Report on Science & Technology Indicators for Norway

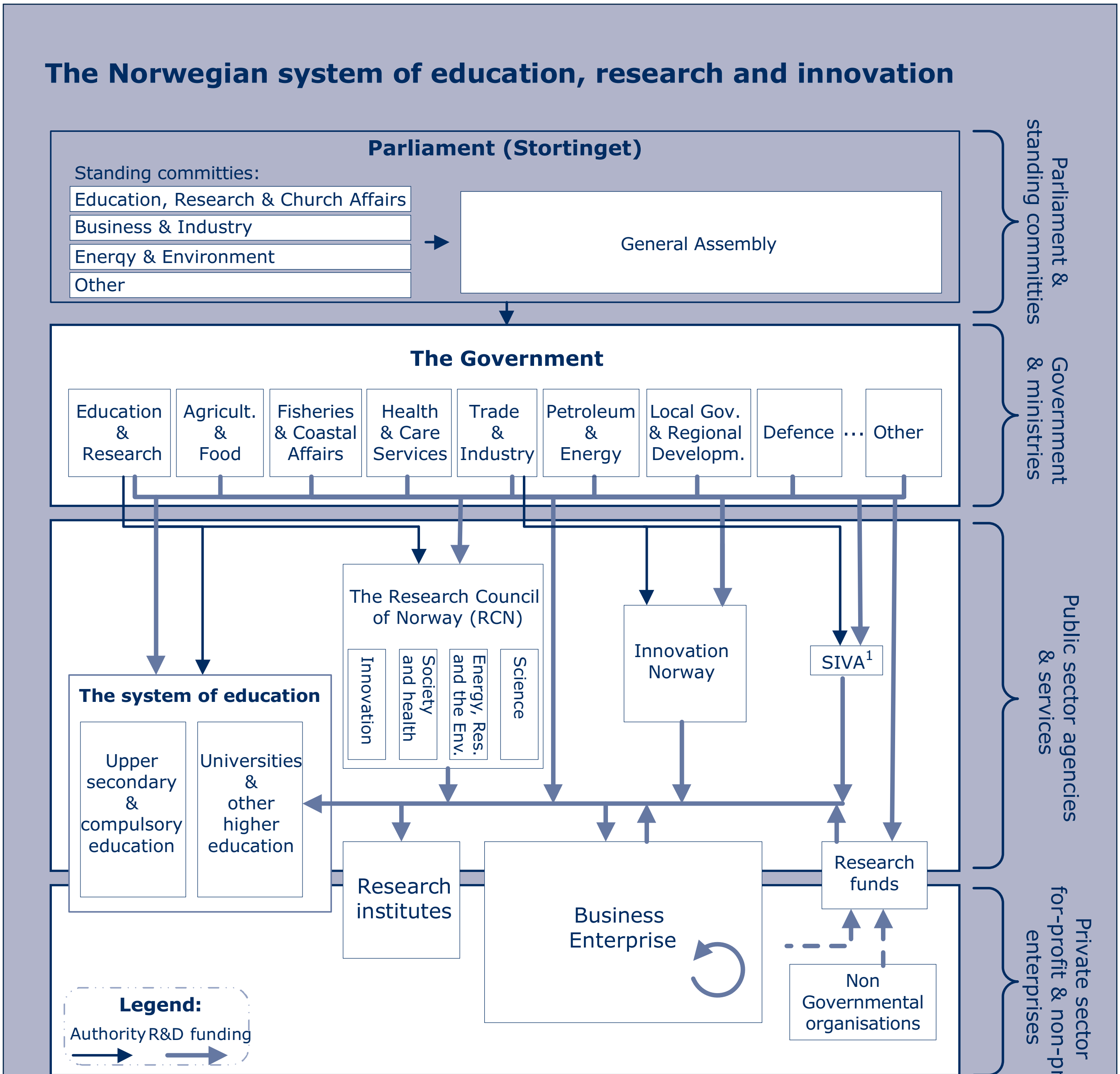
2011

Human Resources

Research and Development

Technology

Innovation



[1] SIVA – The Industrial Development Corporation of Norway.

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Foreword

This new English edition of the Indicator Report provides the most up-to-date data available on research and innovation activity in Norway adapted to an international audience. The report brings together wide-ranging indicators relevant to the development and use of knowledge and research, thereby serving as an important reference point. As well as providing an overview of available data in this important area it presents recent analyses, discussions and explores methodological challenges about how such information is collected and used. Pure data from innovation and research statistics are not sufficient to give us the whole picture - the data must be put into the right context. We hope that the Indicator Report provides a valuable contribution to a real understanding of these complex issues.

There is no obvious way to agree on what an appropriate level of activity in research and innovation should be, or on what kind of results we should expect from it. Financial models or other models provide no concrete answers to these questions. The pragmatic solution to the problem involves acknowledging two things: trends need to be assessed over time and results from any given sector, region or country need to be considered in comparison with others. These considerations have led to a new structure from this year‘s edition of the report with a separate chapter focusing on Norway's position relative to the rest of the world. The report follows up with a more detailed presentation of the various sectors of the Norwegian R&D and innovation system and its development, followed by a chapter with focus on regional comparisons and challenges.

Policy is formulated continually, but annual budget decisions remain of central importance. For this reason, the Norwegian edition is since 2010 published on an annual basis. This will provide the most immediate possible access to robust information about significant developments in this area, to support ongoing assessment. The same considerations apply in explaining the increasing popularity of the internet version of the report. The internet version provides information in downloadable formats, with more detail than the printed version can contain. Tables and figures in the internet edition are also updated regularly throughout the year, as new data becomes available. An overview of the contemporary situation is also provided in the annual publishing calendar («årshjulet»). The complete report is also downloadable as a PDF. So, stay up-to-date via:
http://www.forskningsradet.no/indikatorrapporten.

This report has been produced through cooperation between NIFU, Statistics Norway (SSB) and the Research Council of Norway. Where necessary it also draws in additional expert input and comment, and this year's edition includes NIBR's contributions to the regional chapter. The editorial committee included members from Innovation Norway and the Norwegian Association of Higher Education Institutions (UHR). I wish to thank the editors and all the contributors for their efforts towards this fast-paced and comprehensive work. To the readers and those who use the report, I hope you find the report useful and interesting, and would like to invite your feedback; an ongoing dialogue with those who use this report will help us make this source of information for research and innovation policy even better next year.

Arvid Hallén
Director General
The Research Council of Norway

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Introduction

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.

The full-length Norwegian report presents a larger set of indicators and commentary, divided into international, national and regional sections. 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 directly 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 overview of the Key Indicators presented, before a brief presentation of the Norwegian innovation system. Chapter 1 introduces recent economic developments and then 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 2008 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. Employment statistics and education statistics are also 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 presents regional indicators for R&D and innovation.

Not all sections of the original report are included here. The original Norwegian report also includes 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" that are not included here. 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 2009 (year average):
1 Euro = 8.7 NOK (Norwegian kroner)
1 US$ = 6.3 NOK

As of September 2011:
1 Euro = 7.7 NOK
1 US$ = 5.6 NOK

The Norwegian innovation system

Norway is a small open economy, with just under 5 million inhabitants, that relies heavily on a sophisticated exploitation of several significant natural resources. The Norwegian gross domestic product (GDP) exceeded $55 000 per person in 2010, when measured in constant US dollars.[1] Only four other countries had a higher standard of living. When measured in terms of labour productivity or output per hour worked, Norway ranked second among the most advanced industrial economies, appearing just below Luxembourg. When petroleum activities and ocean transport are excluded, labour productivity was 20 per cent lower but *mainland* Norway appeared just below the USA, the Netherlands and Belgium and was above all other countries where these data are available. Natural resources, innovation, skills, and participation in international research networks were key factors that enhance the performance of Norwegian enterprises.

Flows of technology and knowledge among people, enterprises and organizations define the national innovation system. A complex set of relationships among actors in the system that includes the government, public and private research institutes, universities and enterprises, underlie these flows. The national innovation system also includes the institutional arrangements that provide procedures that facilitate the creation, use and diffusion of new technologies. It also includes the education system, which helps facilitate learning and the creation of new competencies.

There are three distinct layers of enterprises in the Norwegian innovation system:[2] one with small scale enterprises operating with little knowledge accumulation, one with large scale enterprises that are knowledge intensive and rely on collaborative learning, and a third one with small R&D intensive enterprises that rely on collaborative learning with other enterprises and research organizations and likely to operate within global innovation networks. While the different layers are not unique to Norway, this diversity intersects with a specific economic specialization that is related to natural resources. Although relatively large-scale centralized enterprises dominate the economy, offshore petroleum activities have attracted many knowledge-intensive enterprises as well as research organizations.

In the Norwegian innovation system the business enterprise sector carries out almost 52 per cent of Norwegian R&D activity. Traditional industrial activities related to the extraction of raw materials and natural resources (petroleum and natural gas, fish, wood), and to their industrial processing into bulk products and semi-finished goods make up a large share of the Norwegian economy. These industries are less R&D intensive than industries such as pharmaceuticals and ICT, which partly explain why R&D expenditures make up only 1.8 per cent of GDP. When petroleum activities and ocean transport are excluded from GDP, the percentage share of R&D increases to just above the OECD average of 2.3 per cent. There has been broad political agreement that efforts should be made to foster more R&D intensive, knowledge-intensive manufacturing industries and services and in energy technologies, exploiting both renewable and non-renewable sources.

An interesting facet of the Norwegian innovation system is that about 25 per cent of R&D activity is done by independent research organizations, which are formally outside the education system. Historically, these research institutes were established in the Post World War II period as a complement to the universities and were intended to focus on developing specific kinds of knowledge. Many of these organizations began in the public sector, but then became private foundations although most continue to depend on public funding[3]. The remaining third of R&D activity is carried out by the higher education sector. Norway has 8 universities, 6 specialised universities and 25 university colleges. These organizations fund R&D mainly through ordinary budgets, but obtain additional funding for programmes and equipment, mainly from the Research Council.

Governance of the Norwegian innovation system involves many different ministerial bodies, advisory structures and a range of different actors, all concerned with the making and steering of policy and its implementation. The figure on the inside front cover

1 Purchasing power parity. The Conference Board Total Economy Database, September 2011.

2 Olav Wicken 2009. The Historical Evolution of a National Innovation System in Norway in J. Fagerberg, D. Mowery, and B. Verspagen, eds., *Innovation, Path Dependency, and Policy: The Norwegian Case*, Oxford University Press, pp 33-60.

3 In international comparisons the institutes that mainly serve the industrial sector (branch institutes and task-oriented industry institutes) are included in the business enterprise sector according to OECD guidelines.

provides an overview of the various government, public and private actors. The Norwegian Parliament, or *Stortinget*, is the highest political authority for policy debate, legislation and control. While Norway has no single forum focusing solely on science, innovation and technology (STI) policy issues, three Standing Committees of the *Stortinget* deal with these issues directly: (1) Education, Research and Church Affairs; (2) Business and Industry; and (3) Energy and Environment. Policy priorities and relevant appropriations are nevertheless made at the level of the ministries. Three Government Ministries are central in STI funding and policy: (1) Education and Research (KD); (1) Trade and Industry (NHD); and (3) Local Government and Regional Development (KRD). Other ministries also consider STI policy important to their portfolio as the figure illustrates. Several higher-level initiatives have been made in recent years to integrate policy areas to a greater degree across traditional ministerial mandates.

Four agencies have the main responsibility for implementing STI policies: (1) The Research Council of Norway (RCN); (2) Innovation Norway (IN); (3) The Industrial Development Corporation of Norway (SIVA); and (4) The Norwegian Design Council (NDC). The Ministry of Education and Research (KD) administers the RCN, which has the overall responsibility for the promotion of basic and applied research within all scientific and technological areas. Innovation Norway was funded in 2004 and the objective of this state-owned enterprise is to promote private- and socio-economic profitable business development throughout the country, and to release the commercial opportunities of the districts and regions by encouraging innovation, internationalization and image-building. SIVA is a public network organisation that aims to develop strong regional and local industrial clusters through ownership in infrastructure, investment and knowledge networks as well as innovation centres. NDC promotes the use of design as a strategic tool for innovation. Finally also Norwegian counties have their own responsibility for industrial policy and Innovation policy, they are part-owner of Innovation Norway and manage the regional research funds.

The first Norwegian White Paper on innovation policy, titled, *An Innovative and Sustainable Norway* (White Paper No 7) was published in 2008. It was the first comprehensive innovation policy document intended for discussion in the Norwegian Parliament. The White Paper emphasised that an idea or invention does not become an innovation until it becomes a practical application, making it crucial to consider factors that may facilitate the transition from invention to innovation, including lack of critical resources, knowledge, international networks or complementary innovations. The main objectives of Norwegian innovation policy agenda are to: (1) establish better conditions for small and medium sized enterprises; (2) strengthen education and research; and (3) create a more innovative public sector. The White Paper emphasises the role and potential for improvement in education and competence building at all levels, from primary education to higher education, including vocational education and training and lifelong learning. Collaboration between education institutions and enterprises as well as entrepreneurship in education is also emphasised, in particular in higher education. About 22 per cent of the Norwegian population between 18 and 69 are in education and training programmes in 2010, which is more than 50 per cent higher than the EU average, according to Eurostat.

The last White paper of the Norwegian Ministry of Local Government and Regional Development *(Local growth and Hope for the Future*, White paper No. 25 2008–2009) also had innovation policy implications. One main objective of the report was to enable municipal authorities and local communities to make use of local resources and to strengthen local growth. The Norwegian government's objective is that all people shall have real freedom in their choice of where they live.

The 2009 White Paper on research policy, titled, *Climate for Research* (Report to the Storting No. 30 2008–2009) emphasized the continued need to increase R&D expenditures and the role of public finance in facilitating this process. Nine policy objectives are proposed in the White paper, five strategic goals that concern global challenges, social challenges, health and medical issues, knowledge based industry, and research priorities, and four overarching goals that concern high quality, increased internationalization of Norwegian research, more cooperation and efficient use of research funding. The main research priorities become those of the RCN and include food, marine, maritime, tourism, energy, environment, biotechnology, ICT and new materials (nanotechnology).

