured as the R&D expenditure's share of value added in the industrial sector. In Norway most R&D intensive industries are small, while the less R&D intensive industries are large.

Figure 2.16 shows that R&D intensity is relatively stable over time for the different main industries. In *Other industries* extraction of oil and gas has a very low intensity due to the very high gross product. Also the services industries have a relatively low R&D intensity, although these industries have a higher R&D expenditure than the manufacturing industries.

Manufacturing stands out with a significantly higher R&D intensity than the other two main industries, but also because of the way economic conditions affect the intensity of manufacturing industry. During the financial crisis intensity increased. This is due to higher R&D expenditure in 2009 than in the previous years as well as well as a lower gross product in the internationally active part of the industry. In 2010, R&D investment somewhat declined for the industry, which indicates that R&D expenditure adapts to the production level in retrospect (lagged expenditure).

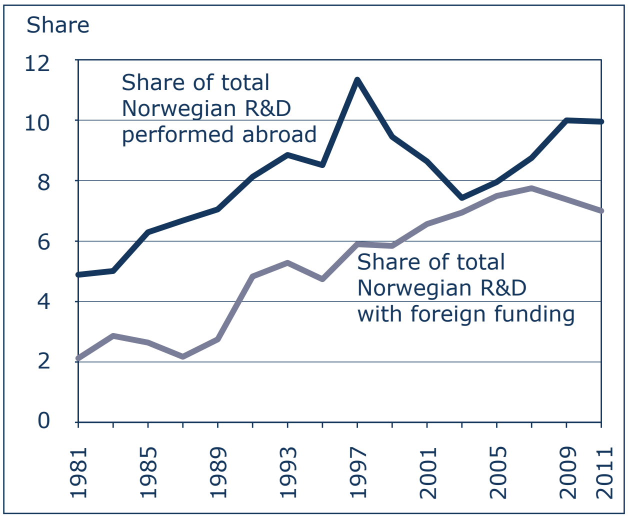
If we go to a more detailed industry level, Figure 2.17 show that the highest rates of R&D intensity within the industrial sector are to be found for *transport equipment* (motor and transport industries except the construction of ships and boats), and *computer and electronic industries*. The former is an example of an industry with few enterprises, a low value added, and with relatively high R&D expenditure. *Computer and electronic industries* has high R&D expenditure, yet high R&D intensity. The same applies to service industries like software *publishing*. *Computer programming* and *architectural and engineering activities* are service industries which have much higher R&D intensity than services in general, while at the same time being large industries, with many enterprises, high value added and high R&D expenditure.

Figure 2.17
R&D intensity in the industrial sector by industry, 2011.



Source: Statistics Norway, R&D statistics

Figure 2.18
Norway's total R&D expenditure[1] funded by and carried out abroad: 1981–2011.



[1] Total R&D expenses including R&D purchased abroad.
Source: NIFU/Statistics Norway, R&D statistics

An increasing part of research and development involves international collaboration. This is reflected in increased mobility, more project collaboration, more co-authorship and increased levels of research funding across borders. The latter implies that the Norwegian authorities and enterprises are funding R&D which is not carried out on Norwegian soil. On the other hand, a considerable part of the research conducted in Norway is funded by foreign sources. These financial flows in and out of Norway, is illustrated with an «R&D-balance of trade» as in Figure 2.18.

Increase in research funding across borders

Over time, international research funding has grown in significance, both in and out of Norway. In the early 1980s foreign sources accounted for only about 2 per cent of R&D in Norway. Today, this share is well over 7 per cent, or roughly 3.5 billion NOK. Meanwhile, an increasing share of Norwegian R&D funding goes to research performed outside Norway. This share has doubled, from about 5 per cent in the early 1980s to over 10 per cent in 2011. In total, about 5 billion NOK funded R&D outside Norway in 2011.

Norwegian-funded R&D performed in other countries involves both the industrial sector's purchase of R&D services as well as public funding of various types of international research collaboration. The purchase of foreign R&D amounts to almost half of all external purchase of R&D from Norwegian enterprises. Thus, measured in NOK, foreign providers are about as important for R&D in the Norwegian industrial sector as the national providers of research.

Various estimates of the total R&D

There are three ways to calculate a country's total R&D: the most common is Gross domestic expenditure on R&D (GERD). It measures the country's total R&D expenditure funded by various national and international sources (45 billion NOK for Norway in 2011). In addition R&D financed by the country, but performed abroad can be included (5 billion NOK). This includes the industrial sectors' purchases of R&D and the public payment of fees for participation in international research programmes/organizations. The latter is the denominator in Figure 2.18 (50 billion NOK). A third way is Gross national expenditure on R&D (GNERD). This method measures R&D funded by national sources. It includes total R&D expenditure minus foreign funding, but plus Norwegian funding of R&D abroad (47 billion NOK).

Public funding of R&D abroad consists mainly of contingents to the EU framework programmes, CERN, EMBL and other international organizations and collaboration arenas. Parts of these contingents will however return to Norway as funding from abroad when Norwegian researchers are successful in the competition for these funds. The EU's framework programmes for research and technological development constitute the largest competitive arena in this respect. In Chapter 3 we give a discussion of the Norwegian researchers' ability to succeed in the competition for funding from the Framework Programme.

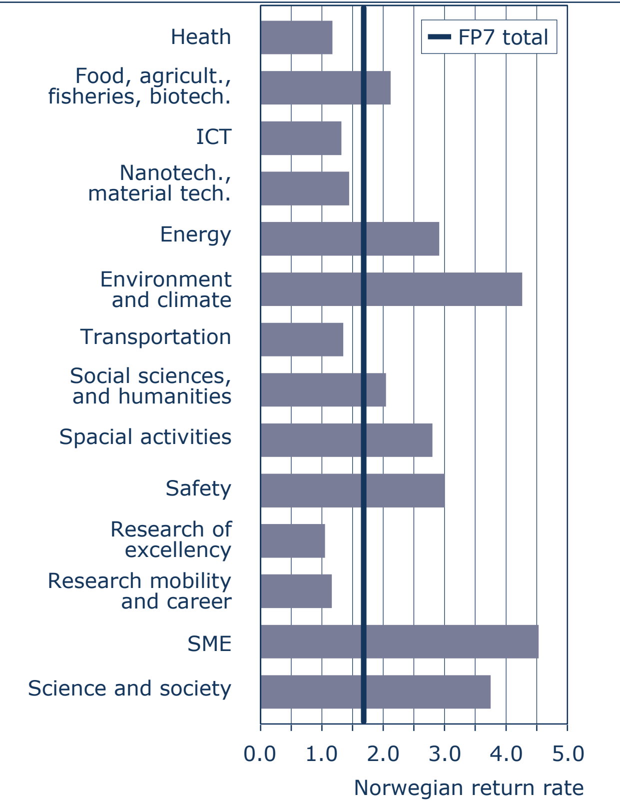
More R&D funds abroad than to Norway

If we consider international funding as some kind of «R&D-trade», the figure shows that in general more research travels out of Norway than what Norway acquires through different sources from abroad. In the middle of the 2000s there was an exception from this, where the «R&D trade» was roughly in balance.

Although the flow of funding in and out of the country is significant, it does not provide an adequate picture of the internationalization of Norwegian research. Much of the R&D carried out on Norwegian ground, has an international dimension which is not captured by the statistics. For example, a significant share of the project portfolio of the Norwegian Research Council is related to internationalization, but only 0.2 per cent of its funds are actually recorded as R&D performed abroad. It may, however be in Norway's interest that some of the R&D is carried out in countries where expertise, equipment, infrastructure or other factors provide better results from the funds than would have been possible in Norway.

2.6.2 Norwegian benefits from the EU framework programmes

Figure 2.19
Norwegian financial returns[1] in EU FP7 by programme.



[1] Norwegian financial return is calculated as awarded EU funding to Norwegian actors as a percentage of total available EU funding (budget).

Source: E-Corda (The Commission)

What is Norway getting in return for their participation in FP7?

We find the highest percentages of Norwegian returns from participation in the EU's Seventh Framework Programme for Research and Technological Development (FP7), in the programme for small and medium enterprises (SME), closely followed by the environmental and climate programme *Environment*. The Norwegian interest in the SME programme has been positive throughout FP7, and many Norwegian enterprises are coordinators. Many of these coordinators get assistance from other Norwegian research actors.

The size of the financial support varies significantly between the sub-programmes. In addition to the volume of the participation, the return rate also depends on where the researchers are involved and should therefore be seen in a larger context. The framework conditions such as the organization of research and the funding systems, industrial structures as well as political, cultural and geographical conditions, vary from country to country. In the SME and Environment programmes, where Norway has achieved the highest return ratios, each participation triggers a relatively low amount of support. This means that Norway obtains less support from the EU than, say, Sweden and Denmark. Less support from the EU is also due to our relatively low participation in ERC (excellence in research) where the support per participation is high.

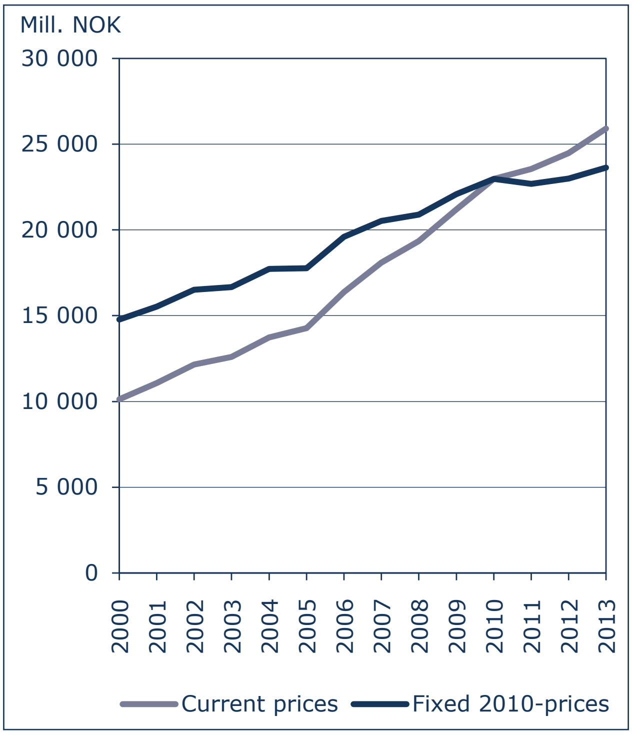
However, it is well known that we obtain more in return from our participation in the framework programme than is obtained from the direct return in the form of project funding. Access to valuable networks, research infrastructure, increased contract research, new business associations and new markets etc. are of great importance in this respect. The same applies to the added value of Norway's participation in nearly 40 technology platforms, which is a direct result of the activity within FP7. In addition to the deductible contributions made by Norwegian project participants, they will get the benefit of other countries' contributions. As most projects involve many stakeholders, this benefit will be worth many times the deductible sums financed by Norway.

Norway has also received funding through calls for proposals in the peripheral activities of FP7. So far, 19 billion NOK was made available, and almost 550 million NOK has so far been allocated to Norway (excluding the ERA-NET, but including participation in COST). Nearly half of those funds are received through the GMES Space Component programme. It is, however within the activities of SESAR JU, Fuel Cells and Hydrogen (FCH) and Eurostars where Norway has obtained most FP7 funding so far. The periphery activities do however have a very different organization and financing, and some of them require a budget proposition. The return from these activities is therefore dependent on what national assets Norway has put at their disposal.

Norwegian EU membership fees

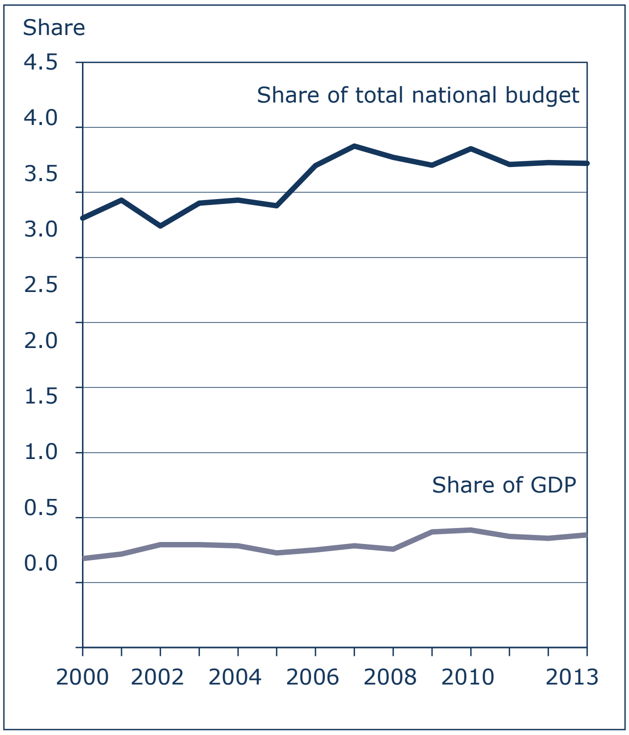
EEA countries' fees to the framework programme is calculated by a share of GDP, and the Norwegian contingent changes in line with changes in EFTA's GDP compared with the EU countries' GDP. The total Norwegian contingent for the FP7 is now estimated to be about 10 billion NOK, based on an average Norwegian share of the annual FP7 payments of around 2.5 per cent in the period 2007–2018. This is a significantly higher estimate than previously assumed. The Norwegian financial return in FP7 is now at 1.7 per cent. The total of available EU funding of all projects is at about 251 billion NOK, of which Norway is allocated 4.2 billion NOK.The return of contingent fees to Norwegian environments depends on how much is applied for from these groups, and the results finally achieved.

Figure 2.20
Estimated R&D allocations in the Norwegian state budget: 2000–2013. Current prices and fixed 2010-prices.



Source: NIFU

Figure 2.21
Government budget appropriations of outlays for R&D (GBAORD) as a share of national budget and share of GDP: 2000–2013.



Source: NIFU

Real growth in R&D allocations since 2000

R&D allocations in the state budget provide a good indication of the government's commitment to research and development. Since 2000 there has been a significant real increase in the allocations. The overall real growth for the period 2000 to 2013 has been close to 60 per cent. This gives an average annual real growth of 3.7 per cent. But this is not unique to Norway. As shown in Chapter 1, many countries have experienced a steady and strong growth in government R&D appropriations over the past decade. The strongest growth in Norway after 2000 took place from 2005 to 2009. During this period the average annual real growth was 5.7 per cent. This rapid growth is to a large degree due to higher reported figures for R&D in health trusts, as well as increased fees for international R&D cooperation.

Flattening after 2009

In recent years, the growth in R&D allocations to some degree leveled off. Average annual real growth in the period 2009 to 2013 has been approximately 1.7 per cent.

Appropriations for R&D in the approved budget for 2013 are estimated at 25.9 billion NOK. Compared with previous years, this represents an increase of 1.4 billion NOK, or a real growth of just below 3 per cent.

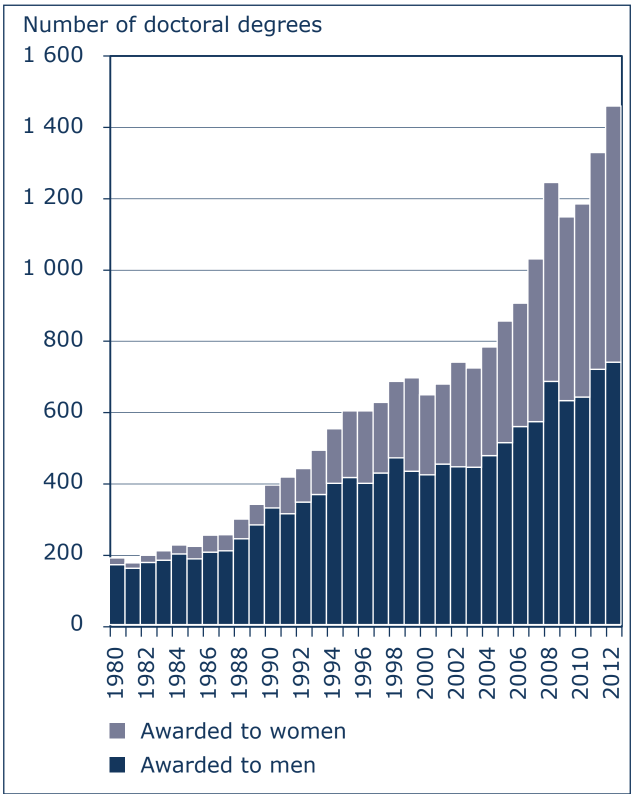
R&D allocations in the Norwegian economy

R&D funding as a percentage of gross domestic product (GDP) is intended to express the relationship between public commitment to R&D and society's overall added value. The indicator is, however, very sensitive to economic fluctuations. Changes in R&D funding as a share of GDP might in theory just as well be caused by some macroeconomic conditions as actual changes in the R&D investment.

The estimated R&D appropriations in the approved budget for 2013 amount to 0.87 per cent of the current estimate for GDP (Revised National Budget 2013). This gives a marginal increase from 2012 when the share was 0.84 per cent, but it is still lower than in 2010, which represents the peak year for this indicator with a share of 0.90 per cent. R&D funding, however, represents a higher share of GDP now than in the mid 2000s. In 2005, the R&D share of GDP was 0.73 per cent.

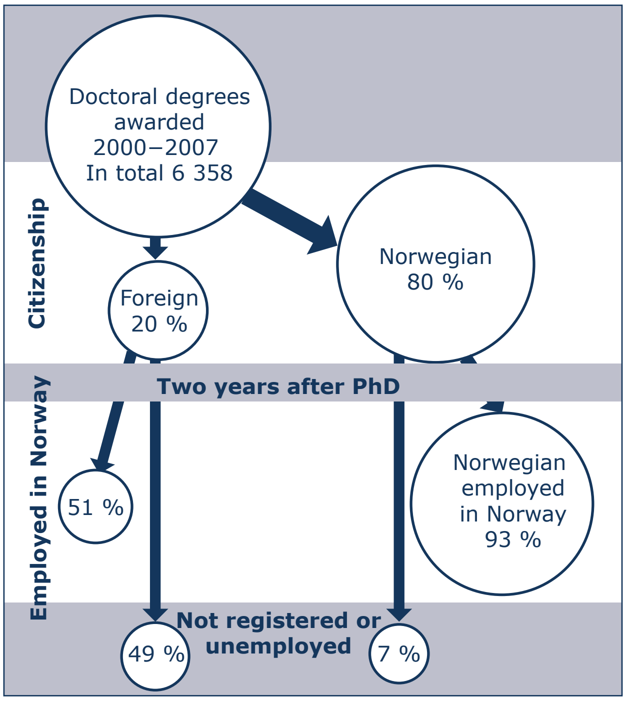
2.8.1 PhDs in Norway

Figure 2.22
Awarded doctoral degrees in Norway: 1980–2012.