Key indicators

The following two tables present a set of key indicators. The intention is to introduce essential trends of Norwegian research and innovation in a concise form. The first table shows main trends in Norway. The second table compares 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 2003, 2005, 2007, 2008 og 2009

	2003	2005	2007	2008	2009
Resources for R&D and innovation					
R&D expenditure as a percentage of GDP	1.71	1.52	1.62	1.61	1.81
R&D expenditure per capita in constant 2009 prices (NOK)	7 410	7 550	8 530	8 810	8 675
R&D expenditure funded by government as a percentage of total R&D expenditure	40	43	45	..	46
R&D expenditure funded by industry as a percentage of total R&D expenditure	52	48	45	..	43
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	28	31	32	32	32
Human resources					
Percentage of the population with higher education	31	33	34	36	..
R&D full time equivalents per 1 000 capita	6.4	6.6	7.2	7.5	7.5
R&D full-time equivalents per qualified researcher/scientist per 1 000 capita	4.6	4.7	5.3	5.5	5.5
Percentage doctoral degree holders among qualified researchers/scientists	24	27	27	28	30
Percentage women among qualified researchers/scientists	30	32	33	34	35
Cooperation in R&D and innovation					
Extramural R&D expenditure compared to intramural R&D expenditure in the industrial sector (%)	26	30	28	29	28
Companies involved in cooperation on R&D as a percentage of all R&D companies	46	52	39	..	39
Companies involved in cooperation on innovation as a percentage of all innovative companies	..	37[1]	39[2]	38[3]	..
Articles in international scientific journals co-authored by Norwegian and foreign researchers as a percentage of all articles by Norwegian researchers[3]	50	50	54	53	56
Results of R&D and innovation					
Percentage innovative companies in the business enterprise sector	25	26[1]	25[2]	27[3]	..
Percentage of turnover of new or substancially altered products in the industrial sector		5.9[1]	6.1[2]	4.5[3]	..
Number of articles in international scientific journals per 100 000 capita[3]	125	147	157	186	194
Number of patent applications to the European Patent Organization per million capita[4]	75	105	98	96	..

[1] 2004.
[2] 2006.
[3] Does not include enterprises with 10–19 employees in Construction and Transportation and storage.
[4] By inventor address and by application date, European applications only (EP-A).

Source: 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	EU15	OECD
Resources for R&D and innovation							
R&D expenditure as a percentage of GDP	2009	1.81	3.62	3.02	3.96	2.05	2.33[1]
R&D expenditure per capita (NOK)	2009	8 675	11 890	10 070	12 360	6 275	6 905[1]
R&D expenditure funded by the government as a percentage of total R&D expenditure	2009	47	27	28	24	34[1]	28[1]
R&D expenditure funded by the business enterprise sector as a percentage of total R&D expenditure	2009	44	59	60	68	55[1]	641
R&D expenditure in the higher education sector as a percentage of total R&D expenditure	2009	32	25	30	19	24[1]	17[1]
Human resources							
Percentage of the population with higher education	2008	36	32	33	36	25[2]	28
R&D full time equivalents per 1 000 capita	2009	7.5	8.2	10.4	10.5	5.6	..
R&D full time equivalents per qualified researcher/scientist per 1 000 capita	2009	5.4	5.0	6.4	7.7	3.4	3.5[3]
Cooperation in R&D and innovation							
Companies involved in cooperation on innovation as a percentage of all innovative companies	2008	35	40	57	37	34[4]	..
Companies involved in cooperation on innovation as a percentage of innovative companies in manufacturing and mining	2008	42	40	56	40	32[4]	..
Results of R&D and innovation							
Percentage of innovative companies in the business enterprise sector	2008	30	42	39	43	33[4]	..
Percentage of innovative companies in manufacturing and mining	2008	30	46	41	49	37[4]	..
Percentage of turnover of new or substancially altered products in the business enterprise sector	2008	3.3	9.2	7.8	11.4	13.3[4]	..
Percentage of turnover of new or substancially altered products in Manufacturing or Mining	2008	14.6	18.7	20.4	25.8	23.0[4]	..
Number of articles in international scientific journals per 100 000 capita	2010	194	214	214	185	98	73
Number of patent applications to the European Patent Organization per million capita[5]	2008	96	292	235	234	111	95

[1] 2008.
[2] EU 19.
[3] 2007.
[4] EU 27.
[5] By inventor address and by application date, European applications only (EP-A).

Source: NIFU, Statistics Norway, OECD, Eurostat

1 Norwegian R&D and innovation activities in an international context

Highlights

Economic development and its effect on research and development

- For many countries R&D expenditure as a percentage of Gross Domestic Product (GDP) has increased, however this is often a result of declines in GDP that mask stagnation or even declines in R&D expenditure. Norway is less affected than other countries by the economic crisis and has maintained R&D expenditures relatively well.
- There are uncertainties concerning economic policy actions and their effects on R&D.

Norway in an international context

- Based on the Innovation Union Scoreboard 2010 for the EU, Norway scores lower than the other Nordic countries.
- However, Norway scores relatively highly for the indexes on *Human Resources*, *An Attractive Research System, Financing* and *Entrepreneurship*.

Human resources

- In 2008, the share of the population with a higher education was 36 per cent in Norway, compared to an OECD average of 28 per cent.
- In 2009, 238 doctoral degrees per million inhabitants were awarded in Norway. Sweden and Finland awarded more, Denmark less.
- Norway has one of the highest proportions of researchers per capita in the world.
- The number of Full-Time Equivalents (FTE) of R&D performed in the Norwegian business enter-prise sector is far below the level of the other Nordic countries.

Resources for R&D and innovation

- The share of the worlds' R&D resources accounted for by the USA and Europe has decreased in recent years, while the shares for Latin America and Asia have increased.
- Over recent years, growth in R&D expenditure in Norway has been slightly higher than the world average. However, R&D statistics show that growth in R&D expenditure in Norway has slowed since the financial crisis.
- The business enterprise sector accounted for 52 per cent of all Norwegian R&D expenditure in 2009. In OECD countries the share was almost 70 per cent, which is also typical the level among the larger R&D actors and the other Nordic countries.
- The higher education sector accounts for a large proportion of R&D expenditures in Norway – almost one third – the share of R&D funding from government sources is also greater than in the other Nordic countries.
- There are signs that Norway's participation in European research is strengthening: so far, Norway has received more EU funding via the EU's 7th Framework Programme, than it did during the 6th Framework Programme.

Results of R&D and innovation

- In terms of reported innovation activity in the industrial sector, Norway is below both the EU average and levels of activity in the other Nordic countries.
- However, the percentage of Norwegian enterprises in the service sector reporting product/process innovation is slightly higher than the EU average; the opposite pattern applies in the manufacturing sector.
- Norway scores lower than all EU countries both in terms of R&D as a percentage of revenues and as a percentage of revenues received from the introduction of new products/services.
- Among the Nordic countries, Norway is second only to Iceland in increases in scientific publishing over the last five years.
- There has been a small decrease in the Norwegian citation index during the last three years, breaking the upward trend that had been established over preceding years.
- Norwegian patenting, as registered by the European Patent Office (EPO) from 2000 until 2008, was modest in comparison to other OECD countries.

Norway's research and innovation profile is presented in this chapter, using the most relevant quantitative indicators available. The indicators are primarily based on R&D and innovation statistics, but other data sources are also drawn on. Updating such international data takes time and therefore some preliminary figures are presented. The indicators have been selected to provide the most up-to-date overview possible of the contemporary range, development, vitality and quality of the Norwegian research and innovation system, in comparison with other countries. Trends in traditional research indicators are presented, including those for R&D expenditure, R&D intensity, size of R&D-performing sectors, funding for R&D, and R&D personnel; additionally, more result-oriented indicators of R&D and innovation are presented. Norway is measured against its Nordic neighbours, other small countries and major trading partners. To provide an overview of international trends in the development of national R&D and innovation systems, data on large, international R&D players and key changes in the global distribution of knowledge are also described.

In recent decades, science, technology and innovation have gained attention in national plans and perspectives for progress and prosperity. In line with an increased emphasis on the economic and social importance of research-based knowledge, interest in nations' overall research efforts, and the results of these efforts, has increased. Both the EU and the OECD publish regularly updated scoreboards, comparing member countries' efforts against each other.

The most popular or widely used indicators include long-established measures, but there is also a steady influx of new indicators, offering new overviews and composite indicators. Both nationally and internationally, statistics producers maintain an on-going dialogue about how far current guidelines for data collection, methods and definitions offer the best and most suitable information to members. Norway participates actively in this work.

In 2010 UNESCO examined data from all countries collecting statistics in this area and brought it together to publish the world indicator report. The data included showed that both the distribution of, and results from, investments in research and innovation are changing; while the USA, Europe and Japan dominate this area now, they increasingly face a challenge from Asia, via countries such as China, India and South Korea and from Latin America, particularly Brazil.

In the wake of the financial crisis, the roles science, technology and innovation can play in supporting stable, sustainable development and in meeting major challenges related to demographic change, global health and climate change, have been further highlighted. The OECD concludes that science, technology and innovation have never been more important. It is therefore worrying that some countries are going ahead with cuts in their budgets for R&D and higher education. While it often takes a long time before investments in knowledge come to fruition, such cuts are likely to decrease the human resources required for innovation in the long term. In contrast countries including Austria, Germany, South Korea and the US have increased investment, aiming to improve future prospects for innovation and growth.

1.1 The impact of economic development on R&D

Overall trends in the economy inevitably have an influence on R&D activity, but no clear relationship between growth and R&D investments has been established. The latest OECD figures show that R&D expenditure (in constant prices) grew more slowly between 2007 and 2009 than in the previous two years. Furthermore, these figures are unlikely to capture the full effect of the financial crisis. It is worth noting that while many countries showed an increase in R&D expenditure as a percentage of gross domestic product (GDP) in 2009, this is due to steeper declines in GDP relative to R&D expenditure.

In the 2008 R&D survey of the Norwegian industrial sector the enterprises were asked whether they expected the financial crisis to affect their R&D expenditure in 2009. As these business forecasts suggested a year ago, the financial crisis has had a moderate, negative impact on R&D in Norway. Two thirds of the companies reported that they expected the financial crisis to have no impact on R&D activity. These firms believed they would use a similar amount of resources for R&D in 2009 as previously planned. However, the other enterprises anticipated that the financial crisis would have consequences for their R&D activity: 29 per cent said that the financial crisis would lead to lower R&D investments in 2009 than previously planned, while 6 per cent expected the crisis would result in them spending more than they otherwise would have. It now seems that firms were too optimistic when they made these forecasts, as reported figures for 2009 are lower than such estimates. The survey for 2010 is now underway, but it is difficult to say whether expectations of a stronger economy will help to increase R&D investments enough for R&D expenditure as a proportion of GDP to increase in 2010.

The Norwegian economy is strong compared with most other economies. Figures from Eurostat show that Norway was the European country with the second highest GDP per capita in 2009 (measured in purchasing power parities) behind Luxembourg, but the Norwegian economy has been affected by the global financial crisis, with a fall in production evident during the second half of 2008 and into 2009. GDP growth for mainland Norway was just 1.8 per cent lower in 2009 than the year before (comparing annual averages). This is a smaller fall in growth than that experienced by the USA or by the overall European area, which are Norway's main trading partners.

European and the OECD countries are generally facing major economic challenges, involving both

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

government debt and aging populations. Many countries in the Euro area are likely at the start of a period of fiscal austerity. OECD and IMF figures indicate that the financial crisis led to a larger decrease in GDP in the Euro area than in the USA or Norway, and that expectations for growth are also weaker for the Euro area. Statistics Norway has set out figures showing an upturn in the condition of the Norwegian economy. The outlook is for weaker global growth following the crisis and for Norwegian exports to grow only slightly. Growth in Norway will largely be driven by domestic demand. Statistics indicate that no dramatic international economic recovery can be expected until 2013, and that there is a significant downside risk to such forecasts.

1.2 Norway in international comparison

Traditionally, Norway has scored fairly poorly in international comparisons of R&D activity and innovation. Reviews of Norwegian efforts in research and innovation tend to show that Norway invests less in research than the countries typically used as its comparators. In particular, the business enterprise sector conducts less research in Norway than in many other countries. On the other hand, Norway has a relatively large higher education sector and public sources contribute substantially to financing R&D efforts.

There are several important background factors that shape a country's research profile. Norway can be broadly characterised as a stable democracy with a well-developed welfare state, high levels of education, extensive cooperation between the social partners, low unemployment, high GDP, solid economic growth and as a country where natural resources contribute heavily to the economy. Norway is also, as described above, one of the countries least affected by the financial crisis, even though estimated GDP has decreased somewhat.

Norway's high level of education is a key factor to consider in describing its research profile. The business structure is also important, being characterised by many small and medium sized businesses (SMEs) and the relatively high proportion of value creation that is driven by primary industries, compared to the other Nordic countries and the EU. These kinds of industries consistently show lower R&D intensity than that found in the service sector. The country has a large petroleum sector and a growing service sector, but relatively low activity in some of the typically R&D intensive industries, such as the electronics manufacturing, pharmaceutical and automotive industries. The country therefore has few, large R&D drivers of the sort found in the neighbouring Nordic countries.

Traditional international R&D indicators are, as mentioned above, gradually being supplemented with new indicators which attempt to measure the results of research and innovation. Efforts to design new, future-oriented research policies have boosted demand for a broad spectrum of detailed and comparable statistics. One set of indicators containing both traditional R&D indicators and a range of other innovation-related variables is provided in the EU Innovation Union Scoreboard (formerly European Innovation Scoreboard). This includes 25 indicators, selected to give the best possible picture of overall national efforts related to research and innovation systems. The indicators cover three main types of indica-

R&D Surveys

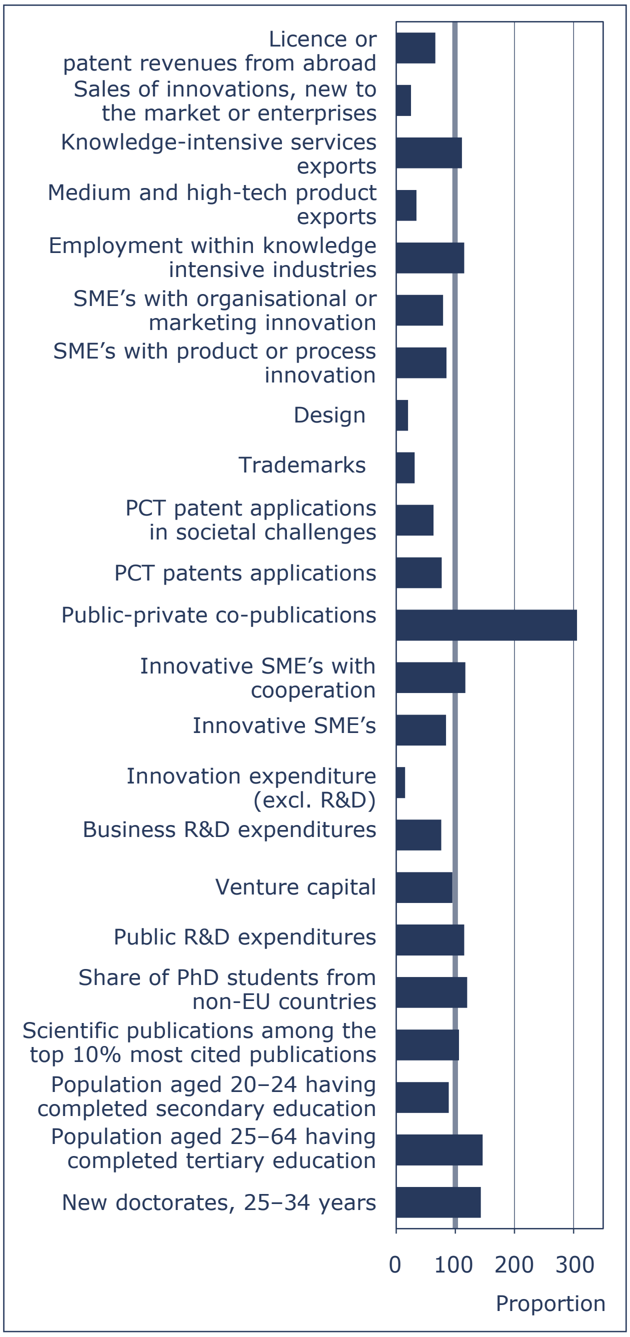
NIFU and Statistics Norway carry out national statistical surveys on resources that are devoted to R&D in Norway. NIFU is responsible for collecting, processing and disseminating statistics and indicators for the institute and higher education sectors, while Statistics Norway is responsible for the industrial sector. NIFU is also responsible for compiling national data into the official R&D statistics for Norway. Annual statistical surveys are carried out for the business enterprise and institute sectors. For the higher education sector, the survey is carried out every second year. Main figures are produced yearly for all three sectors. The statistics are produced using guidelines by the OECD (2002), «Frascati manual».

tors: 1) *enablers* such as human resources, transparency, the excellence and attractiveness of the research system, funding and support; 2) *firm activities*, including business investments, collaboration, entrepreneurship and intellectual property rights; and, 3) *outputs* cover an innovator's dimension and economic effects. This annual indicator set presents an overview of all member countries' efforts within their national research and innovation system. The EU also collects data from several other countries, including Norway, the USA, Japan, China, Brazil, Russia and India.