Source: NIFU, Doctoral Degrees Registrer

Figure 2.23
The distribution of Norwegian and non-Norwegian citizenship among people who obtained their PhD in Norway 2000–2007 and their relation to Norwegian working life two years after the dissertation year.



Source: NIFU, Doctoral Degrees Register

Continued increase in the number of PhDs

By the end of 2012 around 23 000 doctoral degrees had been awarded at Norwegian universities and colleges. The number of degrees per year has skyrocketed in recent years. In the 2000s alone over 12 700 degrees were awarded, which accounts for 55 per cent of the all-time total number since the first degree was awarded in 1817.

In 2012 there were 1 461 doctoral degrees awarded in Norway, compared with 1 329 in 2011 and 1 185 in 2010. The production of doctorates in Norway is, despite the increase, somewhat lower than in the other Nordic countries, both in the number of degrees and the number of degrees per capita.

More women and foreigners

The proportion of women among the doctoral candidates has increased significantly over time. While women accounted for about 10 per cent of doctoral degrees around 1980, the share was almost 50 per cent in 2012. If we look only at doctoral students with Norwegian citizenship at the time of dissertation, women made up the majority (55 per cent).

Woman shares vary between the fields of science. In 2013, the share of female doctoral candidates in medicine and health sciences was 60 per cent, and over 50 per cent for both the humanities and social sciences. Within natural sciences 40 per cent were women, 20 per cent in engineering and technology.

A striking feature of the development is the increasing number of foreigners[2] among doctoral degree holders. The proportion of foreigners was less than 10 per cent at the beginning of the 1990s. In 2012, this share had increased to 35 per cent. A total of 507 of the 1 461 that defended their degree in 2012 were recorded with non-Norwegian citizenship.

The increase in the total number of doctoral degrees between 2008 and 2012 is primarily due to the foreigners. Among doctoral students with Norwegian citizenship there was only a small increase.

The share of foreigners was highest within engineering and technology – in the period 2010–2012 more than half of the doctoral candidates in this field of science were non-Norwegian citizens. Within natural sciences and agricultural sciences/veterinary medicine there were almost as many foreigners as Norwegian candidates. For the humanities, the social sciences and the medicine/health sciences the share of foreign candidates was about 20 per cent.

[2] Persons registered as non-Norwegian citizens at the time of the defence of the thesis.

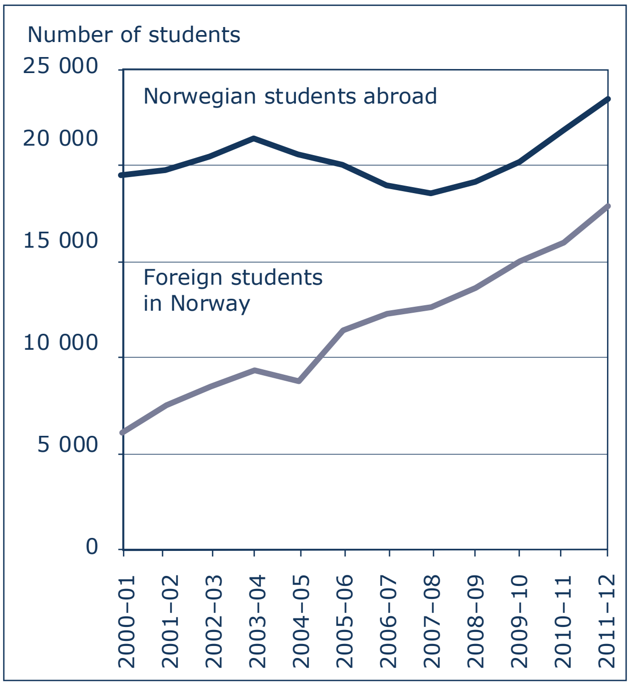
Norway has a great demand for highly skilled labour, and some of this challenge is solved by knowledge imports. Knowledge import happens in part, by Norwegians studying abroad, and then returning (with new knowledge) to Norway after graduation. But it will also happen when foreign students come to Norway and remain after graduation.

Traditionally there have been many Norwegian students abroad, but relatively few incoming students to Norway. This situation has changed significantly in recent years. There is still an increase in the number of Norwegians who leave, but the change is primarily due to a large increase in the number of foreigners studying in Norway.

However, the number of foreign students is higher than the number of incoming students: First, not all foreign citizens studying in Norway came here with the intention of studying, and second, some are children of immigrants who have retained their foreign citizenship.

Figure 2.24 display data on both those taking a full degree, and those on shorter stays. It is based on two data sources: the Norwegian state educational loan fund and Database for Statistics on Higher Education (DBH). This makes it difficult to compare the two lines. The figure illustrate the main trend, that the number of foreign students in Norway is approaching the number of Norwegian students abroad.

Figure 2.24
Norwegian students abroad and foreign students in Norway: 2000–2012.



Source: Database for Statistics on Higher Education (DBH) and Norwegian State Educational Loan Fund

Those who only take parts of a degree abroad choose different countries and subjects than those taking the full degree. Part-time students have English-speaking countries such as the USA, Australia and the UK at the top, but there are also many who choose Western European countries as well as non-Western countries like Tanzania and China (Norwegian state educational loan fund 2012). With regard to the fields of science most of the students are to be found within business studies, social sciences and technology, but there also many students within various health and social care subjects, and within teacher education.

High share of Norwegian students abroad

With the exception of Iceland, Norway has had the highest share of students studying abroad in Scandinavia. Approximately 6–7 per cent of the students are registered as taking a full degree abroad. In addition are those who take parts of their education abroad (part-time students). In the 2000s the part-time students abroad constituted another 3–4 per cent of the student population. In the academic year 2011–2012 there were 15 323 people registered as taking their full degree abroad, and 8 114 as part-time students (Norwegian state educational loan fund 2012). The high share of Norwegian students going abroad is related to internationalization policy and a generous financial support system, combined with the limited availability of certain courses in Norway.

The most popular countries among students doing their full degree abroad are currently Britain and Denmark, followed by Poland, the USA and Australia.

The most popular fields of science for those taking their full degree abroad in the 2000s, are the fields of medicine and business administration. Most medical students attend English language programmes in Eastern European countries.

More foreign students in Norway

Norway has traditionally had few incoming students, which, can be explained by lack of facilitation (language etc.). During the last decade, however, the number of foreign undergraduate and graduate students has nearly doubled and in 2012 this share amounted to 7.7 per cent of the student population at Norwegian institutions (SIU 2012). An important explanation is the emphasis on internationalization at Norwegian institutions, including a significant increase in the number of English language courses.

Most of those categorized as exchange students have come to Norway to study. These make up about one third of all foreign students (SIU, 2012).

FOCUS BOX NO. 4

Lucky SINTEF: The value of foreign researchers in a Norwegian knowledge organization

Over the past few years, SINTEF has developed into an international research group. This has happened through international cooperation, projects for foreign customers, establishing business outside Norway, but primarily by attracting foreign workers.

Of a workforce totalling about 2000, 20 per cent of the employees at SINTEF have a foreign background, distributed across 70 countries – for the research managers alone the corresponding figure is 17 per cent. There has been a steady increase in the share of foreign workers in recent years. In 2005 the share was 9 per cent from 47 foreign countries. Today most of the foreign researchers come from Germany and France, then Sweden and China. In recent years we have also received many from Iran, and otherwise from many countries in America, Asia and Africa. It is possible to see a tendency that we now receive more scientists from crisis-hit European countries like Spain and Italy.

A greater cultural diversity provides a more attractive place to work and make us more able to solve our social mission. SINTEF is dependent on diversity for realizing the main vision of «Technology for a better society». We need to attract people who have the right skills and solid professional knowledge, but they also need to have the commitment and the values that correspond to complex challenges. Moreover, international competencies are needed to succeed internationally. Research in our field is in fact an international exercise.

Table 1
Foreign employees at the research institute SINTEF per 1.1. 2013.

Nationality	Number of employees
Germany	47
France	44
Sweden	25
China	23
USA	14
Denmark	14
United Kingdom	13
Italy	10
Iran	9
Spain	9
Other (60 countries including Chile, Ethiopia, India, Kenya, Peru, Vietnam, Venezuela, Zimbabwe)	165
Total 70 countries	**373 (20 %)**

Source: SINTEF

But this has not been a linear process. When the first foreign researchers came, it was exotic and interesting. When more came, there was concern: Foreign languages, new customs and new needs. Our canteen food was not to their liking. Some Norwegian researchers feared that we had to change the corporate language. Fortunately we stopped seeing it as a new problem in time.

SINTEF's expertise is from the top shelf, academically, socially and culturally. Our international personnel have very high professional skills, often at the highest level. They often have backgrounds in international academia in different countries. This means that they also have a broad cultural understanding, international experience and relationships, often from several continents. Each one represents more than just a foreign country; they are globetrotters in the best sense of the word. Moreover, our international colleagues have solid expertise in areas that may not be typical Norwegian; they are polite, attentive and well-dressed. Here we have a lot to learn.

The fact that we have employees with different backgrounds and fresh eyes has given us the means to see our weaknesses, weaknesses that we have become accustomed to live with; but this was brought to a head when we were no longer just Norwegians. The main challenge here is clear leadership, especially being able to communicate clearly about expectations, requirements and feedback. Also Norwegian employees want a clearer management communication, but they are better equipped to interpret the landscape on their own. For foreign workers who do not know the codes, this can be very difficult. The fact that we have a large share of foreign workers has been a good driver in efforts to develop clear, inspiring and inclusive management.

Something of great importance: the new diversity has given us a necessary reminder of our best qualities and values that we perhaps are in danger of taking for granted: freedom, trust, and equality. These are the qualities we need to take care of. Our new foreign employees feel they are treated with respect and trust. Many have stated that this organizational culture gives them the freedom to work more efficiently than ever before. They can devote their time to exciting work and they do not have to spend time on concerns, bureaucracy and positioning. This is something they value extremely highly. The notion that the Norwegian democratic leadership style is not suitable for foreign workers has proved to be a myth. After the first big surprise, where our new personnel experience little distance between managers and employees, they quickly learn to appreciate our management culture. Rania Mohareb, (Egyptian scientist, female and Muslim) who conducted a study in organization at SINTEF summed it up this way:

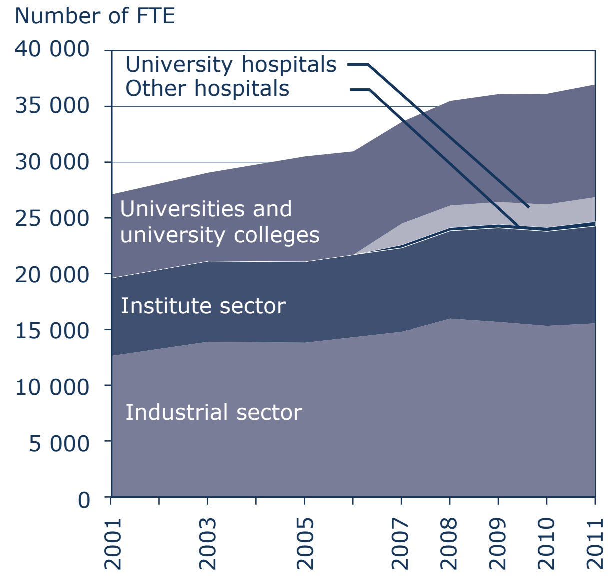
«When you have you been exposed to democratic leadership style it is hard to go back. It's basically human.»[1]

The competition for the best brains is hard. The best will go where they can find the best conditions for growth. SINTEF places great emphasis on getting new foreign employees to thrive and succeed. All foreign workers are greeted with a welcome pack which includes practical assistance, personal counselling, introduction to Norwegian conditions and lifestyles, and to social arenas. The package also includes partner/family. (With solid support from Expat MidNorway and Oslo Chamber of Commerce). Furthermore, all foreigners get a Welcome to SINTEF course, project management courses in English within the SINTEF School and free Norwegian lessons for themselves and their partners. For this work, SINTEF was awarded a prize concerning diversity in the workplace in 2012 (Mangfoldprisen).

[1] Rania Ahmed Mohareb; Organizational Culture Challenges in a Multinational Enterprise and the Role of Organization Learning. TØH 2009.

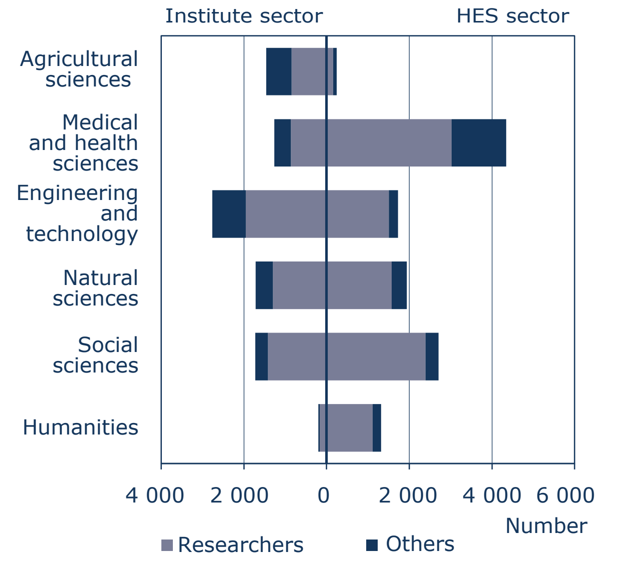
Ingeborg Lund, SINTEF

Figure 2.25
Total R&D FTEs performed in Norway by sector: 2001–2011.



Source: NIFU/Statistics Norway, R&D statistics

Figure 2.26
FTEs performed by field of science, category of personnel and performing sector, 2011.



Source: NIFU, R&D statistics

In Norway in 2011, overall almost 37 000 FTEs (Full time equivalents) were performed in R&D. The industrial sector accounted for 42 per cent of the FTEs, one-third was performed in the higher education sector and a quarter in the institute sector. Three-quarters of the FTEs were conducted by researchers.

The number of R&D FTEs increased steadily 2001–2008, then there was zero growth until 2010, followed by a small increase 2010–2011, see Figure 2.25. In the industrial sector, there was a decrease in the number of FTEs 2008–2010, while both the institute and higher education sector have experienced growth throughout the period. In 2001, the industrial sector accounted for about half of the FTEs, while the higher education sector and research institutes accounted for almost a quarter of the total FTEs each. The higher education sector increased its share of performed R&D FTEs considerably during the last decade.

In terms of number of FTEs in 2011, medical and health sciences was the largest field of science totaling the higher education and institute sector. Social sciences and engineering and technology followed. Figure 2.26 shows that medicine and health sciences was the largest field of science in the higher education sector in 2011, while engineering and technology, natural sciences and social sciences were the largest fields in the institute sector. While almost all FTEs within the humanities were performed in the higher education sector, the agricultural sciences were mainly conducted in the institute sector.

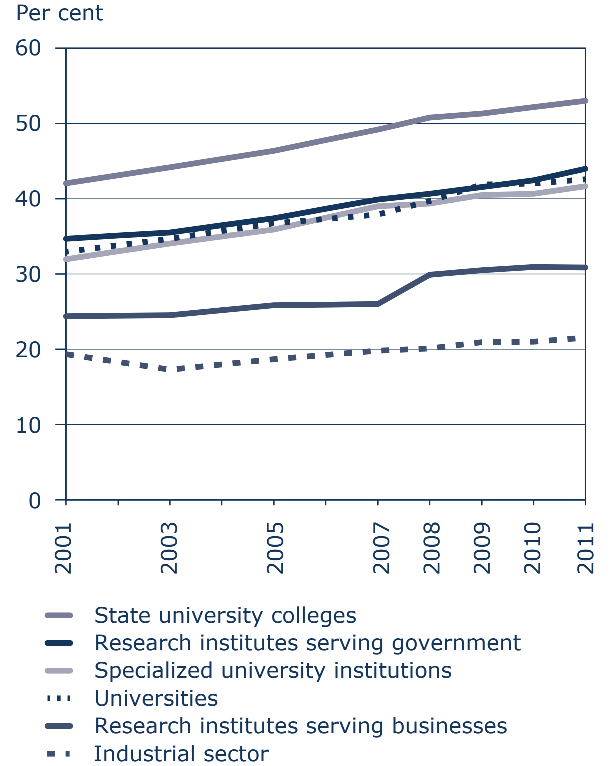
In the institute sector 72 per cent of the FTEs were performed by researchers in 2011. In the higher education sector the corresponding share was 79 per cent. For both sectors agricultural sciences had the highest share of FTEs performed by technical/administrative personnel, followed by medicine. In the latter field of science almost half of the FTEs were conducted at a health trust, of which 41 per cent of the FTEs in this field were in the institute sector and 48 per cent in the higher education sector. The least use of technical/administrative support for R&D was within the social sciences, engineering and humanities in the higher education sector, and within the humanities and social sciences for the institute sector.

About R&D FTEs in the higher education sector and institute sector in Norway

R&D full-time equivalence (FTE) is a measure of actual time devoted to R&D. Each person counts a maximum of 1.0 FTE. The number of FTEs in an educational institution is calculated on the basis of job categories, fields of science and type of institution. Some positions such as postdocs and researchers in the institute sector spend most of their time on R&D. Other job categories will only use a portion of their time to conduct R&D. At the universities, most of the researchers have both an educational and research component included in their position, in addition to other tasks. Doctors at university hospitals will typically have treatment of patients as their primary task, while a smaller share of their working time is dedicated R&D.

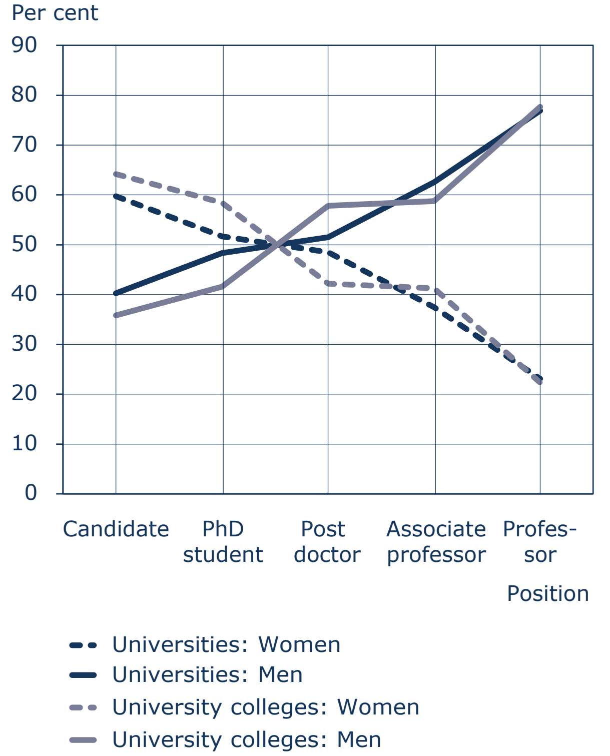
2.8.4 Women in the Norwegian research

Figure 2.27
The share of women in researcher/scientific positions in Norway by type of institution: 2001–2011.



Source: NIFU/Statistics Norway, R&D statistics

Figure 2.28
Share of women and men on different academic career levels at Norwegian universities and university colleges, 2011.



Source: NIFU/DBH

The proportion of women participating in R&D in Norway is growing in all sectors and types of institutions. In 2011 there were 16 500 women in researcher positions in R&D, and women accounted for 36 per cent of the total number of researchers in Norway this year. Ten years earlier, 29 per cent of the research personnel were women, and the proportion of women has increased in all types of institutions in the period. State colleges have had the highest percentage of women during the last ten years, see Figure 2.27. Universities, colleges as well as public-oriented research institutes have had about the same percentage of women throughout the period, from 33 per cent in 2001 to 43 per cent in 2011. In the industry-oriented research institutes and for the industrial sector, the proportion of women was significantly lower, and the proportion of women has not grown appreciably.

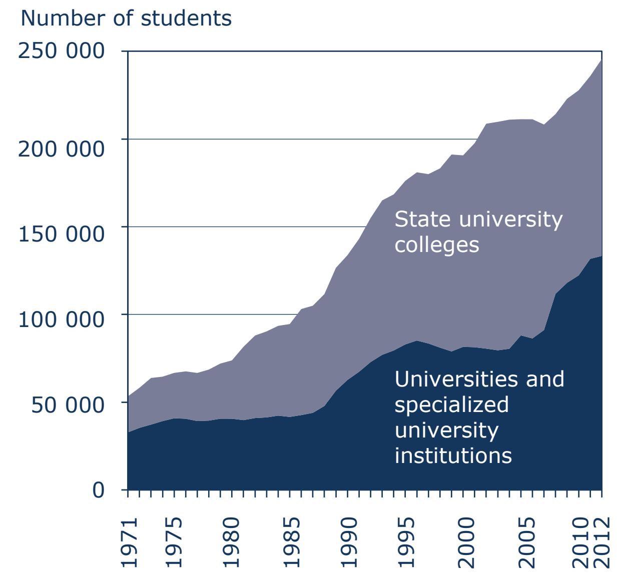
Norwegian research is characterized by large differences in gender composition between the sectors, types of institutions, fields of science and job categories. The proportion of women varies between fields of science, disciplines and job categories. Women seem generally to have a slower career progression than men and are over-represented in the teaching-oriented and temporary job categories.

For professors, the highest proportion of women was within medicine and health sciences and humanities in 2011, the lowest proportion of female professors was within engineering and technology. Among the PhD students, women have been in the majority since 2007, but the proportion of women has varied with respect to field of science from 67 per cent women within medicine and health care, to 30 per cent women in engineering in 2011.

Figure 2.28 shows the career ladder for women and men at universities and university colleges respectively, in Norway in 2011. The proportion of women at professor level was about the same for both types of institutions, 23 per cent of the professors were female at universities and 22 per cent at university colleges. At the associate professor level however, there was a higher proportion of women at university colleges than at universities. Among postdocs, there were a higher proportion of women at the universities. Note that there are few postdocs at the university colleges compared with the universities. Both among the PhD students and master’s degree students there were more women than men in 2011, and the proportion of women in these positions was also higher at the university colleges than at the universities.

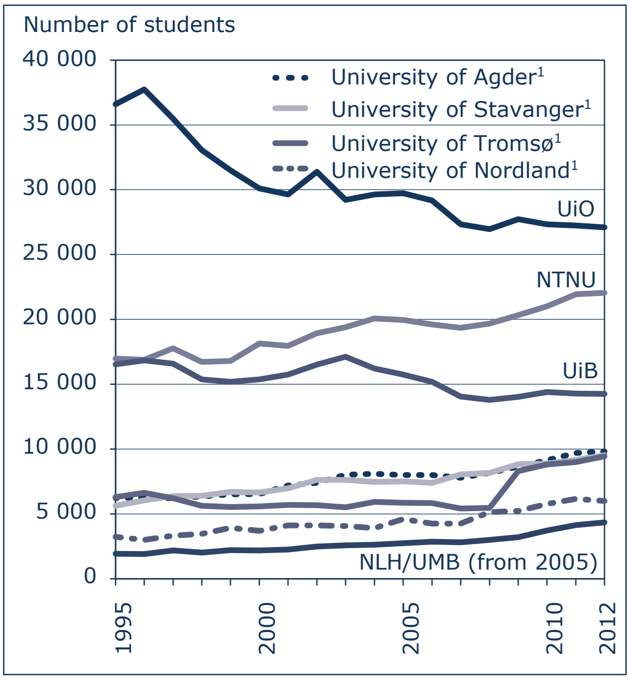
2.8.5 Main trends in the developments of student numbers

Figure 2.29
Number of students at Norwegian universities/specialized university institutions and state university colleges: 1971–2012.



Source: Statistics Norway

Figure 2.30
Number of students at the universities[1]: 1995–2012.



[1] State university colleges who have received university status: the university colleges in Agder (2007), in Stavanger (2005) and in Bodø (2011). In Tromsø the state university college merged with the university in 2009.

Source: Statistics Norway

Future research and innovation depends on how many people choose to pursue higher education, what subjects they choose to study, what they learn and whether they are able to complete their studies. From 1971 to 2012 the number of students increased from about 53 000 to about 245 000, as shown in Figure 2.29. This represents a growth of more than fourfold in 40 years. In comparison, the population increased by just above 25 per cent in the same period.

The growth was particularly strong from the mid 1980s to mid 1990s, and then stagnated somewhat around the year 2000. Since 2008, the numbers of students have again increased significantly, with an annual increase of between 2 and 4 per cent, which corresponds to between 5 000 and 9 000 more students each year. In 2012, for the first time, the number of students in Norway exceeded 245 000. If Norwegian students abroad are also included, there are over 260 000 students within higher education.

Figure 2.29 also illustrates institutional changes in Norwegian higher education. In the early 1990s the number of students in both university colleges and universities increased dramatically. From 1997 to 2004 the number of students at universities has been stable at around 80 000, while the number has increased slightly at the state university colleges. Since 2005, several of the state university colleges have applied for and have also gained university status. All in all these changes in institutional status explain the increase in the number of students at a university/university college.

As to the development of the number of students at the various universities, Figure 2.30 shows that the development has varied over time. The University of Oslo (UiO) had a decline in the number of students from over 37 000 students in 1996 to around 27 000 in 2012. The number of students at UiO has stayed at this level since 2007, despite the fact that the total number of applications for higher education has increased in recent years. In particular prior to the introduction of the reform of higher education of 2003, the Quality reform, the number of students decreased at UiO to around 30 000 students, and the decline continued afterwards. A «clean-up» of the UiO student registry can explain parts of the decrease. Since 2007, the number of students has also declined at the University of Bergen (UiB). UiB experienced a slight decline in the number of students around the turn of the millennium, followed by an increase to around 17 000 students in 2003, when the Quality Reform was introduced. Only the University of Tromsø has had a stable number of students throughout the period. The other universities increased their number of students from 1995 to 2012. It is also interesting to note that in 1995 NTNU and UiB had about the same number of students, around 17 000, whereas in 2012 their number of student was very different.

3 Results, effects and cooperation on R&D and innovation

Chapter 3

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Scientific publication and citation

- The number of scientific papers in Norway increased by 85 per cent from 2004 to 2012. This is more than in most European countries and more also than in the other Nordic countries. However, the increase was even higher in China and South Korea.

- As to citations, Norway had a lower increase in citation frequency over last three years than the other Nordic countries. The highest citation indices in the period 2008–2011 were for clinical medicine, engineering, instrumentation, and agricultural and food science.

Intellectual property rights

- In Norway, patenting is most widespread in engineering activities and certain manufacturing industries such as the production of machinery and equipment.

- Patent applications are typically made by either very small enterprises with fewer than 10 employees, or very large enterprises with more than 200 employees.

- In Norway, few trademarks are registered compared to the average of OECD countries and the other Nordic countries.

Participation in international R&D cooperation

- The Norwegian success rate in the 7th EU Framework Programme is almost four percentage points higher than for all applications.

- A total of 1 120 different Norwegian actors participated in the 7th EU Framework Programme. The ten most active Norwegian operators account for 40 per cent of all Norwegian participation.

R&D and innovation cooperation in the industrial sector

- There has been a decline in business R&D cooperation from 39 to 31 per cent from 2009 to 2011. The decline is spread widely across most industries and sizes of group.

- The scope of R&D cooperation is lower as the geographical distance increases. The scope of R&D cooperation also correlates with the size of enterprises: large enterprises have more cooperation than small.

Results of innovation

- The share of revenues, derived from innovative products, is at 6 per cent in Norway, among the lowest in Europe. The innovators perform better when measured with comparable countries and industries, but Norway has few innovators in innovation-intensive industries and the tendency to innovate is lower than in our neighbouring countries.

R&D and innovation in enterprises with growth

- Norway peaked in the Nordic countries in both proportion and number of gazelles in the period 2006–2009. High research activity, access to highly trained staff and organizational innovation contributes to this growth in Norwegian enterprise.

This chapter presents results and impacts of research and innovation. In this area, there are currently few established and internationally comparable indicators. It is therefore necessary to include experimental indicators and indicators which have a more indirect link to research and innovation. In this chapter, we also include some indicators for collaboration on research and innovation.

Increased emphasis on results

Most of the existing figures, based on research and innovation, highlight the effort in terms of financial and human resources. Fewer indicators express the results of research and innovation activities. However, both in Norway and internationally, the emphasis is to highlight more knowledge about the social impact of research and innovation and better systems to measure these effects.

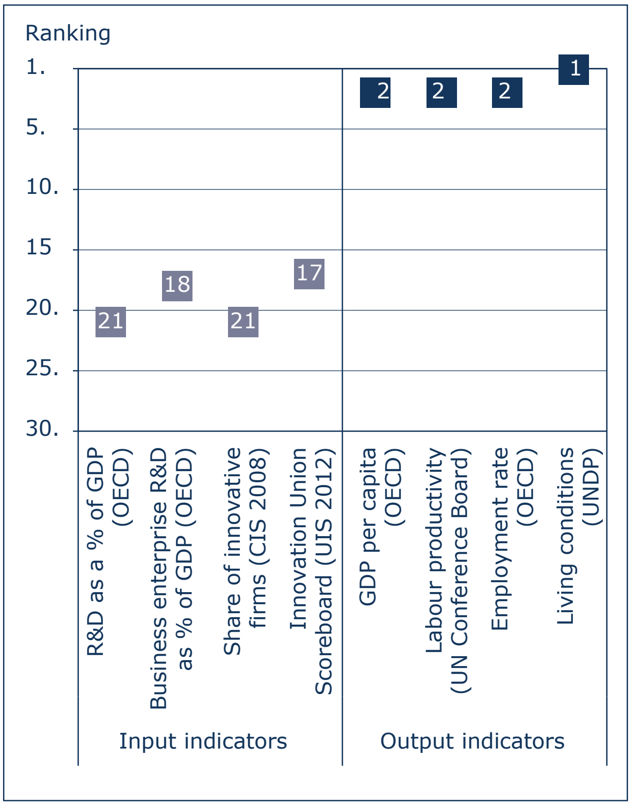
An example from Norway is the so-called FORFI programme by the Research Council of Norway, which has focused on supporting projects that in different ways illustrate the effects of research and innovation. The last White paper on research to the parliament (Report St. 18 (2012–2013)) points out, however, that there is still a need for more knowledge and better measurement of the return of R&D investments.

Indicators on results are also a priority in the international indicator development. The Blue Sky Conference, in 2007, emphasized better indicators of the results as one of the main international challenges in this field. This has also been pointed out by the OECD's innovation strategy of 2010. Results and impacts of R&D is also an issue that should be included in the revision of the so-called Frascati Manual, which provides definitions and framework for R&D statistics, see also the focus box 1.

The Norwegian paradox

At the macro level, Norway appears as a country that scores high on indicators of economic and other social factors, as shown in Figure 3.1. However, at the same time, the scope of research, development and innovation seems lower than in many other comparable countries. This is often referred to as «the Norwegian paradox», i.e. that we get good results out of a small bet. In the following chapters, we will present indicators which, in different ways, can nuance and expand this image. First, we present figures for scientific publications and citations as well as patents and trademarks. These are often regarded as the most established and internationally comparable indicators of the results of research and innovation. In addition, results of innovation, participation in EU framework programmes, business enterprise sector R&D, and indicators on company growth, will be presented.

Figure 3.1
Norwegian ranking on international input and result indicators: 2012 or latest available year.



Source: NIFU based on OECD, Eurostat, EU-Commission, UN (UNDP, UN Conference Board)

Chapter 3

3.1.1 Introduction

Bibliometrics is measuring knowledge and influence

Publication and citation data are widely used as indicators of the results of research. The basis for the use of such so-called «bibliometric indicators» is that new knowledge, which is the fundamental objective of all basic and applied research, is communicated to the scientific community through publications. Publishing can therefore be used as an indirect measure of knowledge production. While the number of publications represents an expression of the extent of the scientific production in different countries and different disciplines, citations will tell you something about the impact this research has had. On this basis, this chapter provides an analysis of Norwegian research in an international comparative perspective.

Commercial data source for bibliometric

There is no international organization that coordinates and represents the collection of data for scientific publications, unlike the situation of R&D and innovation statistics. Instead, bibliometric analyses are based on data collected on a global basis by a private company, Thomson Reuters, located in Philadelphia, USA. Thomson Reuters (formerly named the Institute for Scientific Information, ISI) indexes scientific journals and produces a database which includes the Science Citation Index (SCI), Social Science Citation Index (SSCI) and Arts and Humanities Citation Index (A & HCI), and contains a total of more 12 000 journals (2012). The database is particularly suitable for analysing academic scientific and medical research, with publications in international journals as the main communication method; see also the fact box on bibliometric indicators below.

In the period 1981–2012, around 25 million scientific articles were published globally. The world production has increased throughout the period from 460 000 articles in 1981 to over 1.3 million in 2012.

Bibliometric indicators

The analyses are based on data from Thomson Reuters, which produces the main database for bibliometric purposes and indexes specialized and multidisciplinary peer-reviewed journals, including all major international journals in science, medicine and technology. In addition the journal of social sciences and humanities.

Unlike in previous issues of this report, this year’s edition contains macro data from the Centre for Science and Technology Studies (CWTS) at the University of Leiden, The Netherlands, that are used in the analyses. These macro data are based on Thomson Reuters database, Web of Science. CWTS uses another field classification system than has been used in previous reports, hence other fields are included in the categories. The classification system used by CWTS, consists of 35 different professional categories.

In macro figures, the following types of publications are included; articles, review articles, letters and conference papers published in journals. Other types of publications, such as book reviews and abstracts, are not included in the figures. In order to assign a publication to a country, at least one of the publication’s authors must have his or her address in that country.

Bibliometric indicators do have some limitations that are important to be aware of when interpreting the results. Among other things, coverage of journals between disciplines varies. The highest coverage is in fields such as physics, chemistry, biomedicine and clinical medicine. The coverage is also quite good in biology and technology. For the social sciences and humanities, the coverage is poorer. The reason for these differences is partly that Thomson Reuters does not index all relevant journals, partly because the publication pattern varies between disciplines. In some fields, research communication is less oriented towards international journals. For example, publishing in national magazines, in books, etc. plays an important role in some fields.

In this chapter, we have used a supplementary data source. The institutions in the higher education sector report annually their scientific publications to The Current Research Information System in Norway, CRIStin. These data provide a complete overview of the scientific publication and not only articles in journals. The database covers also research institutes and health trusts.

One of five articles in the world is published by the United States

There are large differences between countries in terms of production of articles. In absolute numbers, the United States is the largest research nation with more than 376 000 publications in 2012. This accounted for 20.9 per cent of the world's scientific knowledge production, measured as the sum of all countries' production. China is now the world's second largest producer of knowledge with about 186 000 articles and a share of 10.3 per cent; see Table 3.1. Then follows the UK and Germany with more than 100 000 articles each. Norwegian researchers published about 11 400 articles in 2012, ranking Norway as the third smallest research nation of the 18 countries, which is shown in Table 3.1. Norway's share of world production amounted to 0.63 per cent, identical to the proportion in 2011. Of the Nordic countries, Sweden is the largest research nation with 56 per cent more articles than the second, Denmark. Present article number is marginally higher in Norway than in Finland.

Norway is number four measured per capita

In terms of population, Norway has 2.30 articles per thousand inhabitants, and ranks as fourth of the countries in Table 3.1. Switzerland is the country that clearly has the highest productivity of 3.36 articles per 1 000 inhabitants. Followed by Denmark and Sweden, who both have a higher productivity number than Norway, respectively 2.67 and 2.46 articles per 1 000 inhabitants.