The EU 27 emerge well from these comparisons overall, although both the USA and Japan score higher. The USA outperforms the EU in 10 indicators, and their lead is gradually increasing. The EU does better in both public R&D expenditures and exports of knowledge intensive services, and has increased their lead in these areas. Japan outperforms the EU on 7 indicators, but scores lower than the EU in terms of numbers of new doctoral degrees, international co-publishing, most cited publications, public R&D expenditure and exports of knowledge intensive services. China, Brazil, India and Russia score far lower than the EU based on overall indicator scores, but countries such as China and Brazil are making serious attempts to close that gap. For China, this is particularly evident in the export of medium-and high-tech products where performance is strong, while Brazil is doing very well in exporting knowledge-intensive services. Russia performs better than the EU when it comes to new doctoral degrees and tertiary education, but overall there is a clear performance lead in favour of the EU.

The EU ranks the countries based on their score in the composite, overall indicator. Norway ends up on the third level in this ranking, grouped as a 'moderate innovator' with a below average performance. Finland, Denmark and Sweden are placed in the group 'innovation leaders' with a performance well above that of the EU 27 average. Finland and Germany are also in the group of countries showing the highest increases in their scores, while Norway belongs to the 'slow growers' group.

Figure 1.1
Norway's relative scores[1] for Innovation Union Scoreboard indicators, 2010.



[1] The areas above 100 are those where national performance is higher than the EU average. Those receiving less than 100 show areas where performance is relatively low.

Source: Innovation Union Scoreboard 2010

FOKUS BOX NO. 1

The use and misuse of statistics in research and innovation policy

We live in a culture where numbers inspire confidence and provide legitimacy to decisions. This is evident in the strong emphasis placed on economic arguments for public investment, and in the widespread belief in 'evidence-based policy development'. The prominence given to quantitative knowledge as a basis for policy and decisions is in part a reflection of the idea that more scientific approaches can provide 'objective' knowledge. Such data are often used over experience-based expertise, which tends to be considered subjective and therefore less reliable.

There is no doubt that the availability of good research and innovation statistics is an essential part of the knowledge base required for good policy. However, as both society and our understanding of society undergo changes, there will inevitably be an on-going need for quality assurance and further development of those statistics.

A good example here is the desire to develop statistics for innovation in the public sector. We know that the public sector plays an important role in social development, and that it affects the innovative capacity of the private sector. Yet we know virtually nothing about this sector's ability to adapt and innovate.

Research statistics emerged in a period when great emphasis was placed on research as a source of innovation and new knowledge. It was therefore natural to focus on indicators for factors such as investment in R&D. The focus was primarily on measuring the inputs and less on understanding the links between investment and anticipated desirable effects (in terms of overall welfare, economic growth, cultural diversity etc.).

Innovation statistics have been further developed through the Oslo Manual – which collects information from companies to see how they go about collecting and making use of knowledge – an approach which broadened perspectives considerably. However, it is still difficult to connect companies' use of knowledge to overall effects of R&D or innovation on wider society. While this latter aim may not be fully realizable – the outcomes and influences are likely too large and complex – these must at least be considered when designing overall policy strategies. However, when an area lacks clear data or numbers, less attention is paid to that area.

This is where we have arrived with these issues: years of significant research have advanced our understanding of knowledge, learning and innovation in society; but these attempts to devise easily understandable statistics have led to measurements that still offer a description of what is going on that, at best, can be described as being of very limited value.

The EU Commission has placed great emphasis on the development of statistics for research and innovation, and deserves credit for this. However, all too often such statistics are used in ways that are plainly misleading. The clearest example of this is the most commonly used indicator of all: R&D as a share of GDP. In itself, this is a useful indicator. It says something about how much of a country's wealth creation is being used in research and development. In political rhetoric it is widely used as a measure of a country's innovation capacity; input is interpreted as output. In this way, investment in research is re-framed as the primary objective, instead of innovation and learning as the basis for welfare and wealth creation.

The Commission has reviewed the development of the European Innovation Scoreboard, now called the Union Innovation Scoreboard, and has tried to respond to such criticism by presenting a composite indicator that takes many different forms of learning and investment in knowledge and innovation into account. This gives the impression of being more objective, but it is not. The choice of indicators and the weighting between them reflects a vision of innovation where research and high technology activities are given greater weight than other forms of learning.

For Norway, this leads to particular problems, as we have an industry structure dominated by industries that invest relatively small amounts in R&D compared with so-called high-tech industries. The oil and gas industry, for example, is by definition 'low tech', as the companies' turnover is so high that even considerable research investments seem relatively modest. The strong focus on research also means that other important forms of innovation become less visible.

We find similar problems with fraction-based indicators in the discussion of R&D as a share of GDP: having one of the world's richest and most productive economies makes it much more difficult to reach the EU's three per cent target. Furthermore, as this target simply focuses on investments in R&D and not on the factors that influence a nation's ability to make use of research, technologies and other forms of knowledge, the social and cultural framework that makes Norway successful is often overlooked. Similarly, Norway has an egalitarian culture that most likely contributes to learning and welfare by offering social security that reduces risk for both individuals and companies. This is not captured by the standard statistics.

There is therefore a need for more realistic narratives that put all the numbers into a larger context, one that does not reduce the 'knowledge society' to a few basic indicators. Norway is leading the way here: this indicator report is considered by many as offering best practice when it comes to placing research and innovation statistics in a broader context. The Ministry of Education aims at something similar through its Research Barometer. In contrast, the EU Commission has decided to close down the Inno-policy TrendChart, that were to give these numbers more meaning in a national context.

Per Koch, The Norwegian Ministry of Education and Research

Figure 1.1 shows Norway's position relative to the EU 27. The Norwegian system's relative strengths are, unsurprisingly, in human resources, an open, excellent and attractive research system, financing and support and entrepreneurship. Areas of relative weakness are found within private sector investments, patents, innovators and results. Changes in scores for some specific indicators have not altered Norway's overall position, compared to the European Innovation Scoreboard from 2009.

Despite the fact that Norway does not score particularly highly on the EU's selected innovation indicators, the country still has good economic results, with a high GDP, high growth and low unemployment. The phenomenon has been termed 'the Norwegian puzzle' and presents a challenge regarding the usefulness and relevance of these indicators. Possible explanations have been sought in terms of high workforce adaptability and the role played by the Norwegian welfare state. However these factors are, to a greater or lesser extent, also present in the other Nordic countries, which scored higher on innovation indicators.

1.3 Human resources

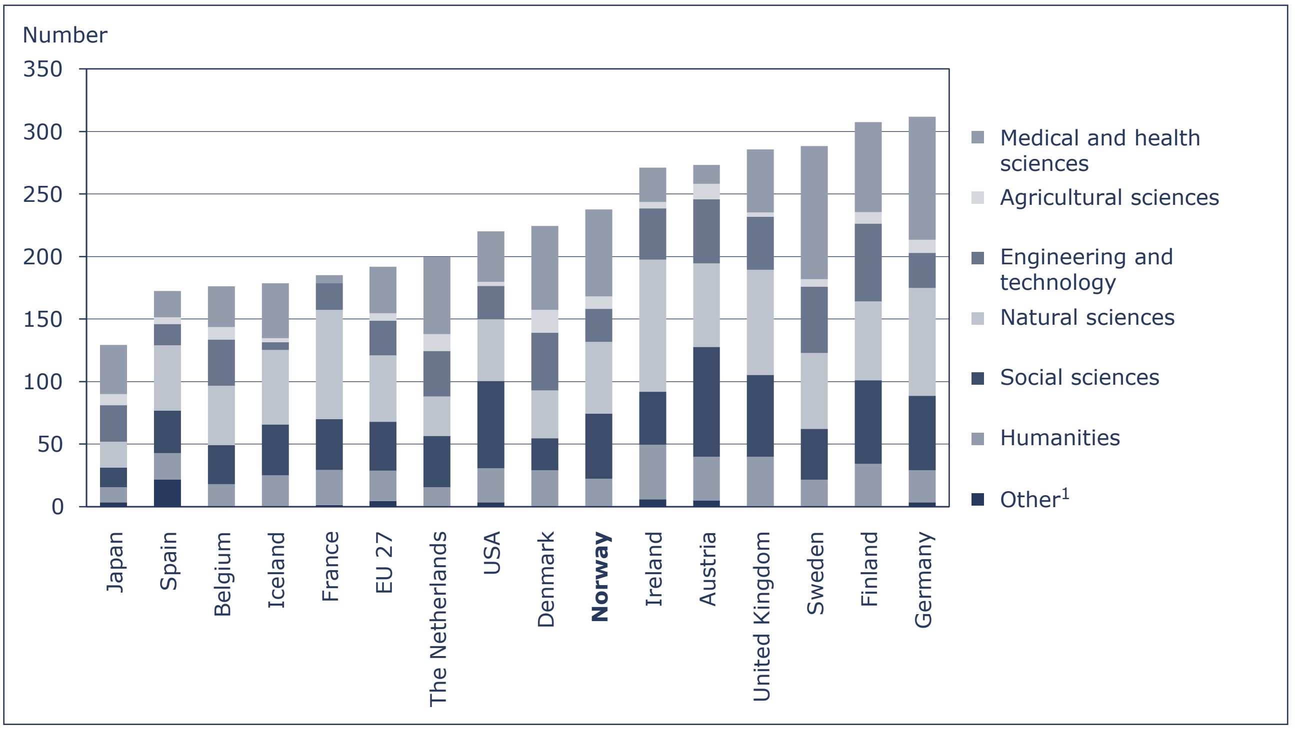
The available human resources in a country are of crucial importance for efforts and achievement in science, technology and innovation. Another important background factor influencing Norway's R&D profile is the country's size: a country with a small population cannot perform very strongly in all areas, industries or fields of research. However, it is important that small states possess a certain level of knowledge within central areas, so that important research findings outside national borders can be exploited. As a high-cost country Norway has focused on ensuring it has highly educated workers: it has a well-developed national system of free education and has retained generous funding for post-compulsory studies. Such large public investments have contributed to today's population having a very high overall level of education. In 2008, the proportion of the adult population with higher education stood at 36 per cent in Norway, compared to an OECD average of 28 per cent.

The unemployment level in Norway is low compared with most other countries. Data from the OECD shows that unemployment levels tend to decrease as the proportion with higher education rises.

The OECD has estimated that among the 59 million immigrants living in OECD countries, 20 million have higher education. Norway is one of the countries that benefits from these migration flows. The share of non-Norwegian citizens has increased more among researchers than the general population in Norway (see chapter 2 for more details). In some cases, overqualified labour may be a sign of a dysfunctional economy. At the same time, the expectation is that economic growth will tend to take place in knowledge-intensive industries, meaning the demand for highly-educated workers should continue to rise.

Statistics Norway have produced projections showing an acute need for people with bachelor-level education in areas including business, health care and nursing, and needs for more post-graduate trained people in areas such as civil engineering and science

Figure 1.2
Number of doctorate degrees per million inhabitants, for selected countries by field of science, 2009.



1 Incl. services and others not classified elsewhere.
Source: OECD/NORBAL

subjects. The natural sciences have proved to be a particularly challenging area in terms of meeting demand for skilled workers. As shown in section 2.1.1, although there has been an increase in the number of people taking higher degrees, this has been accompanied by a decline in the proportion of students taking a science subject; from around 50 per cent in 1990 to fewer than 30 per cent in 2008 (although actual numbers of science graduates have risen, they have not matched overall expansion).

1.3.1 International comparison of human resources

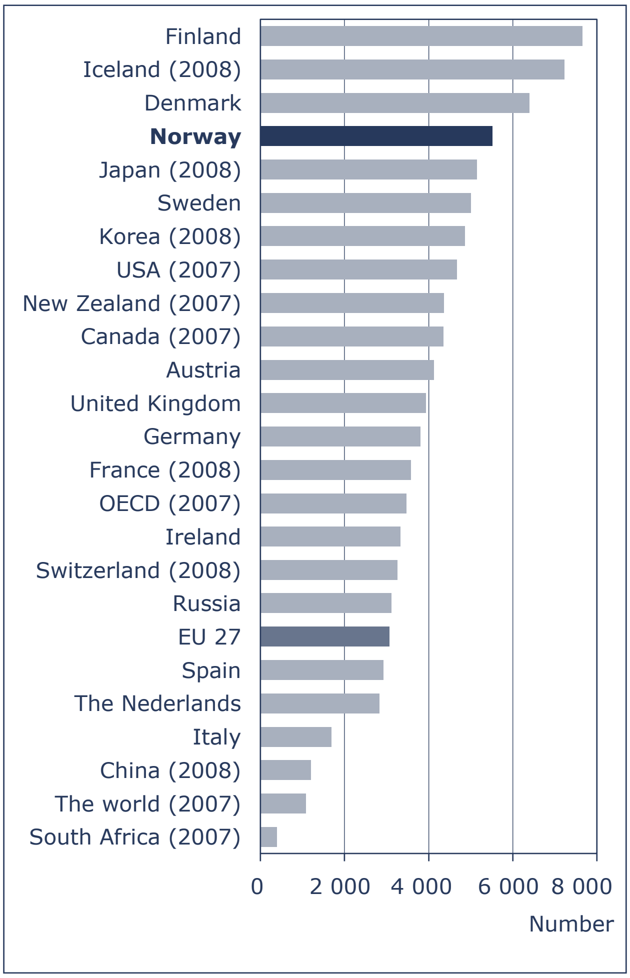
Norway invests the equivalent of 5.5 per cent of its GDP in its education system (across all levels) slightly less than the OECD average of 6.2 per cent. These figures include only public investment, as private investment in education is very low in Norway compared with other countries where the OECD collects such statistics. Among OECD countries 90 per cent of primary and secondary education is paid for through public funds. However, private financing is increasingly significant in university and college education, with the proportion of private funding varying considerably between countries, from under 5 per cent in Norway, Denmark and Finland to over 75 per cent in Chile and South Korea. Norway also scores highly on annual public investment in higher education per student.