Differences in population size do not necessarily reflect differences in research. A better indicator would be to calculate the relationship between article production and inputs such as R&D expenditure and R&D employment. However, it is difficult to say more about differences in productivity, as differences in scientific specialisation profile will influence the picture.

The biggest growth is in China

Table 3.1 shows how the article production in different countries has developed in the period 2004 to 2012. Particularly noteworthy is the increase in article production in China, which has more than tripled during the period (210 per cent increase). This is due to the expansion in the nation's research resources, incentives to publish in peer-reviewed journals as well

Table 3.1
Number of scientific articles in 2012, per capita; and relative growth in number of articles for selected countries: 2004–2012.

Country	Number of articles	Number of articles per 1 000 capita[1]	Percentage of world production[2]	Growth in articles 2004–2012 (%)[3]
USA	376 804	1.21	20.91	25
China	186 377	0.14	10.34	210
United Kingdom	107 894	1.72	5.99	32
Germany	100 457	1.23	5.57	33
Japan	78 659	0.62	4.37	0
France	69 948	1.07	3.88	30
Canada	61 530	1.78	3.41	47
Australia	49 686	2.18	2.76	82
South Korea	49 298	0.99	2.74	100
Netherlands	36 893	2.21	2.05	59
Switzerland	26 473	3.36	1.47	56
Sweden	23 204	2.46	1.29	37
Belgium	19 886	1.81	1.10	54
Denmark	14 881	2.67	0.83	64
Austria	13 471	1.60	0.75	47
Norway	**11 405**	**2.30**	**0.63**	**85**
Finland	11 213	2.08	0.62	32
Ireland	7 545	1.65	0.42	92

1 Number of articles in 2012 per 1 000 capita in 2011.
2 Percentage of World production is calculated on the basis of the sum of all countries production.
3 Growth in the number of publications is also caused by the expansion of the Web of Science data base, in particular after 2008.

Source: Thomson Reuters/CWTS Web of Science. Computations: CWTS/NIFU

as increased coverage of Asian scientific journals. In addition to China, Brazil has a particularly high growth rate, and article production increase in other Asian countries such as India and South Korea (Brazil and India are not shown in the figure) as well.

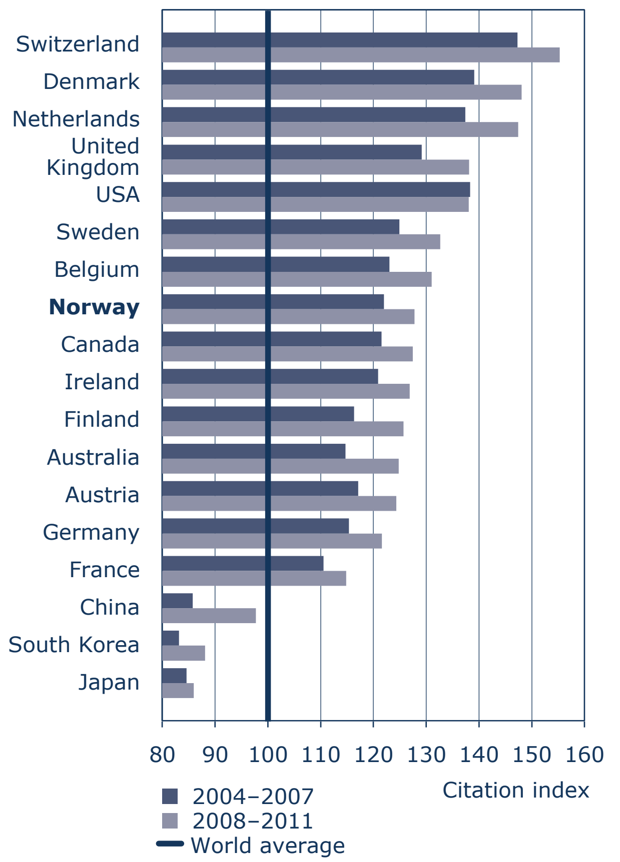
The Norwegian production of articles has increased greatly during the period. With an increase of 85 per cent, Norway ranks as number 4 of the 18 countries shown in the table. Most European countries have a significantly lower growth rate than Norway.

The development is measured within the universe Thomson Reuters' database represents. A complicating factor in the interpretation of the figures is that the database has increased relatively widely in scope during the period. It is therefore clear that the growth rate can be partially attributed to methodological issues and does not reflect a «real» increase in research output.

3.1.3 Citation index by country

In absolute terms, countries with the highest production of scientific papers generally also receive the most citations. However, it is common to use size as an independent measure for assessing whether a country's articles are high or low quoted. One such indicator is the relative citation index, which expresses the average number of citations per publication. It shows whether a country's publications are more or less cited than the world average, which is normalized to 100.

Figure 3.2
Relative citation index for selected countries: 2004–2007 and 2008–2011.[1]



[1] Relative citation index for article publicised during the two periods 2004–2007 and 2008–2011.

Source: Thomson Reuters/CWTS Web of Science. Computations: CWTS/NIFU

Switzerland, the top cited country

In Figure 3.2, we calculated the relative citation index for articles published in the two periods 2004–2007 and 2008–2011. The indicator covers all subject areas. In the second period, Norway was rated at number eight of 18 countries, with a citation index of 128. This means that the Norwegian articles were cited 28 per cent above the world average in the period 2008-2011. The vast majority of countries in the table were cited more than the world average, and all the European countries had index values well above 100. Switzerland and Denmark are the countries that have achieved the greatest scientific impact as measured by citations, in this period. The articles in these countries were cited respectively 55 and 48 per cent more than the world average. Lowest citation frequency are publications from non-Western countries. It is noticeable that China scores significantly lower in terms of citation frequency than in terms of publication volume.

Citations as indicator

A characteristic of a scientific publication is that it contains references to previous scientific literature. These references show the concepts, methods, theories, empirical findings, etc. that the current publication is based on, and how it is related to previous research. At Thomson Reuters, all references in the indexed literature are systematically recorded. This makes it possible to calculate how many times each publication has been cited in the subsequent scientific literature. Based on these statistics, it is possible to make citation analysis at aggregated levels.

It is common to assume that articles are more or less quoted by how big or small the influence they have on further research. Based on these assumptions, citations are frequently used as an indicator of scientific impact, and thus as a partial measure of quality. A standard indicator is the average number of citations to a country's publications. Generally, this indicator is seen as an indirect expression of attention the publications of a country achieves in the international scientific community. Citations have increasingly been used as indicators of evaluation of research. However, it is important to be aware that there are various limitations and weaknesses of citations as an indicator, and citation analysis cannot in any case replace an evaluation conducted by peers (cf. Aksnes, 2005).

There are large differences in the average citation frequency between different disciplines. For instance, an article in molecular biology is, on average, quoted about ten times as often as an article in mathematics. Such differences are adjusted in the calculation of the citation index.

3.1.4 National publication and citation profile – field of science profile

Norway's profile when it comes to publishing activity varies widely between disciplines. Table 3.2 provides an overview of the subject profile, based on publications for 2012. The disciplines are very different in size, which is important to be aware of when interpreting the results. The table also shows changes in the article number from 2004. As a reference value, we have included changes in publications for the EU 15 countries that make up a more relevant benchmark for Norway than the world average.

Clinical medicine is by far the largest field in terms of publication volume in Norway. Norwegian scientists published almost 3 000 articles in this field. This represents an increase of 74 per cent compared to 2004, slightly below the increase for a total of Norway (85 per cent), but significantly above the average for the EU 15 countries, at 32 per cent. The increase in publications in clinical medicine is greater than in biomedicine (53 per cent). The growth in health volume (includes nursing and public health) and basal medicine has doubled during the period, but the latter field is small in terms of number of articles.

In the natural sciences, *earth science* is the largest field in terms of the number of articles, followed by *environmental science*. In these fields, around 1 200 and 1 100 articles were published respectively in 2012. These fields had the largest relative growth in terms of volume published with more than 100 per cent. *Biology* has the weakest relative increase of the science disciplines with 43 per cent.

The subfields within engineering and technology vary quite a bit. *Electronic engineering and telecommunications* is the largest field in terms of publication volume. The number of articles had grown by 127 per cent since 2004. The relative growth rate is highest for the category that includes general and industrial engineering (260 per cent) followed by the construction (214 per cent). *Computer engineering and computer science* have an increase of only 10 per cent, however, the other countries in the EU 15, had a decline.

However, the social sciences and humanities stand out with particularly large relative increases. The number of publications in international scientific journals in particular is more than doubled in all fields. Some of the increase can be explained by an extended coverage of social science and humanities journals in the database, we thus see that the EU 15 countries have large increase in publication volume, albeit significantly lower than Norway. The figures show that Norwegian researchers in these disciplines increasingly publish in international journals. Nevertheless, it is important to note that only a small share of scientific publications in the fields are indexed in the database, in particular this applies to the humanities.

Table 3.2
Number of articles per field of science in 2012; relative increase[1] from 2004 for Norway and the EU 15-countries.

	Number of articles 2012	Relative specialization-index	Relative growth in the number of articles 2004–2012	
Field of science	Norway	Norway	Norway	EU 15
Mathematics and natural sciences				
Astronomy and astrophysics	168	0.05	49 %	28 %
Biology	996	0.23	43 %	31 %
Physics and material sciences	975	-0.29	76 %	11 %
Geo sciences and technology	1 211	0.48	103 %	53 %
Chemistry and chemical technology	822	-0.34	70 %	20 %
Mathematics	302	-0.13	100 %	41 %
Environmental sciences and technology	1 099	0.30	114 %	83 %
Statistics	193	0.13	101 %	66 %
Agricultural and food sciences	415	-0.01	65 %	55 %
Medicine and health				
Basal bio sciences	956	-0.10	46 %	15 %
Basal medicine	154	-0.21	221 %	89 %
Bio medicine	1 113	-0.07	53 %	25 %
Health sciences	616	0.29	200 %	103 %
Clinical medicine	2 995	0.03	74 %	32 %
Psycology	337	0.12	125 %	85 %
Technology				
Civil engineering and construction	123	-0.01	215 %	136 %
Computer science and informatics	295	-0.07	18 %	-10 %
Electrical engineering and telecommunications	309	-0.23	127 %	62 %
Energy research and technology	294	0.09	194 %	58 %
General and industrial engineering	126	-0.08	260 %	64 %
Instruments and instrumentation	72	-0.23	71 %	22 %
Machine and space engineering	224	-0.13	90 %	39 %
Social sciences				
Information and communication sciences	42	-0.07	100 %	141 %
Management and administration	188	0.31	370 %	151 %
Law and criminology	59	-0.04	638 %	147 %
Social and behavioural sciences, interdisciplinary	149	0.36	140 %	81 %
Sociology and anthropology	142	0.10	209 %	136 %
Political science and public administration	140	0.28	141 %	118 %
Educational science	114	-0.05	217 %	172 %
Economy	282	0.15	114 %	128 %
Humanities				
History, philosophy and religion	144	-0.04	153 %	100 %
Art, culture and music	60	-0.26	253 %	91 %
Literature	15	-0.63	200 %	43 %
Languages and linguistics	52	0.13	206 %	101 %
Multidisciplinary journals	364	0.06	691 %	427 %

[1] The growth in the number of publications is also caused by the expansion of the Web of Science data base, particularly after 2008.

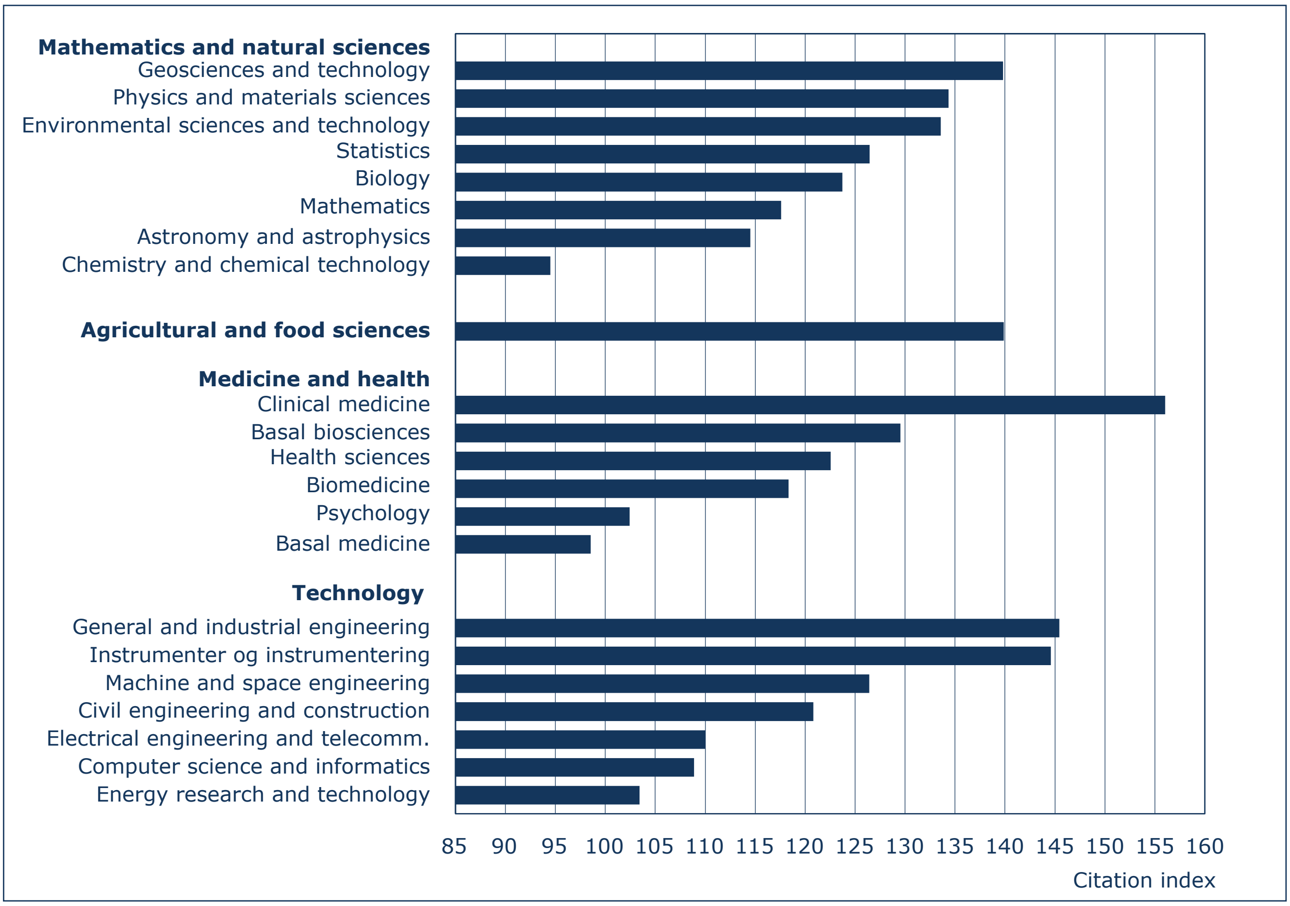
Source: Thomson Reuters/CWTS Web of Science. Computations: NIFU. Statistics on population: OECD

Chapter 3

3.1.5 Citation index by major fields in Norway

Figure 3.3

Relative citation index for Norwegian publishing within natural sciences, medicine and technology: 2008–2011[1].



[1] Relative citation index for articles published between 2008 and 2011. World average for all articles in the field of science = 100.

Source: Thomson Reuters/CWTS Web of Science. Computations: NIFU

Large variations in citation between disciplines

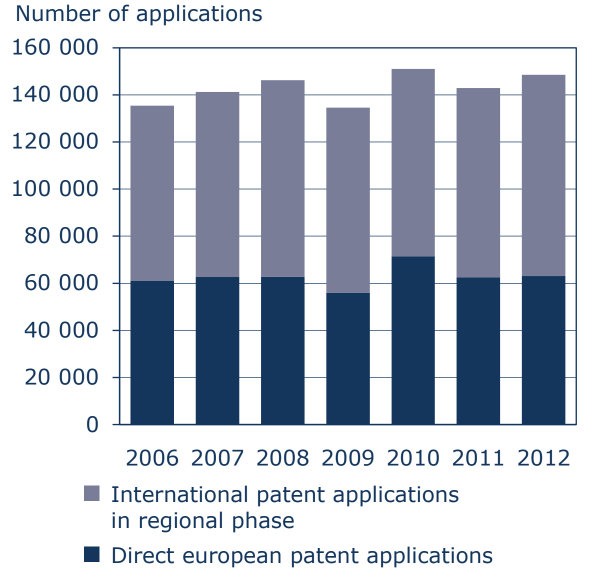
As shown in Figure 3.2, Norway's citation index was 128 in the period 2008–2011. This represents a total value for all major fields. On the field level the citation index varies widely as shown in Figure 3.3. Social sciences and humanities are not included in the analysis, because of the database provides a poor coverage of the research literature on these subjects.

In the natural sciences, Norwegian research has a particularly high citation index in earth sciences. The articles were cited 40 per cent above the international average in the field, in the period 2008–2011. As described earlier, this is also the field with strongest specialization. Physics and materials science, and environmental science do also have relatively high citation index values (134). The Norwegian publications in chemistry and chemical technology are however cited less. With an index value of 95, this is below the international average and significantly below the Norwegian average for all disciplines.

In medicine and health sciences, clinical medicine had the highest citation index, at 156. No other fields in Norway have a similarly high citation rate. Clinical medicine is also by far the largest field in terms of publication volume and contributes heavily to raise the Norwegian total citation index. Norwegian biomedical research is less frequently cited, and citation index of 118 is below the national average for all subjects. Lowest citation frequency has basic medicine and psychology with index values of respectively 99 and 102; the former field is, however, low in terms of publication volume.

In engineering and technology, we also find a varied picture. Highest citation index is found for general and industrial engineering as well as instruments and instrumentation (index 145). Energy research and technology has the lowest citation index of 103, slightly above the world average and significantly below the average for Norwegian research overall.

Figure 3.4
Patent applications handed in to the EPO[1] and PCT[2]: 2006–2012.



[1] European Patent Office.
[2] Patent Cooperation Treaty.
Source: OECD

Table 3.3
Number of Norwegian patent applications: 2002–2012.