A doctorate marks the highest level of research training, and the concentration of such qualifications can therefore be seen as an indicator of the level of competence in a country's research population. It is important to note that there are some national differences in the regulations, content and level of PhD programs.

Norway saw relatively high numbers of new doctorates in 2009, with 238 new doctorates awarded per million inhabitants. The leading countries in terms of the production of new doctorates were Finland and Germany, with over 300 new doctorates per million inhabitants. As figure 1.2 shows, the Norwegian discipline profile for doctorates includes a higher share of degrees in medicical and health sciences, a slightly higher proportion of social sciences and a slightly lower proportion in technology, mathematics, natural sciences and humanities. The other Nordic countries (except for Iceland) have a much higher proportion of doctoral degrees in technology.

If we compare national R&D efforts in terms of the number of researchers (measured as full time equivalents of R&D work conducted) the picture is clearly dominated by China, the EU and the USA.

Figure 1.3
R&D full-time equivalents of higher education, per million inhabitants, 2009 (or last year with available statistics).



Source: OECD – Main Science and Technology Indicators 2010:2

Together, these three giants account for about 60 per cent of the world's research workers. The USA contained about 20 per cent of all researchers working in 2007 (down from 23 per cent in 2002). In terms of absolute numbers, China overtook the USA and the EU recently, with an increase in the number of researchers from 1.42 million in 2007 to 1.59 million in 2009. However, while research is concentrated in wealthier regions, the global proportion of researchers based in developing countries increased from 30 to 37 per cent in the period 2002–2007.

Figure 1.3 shows that Norway, despite relatively low R&D investments, has one of the highest levels of researchers among the population. The world average stands at almost 1 100 researchers per million inhabitants, the OECD average is nearly 3 500, while the Nordic countries and Japan have between 5 000 and 7 500 researchers per million inhabitants.

In the Norwegian business enterprise sector, the number of employees are distributed across the largest industries in a relatively similar pattern to that found in the other Nordic countries. However, when it comes to full-time equivalents (FTEs or person-years) of work conducted by these employees, large differences emerge. Norway sees 18 000 R&D FTEs conducted in the business enterprise sector, around half the number performed in Denmark or Finland, and about a third of the Swedish total. Norway also seems to spend less time on the areas of *industry, energy, plumbing, building and construction*, when compared with Finland and Sweden. Although the energy sector contributes heavily to GDP, this has not resulted in large investments in research and development as measured by FTEs. The Norwegian service sector, in contrast, shows a relatively high total of FTEs compared with the other Nordic countries. Furthermore, when we relate total full-time equivalents in R&D to the size of the population, Norway ends up with 3.9 FTEs in the business enterprise sector per 1 000 of the population for 2009, a higher result than the EU 27 average of just 3.0. On this measure Norway remains behind the other Nordic countries, whose 2009 results were 4.6 in Iceland, 5.8 for Sweden, 6.0 for Finland and 6.8 for Denmark.

1.4 R&D and innovation resources

1.4.1 International developments in R&D resources

The global distribution of R&D resources is changing. From 2002 to 2007 global investment in R&D grew from 790 to 1 145 PPP $ billion:[1] this equates to nominal average annual growth of just under 8 per cent, as shown in Table 1.1. Spending data show that the dominant positions are still held by the USA and Europe, but that Asian investments are rapidly catching up and both Europe and the USA's overall share of world R&D decreased between 2002 and 2007.[2] Norway has maintained its overall share of world R&D investment, and is showing stronger annual growth in R&D expenditures than Europe or the USA.[3] To explain these changes in the distribution of R&D efforts, the UNESCO World Science Report points out several factors, including the rise of cheap and readily available digital technology, broadband, internet and mobile phones, resulting in new parts of the world having more opportunities to participate in international research.

The full effects of the financial crisis are not yet reflected in such R&D data, and the UNESCO report argues that the crisis will accentuate the decline in Western dominance in science and technology. It stresses the increasing role of emerging economies such as Brazil, China, India and South Africa in activities further up the value chain, and their development from locations for cheap outsourcing of production, to autonomous developers of process technology, product development, design and applied research.

While global investments are changing, the uneven distribution of research and innovation is emerging in new, sub-national forms. In Brazil, 40 per cent of all R&D expenditure was linked to the Sao Paulo region, while South Africa's Gauteng province accounts for 51 per cent of the national total.

Investment in R&D as a share of GDP is widely used as an indicator to describe a country's R&D effort. From 2002 to 2007 the world's R&D spending grew slightly faster than overall GDP. Globally, R&D expenditure as a share of GDP was 1.7 per cent both years. China has performed particularly well on this measure, with R&D spending as a share of GDP at 1.54 per cent in 2008, up from 1.07 in 2002.

The EU has also focused attention on R&D investment as a share of GDP. This was the main indicator selected when launching a vision for "smart, sustainable and inclusive growth" in the EU's growth report and the Green Paper.[4] There are concerns within the EU about the region's R&D investment compared to that of the USA and other advanced economies, particularly in terms of private investment. The EU wants to achieve the overall goal of 3 per cent of GDP going to R&D by 2020, and all member states have been asked to set their goals to support this outcome. Many countries are aiming high with targets approaching 3 per cent, while Austria, Finland and Sweden have gone further to set a 4 per cent target.

Norway's R&D investment is well above the OECD average in terms of per capita spending (see Figure 1.4). Norway spends just under 9 000 NOK per capita, well above the OECD average of under 7 000 NOK, and the country has remained above the OECD average on this measurement since 2001. However, Norway is below the OECD average of R&D spending as a share of GDP. The countries

1 PPP stands for Purchasing Power Parity. This is a conversion to a common unit on the basis of U.S. dollars to make all countries R&D efforts comparable regarding currency and purchasing power.

2 See the UNESCO World Science Report 2010.

3 OECD – Main Science and Technology Indicators 2010:2.

4 European Commission (2011): Green paper and Annual growth survey.

Table 1.1
R&D expenditure by continent and selected countries: 2002–2007. Absolute amounts PPP $, growth and share of global R&D and world GDP.

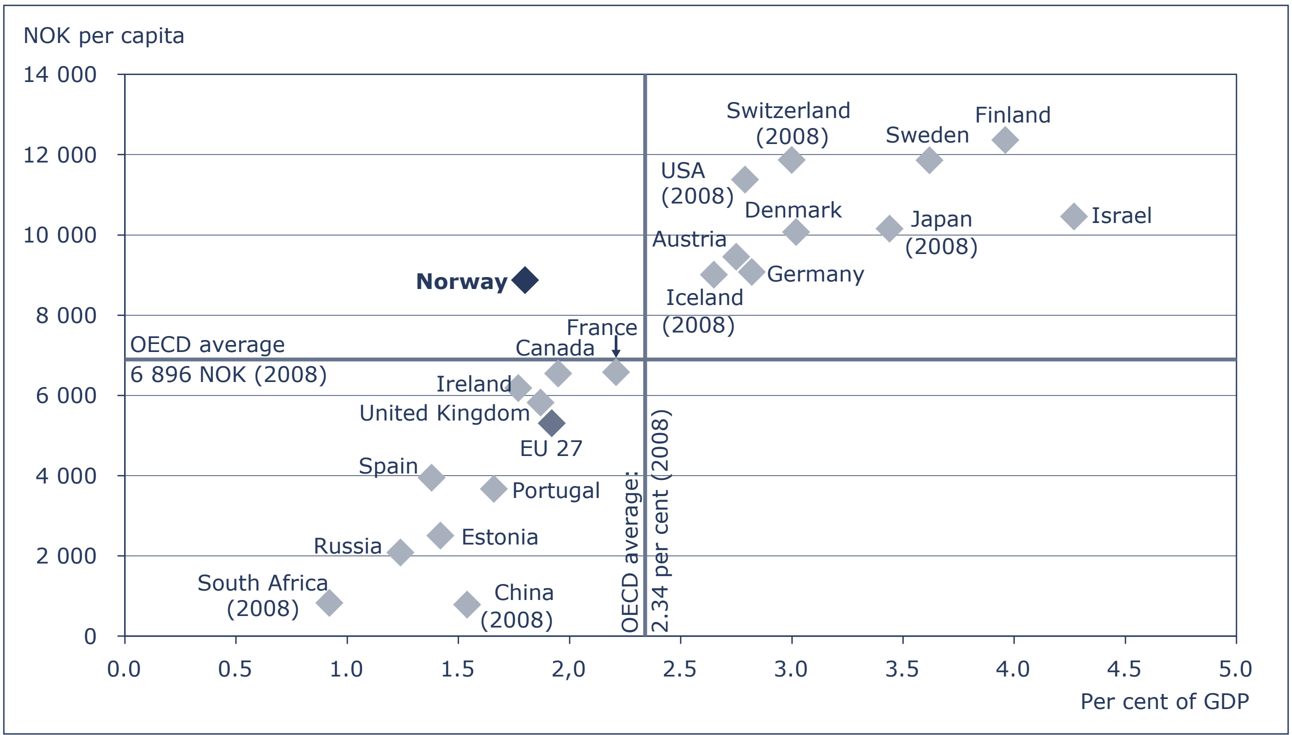
Part of the world/ country	R&D (Bill. PPP $)		Per cent					
				Proportion of the world's R&D		Proportion of the world's GDP	
	2002	2007	Average yearly growth	2002	2007	2002	2007
North America	297.8	399.3	6.0	37.7	34.9	24.7	22.8
Latin America	22.1	34.6	9.4	2.8	3.0	8.1	8.5
Europe	238.5	314.0	5.7	30.2	27.4	31.1	29.0
Africa	6.9	10.2	8.1	0.9	0.9	3.6	3.9
Asia	213.9	369.3	11.5	27.1	32.2	31.0	34.5
Oseania	11.2	18.3	10.3	1.4	1.6	1.5	1.4
The world	**790.3**	**1 145.7**	**7.7**	**100.0**	**100.0**	**100.0**	**100.0**
China	39.2	102.4	21.2	5.0	8.9	7.9	10.7
USA	277.1	373.2	6.1	35.1	32.6	22.5	20.7
Japan	108.2	147.9	6.5	13.7	12.9	7.4	6.5
Brazil	13.0	20.2	9.2	1.6	1.8	2.9	2.8
India	12.9	24.8	14.0	1.6	2.2	3.8	4.7
Norway	**2.8**	**4.3**	**8.8**	**0.4**	**0.4**	**0.4**	**0.4**

Sources: UNESCO World Science Report 2010 and OECD MSTI 2010:2/National R&D statistics for Norway

where R&D spending makes up the largest shares of GDP are Israel, Finland, Sweden, Japan, Denmark and Switzerland; all invest more than 3 per cent of GDP in R&D.

For a number of years Norway has had an explicit national goal to achieve the OECD average result in terms of R&D investment as a share of GDP. This target has now been placed on the back burner, but re-

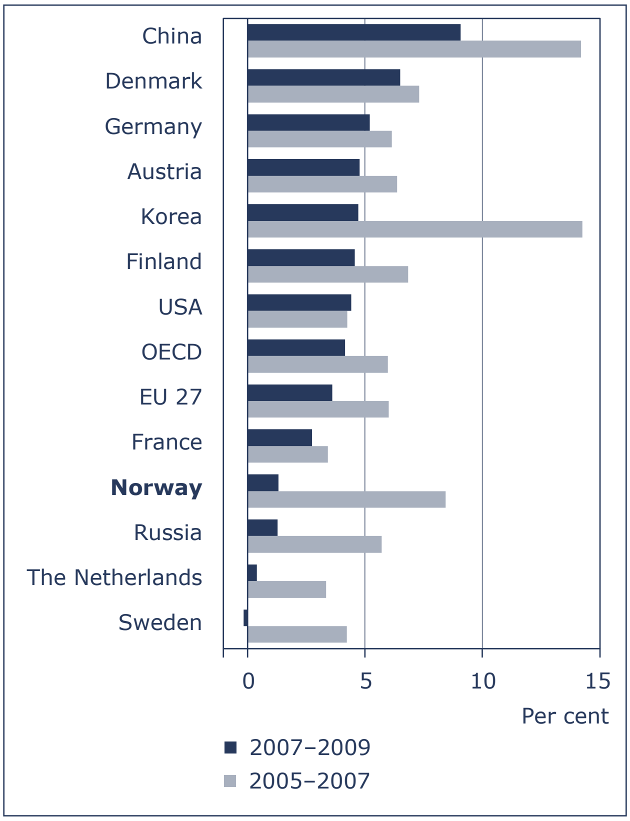
Figure 1.4
R&D expenditure per capita and as a share of GDP for selected countries, 2009.



Source: OECD – Main Science and Technology Indicators 2010:2

Figure 1.5

Increases in R&D spending for selected countries:[1] 2005–2007 and 2007–2009 (average annualised real growth).



[1] For the OECD, China, South Korea and the USA figures from the period 2007–2008 are used for the second period.

Source: OECD – Main Science and Technology Indicators 2010:2

mains a long-term goal. In the recent white paper "Climate for Research" the government relaxed their focus on this target, and suggested this indicator should be linked to several others in target setting, including R&D full-time equivalents.[5]

To look for signs of the impact of the financial crisis on R&D investment, statistics from the OECD are the best option currently available. There was growth in R&D expenditure in real terms (in average annualised growth) from 2007 to 2009, but the rate of growth has slowed when compared with growth in the two previous periods of 2005–2007 and 2003–2005. However, these changes are very recent, and data for 2009 are still preliminary in many cases, and perhaps present over-optimistic estimates. In the EU, average annual real growth in expenditure was just under 3 per cent from 2003 to 2005, 6 per cent from 2005 to 2007, and was below 4 per cent from 2007 to 2009. Figures from 2008 to 2009 suggest a substantial change has occurred in this region, with this latest period seeing an increase of just 0.8 per cent. There are no updated results available for the whole OECD area, but countries own statistics suggest a slow-down took place in 2008 to 2009. Decreases in R&D expenditures have been reported by Norway, Belgium, Finland, Israel, Italy, Romania, Spain, UK, Sweden and Austria. Iceland has not updated their figures for 2009, but has experienced a real decrease in R&D expenditure in recent years.