Year	Total number of patent applications	National applications submitted by domestic applicants			National applications submitted by foreign applicants	Transferred international applications (PCT)
		Total	Enterprises	Individuals		
2002	6 287	1 178			766	4 343
2003	5 861	1 079			814	3 968
2004	5 433	1 142			704	3 587
2005	5 986	1 143	750	579	706	4 137
2006	6 076	1 119	761	498	693	4 264
2007	6 654	1 109	835	455	643	4 902
2008	5 420	1 052	790	409	245	4 123
2009	3 604	1 178	820	486	187	2 239
2010	1 813	1 085	725	429	154	574
2011	1 776	1 083	748	335	184	509
2012	1 556	980	..	..	150	436

Source: The Norwegian Patent Board (Patentstyret)

Patents as indicator

Patenting is a subtype of industrial property rights that gives the patent holder exclusive rights on an invention or technical solution for a certain period. Such protection can stimulate innovation through a combination of time-limited exclusive rights to inventions and publication of information on the same inventions. Herein lies a balance between respect to the patent applicant and the community.

There may be significant development behind a patent. The willingness to invest in development is expected to be greater when the exclusive rights can be secured, so that innovation is stimulated. Patent applications are therefore used as an indicator of innovative activity, and hence as an indicator of the results of innovation. A high degree of patenting is considered a sign of high innovation capability.

At the same time, it is part of the picture that patents prevent others from using inventions. In certain circumstances, this can also lead to a decrease of the positive effect of patenting, which in turn may inhibit innovation. Especially in certain areas of technology there can be a number of partially overlapping intellectual property rights that protect innovative products (patent thickets). This may prevent especially smaller enterprises from launching innovative products.

About patents

A patent provides the right to prevent others from exploiting the invention, which can be new products, processes or applications, such as solutions to a technical problem (business perspective). In return, the invention must be made public. The information will partly help to prevent others from using resources to do the same inventions again, sometimes it may provide inspiration for further developments as well. An important point is that others can use patents freely after the expiration of rights (social perspective).

Decrease in international patenting

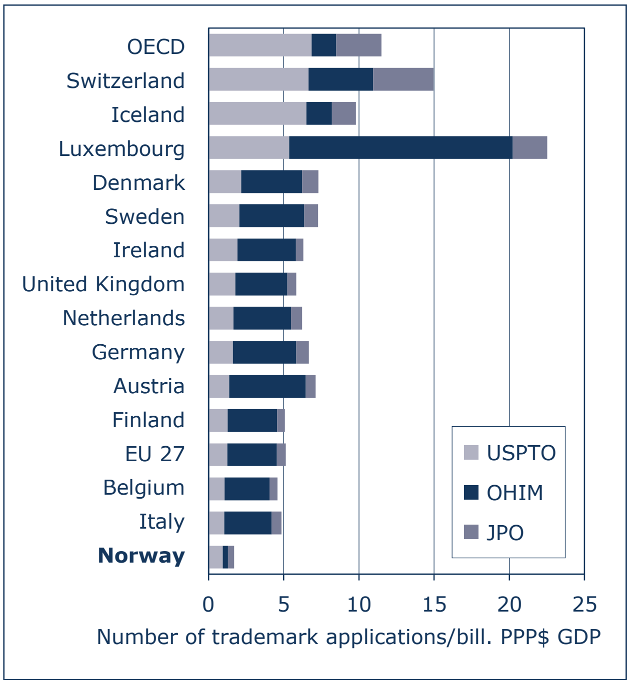
Internationally, there was a steady growth in the number of patent applications until 2008. The financial crisis resulted in a decline in patenting in general in 2009, but picked up the following year, see Figure 3.4. However, patent applications to the European Patent Office (EPO) declined again in 2011 and 2012 and this may have been an effect of the uncertain economic situation. Patent applications from other countries into the European market, however, showed an increase in 2011 and 2012.

In Europe, there has been quite a big variation between the countries in the development of patent applications from 2011 to 2012. Countries like Germany, France and Switzerland reinforced their positions as countries with a high number of patent applications, while other patent-intensive countries such as the Netherlands, Sweden and Italy have decreased. Norway has increased by 20 per cent from 2011, but is still low in the number of patent applications.

3.2.2 Norwegian trademark registration

Figure 3.5

Trademark applications as a proportion of billion GDP at the US USPTO, european OHIM and japanese JPO for selected countries. 2007–2009 average.



Source: OECD (2011), «Trademarks», in OECD Science, Technology and Industry Scoreboard 2011, OECD Publishing. Based on data from the American USPTO, European OHIM and Japanese JPO

Trademarks as indicator

Corporations use trademarks primarily in connection with the launch of new products and services. Trademarks protect the investment a firm has made in differentiating their product or service from others on the market. Such protection demonstrates the uniqueness of the product or service, and there is even a requirement that the trademark owner actively maintains this character. Trademark registration thus represents an innovation indicator that differs from and complements the more traditional patent indicators.

There is growing interest in trademarks as an indicator of economic activity. A robust correlation between trademark registration and the company's market value has been proved. Trademarks may be particularly important in relation to services, for example in the tourism industry. Trademark protection can be an equally good indicator as patents when it comes to innovation in service industries. Moreover, some products and services often use a combination of patent and trademark registration protection, which, amongst others, we have seen for Apple's various products and solutions.

Trademark registration cannot be used uncritically as an indicator of innovation. One issue is that the trademarks are often used without the occurrence of particular innovative business. This includes, among others, the restaurant industry, where innovation is not necessarily so prevalent.

Trademark protection in international context

The OECD recently directed attention to trademark protection as an innovation indicator. Norwegian actors are, to a small extent, applying trademark protection abroad, according to the report (OECD, 2011). Figure 3.5 shows that OECD countries recorded an average of 11 trademarks per billion PPP$ GDP in the major markets: the United States (USPTO), Europe (OHIM) and Japan (JPO). This provides a broad measure on how intensive economies are bringing new products and services to the international market.

The figure shows that Switzerland registered by far the most trademarks internationally with 15 per billion PPP$ GDP, while Norway registered the fewest, less than two in the period. The Swiss pharmaceutical industry is large and research-intensive. The fact that this industry is also actively marketing itself globally helps to explain why the trademark registration is relatively high in Switzerland. The Norwegian oil industry increased value added, but contributed little to trademark registration. This does not appear to be the explanation for why Norway is at the other end of the scale. The other open economies in the Nordic countries are among the most international in the trademark context.

Trademark registration in Norway

Unlike the rest of the Nordic countries, Norway is not a member of the European cooperation in the design and trademarks, the Office of Harmonization for the Internal Market (OHIM). It becomes most obvious for Norwegian companies to only seek trademark protection nationally (through the Patent Office) and not regionally (through OHIM). We therefore examine the evolution of trademark registration in Norway.

About trademarks

A trademark can be registered for a number of types of characteristics of both products and services. Trademarks are divided by the product type or the service featured covers. A trademark can be registered for up to 42 classes, 11 of which relate to services and the rest are commodities. Trademark protection has traditionally covered characteristics in terms of shapes, word marks and slogans. Gradually trademarks also include «motion brands», sound cues and three-dimensional characteristics.

3.3.1 Norwegian success rate in the EU framework programmes

Table 3.4
Norwegian participation in FP7 by program. Applications, approved projects and rate of success.

	Applications			Approved projects			Success rate	
Programmes	Tot number of applications. All countries	Of which with NO partner	NO share of total Per cent	Tot number of projects All countries	Of which with NO partner	NO share of total Per cent	NO success rate Per cent	Ranking over/under average (% points)
HEALTH	3 480	295	8	820	83	10	28	4,6
BIO	2 300	362	16	422	88	21	24	6,0
ICT	12 533	958	8	1 898	143	8	15	-0,2
NMP	1 974	192	10	631	68	11	35	3,5
ENERGY	1 396	187	13	317	61	19	33	9,9
ENVIRONMENT	2 175	381	18	408	111	27	29	10,4
TRANSPORT	2 593	226	9	666	69	10	31	4,8
SSH	2 197	311	14	202	41	20	13	4,0
SPACE	693	70	10	200	26	13	37	8,3
SECURITY	1 441	204	14	233	55	24	27	10,8
ERA-NET	33	6	18	25	5	20	83	7,6
Total Cooperation	**30 815**	**3 192**	**10**	**5 822**	**750**	**13**	**23**	**4,6**
RI	839	135	16	318	68	21	50	12,5
SME	4 080	513	13	771	130	17	25	6,4
REGIONS	382	22	6	72	5	7	23	
POTENTIAL	2 093	2	0	165	1	1	50	
SiS	745	103	14	197	37	19	36	9,5
COH	36	2	6	22	0	0	0	
INCO	465	20	4	132	14	11	70	41,6
Total Capacity	**8 640**	**797**	**9**	**1 677**	**255**	**15**	**32**	**12,6**
ERC/Ideas	22 375	333	1	2 955	34	1	10	-3,0
MCA/People	30 551	668	2	7 947	134	2	20	-6,0
EURATOM	257	13	5	112	10	9	77	
Total all programmes	**92 638**	**5 003**	**5**	**18 513**	**1 183**	**6**	**24**	**3,7**

Source: E-Corda (Commission)

Norwegian participation in EU framework programmes for research and technological development is described in Chapter 2. Here we look at the outcome of participation as an indication of the quality and the impact of Norwegian research. The EU framework programme is a large, open competitive arena, where approvals can be seen as a sign of quality and relevance.

In the remaining one year of the Seventh Framework Programme (FP7), Norwegian communities participated or is participating in 5 003 applications. Of these 1 183 projects are set for funding. This means that nearly 24 per cent of all Norwegian applications are accepted for funding. This is often referred to as the «success rate». The Norwegian success rate is almost four percentage points higher than the average for all applications to FP7, as shown in Table 3.4.

While the Norwegian presence in applications for thematic programmes has remained stable in recent years, the Norwegian share in granted «Cooperation» projects increased slightly from the start of FP7 to the present day.

Norwegian researchers are doing well in several fields. Throughout the whole FP7 programme, the Norwegian count was particularly good in the environmental and climate programme «Environment». In this area, Norwegian communities were represented in more than a quarter of recommended projects by the end of 2012. Also within other sub-programmes, Norway is doing well, including in the programme «Security».

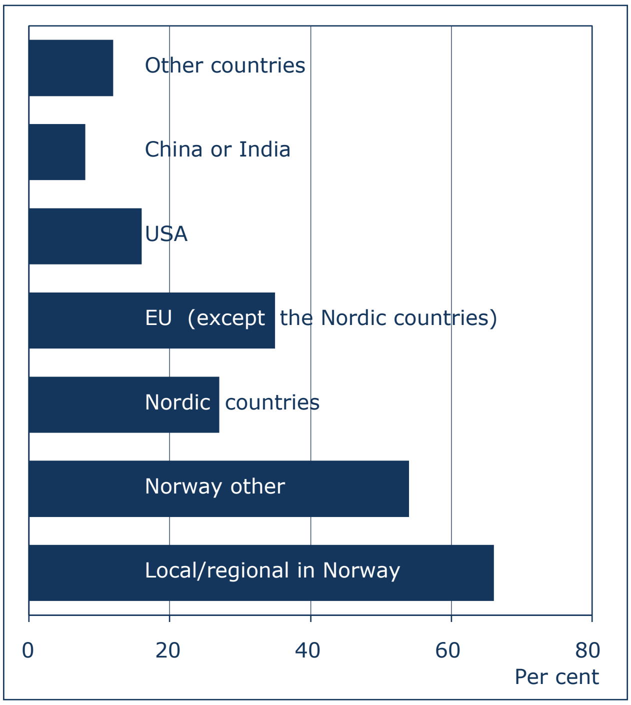
In Norway, most projects are within the programmes for ICT, researcher mobility and career development as well as the programme for small and medium enterprises «SMEs». ICT has the largest budget in FP7.

Success rate as an indicator

Granted EU projects as a proportion of applications is often used as an indicator of quality and international impact of the research. But the indicator is just as much an expression of the *application* quality. It does not necessarily reflect the quality of the *research* that is actually performed.

3.4.1 R&D and innovation cooperation in the industrial sector

Figure 3.6
Share of businesses with R&D cooperation by country: 2011.



Source: Statistics Norway, R&D statistics

3.4.1 R&D and innovation cooperation in the industrial sector

Decrease in R&D cooperation

Some parts of industry R&D activities are carried out in cooperation projects. Enterprises can participate in joint R&D activities with other enterprises or institutions, both in Norway and abroad. This involves active participation, while fixed contract work in terms of buying and selling R&D services are not considered R&D cooperation. The R&D survey for 2011 shows a decrease in the number of Norwegian enterprises with R&D cooperation compared with 2009. Among the companies that performed R&D, 31 per cent participated in R&D collaboration with others, a decrease of 8 percentage points. The decline is spread across industries and size groups. This trend is consistent with the results of the R&D and innovation survey in 2010, which showed that fewer innovative enterprises participated in innovation cooperation (including cooperation on R&D) in the period 2008–2010 compared with 2006–2008. The long-term trend is that the spread of R&D cooperation has been reduced since 2005 when half of all R&D enterprise cooperated with others. It is not easy to find any obvious reason for this decline, and there have not been any major changes in the wording of the question that may explain the development.

The scope of R&D cooperation correlates with the size of the enterprises. There is a higher proportion of enterprises with R&D cooperation among large enterprises than in small firms. For the group of R&D active enterprises with 10–49 employees, 27 per cent collaborated on R&D in 2011, and the proportion is 58 per cent for the largest firms with at least 500 employees.

Most companies collaborate with just a few partners, but there are also some companies with a complex pattern of cooperation with various partners. There are no major changes over time on how or with whom enterprises cooperate on R&D. The most common partners are suppliers, universities and research institutes. Each of these three groups reported by almost half of the enterprises to have R&D cooperation. 37 per cent of firms with R&D cooperated in partnership with clients and customers. Around a third of firms reporting collaboration with other companies in their own organization, and about the same proportion had cooperation with consulting companies. Commercial laboratories and R&D enterprises are somewhat less prevalent. 14 per cent of firms reported cooperation with competitors.

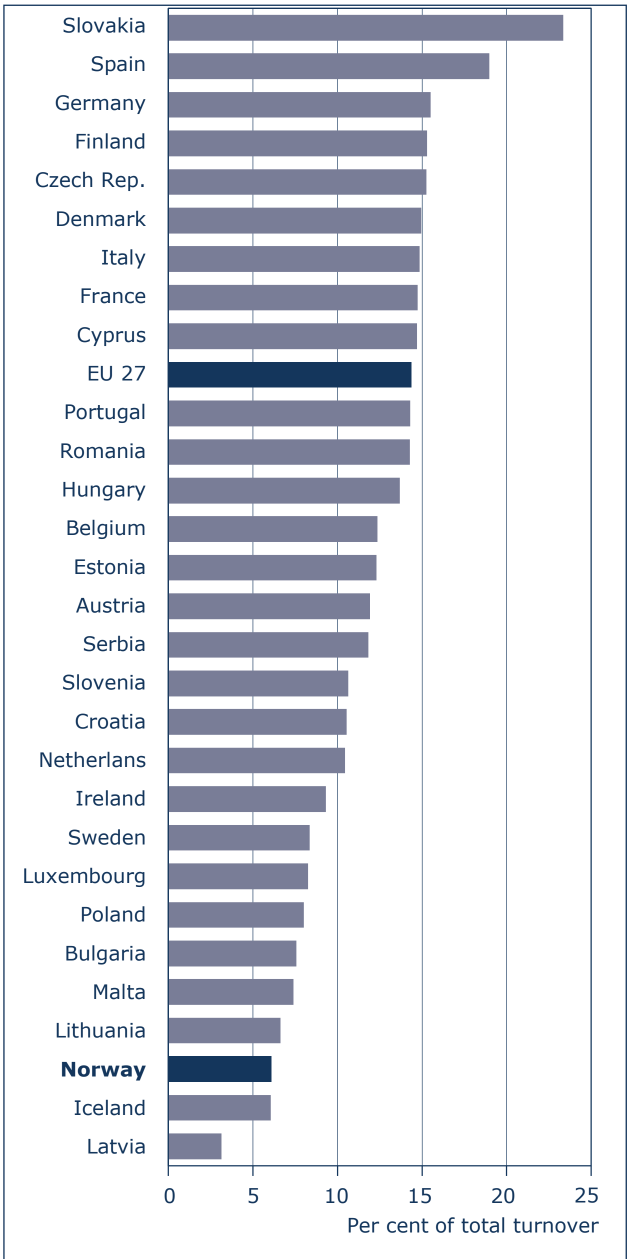
Geographical proximity is important for cooperation

The geographical cooperation pattern is relatively stable from year to year. Almost all firms that have R&D collaboration report collaboration with stakeholders in Norway. Figure 3.6 shows that cooperation locally or regionally in Norway is more prevalent than cooperation in Norway in general.

The scope of cooperation is lower as the geographical distance increases. About half of the firms with R&D collaboration reported that they collaborated with foreign partners. Cooperation with partners in Europe outside the Nordic countries is more prevalent than cooperation in the region. There is far less cooperation with actors outside Europe. China and India are among the priority countries for collaborative research in Norway. Amongst businesses, 8 per cent of companies with R&D cooperation reported that they had partners in China or India. Cooperation with these countries is generally not very widespread in the industrial enterprise sector. Some individual industries stand out, including petroleum, coal supply and chemical industry and machine industry where almost a third of firms with R&D reported that they had cooperation partners in China or India.

3.5.1 Results of innovation in the industrial sector

Figure 3.7
Innovative products as a share of total turnover in EU 27 and associated countries: 2010.



Source: Eurostat

Lack of good indicators and low scores for innovation turnover

Innovation statistics provide good information about the number of innovative enterprises, etc., but the investigation has provided less information on what were the results of innovation for the enterprise. It has proved difficult to develop good indicators on this, but the most commonly used indicator today indicates how much of the total turnover resulted from the sale of new or significantly improved products.

Previously questions about other effects of innovation have been included by asking firms about the importance of various factors on a graduated scale, including: increased profitability; improved production capacity; improved market access; and improved quality of goods and services. It has been shown that it is often difficult for companies to provide information on this within the period that the survey covers. Measurable results of innovations are not necessarily shown immediately, and not many companies evaluated their innovations. Although knowledge about the innovation effects are clearly of interest, the answers to these questions have proved to be of limited value. In the innovation survey for 2010 question on results were therefore replaced by an equivalent formulation that seeks to identify the purpose of the innovation activities. These figures are discussed in Chapter 1.3.