Almost all countries shown in Figure 1.5 experienced slower growth in R&D expenditure from 2007 to 2009 than in the previous two year period. China has shown the strongest growth since 2007, but even there, growth has clearly slowed. While Norwegian R&D expenditure showed real growth of 4.6 per cent from 2007–2008, the period 2008–2009 saw a decline

International comparisons

International comparisons are based on R&D surveys conducted by each country but standardised according to the OECDs «Frascati Manual». This manual contains definitions, classifications and guidelines on how to treat data in order to measure R&D activity. According to the OECD guidelines, several performing sectors form the basis of the mapping of R&D effort. The four performing sectors are:

- Business enterprise sector
- Government sector
- Private Non Profit sector (PNP sector)
- Higher education sector

These four sectors do not fit the Norwegian situation neatly. The higher education sector is the only performing sector that is identical for both national and international statistics. In addition to industry, the business enterprise sector in Norway also includes some units in the institute sector. These institutes mainly serve the industrial sector and include special branch institutes and task-oriented industry institutes. The government sector includes institute sector units that are related or directly connected to Departments, in addition to other public or semi-public institutions and government-directed, task-oriented institutes. In Norway the institute sector is monitored and measured in addititon to the sectors set out above. The Norwegain PNP sector contains relatively few, and typically small, units. In reports to the OECD and in other international efforts to collect statistics, these institutions are therefore included under the government sector.

[5] See the white paper "Klima for forskning", St.meld. nr. 30 (2008–2009).

of 0.3 per cent, giving an average annual real growth rate of just of 2.1 per cent for 2007–2009.

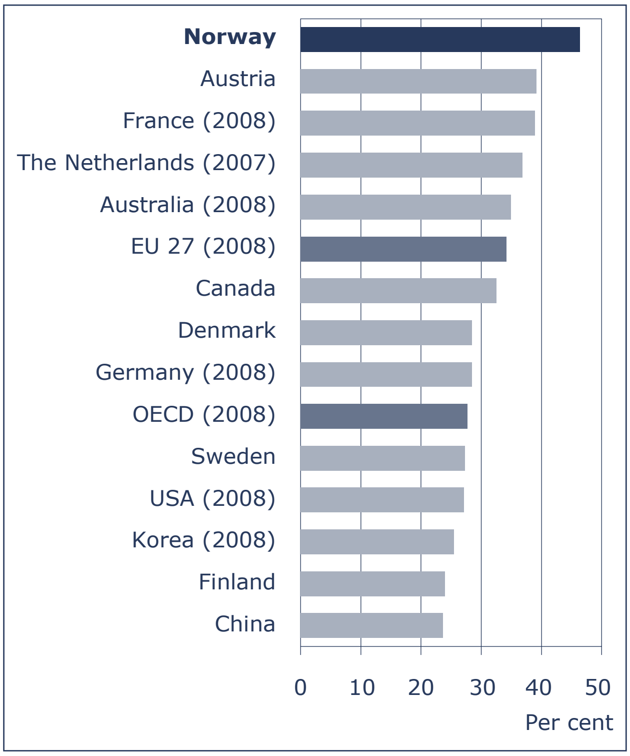
The importance of various research-performing sectors varies between countries. There are many reasons that influence the range of research performers, such as industry structure, historical conditions, economic conditions, and educational and political priorities. In Norway, the role of the public sector in R&D is relatively strong. Policies to increase private sector R&D efforts have been pursued for several years. The EU also sees this as a key objective, as one possible measure to increase R&D efforts in the competition with Asia and the United States. However, neither the EU nor Norway has managed to increase the business enterprise sector's share of R&D activity over the last few years. Indeed, in 2009 the EU and Norway saw this share drop slightly, from 62 per cent to 61 per cent in the EU, and from 54 to 52 per cent in Norway. Meanwhile, the largest R&D actors, the USA, Japan and China, all have a pattern of R&D efforts where the business enterprise sector accounts for over 70 per cent of total expenditure. Other Nordic countries also have business enterprise sectors responsible for large shares of R&D expenditure: Finland, Sweden and Denmark have shares of 71, 71 and 67 per cent respectively.

The business enterprise sector in Norway consists of businesses and the business-oriented part of the institute sector (see box on international comparisons). Norwegian businesses are commodity based, but knowledge intensive. Although R&D measured as a percentage of sales is low in many places, many companies use advanced technologies.

The share of R&D expenditure drawn from Norwegian universities and colleges is high compared to other countries. In Norway the higher education sector accounted for 32 per cent of total R&D expenditure in 2009, while the OECD average was 17 per cent (in 2008). Denmark also sees a high proportion of investment from the university and college sector (30 per cent), while this sector is smaller in Sweden (25 per cent) and Finland (19 per cent). The high share of spending in the Danish university sector is partly explained by institutional changes which have seen research units from the government sector merged with universities.

If we compare R&D expenditure in the higher education sector per capita, the differences between the Nordic countries are small: Denmark and Sweden's higher education sectors spend nearly 3 000 NOK per capita, Norway's result is just slightly lower, and Finland and Iceland stand at just under 2 500 NOK per capita. Among the Nordic countries Norway had the highest proportion of higher education funded by public sources, at just over 90 per cent.[6] This includes the general university funding, other funding from ministries and government bodies, funding from the Research Council of Norway and from the counties and municipalities. Among the Nordic countries, Norway also had the lowest proportion of funding from abroad (2.5 per cent) and from enterprises (less than 4 per cent) in the higher education sector in 2009.

Figure 1.6
R&D expenditure financed through public sources. Selected countries, 2009 or latest available year.



Sources: OECD – Main Science and Technology Indicators 2010:2

The overall proportion of R&D expenditure funded by public sources is also relatively high in Norway. Among the countries shown in Figure 1.6, Norway had the highest proportion of public funding of R&D, at nearly 47 per cent. The OECD average was 28 per cent in 2008, and the other Nordic countries are fairly close to this result. In both the business enterprise sector and higher education sector in Norway, the share of public financing is particularly high, while the balance of funding in the government sector itself is in line with, or lower than other countries in Scandinavia. The government sector in Norway includes a high proportion of publicly-oriented research institutes (see box on International comparisons).

[6] Sweden, Denmark, Iceland and Finland have shares between 77.2 and 81.8 per cent.

Table 1.2
Key results for Norwegian participation in FP6 and FP7.

Indicator	All programs 6RP (2003–2006)	All programs 7RP (2007–dec 2010)
Number of projects with Norwegian participation	849	728
Rate of success for Norwegian projects	27.1%	23.7%
Proportion of projects with norwegian participation of all cancelled projects.	8.4%	6.7%
Number of Norwegian projects	1 299	1 059
Number of Norwegian coordinators	148	170
Estimated EU funding to Norwegian particiants (NOK)	2.3 bill.	2.7 bill.
	1.7%	1.8%

Source: E-Corda/EU-Commission

1.4.2 The EU Framework Programme

The EU's Framework Programme for Research and Technological Development is seen as having a key role in meeting the objectives of the EU Lisbon strategy for competitiveness, growth and employment. It is also regarded as Norway's most important arena for building international cooperation, internationalisation and for steps to improve the quality of Norwegian research. Participation provides opportunities for networking, opportunities to collaborate with leading scientists in Europe and contributes to knowledge-based innovation and innovation in Norwegian industry and society. Success rates for participation in the programs can be considered as indicators of the quality of the country's research.

Norway's participation in the EU Framework Programme is in line with that of EU member countries (it is part of the EEA Agreement). Member countries' funding contribution to the Framework Programme is calculated as a share of GDP. The 7th Framework Programme (FP7) runs for seven years (2007–2013) while the previous Programme lasted just four years. Norway participates in the following specific programmes:

1) Cooperation (10 major programmes);
2) Ideas (frontier research);
3) People (researcher mobility);
4) Capacities (7 capacity-enhancing activities);
5) The EU Joint Research Centre.

At the end of 2010, the fourth year of FP7 was completed. However, only just over a third of the total FP7 budget of 50.5 billion euros had been allocated by that time. The FP7 budget is therefore set to increase significantly in the programme's second half. During the first four years of FP7 Norway participated in 3 071 applications, resulting in 728 projects. The 728 approved projects are expected to provide Norway with overall funds of 331 million euros (approx. 2.7 billion NOK). Estimates suggest this puts Norway's share at about 1.8 per cent of all competitive funding allocated under FP7 so far.[7]

Norway is particularly well-represented in some of the specific Framework Programme areas. Under the Environment Programme, 28 per cent of all projects include Norwegian participants. Participation is also high in the programs for Energy, Science in Society (SiS), SME, Space, Research Infrastructure (RI) and Security. Norway has the highest success rate of any of the EU member countries and associate countries in both the Energy program and SiS, and has the second highest success rate in the SME programme.

At the end of 2010 there had been a total of 4 271 Norwegian participants in FP7 applications and 1 057 in recommended projects. The Research Council of Norway estimates that the recommended projects which include Norwegian participation will involve almost 3 200 scientists in total. However, participation in these projects is quite concentrated: the ten most active Norwegian actors account for nearly 40 per cent of all Norwegian participation in FP7. The same actors tend to have coordinator roles, both in applications as well as recommended projects.

Over a third of all Norwegian participation in FP7 comes from the institute sector. Research institutes are also the group with the highest success rate for applications. Universities and colleges are the second largest sector in terms of numbers of applications, but come out third, after companies, in recommended projects. Government departments have increased their participation in FP7 compared to FP6, up by 4 percentage points, while companies have reduced their share of participants accordingly.

Norway's most common partner countries for FP7 projects are the United Kingdom, Germany, Italy, France and Spain. These are also the larger European

7 See data on applications and projects under FP, compiled by The Research Council of Norway/ E-Corda (The EU Commission).

The future of EU's Framework Programme

The EU's 7th Framework Programme will run until 2013, but the preparation for the next programme, and comprehensive restructuring of these policies, is already in full swing. Participating countries have been asked to provide input for changes, visions, challenges and solutions. In Norway, the Ministry submitted input based on feedback from 19 different environments. The Norwegian proposal highlights the continued importance of public spaces for research and where researchers' voices can be heard, innovation in the public sector and the important role played by the education system in innovation and demonstration activity. It also stresses the need to make the system more accessible and user friendly, and urges caution in increasing the framework budgets. The Norwegian Ministry has also already chosen two of the thematic areas central to the Grand Challenges: marine and maritime research and Arctic research. The expectations are that the EU will simplify application procedures and rules about the application process and participation in research and that additional investment will be made in the areas of renewable energy, a new energy program, ICT and connected medicine.

countries, which tend to dominate the Framework Programme; indeed, of the 199 countries participating in FP7 applications so far, these five together account for half of all participation. If we weight the number of joint applications by population size for each partner, then Denmark, Sweden and Finland are the most important countries for Norwegian cooperation.

Table 1.2 compares Norwegian results under FP7 so far (up to the end of 2010) with results from FP6. The results for both periods cover four years of activity, with comparable budgets: FP6 distributed approximately 16.7 billion euros, while FP7 distributed approximately 18.4 billion Euros in the period 2007–2011.

Norway participated in fewer projects for the first four years of FP7 compared with FP6, despite the fact that FP6 involved fewer (and larger) projects than FP7 so far. There is also slightly less Norwegian participation per project in FP7, compared to FP6. Furthermore the Norwegian success rate is lower in FP7 than in FP6, although part of this follows from lower average success under FP7 as a whole. While Norway has received more support in total from FP7 projects than it did in 6RP, this can partly be explained by changes in funding whereby the EU finances up to 75 per cent of project costs in FP7, compared with 50 per cent in FP6.

1.5 The results of R&D and innovation

1.5.1 Results from the European Innovation Survey

The Norwegian industrial sector's innovation activity appears to be lower than the EU average.[8] The European Community Innovation Survey (CIS) for 2008 illustrates this, both when we look at the proportion of enterprises reporting innovation activity overall, and the proportion of enterprises that have introduced new products or processes (PP-innovation) in the period 2006–2008. As Figure 1.7 shows, the Norwegian results are also below those of Sweden, Denmark and Finland.

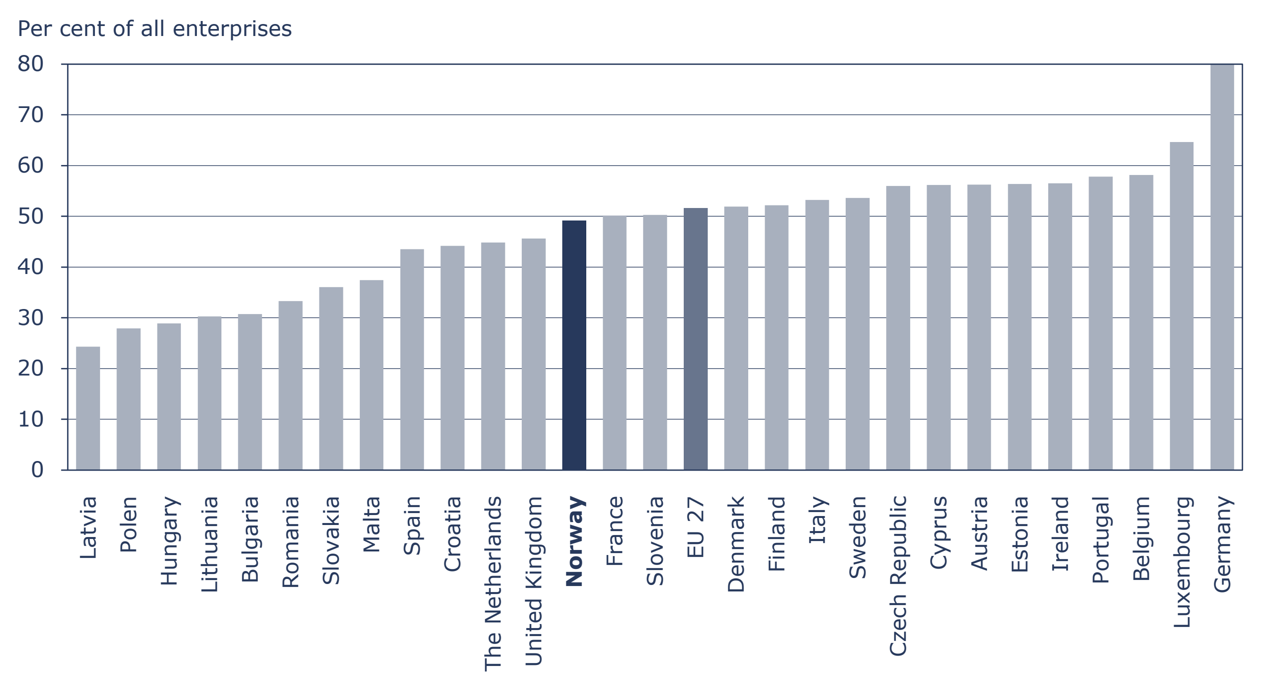
Norway has the lowest innovation activity of all the Nordic countries. Only around half (49 per cent) of Norwegian enterprises reported some form of innovation activity in the period 2006–2008.[9] This is three percentage points below the EU average. When countries are ranked in ascending order, Norway is number 16 out of 28 countries, while Sweden, Finland and Denmark are in positions 10, 12 and 13 respectively (with 52 per cent, 52 per cent and 54 per cent). Germany's result on this indicator really stands out, with 80 per cent of surveyed enterprises reporting innovation activity. However, there may be reason to treat this result with some scepticism. Germany had the lowest response rate of all countries participating in the survey, at just over 20 per cent in 2006. Germany also reported the most substantial methodological deviations from the standard survey procedures. As it is, this German result has a powerful effect on the EU average: if the German result is excluded the EU average drops to 46 per cent.

Norway stands out from other countries most clearly when it comes to the proportion of companies that have introduced innovative processes, but which have not been completed or which have not led to some innovation by the end of the period: 10 per cent of Norwegian enterprises are in this situation, com-

8 EU averages (EU 27) are calculated on the basis of the available data for the individual indicators. This means there can be missing data for many cases from countries; it is not mandatory to submit all data to Eurostat. Greece has not provided data for CIS 2008 and is therefore not included in any totals.

9 Innovation activity refers to firms that have done one or more of the following: companies that have introduced new products or new processes; that have introduced organisational changes or changes in the way the company markets itself or its products; that have interrupted or delayed activity with a view to introducing new products or processes; or, have begun such innovative activity even if it was not completed at the end of 2008.

Figure 1.7
Proportion of enterprises reporting innovation activity in EU 27 and Norway: 2006–2008.



Source: Eurostat

pared to an EU average of only 3 per cent. Part of the reason for this high level of aborted or incomplete innovation may be explained by Norway conducting a combined R&D and innovation survey. This has a high response rate and a large number of items that recur from survey to survey. This broader information base provided by the Norwegian study (compared with most other countries) may have influenced results by including units that would probably not have been included in an innovation-only survey.

If the results from CIS 2008 are broken down into broad sectors,[10] it does not change the picture substantially (see Figure 1.8). While Norwegian companies in the service sector scored higher than the EU average, the results for industrial firms are below average.

Norway's poor ranking is also related to the Norwegian industrial structure. In particular, larger enterprises are less often located in industries with high innovation density. A joint Nordic study has attempted to correct for the effect of varying industrial structures across different countries, and this resulted in significant increases in the relative innovation activity in Norway.

[10] Industry here includes industry codes B05–09, C10–33, D35 and E36–39, while the services sector includes codes G46, H49–53, J58, J61, J62, J63, K64–66 and M71. Together, these two groups constitute the required range of sectors set out for CIS 2008.

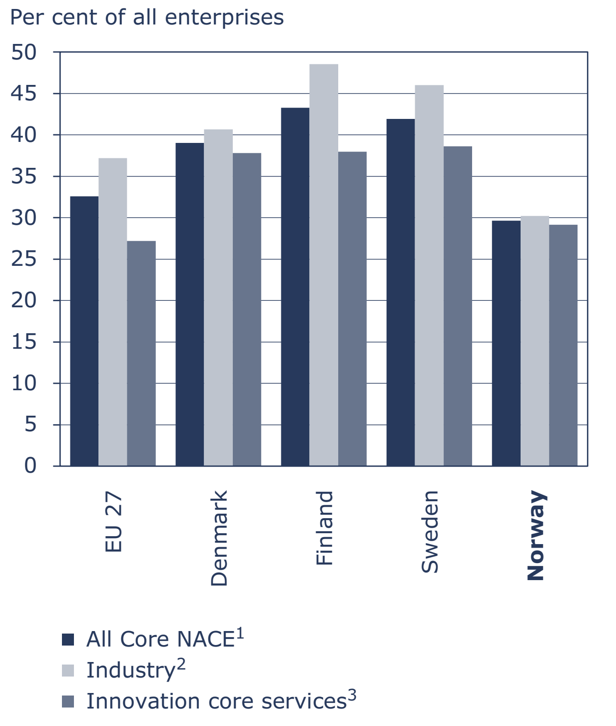
When it comes to the proportion of business turnover that is derived from the introduction of new products (goods or services) introduced in the last three years, Norway again ends up at the bottom of the rankings for Europe. Again, these results are explained by Norway's industrial structure to a large degree. Different business sectors show very varied results on this variable, and these results also vary substantially from survey to survey. For example, Norway has only a small number of enterprises in high-turnover sectors, which typically involve consumer-oriented technology products, which are rapidly replaced by updated new models. The Norwegian industrial sector is dominated by the oil industry and related industries that are undoubtedly technology heavy, but are not typically classified as high-tech industries in European comparisons. Such industries are also rarely involved in innovative activities involving new products: continuous improvements in industry are not reported as innovations, even though they can involve substantial and innovative change over time.

When we try to exclude the effects of national industry composition, by looking at innovation as measured by the percentage of sales only in those enterprises with product or process-oriented innovation activity, the picture changes. On this basis, Norwegian product or process innovators are performing better than those in Sweden. This indicates that Norwegian innovators do well when measured against other innovators based in comparable countries and industries. Norway simply has too few of these kinds of enterprises to perform well on many of these indicators, both due to a small pool of firms in the relevant industries, but also as the specific kinds of firms and industrial areas that are stronger in Norway seem to have a lower tendency to innovate than those in neighbouring countries.

There is widespread agreement across countries about the main purpose of innovation activity. When firms are asked about possible purposes that drive innovation, a set of common issues emerges. Improving the quality of goods produced or services provided is most often seen as a very important reason driving innovation. Expanding the range of goods or services on offer is the second most commonly reported purpose in most countries, although Denmark stands out with a relatively small share of companies who say that this is a very important aspect. The third most frequently reported objective is to increase the company's market share.

However, there are differences in the range of aims or factors that are seen as important. Norwegian enterprises cite a high number of factors as being 'very important', and are focused on more factors than the average for firms across the EU. The greatest difference is apparent when it comes to improving health or safety, which is the factor that is least likely to be reported as driving innovation in the EU overall, but which is reported by 49 per cent of Norwegian respondents as being very important; almost twice the EU average.

Figure 1.8
Share of enterprises reporting product and/or process innovation, by industrial activity group in EU 27 and the Nordic countries: 2006–2008.



[1] All NACE core industries related to innovation activity (B, C, D, E, G46, H, J58, J61, J62, J63, K and M71).
[2] Except building and construction businesses.
[3] NACE G46, H, J58, J61, J62, J63, K and M71.
Source: Eurostat

1.5.2 Scientific publishing and citation

Publication and citation data are widely used as indicators for the results of research. The basis for the use of such 'bibliometric indicators' is that new knowledge, which is the fundamental goal of all basic and applied research, is typically disseminated to the scientific community through publications. Publication can therefore be used as an indirect measure of knowledge production. The number of publications can be seen as representing the extent of scientific output in countries or disciplines, while the numbers of citations can be seen as an indirect measure of the impact published research has had. This chapter provides a comparative international analysis of Norwegian research based on these perspectives.

In the period 1981–2010 more than 22 million scientific articles were published worldwide. Global publication production increased throughout the period, from 460 000 articles in 1981 to nearly 1.2 million articles in 2010. Norwegian production has also increased. In 1981 Norwegian scientists published almost 2 400 articles. In 2010 that number had increased to just over 9 300. This reflects the huge expansion in the production of knowledge over this period, but also that the number of journals included in monitoring has increased. A significantly increased proportion of the articles with a Norwegian author also feature author addresses from other countries. Of all the Norwegian articles from 2010, 55 per cent involved international co-authorship.

There are large differences between countries' article production, as Table 1.3 shows. Figures from 2010 show that the USA accounted for 22 per cent of the world's scientific knowledge production, measured as a sum of all countries' output. China is now the next largest knowledge producer, with a share of 8.9 per cent, followed by the UK and Germany, with shares of around 6 per cent. Of the Nordic countries, Sweden is the largest knowledge producer. Norway's share was 0.61 per cent, but the country's share of world production has increased over the last years and has

Bibliometric indicators

Data:
This analysis is based on data from Thomson Reuters (formerly the Institute for Scientific Information (ISI). Thomson Reuters produces the most important database for bibliometric purposes. It indexes peer-reviewed journals, including all major international journals in science, medicine and technology, as well as journals from the social sciences and humanities. This report includes data from the National Science Indicators (NSI) database and National Citation Report (NCR) for Norway. The NSI contains aggregated publication and citation numbers for detailed sub-fields. The analysis includes only regular articles and 'review' articles, but not book reviews, abstracts etc.

Methods:
Bibliometric indicators have some important limitations that must be considered in interpreting results. Among other things, the coverage of journals varies between disciplines. The best coverage is achieved for physics, chemistry, biomedicine and clinical medicine. In biology and technology coverage is also relatively high. However, coverage in the social sciences and humanities is poor. This is partly because Thomson Reuters does not index all the relevant journals and partly because publication patterns differ between disciplines; in some disciplines, less centralised research communication outside of international journals, plays a more important role, via national magazines, books, etc.

climbed from 0.53 per cent 10 years ago; impressive for a period when most Western European countries experienced a decline in publication share.

When publishing is weighted by population size, to provide figures on articles per thousand inhabitants, the Nordic countries perform very well. Norway comes fifth out of the countries listed in Table 1.3. Iceland is second, Denmark third and Sweden fourth. However, differences in publishing weighted by overall population size do not necessarily reflect national research performance: a better indicator would calculate the relationship between publication outputs and inputs such as R&D funding. However, these kinds of productivity measures, comparing differences in the relationship between 'inputs' and 'outputs', do not only reflect productivity differences, but would also vary as a consequence of differences in countries' scientific specialisation profile.

Table 1.3
Scientific publishing. Selected coutries, numbers and percentages, 2010.

Country	Number of articles	Percentage of world production[1]	Number of articles per 1 000 capita	Relative change in the number of articles 2002–2010
USA	338 784	22.17	1.10	27
China	135 375	8.86	0.10	243
United Kingdom	93 092	6.09	1.51	32
Germany	88 420	5.79	1.08	29
Japan	72 882	4.77	0.57	-1
France	63 601	4.16	0.99	31
Canada	54 756	3.58	1.62	56
Italy	51 453	3.37	0.85	51
Spain	44 688	2.92	0.97	78
India	40 905	2.68	0.03	114
South Korea	39 843	2.61	0.82	133
Australia	39 559	2.59	1.79	74
Brazil	31 639	2.07	0.17	145
The Netherlands	30 948	2.03	1.87	55
Russia	26 836	1.76	0.19	3
Taiwan	23 834	1.56	1.03	108
Switzerland	22 239	1.46	2.85	59
Turkey	22 163	1.45	0.31	160
Sweden	19 976	1.31	2.14	28
Polen	19 512	1.28	0.51	72
Belgium	17 019	1.11	1.58	58
Israel	11 850	0.78	1.59	19
Denmark	11 836	0.77	2.14	50
Austria	11 425	0.75	1.37	48
Greece	10 219	0.67	0.91	79
Finland	9 881	0.65	1.85	30
Norway	**9 367**	**0.61**	**1.94**	**81**
Mexico	9 274	0.61	0.09	66
Portugal	9 048	0.59	0.85	136
Czech Republic	8 862	0.58	0.84	83
New Zealand	7 321	0.48	1.71	63
Ireland	6 640	0.43	1.49	121
Hungary	5 151	0.34	0.51	22
Iceland	781	0.05	2.45	110
The World	1 180 761	100.00	0.17	48

[1] The national share of global production is calculated based on the sum of all countries' publishing output.

Sources: National Science Indicators/Thomson Reuters/NIFU

Table 1.3 also shows how article production changed between 2002 and 2010. The increase in China's article production is particularly remarkable, having more than tripled during this period (an increase of 243 per cent). This is due to an expansion of the country's research resources, incentives to publish in peer-reviewed journals as well as increased coverage of Asian scientific journals by publication databases. Turkey and Brazil also have high growth rates, as do several other Asian countries, including South South Korea, India and Taiwan.

In Europe, Portugal and Ireland's publication volume grew most in the period, by 136 and 121 per cent respectively. There was also relatively strong growth in Iceland, the Czech Republic and Norway (growing by between 110 and 81 per cent). The major scientific nations of Britain, Germany and France saw growth of around 30 per cent, marginally above the USA's increase. In general, many of the smaller and newer EU countries experienced great growth in scientific publications in recent years. This is likely due in part to participation in EU Framework Programmes and other European research programs, as well as increases in these countries' own R&D initiatives.

Norway had the second strongest growth in publishing output of the Nordic countries (after Iceland) with an 81 per cent increase since 2002. Sweden's output grew the least, by just 28 per cent. In the last five years Norway's development has been more positive than the other Nordic countries, a turnaround from the period 1981 to 1999, when Norway had the second lowest growth among the Nordic countries. Areas that have grown particularly strongly in the more recent years (in terms of relative volume) include the social sciences and technology.

These positive developments in Norway are partly explained by the increased resources channelled into research as well as increased numbers of researchers. R&D expenditure in the higher education sector in Norway, where the bulk of journal publishing takes place, grew by 62 per cent in fixed prices, from 2001 to 2009. In addition, this increased productivity is associated with changes which have increased the focus on the production of publications. Since 2004, Norway has had a performance-based funding model for higher education institutions, and rates of academic publishing are one of the performance indicators. The institute sector and health trusts have also adopted publishing as performance indicators linked to funding. In this way, Norwegian research institutions have incentivised publishing (Sivertsen 2008). There is reason to believe that this system has contributed to the recent increases in scientific publication in Norway, although the overall significance of these incentive effects, relative to other factors, is difficult to determine.

Norwegian researchers published round 140 000 articles in the period 1981–2009 and together these have been cited more than 2 million times. It is of course the case that those countries producing the highest numbers of articles also tend to receive the most citations. However it is common to use measures that are independent of overall publishing volume, to assess whether a country's articles are having a high or low impact. One such indicator is the relative citation index, which provides the average number of citations per publication for each country. It shows how often each country's publications are cited, relative to the global average (which is normalised to 100). However, there are large differences in average citation frequency between different disciplines: a molecular biology article is cited, on average, about ten times as often as an article in mathematics. A country's citation rates will therefore depend on the distribution of articles across various disciplines, and the concentration of publications in highly cited fields could increase a country's citation rate significantly. To correct for these differences, we have weighted each country's citation indicators in the analysis that follows, meaning that the national index is weighted according to the relative distribution of articles across different fields. The Citation Index used here therefore allows more direct international comparisons.