In respect of proportion of turnover in the reference year stemming from innovative products - that is, from new or significantly improved products, (goods or services) introduced during the last three years - Norway appears among the lowest in Europe, with 6 per cent of total revenue, as shown in Figure 3.7. This is still an improvement from the previous survey in which Norway was decidedly last with a figures of just over 3 per cent of total revenue. When distinguishing between manufacturing and service industries the Norwegian figures are 7 and 5 per cent against the EU average of 18 and 11 per cent respectively.

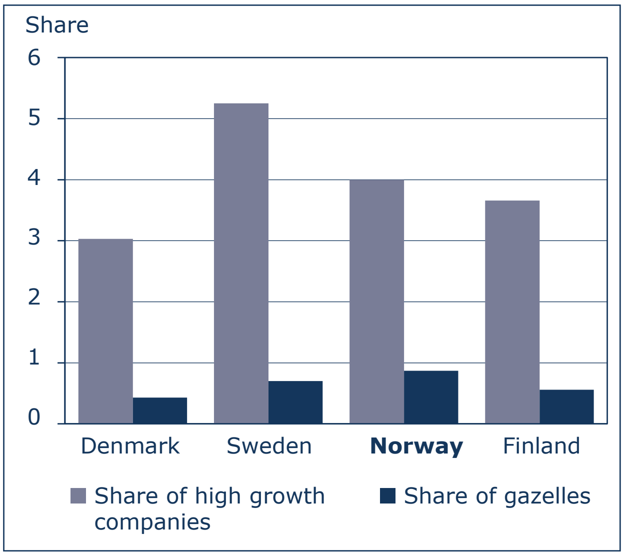
As with the other variables in the innovation survey, it is natural that the weak Norwegian score to some extent may be explained by the Norwegian industrial structure. We know that the variation between industries is very high and that these differences are the same from one survey to another. Norway has a limited number of companies with a high turnover based on sales of consumer-oriented technology products. Large Norwegian industrial companies especially are seldom located in sectors with a high innovation activity of this kind.

Conversely, Norwegian businesses are largely dominated by the oil industry and suppliers within process industries. These industries are undoubtedly technology based and occupy substantial financial capital, yet they are typically not classified as high-tech industries in a European comparative perspective, and they are rarely innovative in the sense that they introduce new products. This is reflected in the results partly as they are often very large businesses with very high turnover and partly because ongoing and continuous improvements in these industries are not reported as innovations.

3.6.1 R&D and innovation in growth enterprises

Figure 3.8

High growth companies[1] and gazelles[2] in the Nordic countries: 2006–2009. Proportion of all companies with at least 10 employees at the beginning of the period: 2006–2009.



[1] At least 20 per cent real growth the last three years.

[2] At least 20 per cent real growth the last three years, not older than two years at starting point

Source: NIFU/Nordic Growth Entrepreneurship Review 2012

An important reason for investment in research and innovation is that such activities will contribute to economic growth and industrial development. Therefore, it is relevant to look at research and innovation in the context of firms' ability to grow.

High proportion of gazelles and growth enterprises in Norway

Economic growth occurs through both the establishment of new enterprises and the growth of existing enterprises. The concept of high-growth enterprises is often used for enterprises that have had a high percentage growth over a number of years. Often one defines a lower limit for the number of employees at the beginning of the period, so that one does not capture enterprise that grows from, for example 1 to 3 employees. The term «gazelles» is often used for start-up businesses that grow rapidly right after they are started. A gazelle can be defined as a high-growth enterprise that is not older than 2 years at the start of the growing season; see fact box.

A new Nordic study compared growth enterprises and gazelles in the Nordic countries for the period 2006–2009. Figure 3.8 shows high growth enterprises as a proportion of all enterprises in the respective country. Sweden comes out with the highest percentage of high-growth enterprises, with Norway ranked as number two in the region. In the period 2006–2009, 988 Norwegian companies were defined as of high-growth enterprises, corresponding to 4 per cent of the enterprises included. Looking at gazelles, Norway was first among the Nordic countries for the period 2006–2009. This applies both when looking at the proportion of gazelles of all enterprises and total number of gazelles. Although gazelles and high-growth enterprises only account for a small proportion of the enterprises, they are important for growth, dynamism and innovation in business.

Growth enterprises - more knowledge-intensive

A key question is however, whether the emergence of these growth companies is a result of research, innovation and knowledge in a broad sense. A closer look at Norwegian high-growth enterprises shows that they have a relatively high proportion of employees with higher education, i.e. master's degree or higher. The share of employees with education at or above this level is almost twice as high in high-growth enterprises as in the other enterprises in the overall population. Furthermore, we find that high-growth enterprises more frequently carried out intramural R&D than other firms. Just over 25 per cent of high-growth enterprises were R&D-intensive compared with 15 per cent among the other enterprises in the population. Taken together, this may indicate that research and access to highly trained staff are factors that contribute to high growth among Norwegian enterprises.

The data provide little opportunity to compare the degree of innovation in growth enterprises with other enterprises. Still it seems as if high-growth enterprises in Norway have a higher degree of organizational innovation than other firms. This could indicate that strong growth requires changing the organization and working methods of the entity.

High-growth enterprises and gazelles

There are different ways to classify and measure the growth of enterprises. The OECD defines high-growth enterprises as enterprises with an average annual real growth of at least 20 per cent over three years. Enterprises must have at least 10 employees at the beginning of the period. Gazelles follow the same definition, and should not be older than two years at the start of the period. Growth can be measured in both turnover and number of employees. The calculations above are subject to the OECD definition, and the projected growth in employment based on registry data from the Nordic countries.

4 Regional comparisons of R&D and innovation

Hebe Gunnes, Kristine Langhoff, Espen Solberg,
Olav R. Spilling, Lars Wilhelmsen

Expenditure on R&D and innovation by region and county

- R&D activities in Norway are geographically concentrated in university cities and certain industrial clusters.
- Nearly three-quarters of total R&D expenditure in Norway was used in the four counties of Oslo, Sør-Trøndelag, Akershus and Hordaland in 2011.
- 46 per cent or 20.8 billion NOK of the total R&D expenditure in 2011 was concentrated in the Oslo area or the capital region (Oslo and Akershus), while the smallest research region was Innlandet (Hedmark and Oppland) with 0.8 billion NOK in R&D expenditure.
- Of the six Norwegian regions the capital region (Oslo/Akershus) has the highest rank in the European Regional Innovation Scoreboard and is considered a «follower high». In comparison Sweden, Finland and Denmark, have respectively, 5, 3 and 2 leading regions on the European Regional Innovation Scoreboard.
- Oslo and Sør-Trøndelag had the highest R&D expenditure per capita in 2011, both with over 24 000 NOK per capita.
- The counties of Vestfold, Sør-Trøndelag and Oslo have had the highest relative growth in R&D expenditure in the decade 2001–2011.
- Over the past five years there has been a centralization of R&D activity in the industrial sector. Oslo and Akershus accounted for just below 41 per cent of R&D expenditure in the industrial sector in 2005 and close to 49 per cent in 2011.
- The industrial sector was particularly important for the counties in the Oslofjord region, accounting for over half of R&D expenditure in Østfold, Buskerud, Vestfold and Telemark.
- Public funding accounted for half or more of R&D expenditure in Finnmark, Troms, Oslo, Hedmark, Nordland, Nord-Trøndelag, Oslo and Sør-Trøndelag.
- The counties' allocation of research activity depends on the composition of the R&D-performing sectors. With most of the R&D expenditure in the industrial sector, Buskerud and Vestfold had the highest proportions of experimental development R&D activities in 2011.
- As a share of gross regional product the industrial sectors' R&D expenditure was highest in Sør-Trøndelag with 2.01 per cent in 2010, but this share has declined from 2.29 per cent in 2007. Rogaland and Hordaland have also had a declining R&D intensity, while the greatest relative increase was in Oppland.
- Innovation activity within the industrial sector shows a greater regional distribution than the R&D activity.

Regional distribution of human resources

- 4 of 10 researchers in Norway were employed by an institution or business in Oslo and Akershus. Fewest researchers were found in the Innlandet region and the Agder region.
- Looking at researchers per 1 000 employees, the highest researcher density was to be found in Sør-Trøndelag with 46 researchers per 1 000 employees, followed by Oslo (43), Troms (28) and Hordaland (22).

Even though new communication technologies have made it possible to collaborate over great distances, the geographical location of R&D and innovation activities is still of great importance. Much knowledge-intensive activity is concentrated in certain regions and for some of this activity single regions can have a distinct influence in a global context. For instance, OECD shows that patenting in ICT, biotechnology and nanotechnology is concentrated in a few so-called «technology hotspots» (OECD, 2011). Silicon Valley in California is the best known example, but also regions like Bavaria in Germany and the Kanto region in Japan account for a large share of the world's patents in these three technology areas.

The R&D statistics show that research is often concentrated around the capital region. Internationally, this is the rule more than the exception. In Norway the Oslo region accounts for slightly less than half of Norway's total R&D activity, but in many countries, the capital region accounts for well above half of the total, which is the case for, among others, Denmark and Finland.

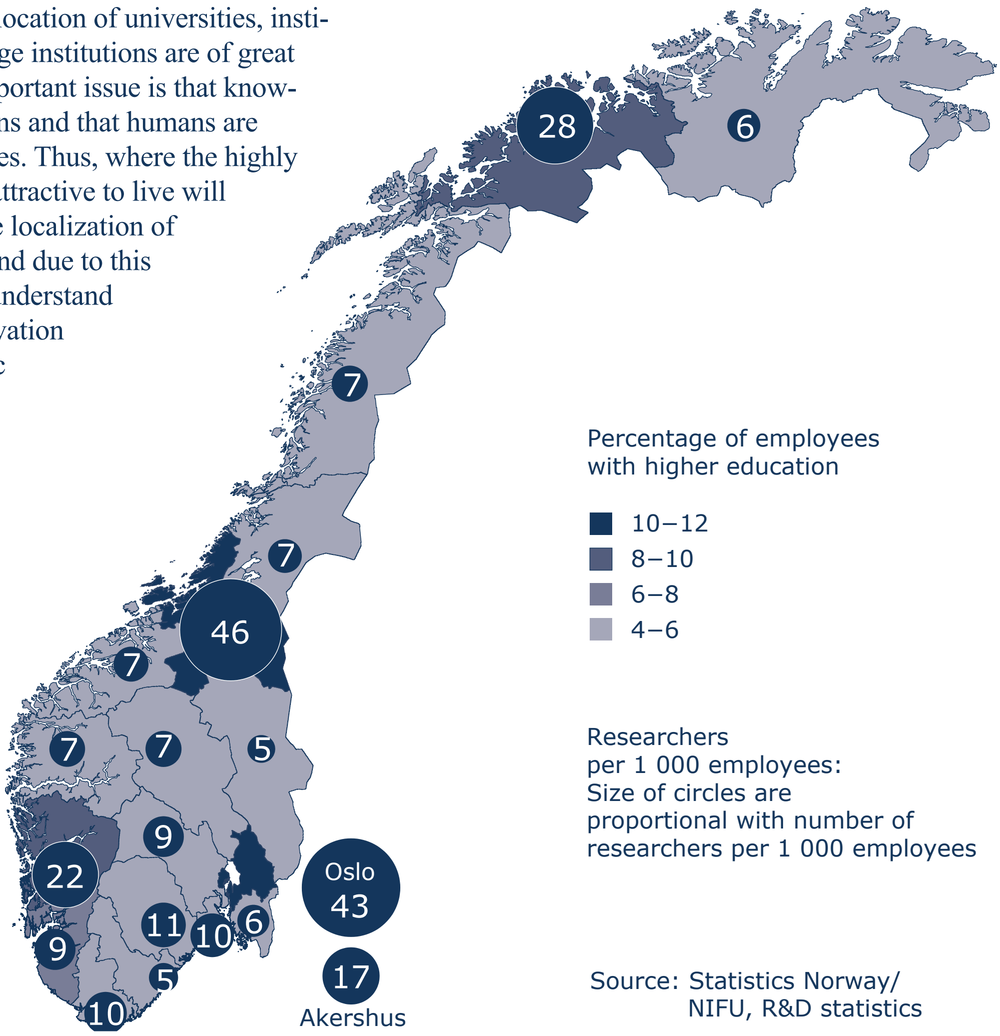
There are many reasons why R&D and innovation activities are concentrated in certain regions. Industrial structure and location of universities, institutes and other knowledge institutions are of great importance. Another important issue is that knowledge is related to humans and that humans are attached to specific places. Thus, where the highly educated people find it attractive to live will also be important for the localization of R&D and innovation. And due to this issue there is a need to understand regional R&D and innovation from a broader, systemic perspective.

Consequently, studies of regional innovation systems have emerged as an important part of research on innovation systems. As discussed in the Norwegian version of the Report on Science and Technology Indicators for 2012 (p. 159–160) there are several types of regional innovation systems. Some innovation systems are locally based, while others may have considerable elements of international cooperation and networking with other regions.

The cluster theory represents another branch of innovation system studies, which look at innovation from a regional and systemic perspective. The cluster theory is, however, controversial. Also, it focuses primarily on cooperation between companies. Thus, a cluster is therefore not necessarily geographically rooted.

In the following chapter, we will highlight the regional distribution of Norwegian research and innovation. Firstly, we look at the Norwegian regions compared with regions in other countries. Then we will focus on the regional distribution within Norway, regarding, among other things, research investments, human resources and innovation activity.

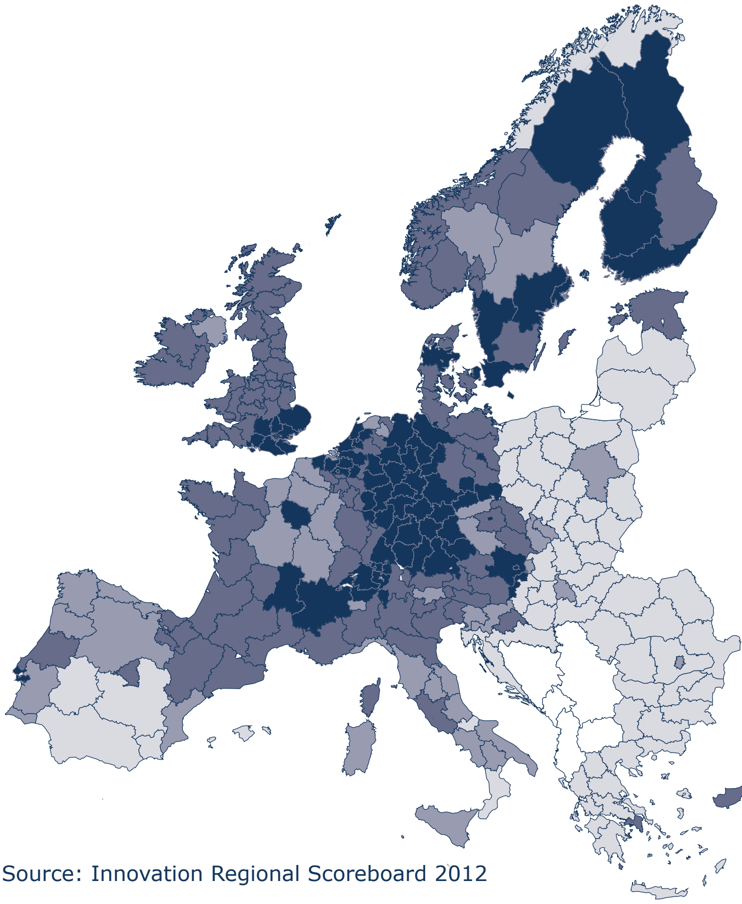
Figure 4.1
Proportion of employees with higher education and share of researchers per 1 000 employees, by county: 2011.



Source: Statistics Norway/ NIFU, R&D statistics

4.1 Norway in Regional Innovation Scoreboard

Figure 4.2
Regional distribution of innovation intensity in the EU Innovation Regional Scoreboard: 2012.



Norwegian regions in the Regional Innovation Scoreboard 2012

Region (NUTS2)	Status
Oslo/Akershus	Follower – high
Trøndelag	Follower – medium
Sør-Østlandet	Follower – low
Agder	Follower – low
Vestlandet	Follower – low
Hedmark and Oppland	Moderate – medium
Nord-Norge	Modest – high

Source: Innovation Regional Scoreboard 2012

The European Commission's ranking of national innovation is widely discussed and debated, see also section 1.3. Innovation is also largely dependent on regional conditions and frameworks. Therefore the Commission periodically publishes a comparison of innovation capacity between 190 regions in Europe, the so-called Regional Innovation Scoreboard (RIS). RIS operates with quite broad regional regions. Norway is divided into seven large regions.