Norway performs fairly well on the relative citation index, with an index of 125. This result means that the Norwegian articles were cited 25 per cent more often than the world average. In the 1980s, Norwegian research was less cited than the international average, but a significant increase in citation fre-

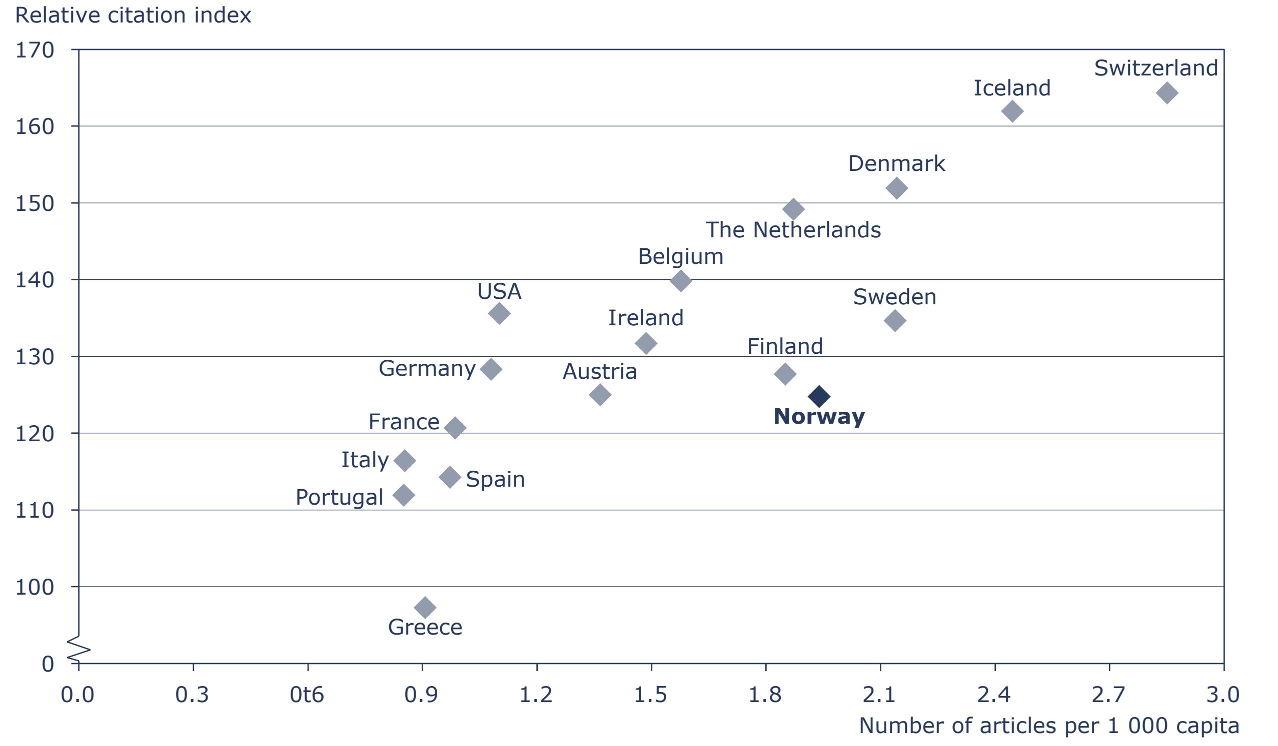
Bibliometric indicators

Using citations as an indicator

Scientific publications typically refer in some detail to previous literature. These references might be relevant to the concepts, methods, theories, empirical findings or other aspects of the publication. Thomson Reuters systematically record all the references in their indexed literature, making it possible to calculate how many times any given publication has been cited in the subsequent literature. Based on these statistics, citation analysis can be conducted on aggregated and national levels.

It is common to assume that articles are cited more or less depending on their influence on further research. Citations are therefore used as indicators of scientific 'impact'. The average number of citations for a country's publications is a widely used indicator, and is seen as offering an indirect guage of the attention a country's publications achieve among the international scientific community. Citation indicators have increasingly been used in the evaluation of research. However, it is important to recognise that there are limitations and weaknesses to such indicators, and that they therefore cannot replace peer evaluation (see Aksnes 2005).

Figure 1.9
The number of publications per capita, 2010 and the relative citation index for selected countries: 2007–2009.[1]



[1] The relative citation index for articles published in 2007, 2008 and 2009 and the accumulated citations for these publications up to 2010. The index for each country has been weighted to reflect each country's relative distribution of articles across subject areas.

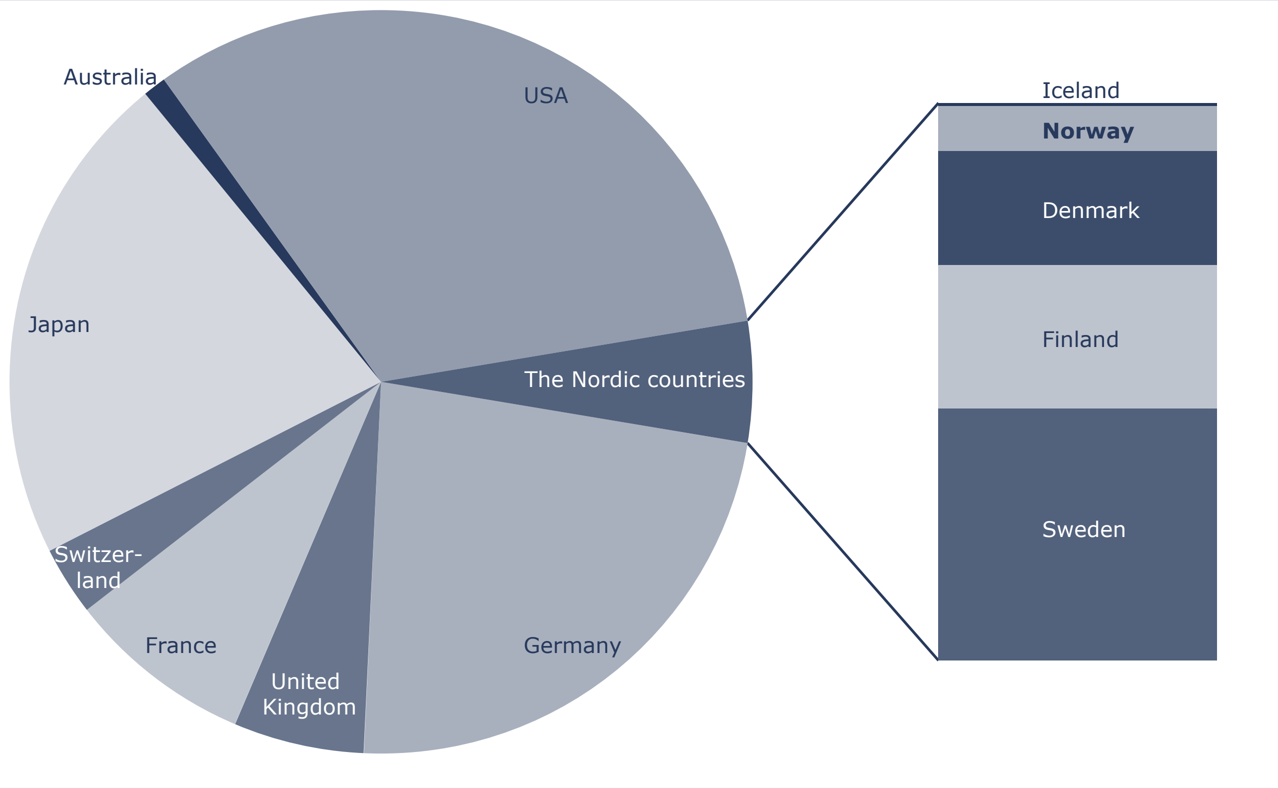
Source: National Science Indicators/Thomson Reuters/NIFU

quency was achieved during the 1990s. While these results are positive for Norway, almost all western and northern European countries had index values well above 100 in this period (the OECD countries average was 110) and Switzerland (index of 164) and Iceland (162) achieved the greatest impact according to the citation index (Figure 1.9).

Compared to the previous period for the Citation Index (2004–2006) Norway's performance stood out as it was one of only five of the OECD countries that did not increase its results on the index. The average for EU 15 countries improved from 109 to 115 in this period. Increases were particularly strong for many of the northern European countries. These changes cannot simply be attributed to increased citation rates, but also to methodological issues such as the expansion of the range of journals covered in the database (see above). Many of the new journals that have been added are cited much less often. Therefore, if researchers in certain countries publish more in these lower-cited journals, the average citation rate will drop. Norway saw a decline in the citation index of 1.8 points from 2004–2006, breaking a long running trend of increases in its citation index. The reason for this development for Norway has not been fylly analysed or explained, as yet. When it comes to the number of publications, one sees that this normally corresponds relatively strongly with resource availability: increased research resources leads to increases in the number of researchers, which in turn increases the number of articles. There is no such direct correlation in terms of citation frequency and resource supply – although there may be a connection. Norway's position in terms of these results has worsened compared to many other countries, over the last three years. However, weakened citation results must be viewed in the context of the major growth in scientific production in Norway: in such a situation it is perhaps unsurprising that improved scientific impact, as measured by the average citation rate per article, has been difficult to maintain or improve.

Norway's level of publication activity and citation rate varies greatly between disciplines. If we focus instead on different fields of science, technology, medicine and social sciences, two types of indicators can be calculated. First, the activity index, which is an in-

Figure 1.10
EPO[1] patents originating in OECD countries: 1999–2008.



[1] EPO-A-dokuments (applications). Origin is derived from the applicant's address (using fractional counting); the date of application determines the time period it is allocated to.

Source: NIFU on the basis of OECD data: http://stats.OECD.org/wbos/Index.aspx?DatasetCode=PATS_IPC.

dicator that shows whether a country has a higher or lower proportion of publications in a particular field than the average for all countries; it therefore expresses the internal balance between the fields in any given country, but says nothing about production in absolute terms. This kind of result is commonly referred to as the specialisation index. Second, it is possible to calculate the relative frequency of citations in different fields (a field-specific citation index). A country's publication performance within a particular field can then be compared with others, to see if it is cited more or less often than the global average for the field. If we look at the results of such indicators, it is clear that Norway's activity profile differs considerably from the average.[11] In general, Norwegian research involves a relatively strong focus on biology, earth sciences and social sciences. Conversely, there is relatively low activity in areas such as physics, chemistry and technology. This specialisation pattern has its roots in the country's history. Norway's traditional focus on marine and coastal industries and fishing, support specialisations linked to biology. This may also account for Norway's relatively high activity in ecology, environmental science and zoology. With the exception of botany and microbiology, Norwegian biological research is more cited than the international average.

Norway also shows a strong specialisation in earth science, but only received an average level of citations in this field. A sharp increase in geosciences publishing marks the most significant change in the national academic profile since the early 1970s, directly related to Norway's emergence as an oil nation.

1.5.3 Patents

Intellectual Property Rights, or IPR, have long been used as a measure of the results of research and innovation activities. This applies primarily to patents. Aggregate patent data systematise information about various aspects of knowledge, including what is being invented, by whom, when and where. Such analyses of patents can be compared with other indicators, such as

[11] Based on NIFU's analysis of data from the National Science Indicators/Thomson Reuters/NIFU.

trade statistics, to raise awareness about where this activity comes from and, importantly, where it is applied.[12]

This section is based on the Norwegian patent applications sought via the Norwegian Industrial Property Office [13] and/or pending through Europe at the European Patent Office (EPO).[14] Norwegian actors can use the EPO as a home office, on an equal footing with European countries, after Norway became a full member of the European Patent Convention (EPC) in 2008. This represents a step to a stronger international orientation of the patent system, and this is expected to affect patenting patterns of Norwegian players going forward. This section provides a brief status report on Norwegian patenting in Europe and in Norway during this transition, where particular efforts are made to distinguish between different types of applicants.

An overview of Norwegian patenting via the EPO, in the years prior to Norway's EPC membership, gives a sense of Norwegian patenting in an international context. Norway's European patent activity for the period 2000–2008 was modest compared to other OECD countries. Figure 1.10 presents EPO patents from a number of OECD countries for the nine-year period. It shows that 64 per cent came from just three countries: the USA, Germany and Japan. The figure shows Norway's European patents compared with other countries in the period.

Norwegian actors accounted for 3 750, or 0.4 per cent of all European applications originating from OECD countries. The corresponding figures for Danish actors was 8 410. The number of Norwegian applications is lower than in the other Nordic countries, which in turn are overshadowed by the larger countries. OECD countries increased patenting activity in Europe by 14 per cent from the first three years of the period (1999–2001) to the last (2005–2007). The corresponding increase for Norwegian companies was 10 per cent, and this was also the period before the Norwegian membership in the EPC came into force.

In general, patent protection is mainly sought in the domestic market, e.g. mostly just in Norway for most Norwegian actors. This pattern in activity persisted during the first year of Norwegian membership of the EPC (2008) when Norwegian companies did not increase their demand for patent protection in Europe (in nominal terms) from the previous year. Norwegian EP applications were flat in 2008, at 460 applications (the same as the previous year), while the number declined for most OECD countries.

12 See the OECD's Patent Manual (2009) for an up-to-date presentation of patents as indicators.

13 Extracted from the patent database at the Norwegian Industrial Property Office, February 2011.

14 Based on raw OECD data: http://stats.OECD.org/wbos/Index.aspx?DatasetCode=PATS_IPC.

2 The Norwegian system of R&D and innovation

Highlights

The number of students

- Numbers of students in Norway quadrupled over the last 40 years, reaching 230 000 in 2010.
- The proportion of foreign students in Norway is high in comparison to other countries.

Higher degree candidates

- In 2010, just over 11 000 higher degree candidates graduated in Norway.
- Since 2004, women have been in the majority amongst master's degree candidates.

Doctoral degrees in Norway

- The largest shares of doctoral degrees are awarded within natural sciences and engineering and technology, while the numbers of doctoral degrees in medical and health sciences have experienced the highest growth.
- Between 1970 and 2010, the proportion of doctorates awarded to women increased from 7 to 46 per cent.
- In 2010, 28 per cent of all those awarded PhDs in Norway had foreign citizenship.
- The completion rates in research training have increased over recent years.

Higher degree candidates in the labour market

- Most higher degree candidates are employed in the public sectors of health and social services, education or public administration.
- The education sector employs the largest share of higher degree candidates—almost 75 per cent of all such graduates find employment here.