Regional differences follow national patterns

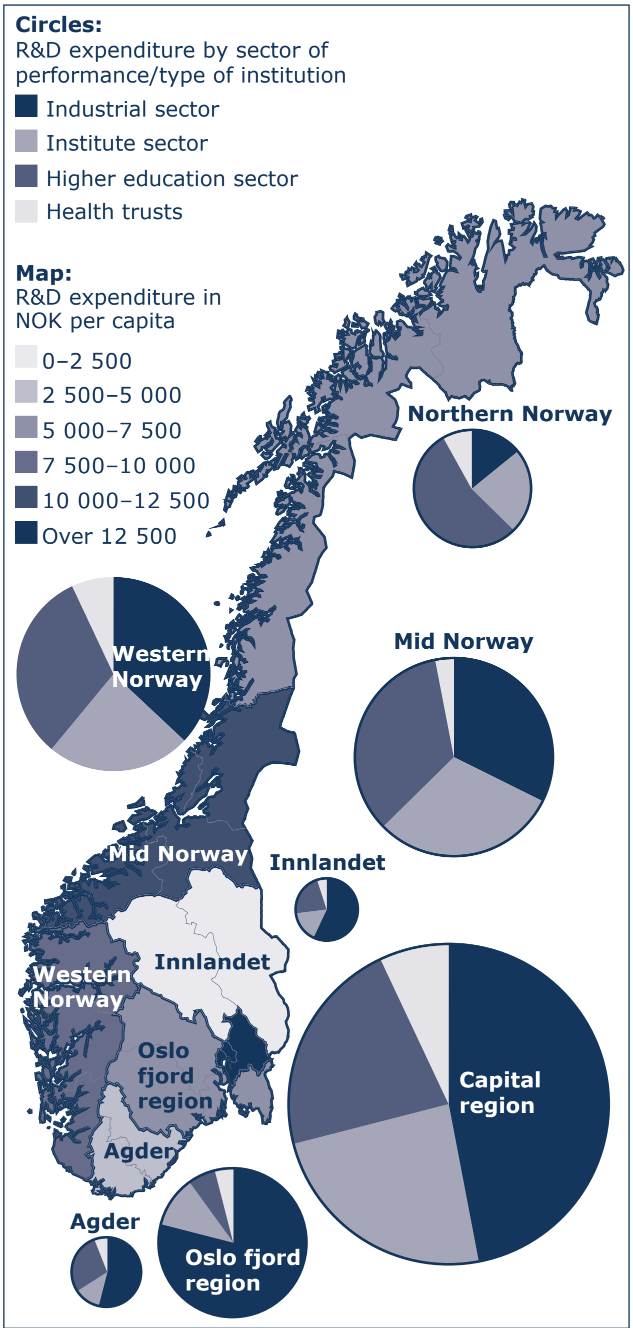
Following the pattern of the national ranking, the regions are divided into four categories: «innovation leaders», «innovation followers», «moderate innovators» and «modest innovators». In addition, the regions are ranked according to whether they are high, medium or low within each of these categories. The main picture in the regional rankings reflects the rankings in the international comparison. For example, 12 of the 16 German regions are ranked as leaders. A total of 39 regions in Europe are ranked as leading innovation regions. Most of these are capital, or larger cities, regions. No Norwegian regions are considered among the leaders. The closest to that category is the Oslo/Akershus-region which is considered as a «follower high». In comparison Sweden, Finland and Denmark, have respectively, 5, 3 and 2 leading regions on the European Regional Innovation Scoreboard.

The Regional Innovation Scoreboard builds on a regional breakdown of the indicators in the Innovation Union Scoreboard. Thus, it is natural that the two rankings reflect each other. As some of the indicators do not have a regional dimension, there are only 12 indicators in the regional rankings compared to 24 in the national ranking. Eight of the indicators in the RIS are from the R&D and Innovation Survey.

Innovative regions also in less innovative countries

The RIS ranking also uncovers major regional differences within each country. For instance, France and Portugal consist of regions in all four categories of innovation ability, from the highest to the lowest level. Norway does also have a large spread of categories, but is lacking a region in the top category. It is also interesting that leading innovation regions are to be found in countries that are ranked low on innovation ability. For example, the regions of Lisbon and Prague are regarded as leading, although Portugal and the Czech Republic are ranked low as innovation nations.

Figure 4.3
Total R&D expenditure by sector, per capita and by region of funding, 2011.



Source: Statistics Norway/NIFU, R&D statistics

Distinct regional concentration of R&D

If the R&D expenditure is allocated by funding region, the capital region is dominant with a total of R&D expenditure of 20.8 billion NOK in 2011, representing 46 per cent of the country's total R&D expenditure. The second largest region was Midt-Norge with 7.9 billion NOK, followed by Vestlandet with an R&D expenditure of 7.7 billion NOK. The smallest research region was Innlandet, with 0.8 billion NOK.

The regions also have an unequal distribution of research by sectors. In the Oslofjord region the industrial sector dominated with nearly 80 per cent of the R&D expenditure. Especially Buskerud, and in particular Kongsberg have a significant R&D intensive industry. For Innlandet and the Agder region the industrial sector also accounted for more than half of the R&D expenditure. The higher education sector was the largest research sector in Northern Norway and accounted for over 54 per cent of the total R&D in this region. The higher education sector, the industrial sector and the institute sector accounted for about the same share of the R&D expenditure in Mid Norway. As R&D performing institutions, the health trusts were relatively small in all the regions; 7 per cent of total R&D expenditure in the capital region.

The industrial sector was the main source of funding in the Oslofjord region in 2011. This region has no universities and only a few units in the institute sector. Also in the Agder region the industrial sector was the largest sector, accounting for almost half of the R&D expenditure. Half of the R&D activity in Western Norway was financed through public funds, which were also the largest source of funding in the Mid Norway region. In Northern Norway as much as 77 per cent of R&D expenditure was financed by public funds. Public funding was also the largest source of financing both in the Capital region and for Innlandet, barely larger than funding from the industrial sector. Foreign sources accounted for just below 10 per cent of total R&D expenditure and were of greatest significance in Innlandet were it accounted for 11 per cent of the total R&D for the region. Other sources were marginal in all of the regions, and funded between 2 and 4 per cent of total R&D.

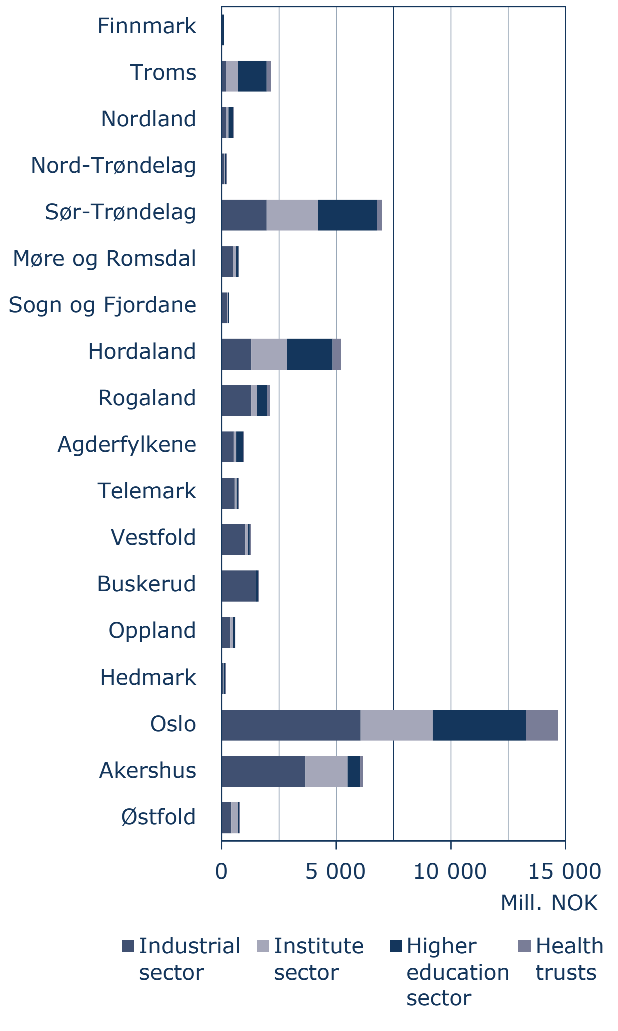
Regions

R&D expenditure can be allocated by different regional classifications. Internationally the reports are by NUTS2, a geographical standard developed by the EU, and where Norway is divided into seven regions. The establishment of the regional research funds in Norway in 2010 resulted in a slightly different regional division, but also with seven regions by which the R&D expenditure in this chapter are allocated:

- The Capital region: Oslo and Akershus
- Innlandet: Hedmark and Oppland
- Oslo fjord region: Østfold, Vestfold, Buskerud and Telemark
- Agder region: Aust-Agder and Vest-Agder
- Western Norway: Rogaland, Hordaland and Sogn og Fjordane
- Mid Norway: Møre- og Romsdal, Sør-Trøndelag and Nord-Trøndelag
- Northern Norway: Nordland, Troms and Finnmark

4.3 R&D expenditure by county

Figure 4.4
Total R&D expenditure by sector of performance and county, 2011.



Source: Statistics Norway/NIFU, R&D statistics

Great variation in the counties' R&D expenditure

The structure of the industrial sector as well as the localization of the major higher education institutions, particularly the universities, affects the size of R&D expenditure in each county. As in many other countries, R&D expenditure in Norway is geographically concentrated. Nearly three-quarters of the total R&D expenditure in Norway was spent in the four counties of Oslo, Sør-Trøndelag, Akershus and Hordaland in 2011.

Oslo is in a class by itself in terms of expenditure on R&D, see figure 4.4. In current prices NOK 14.6 billion was used for this purpose in Oslo in 2011. This represents 32 per cent of the total expenditure spent on research and development in Norway. The country's largest university is located in Oslo, together with the country's largest state university college and several other major colleges. In addition about half of the R&D efforts at the health trusts are performed in Oslo. In the institute sector the Oslo-based research institutes and units with R&D allocated almost a third of the total R&D expenditure in this sector. Also, the industrial sector in Oslo consists of several major companies. These accounted for 30 per cent of R&D expenditure in the industrial sector in 2011.

The second largest county in terms of R&D expenditure was Sør-Trøndelag, where 7.0 NOK billion was spent on R&D in 2011. Almost all of the R&D activities in this county took place in Trondheim, where NTNU, SINTEF and companies related to these institutions are the major locomotives. Sør-Trøndelag is then followed by Akershus where R&D expenditure amounted to 6.2 NOK billion and by Hordaland where 5.2 billion NOK were spent on R&D. While Hordaland has a large higher education sector consisting of the University of Bergen and several colleges, this sector is small in Akershus. The industrial sector in Akershus performed R&D equivalent to nearly a fifth of the total R&D performed by the industrial sector in Norway. The industrial sector in Hordaland accounted for barely 6 per cent of the total R&D in this sector.

The R&D expenditure in the counties of Hedmark, Aust-Agder, Sogn og Fjordane, Nord-Trøndelag and Finnmark, amounted to less than 1 per cent of the total R&D expenditure in Norway.

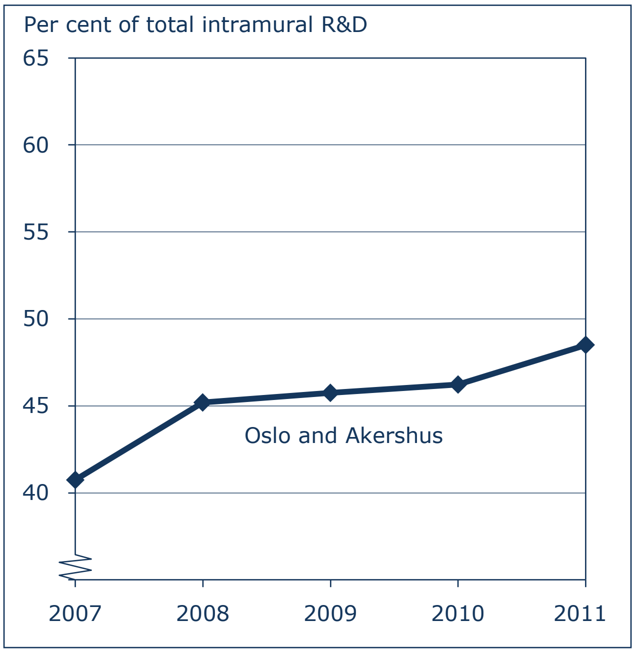
Oslo and Sør-Trøndelag had the highest R&D expenditure per capita in 2011, both just over 24 000 NOK. Troms spent 14 000 NOK per capita on R&D, while nearly 12 000 NOK was spent in Akershus and 11 000 NOK in Hordaland.

The university counties dominate

The localization of the universities is of great significance for where the research activity in Norway is carried out. All in all, 85 per cent of the R&D expenditure was spent in the country's eight university counties in 2011. Especially counties where the four «old» universities are located, that is Oslo, Hordaland, Sør-Trøndelag and Troms, score highly on the R&D indicators. In all of these counties, the higher education sector is important, but the institute sector is also quite large in terms of R&D expenditure.

In the four new university counties, that is Akershus, Rogaland, Vest-Agder and Nordland, the industrial sector plays a more important role than the higher education sector. In Akershus there is also an extensive R&D activity in the institute sector, but this sector has relatively little impact in the other new university counties.

Figure 4.5
Intramural expenditure on R&D in the industrial sector in Oslo and Akershus: 2007–2011.



Source: Statistics Norway, R&D statistics

Table 4.1
Total intramural R&D expenditure in the industrial sector: 2007–2011. Mill. NOK, current prices.

County	2007	2008	2009	2010	2011
Østfold	388	384	331	369	430
Akershus	2 664	3 063	3 344	3 132	3 666
Oslo	4 162	5 206	4 983	5 426	6 065
Hedmark	82	74	75	85	66
Oppland	397	355	279	270	386
Buskerud	1 233	1 176	1 120	1 260	1 507
Vestfold	715	800	856	936	1 040
Telemark	479	680	636	747	575
Aust-Agder	118	298	172	149	134
Vest-Agder	520	606	634	419	399
Rogaland	1 449	1 287	1 278	1 292	1 291
Hordaland	1 321	1 433	1 136	1 108	1 301
Sogn og Fjordane	206	224	192	265	233
Møre og Romsdal	564	592	645	627	498
Sør-Trøndelag	1 938	1 954	1 905	2 007	1 973
Nord-Trøndelag	96	89	117	93	97
Nordland	230	266	236	242	214
Troms	171	164	222	251	187
Finnmark	7	5	15	10	3
Total	**16 755**	**18 295**	**18 202**	**18 514**	**20 066**

[1] These regional figures are calculated using differently weighted data, so that the values of the individual variables (calculated with national weighting) will differ slightly from the sum of the counties shown here.

Source: Statistics Norway, R&D statistics

Increased centralization of R&D activity

Regarding the regional distribution of R&D in the industrial sector, the most obvious trend over the past five years is that there has been a centralization of the R&D activity in Norway. This has been particularly directed towards Oslo and Akershus, as shown in Figure 4.5. Measured in fixed prices the intramural R&D activity reached a national peak in 2008, followed by three years of stagnation or real decrease in the R&D costs. A new real increase in 2011 was just enough to bring the price-adjusted R&D effort slightly above the 2007 level. The trend shown in the figure can also occur in a situation where R&D costs in Oslo and Akershus grow faster than in the other counties. Since the total R&D costs are approximately constant measured in fixed prices, the figure shows that there is an actual shift in the R&D activities.

This also applies to the other counties that are relatively large R&D performers in a Norwegian context. Sør-Trøndelag, Rogaland and Hordaland – which was ranked lower than Oslo and Akershus at the beginning of the period – have all had a real decrease between 2007 and 2011. Buskerud, however, has seen an increase over the last three years and is by now the fourth largest R&D county. Apart from Oslo and Akershus, there is only one county where there has been a steady increase during the whole period. This is Vestfold, which in 2011 for the first time conducted research in the industrial sector for over one billion NOK.

The composition of the industries in each county affects centralization

The aggregated numbers give however no clear indications of why this shift has occurred. It might be that enterprises with several companies have moved their R&D to the counties in growth. Enterprises in counties where the R&D activity has declined may have been outdone by enterprises in other counties which have invested more in R&D.

Or it could be that the industries with the highest growth in R&D expenditure are mainly located in the east of Norway, while industries which have reduced their R&D activity to a greater extent are located elsewhere in the country. In particular, the service industry has experienced serious growth in recent years, and much of this industry is located in Oslo and Akershus. Looking into the numbers/figures of each enterprise we will probably be able to find elements of all these factors, but there may also be other explanations. We cannot immediately determine which of them is the most important.

Appendix

Tables

Table 1
Total R&D expenditure in Norway by sector of performance and source of funds, 2011. 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	23 709.5	18 083.6	..	2 309.1	1 406.2	721.6	2 595.2	264.5
Of which: Industrial sector[1]	20 065.9	16 635.1	..	772.2	335.5	532.1	2 126.5	80.4
Institutions serving enterprises[2]	3 643.6	1 448.5	339.1	1 536.9	1 070.7	189.5	468.7	184.1
Government sector	7 471.5	710.9	139.1	5 871.3	1 751.6	269.3	620.0	181.2
Of which: Institutions serving government	6 966.1	696.2	139.1	5 407.7	1 741.3	242.5	619.7	181.2
Health trusts without university functions	505.4	14.7	-	463.6	10.3	26.8	0.3	0.0
Higher education sector	14 259.4	572.2	86.1	12 766.8	2 517.4	597.5	322.9	225.9
Of which: Universities and specialiced university institutions	10 807.9	500.2	86.0	9 576.2	2 246.9	445.9	285.6	194.9
University colleges	1 180.9	33.1	0.1	1 114.5	107.6	17.5	15.9	14.3
University hospitals	2 270.6	38.9	-	2 076.2	162.9	134.1	21.4	16.7
Total Norway	**45 440.4**	**19 366.7**	**..**	**20 947.2**	**5 675.2**	**1 588.4**	**3 538.1**	**671.6**

[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 science, 2011. Million NOK.

Field of science	Total	Industrial sector	Institute sector	Higher education sector
Humanities	1 527.3	..	215.9	1 311.4
Social scienes	4 890.4	..	1 833.4	3 057.0
Natural sciences	4 386.4	..	2 006.3	2 380.1
Engineering and technology	5 445.6	..	3 626.4	1 819.2
Medical and health sciences	5 913.6	..	1 323.0	4 590.6
Agricultural sciences	1 881.6	..	1 652.3	229.3
Not elsewhere classified	18 532.5	18 532.5	..	..
Total	**42 577.5**	**18 532.5**	**10 657.4**	**13 387.6**

Source: NIFU/Statistics Norway, R&D Statistics

Table 3
**Current expenditure on R&D by type of R&D and sector of performance, 2011.
Million NOK and per cent.**

Sector of performance		Total	Basic research	Applied research	Experimental development
Industrial sector	Million NOK	18 532.5	495.7	3 891.8	14 145.0
	Per cent	100	3	21	76
Institute sector	Million NOK	10 657.4	1 400.4	7 260.5	1 996.5
	Per cent	100	13	68	19
Higher education sector	Million NOK	13 387.6	6 278.9	5 435.9	1 672.8
	Per cent	100	47	41	12
Total	Million NOK	42 577.5	8 175.0	16 588.3	17 814.3
	Per cent	**100**	**19**	**39**	**42**

Source: NIFU/Statistics Norway, R&D Statistics

Table 4

R&D expenditure in Norway by sector of performance and type of cost: 1970–2011. 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

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: 1974–2011.

	Total			Industrial sector[1]			Institute sector			Higher education sector		
Year	Total	Resear-chers[2]	Women (%)	Total	Resear-chers[2]	Women (%)	Total	Resear-chers[2]	Women (%)	Total	Resear-chers[2]	Women (%)
1974	9 756	..	..	1 419	..	..	3 286	306	9	5 051	606	12
1977	10 818	..	..	1 688	..	..	3 517	334	9	5 613	775	14
1979	11 851	..	..	2 017	..	..	3 982	375	9	5 852	841	14
1981	12 939	..	..	2 316	..	..	4 376	511	12	6 247	955	15
1983	14 002	..	..	2 909	..	..	4 663	504	11	6 430	1 032	16
1985	15 923	..	..	4 475	..	..	4 792	638	13	6 656	1 178	18
1987	18 128	..	..	5 897	..	..	5 343	843	16	6 888	1 336	19
1989	19 515	3 599	18	5 861	741	13	5 882	1 131	19	7 772	1 727	22
1991	20 118	4 020	20	5 671	780	14	5 909	1 204	20	8 538	2 036	24
1993	21 879	4 837	22	6 192	966	16	6 339	1 500	24	9 348	2 371	25
1995[3]	26 712	6 454	23	8 012	1 209	15	6 048	1 551	26	12 652	3 694	29
1997	30 280	7 907	26	10 377	1 815	18	6 118	1 730	28	13 785	4 362	32
1999	30 994	8 629	28	10 710	2 063	19	5 920	1 727	29	14 364	4 839	34
2001	34 549	9 904	29	13 308	2 574	19	6 077	1 912	31	15 164	5 418	36
2003	35 307	10 350	29	12 741	2 202	17	6 350	2 049	32	16 216	6 099	38
2005	36 570	11 570	32	11 999	2 242	19	6 484	2 207	34	18 087	7 121	39
2007	41 347	13 867	34	14 068	2 788	20	7 467	2 730	37	19 812	8 349	42
2008	43 715	14 902	34	15 412	3 100	20	7 713	2 925	38	20 590	8 877	43
2009[4]	44 762	15 770	35	15 249	3 191	21	8 198	3 187	39	21 315	9 392	44
2010	44 774	15 998	36	14 854	3 121	21	8 277	3 270	40	21 643	9 607	44
2011	45 578	16 504	36	15 332	3 304	22	8 434	3 417	41	21 812	9 783	45

[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: 1970–2011.

	Total			Industrial sector[1]			Institute sector			Higher education sector		
Year	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

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: 2011.

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	Percentage of innovative companies involved in cooperation on innovation	Innovation activity financed by Innovation Norway Per cent	R&D intensity in the industrial sector	Percentage of publicly financed R&D	Percentage of funding from Research council of Norway
Norway	**8**	**2 420**	**44**	**23**	**100**	**1.04**	**46**	**100**
Østfold	5	224	53	21	2.7	0.53	23	0.8
Akershus	10	1 016	59	23	2.7	1.72	32	13.7
Oslo	17	6 554	42	27	5.2	1.44	50	30.8
Hedmark	5	412	37	15	4.1	0.17	62	0.4
Oppland	5	513	63	20	4.3	0.55	41	0.9
Buskerud	6	227	93	25	3.7	1.56	7	0.8
Vestfold	6	333	81	26	2.3	1.48	22	0.5
Telemark	5	418	76	22	3.2	1.48	22	0.7
Agder counties	6	980	54	19	6.2	0.66	44	0.8
Rogaland	7	961	61	19	6.8	0.69	29	3.6
Hordaland	8	4 098	25	25	6.3	0.62	65	12.9
Sogn og Fjordane	4	465	71	27	4.9	0.73	29	0.3
Møre og Romsdal	4	440	67	26	6.6	0.69	28	1.1
Sør-Trøndelag	10	8 679	28	25	4.9	2.01	50	22.4
Nord-Trøndelag	5	409	42	21	5.3	0.27	54	0.6
Nordland	4	908	39	21	7.2	0.33	59	1.0
Troms	8	7 407	9	21	6.4	0.53	80	5.8
Finnmark	4	858	3	13	3.1	0.04	86	0.1

Source: Statistics Norway/NIFU, R&D statistics

Table 8

EU indicators for science, technology and innovation. Structural indicators in selected countries: 2011 or latest year for available data.

	Structural indicators – Innovation and research	Year of reference	EU 27	Austria	Belgium	Denmark	Estonia	Finland	France	Germany	Iceland	Ireland	Italy	Latvia	Lithuania	Netherlands	**Norway**	Poland	Portugal	Slovenia	Spain	Sweden	Switzerland	United Kingdom	United States
1	**Spending on Human Resources**																								
1.1	Total public expenditure on education as a percentage of GDP	2 010	5.44	5.89	6.57	8.80	5.68	6.84	5.86	5.08	7.60	6.47	4.50	5.01	5.38	5.96	**6.87**	5.17	5.62	5.66	4.97	6.98	5.22	6.22	5.49
2	**Gross domestic expenditure on R&D (GERD)**																								
2.1	Percentage of GDP	2011	2.03	2.75	2.04	3.09	2.38	3.78	2.24	2.84	:	1.72	1.25	0.70	0.92	2.04	**1.65**	0.76	1.49	2.47	1.33	3.37	:	1.75	:
2.2	By source of funds - percentage of GERD financed by industry	2010	53.9	44.7	:	60.7	43.6	66.1	53.5	65.6	:	52.6	44.7	38.8	32.4	:	**:**	24.4	44.1	58.4	43.0	:	:	44.0	:
3	**Level of Internet access**																								
3.1	Percentage of households who have Internet access at home	2012	76	79	78	92	75	87	80	85	95	81	63	69	62	94	**93**	70	61	74	68	92	:	87	:
4	**Science and technology graduates**																								
4.1	Tertiary graduates in science and technology per 1 000 of population aged 20–29 years	2011	16.8	16.1	12.6	17.9	11.9	21.2	:	16.5	:	21.1	12.8	12.8	22.6	9.4	**10.8**	17.5	17.3	17.4	16.8	15.6	16.4	19.5	11.6
5	**Patents**																								
5.1	Number of applications per million inhabitants to EPO	2011	107.5	194.0	115.5	204.9	44.3	243.4	132.4	272.3	:	80.0	63.8	9.0	2.3	194.5	**132.3**	9.9	7.1	64.4	35.3	259.9	370.8	79.5	:
5.2	Number of patents granted per million inhabitants by USPTO	2007	34.2	56.5	36.6	58.3	8.1	94.9	38.7	85.1	12.0	39.6	16.7	0.6	0.1	51.1	**42.5**	1.0	2.8	12.1	7.1	102.2	119.5	36.2	251.4
6	**Venture capital investments**																								
6.1	Early stage investments - percentage of GDP	2012	:	0.008	0.030	0.072	:	0.041	0.032	0.021		0.044	0.004	:	:	0.027	**0.025**	0.002	0.010	:	0.009	0.053	0.030	0.038	:
7	**ICT expenditure**																								
7.1	Information Technology Expenditure - percentage of GDP	2010	2.5	2.0	2.4	2.9	1.4	3.3	2.6	2.6		2.8	1.6	1.1	1.2	2.8	**:**	1.7	2.1	2.0	1.8	2.9	:	3.8	:
8	**E-Commerce**																								
8.1	Percentage of enterprises' total turnover from E-commerce via Internet	2007	4.2	2.8	3.4	:	:	:	:	3.3	:	9.8	0.9	:	5.4	6.1	**8.5**	3.2	:	:	6.2	:	:	7.0	:
9	**Youth education attainment**																								
9.1	Percentage of the population aged 20 to 24 having completed at least upper secondary education	2012	80.2	86.6	82.8	72.0	81.3	86.3	84.4	76.2	58.3	87.2	77.6	84.3	89.3	78.9	**71.3**	89.8	67.5	90.1	62.8	86.4	84.3	81.8	:
10	**E-government on-line availability**																								
10.1	Percentage of online availability of 20 basic public services	2010	84	100	79	95	94	95	85	95	58	100	100	93	72	95	**90**	79	100	95	95	100	70	98	:

	Structural indicators – Innovation and research	Year of refe-rence	EU 27	Austria	Bel-gium	Den-mark	Estonia	Finland	France	Ger-many	Iceland	Ireland	Italy	Latvia	Lithua-nia	Nether-lands	**Norway**	Poland	Portu-gal	Slove-nia	Spain	Swe-den	Swit-zerland	United King-dom	United States
11	**E-government usage by indi-viduals**																								
11.1	Percentage of individuals aged 16 to 74 using the Internet for inte-raction with public authorities	2010	32	39	32	72	48	58	36	37	77	27	17	31	22	59	**68**	21	23	40	32	62	:	40	:
12	**E-government usage by en-terprises**																								
12.1	Percentage of enterprises which use the Internet for interaction with public authorities	2009	72	79	:	:	80	96	76	64	:	88	82	63	92	83	**83**	:	79	93	66	87	:	68	:
13	**Broadband penetration rate**																								
13.1	Number of broadband access lines per 100 inhabitants	2 007	26.5	23.8	30.8	38.7	26.7	29.0	32.7	32.0	:	23.1	21.9	19.5	21.1	38.5	**:**	16.0	20.5	24.1	23.6	31.7	:	31.4	:
14	**High-tech exports**																								
14.1	Exports of high technology pro-ducts as a share of total exports	2012	15.6	12.7	8.6	9.5	14.1	7.3	20.0	13.9	:	20.6	6.4	6.3	5.8	18.3	**:**	5.9	3.2	5.2	4.9	12.9	:	17.4	:

Source: Eurostat

Table 9

EU indicators for science, technology and innovation. Indicators for benchmarking in selected countries: 2011 or latest year for available data.

	EU innovation scoreboard 2012	Year of reference	EU 27	Austria	Belgium	Denmark	Estonia	Finland	France	Germany	Iceland	Ireland	Italy	Netherlands	**Norway**	Poland	Portugal	Slovenia	Spain	Sweden	Switzerland	Czech republic	United Kingdom
	Composite index		0.544	0.602	0.624	0.718	0.500	0.681	0.568	0.720	0.622	0.597	0.445	0.648	**0.485**	0.270	0.406	0.508	0.407	0.747	0.835	0.402	0.622
	ENABLERS																						
	Human resources																						
1.1.1	New doctorate graduates	2010	1.5	2.3	1.5	2.1	0.9	2.6	:	2.7	0.8	1.6	:	1.9	**1.9**	0.5	1.9	1.5	1.2	2.9	3.7	1.3	2.3
1.1.2	Population completed tertiary education	2011	34.6	23.8	42.6	41.2	40.3	46.0	43.4	30.7	44.6	49.4	20.3	41.1	**48.8**	36.9	26.1	37.9	40.6	47.5	44.0	23.8	45.8
1.1.3	Youth with upper secondary level education	2011	79.5	85.4	81.6	70.0	82.6	85.4	83.8	75.8	56.9	86.9	76.9	78.2	**71.2**	90.0	64.4	90.1	61.7	88.7	83.0	91.7	80.1
	Open, excellent and attractive research systems																						
1.2.1	International scientific co-publications	2011	300	1 180	1 280	1 692	734	1 323	683	715	2 349	1131	500	1330	**1 483**	213	678	955	599	1604	2 505	529	989
1.2.2	Scientific publications among top 10% most cited	2008	10.90	10.92	13.59	14.60	7.45	11.48	10.33	11.64	11.19	11.38	10.11	15.13	**12.17**	3.52	10.04	7.39	10.19	12.28	15.84	5.51	13.28
1.2.3	Non-EU doctorate students	2010	20.02	8.78	19.69	15.43	1.55	5.91	35.39	:	20.77	22.25	:	:	**30.93**	1.91	10.59	6.54	17.33	19.99	48.22	4.00	31.42
	Finance and support																						
1.3.1	Public R&D expenditure	2011	0.75	0.87	0.65	0.99	0.87	1.09	0.80	0.94	:	0.55	0.53	0.97	**0.84**	0.53	:	0.64	0.64	1.03	:	0.72	0.64
1.3.2	Venture capital	2011	0.094	0.022	0.090	0.104	:	0.108	0.105	0.057	:	0.026	0.020	0.105	**0.069**	0.051	0.032	:	0.050	0.156	0.094	0.010	0.239
	FIRM ACTIVITIES																						
	Firm investments																						
2.1.1	Business R&D expenditure	2011	1.27	1.87	1.37	2.09	1.49	2.67	1.43	1.90	:	1.17	0.68	:	**0.86**	0.23	:	:	0.67	2.34	:	1.11	1.09
2.1.2	Non-R&D innovation expenditure	2010	0.56	0.35	0.53	0.51	1.03	0.51	0.25	:	:	0.30	0.59	0.61	**0.14**	1.02	0.53	0.56	0.39	0.64	:	0.69	:
	Linkages & entrepreneurship																						
2.2.1	SMEs innovating in-house	2010	31.83	36.35	39.80	:	33.57	33.18	:	45.25	:	:	34.79	39.10	**23.22**	11.34	:	:	:	37.68	:	27.21	:
2.2.2	Innovative SMEs collaborating with others	2010	11.69	20.52	20.15	15.46	18.52	16.50	11.09	14.01	17.44	11.93	4.41	14.87	**9.56**	4.15	8.09	13.63	5.81	17.47	:	10.26	25.23
2.2.3	Public-private co-publications	2011	52.8	86.4	97.1	196.7	25.0	97.9	49.0	75.5	254.7	34.4	33.4	128.2	**115.9**	5.3	17.0	85.4	28.7	147.0	277.8	33.7	79.5
	Intellectual Assets																						
2.3.1	PCT patent applications	2009	3.90	5.11	3.73	7.04	2.35	10.48	4.20	7.42	3.86	2.76	2.10	6.24	**3.61**	0.45	0.65	3.01	1.43	10.54	8.12	0.89	3.23
2.3.2	PCT patent applications in societal challenges	2009	0.96	1.30	0.81	2.66	0.56	1.35	1.04	1.85	1.21	0.80	0.59	1.48	**0.80**	0.12	0.15	1.46	0.39	2.01	2.99	0.20	0.76
2.3.3	Community trademarks	2011	5.86	10.22	5.89	7.93	8.18	6.68	4.21	8.17	3.89	5.92	5.32	7.18	**1.59**	3.16	4.64	4.25	6.78	7.81	12.98	3.34	5.12
2.3.4	Community designs	2011	4.80	8.59	4.65	7.67	3.62	4.56	3.96	7.70	1.19	1.75	6.84	4.12	**0.66**	4.51	4.36	3.56	3.40	5.09	8.56	3.08	2.86
	OUTPUTS																						
	Innovators																						
3.1.1	SMEs introducing product or process innovations	2010	38.44	42.20	50.34	41.60	45.56	44.75	32.68	63.19	55.13	45.50	39.80	46.02	**32.79**	14.36	45.57	32.61	28.09	47.38	:	33.01	21.26
3.1.2	SMEs introducing marketing/organisational innovations	2010	40.30	42.33	41.73	42.64	35.99	38.89	42.80	60.55	45.90	45.04	43.04	36.91	**29.13**	19.95	47.38	37.65	27.74	42.15	:	41.12	30.64

	EU innovation scoreboard 2012	Year of reference	EU 27	Austria	Belgium	Denmark	Estonia	Finland	France	Germany	Iceland	Ireland	Italy	Netherlands	**Norway**	Poland	Portugal	Slovenia	Spain	Sweden	Switzerland	Czech republic	United Kingdom
	Economic effects																						
3.2.1	Employment in knowledge-intensive activities	2011	13.6	14.0	14.8	15.6	10.7	15.3	14.4	15.1	18.5	19.8	13.4	14.9	**15.1**	9.3	9.1	13.7	11.8	17.4	20.0	12.3	17.6
3.2.2	Medium and high-tech product exports	2011	1.28	3.18	2.37	-2.77	-2.70	1.69	4.65	8.54	-13.57	2.57	4.96	1.68	**-17.38**	0.88	-1.20	6.05	3.05	2.02	8.44	3.82	3.13
3.2.3	Knowledge-intensive services exports	2010	45.14	22.21	41.32	63.33	37.40	35.93	32.58	56.70	50.32	73.05	27.19	26.31	**:**	26.14	28.99	20.91	21.61	38.70	26.51	27.26	57.59
3.2.4	Sales of new to market and new to firm innovations	2010	14.37	11.92	12.36	14.96	12.31	15.29	14.73	15.50	6.07	9.32	14.86	10.45	**6.09**	8.00	14.30	10.65	18.97	8.37	:	15.25	:
3.2.5	Licence and patent revenues from abroad	2011	0.58	0.19	0.50	0.79	0.10	1.22	0.57	0.40	:	2.29	0.17	3.69	**:**	0.05	0.03	0.17	0.07	1.16	2.95	0.05	0.58

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
GBAORD	Government Budget Appropriations or Outlays for R&D
GDP	Gross Domestic Product
GUF	General University Funds
HES	Higher education sector
ICT	Information and Communication Technology
IMF	International Monitory Fund
ISCED	International Standard Classification of Education (of UNESCO)
ISI	Institute of Scientific Information
NIFU	Norwegian 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
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

Norwegian 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 the Environment	Miljøverndepartementet	MD
Ministry of Finance	Finansdepartementet	FIN
Ministry of Fisheries and Coastal Affairs	Fiskeri- og kystdepartementet	FKD
Ministry of Foreign Affairs	Utenriksdepartementet	UD
Ministry of Government Administration, Reform and Church Affairs	Fornyings-, administrasjons- og kirkedepartementet	FAD
Ministry of Health and Care Services	Helse- og omsorgsdepartementet	HOD
Ministry of Justice and Public Security	Justis- og beredskapsdepartementet	JD
Ministry of Labour	Arbeidsdepartementet	AD
Ministry of Local Government and Regional Development	Kommunal- og regionaldepartementet	KRD
Ministry of Petroleum and Energy	Olje- og energidepartementet	OED
Ministry of Trade and Industry	Nærings- og handelsdepartementet	NHD
Ministry of Transport and Communications	Samferdselsdepartementet	SD