R&D personnel and R&D Full Time Equivalents (FTEs)

- In 2009, 64 000 persons were involved in R&D, performing 36 000 FTEs.
- Between 2008 and 2009, both the number of R&D personnel and the number of R&D FTEs increased in the higher education sector and in the institute sector, while there was a decrease in the industrial sector.
- Researchers performed roughly three-quarters of the total R&D FTEs.
- Among those employed as researchers, the proportion of doctorate holders was lowest in the industrial sector (10 per cent).
- Among researchers in the university colleges or specialised institutions at university level, women are in the majority. The second highest share of women researchers was found in health trusts, followed by institutes serving the government.
- Among researchers, the proportion of those with foreign citizenship is 2.4 times higher than among the general population.
- R&D FTEs in foreign-controlled enterprises represented 27 per cent of total R&D FTEs in the industrial sector.

Resources for R&D and innovation

- In 2009, Norwegian R&D expenditure amounted to 42 billion NOK, leading to an average yearly increase of 2.1 per cent since 2007.
- Norwegian R&D expenditure constituted 1.8 per cent of GDP in 2009.
- The higher education sector accounted for 32 per cent of total R&D expenditures in 2009.
- In 2009, almost 6 per cent of all R&D expenditure was accounted for by the health trusts.
- In the institute sector, recent increases in R&D expenditure were due to increased activity among institutes serving government agencies and departments; R&D expenditure among institutes serving enterprises remained at the same level.
- Between 2008 and 2009, the real value of R&D expenditures in the industrial sector fell by 3.7 per cent.
- In the industrial sector, 43 per cent of all R&D activities were performed in manufacturing, while services accounted for 47 per cent.

Thematic priorities and technology areas

- Global challenges, including energy, environment and development studies, represented the most important Norwegian thematic priority in 2009, with R&D expenditures in this area reaching 10 billion NOK.

Innovation activities and costs

- A total of 27 per cent of enterprises in the industrial sector reported they had experienced product or process innovation activities in 2008; such innovation tendencies tended to increase with firm size.
- In terms of innovation costs, intramural R&D accounted for 64 per cent, while extramural services made up 19 per cent.

R&D funding

- In 2009, government funding accounted for 46 per cent of all R&D expenditure, with industry providing 42 per cent. Other national sources and funding from abroad accounted for 4 and 8 per cent respectively.
- The amount of R&D funding from abroad has increased fivefold during the last 20 years.
- Within the higher education sector, the most important source of funding for research is the General University Funds, followed by The Research Council of Norway (RCN).
- In the institute sector, the primary sources of funding for techno-industrial research institutes were industrial sector organisations, while the RCN was the primary funder for research institutes in the social sciences and of regional research institutes.
- In the industrial sector, 75 per cent of intramural R&D activity was financed by enterprises' own funds – this pattern applied more strongly in manufacturing than services.

Grants from the Research Council of Norway (RCN)

- In 2010, the RCN granted 6.7 billion NOK across the three R&D performing sectors: the institute sector received 41 per cent of these funds and the higher education sector 37 per cent.

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

- For 2011, the Norwegian GBAORD was estimated at 23.5 billion NOK; equivalent to 3.7 per cent of the state budget, or 0.8 per cent of GDP.

Results from R&D and innovation

Patents in Norway

- In terms of patents, the prime concern of Norwegian actors is the home market, even though patent applications from Norwegian actors only made up about 20 per cent of all patent applications made in Norway in the period of 2005–2009.
- Concerning Norwegian home patents, the proportion of foreign actors involved in co-patenting is rising, which shows that Norwegian actors are involving foreign actors more often in their new innovations.

Scientific publishing and citation

- From 2006–2010 the increase in articles written by Norwegian authors was especially large among those based at university colleges.
- 56 per cent of Norwegian articles that were published in scientific journals involved international co-operation in 2010.

Survival in newly established enterprises

- Three out of ten newly established enterprises survived for at least five years: limited (liability) companies show the highest survival rates.
- The survival rate increases with the size of the firm, in terms of the number of employees.

Human resources are the main driving force in the national R&D and innovation system. It is essential that high-level and appropriate skills are available to compete internationally. The chapter will show that there has been a long-running, sustained growth in the number of students in Norway. In 2009 there were 230 000 students in education, but only a relatively small proportion of all students go on to higher (post graduate) degrees each year. In 2009 the number of those going on to post graduate education was over 7 000, only 3 per cent of the total number of students. This shows that a large share of students either exit at degree level or drop out along the way to post graduate qualifications.

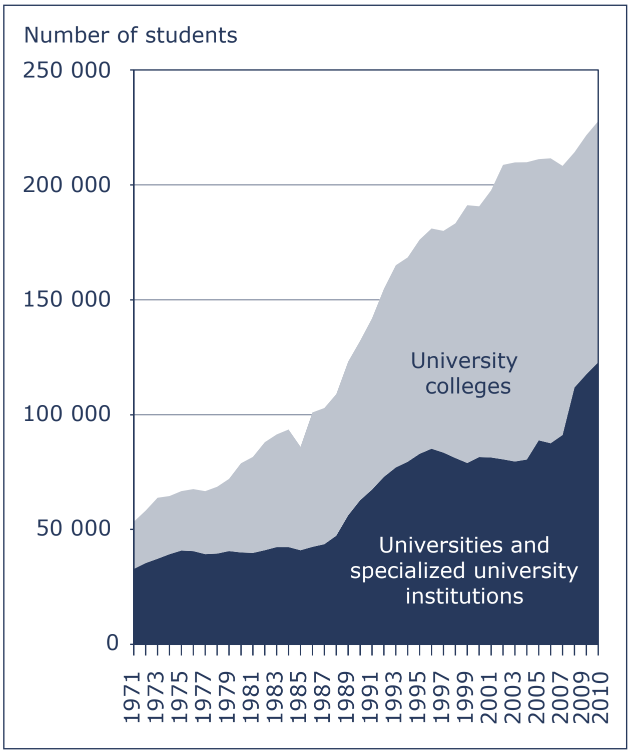
Among the candidates with higher degrees, a far higher proportion now goes on to obtain a doctorate. The number of PhDs awarded annually is now around 1 200. It is also worth noting that there are many foreigners who take a Norwegian doctorate. In 2010 28 per cent of all doctorates were awarded to non-Norwegian citizens. The increasing proportion of non-Norwegian researchers shows a there has been a strong internationalisation in Norwegian research. Growth in the number of people taking higher education has also led to growth in the number of those employed with higher education.

There are detailed statistics on human resources related to research and development, both measured by the number of employees in research-relevant positions and by the number of Full Time Equivalents (FTE) that are spent on R&D . Trends show continued increases in both R&D personnel numbers and FTEs, but this growth is somewhat differently distributed among the three R&D performing sectors of universities and colleges, research institutes and business enterprises.

Trends in the costs of R&D will of course be related to changes in human resources. Research is certainly labour intensive: nearly two thirds of total R&D expenditures are direct labour costs. Total R&D expenditures increased in the last year, but growth was slower than the previous year. Another interesting feature is that R&D expenditure as a share of GDP has increased, mainly due to a decline in GDP. The financing structures of the three main R&D performing sectors vary: the industrial sector largely finances its own research, while public funds dominate the higher education sector and institute sector.

The statistics offer reasonably good coverage when it comes to the measurement of inputs for research and innovation. The most important measurements, however, relate to research outputs in the form of new products or processes, new therapies for various diseases, better climate, higher profitability for business and so on. The Fagerberg Committee has also raised concerns about how to get the highest possible economic return on research investment and how to measure the social impact of research. These variables are often more difficult to measure than inputs, and statistics are lacking in this area, a conclusion the Fagerberg Committee also highlighted. Despite these limitations, this report presents a range of results-oriented indicators. These include indicators for innovation in Norwegian industry, patenting, corporate survival and scientific publications and citation rates. In addition, results are presented for Norwegian participation in EU Framework Programmes, where Norway has a good success rate in certain programme areas. A common feature of many areas of good performance in R&D or innovation is collaboration different partners, both nationally and internationally. Earlier issues of the Indicator report had separate own chapter on cooperation, but this is now incorporated throughout the other chapters.

Figure 2.1
Total number of students in the higher education sector: 1971–2010.[1]



[1] Preliminary figures.
Source: Statistics Norway

2.1 Human resources

2.1.1 Students in Norway and abroad

Over the past 40 years, Norway has seen student numbers rise from fewer than 54 000 to nearly 230 000 today. The trend towards mass higher education has not just involved changes in scale, but has changed the character of higher education institutions and the academic communities that inhabit them. However, while more students require more from academic staff, the number of those employed in higher education has also increased, and thus the overall activity in this area, including R&D activities, has risen. The most important consequence of these changes, however, is the raised level of education among the working population.

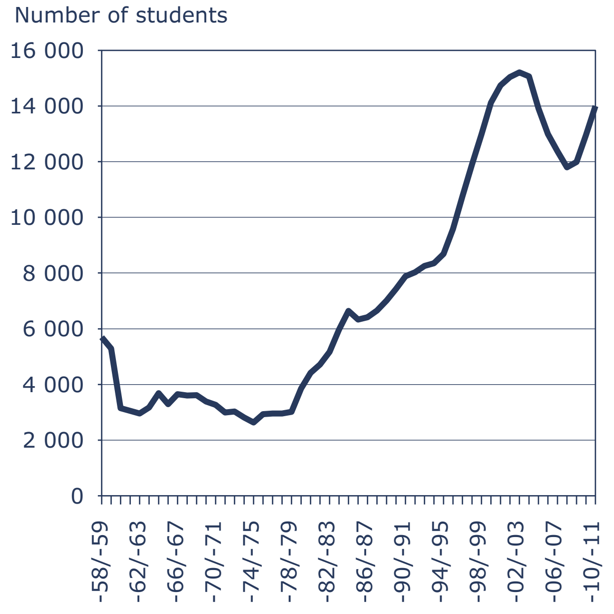
This overview of recent changes and expansion starts in 1971 (see Figure 2.1) in part because of data available, but primarily as this year saw a college-sector established outside of the universities. The universities had already expanded sharply by this time, with student numbers quadrupling between 1960 and 1975. The establishment of university colleges – known as state university colleges from 1994 – marked a deliberate policy to channel further growth into these institutions, and student numbers at universities and specialised institutions at university level did indeed stagnate until the late 1980s. The number of professional positions also remained steady, until the next major period of growth in student numbers, from the late 1980 to the mid-1990s, when university staff numbers also rose. There followed a ten year period of relative stability after 1995.

In 2005 two university colleges received university status. These new universities of Stavanger and Agder marked the biggest shift between the two sectors. If we consider the overall pattern of change since the early 1970s, the universities' experience can be summed up by two periods of strong growth and two periods of stagnation, while the university colleges have seen their student population increase steadily throughout the period.

As shown in Figure 2.2 Norway has a long tradition of having large numbers of students study abroad, and has a higher proportion of students who go overseas than most western countries. In part this is due to patterns of demand, but it is also due to a deliberate internationalisation process, including funding policies that facilitate international studies. A key policy tool here is that student loans provided by State Educational Loan Fund (Lånekassen) offer support through loans and grants for those who wish to study abroad. This means that, unlike in many other countries, it is often no more expensive to take up higher education abroad, than at home.

There are also particular groups of students whose choice to study in other countries reflects the limited

Figure 2.2
Norwegian graduates abroad: 1958/59–2010/11.[1]



[1] Figures by 01.03.2011.
Source: Norwegian State Educational Loan Fund

availability of certain courses in Norway. Medical students and veterinary students are examples of this situation. However, the majority of students choose to travel because they want to study in a foreign environment, and experience the academic, cultural and social challenges involved.

Developments in the numbers of Norwegian students taking a full degree abroad followed a similar pattern of growth to numbers of home students until 2003, when the numbers heading abroad sunk (see Figure 2.2). This may have been due to changes in student funding, which meant that it became more expensive to study abroad in many cases, at the same time as the Quality Reform was leading to a more wide-ranging set of higher education options within Norway. The number of students going abroad has rebounded in recent years, in part linked to the increased pressure on the higher education system in Norway.

The countries receiving the highest number of Norwegian students are the United Kingdom, Denmark, Australia, Poland, USA and Hungary. Norwegian students are increasingly choosing countries where the language requirements for courses are easier, which in practice means English-speaking countries, Nordic countries and Eastern European countries that offer programs taught in English.

2.1.2 Graduate degrees in Norway

The total number of those completing post-graduate courses from the Norwegian universities, scientific, public and private university colleges has increased in recent years, from about 9 100 in 2008, to 11 000 in 2009 and 11 300 in 2010. The high numbers in the last two years are not primarily driven by increases in the number of such graduates, but primarily by the inclusion of the BI School of Management from 2009, which added 1 800 master's degrees to the total in 2009 and 1 500 in 2010.

In 2004, the proportion of female masters graduates exceeded 50 per cent (across all types of higher education institution). It has since increased, and has remained at 54 per cent since 2008. Educational science (pedagogy) attracts the highest proportion of female students (at 77 per cent) and has done so consistently since these statistics began being monitored (back to 1991). In recent years, medicine and other health-related subjects have also attracted a high share of women, at around 70 per cent. In contrast, the lowest proportions of female students are found in the areas of natural sciences and technology, with overall rates varying between 32 and 37 per cent since 2003.

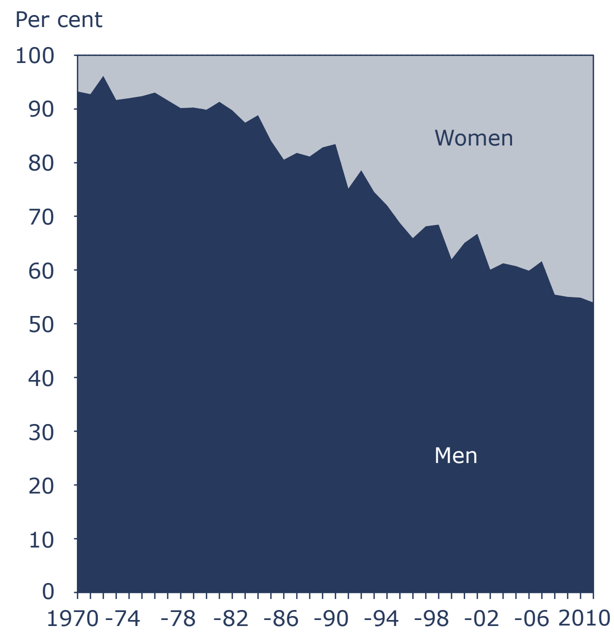
The last 40 years there has been a tremendous increase in the number of graduates in the Norwegian higher education sector. The number of those completing and graduating each year is, however, significantly lower than the number of registered students. The main reason for this is that the number of students includes all students at all levels and age groups, both full time and part-time, and bachelor studies and professional studies do not always lead to a higher degree. Candidates include those who have completed a master's degree or bachelor's degree. The drop-out rate among students is about 25 per cent, and in addition to this, there are many students who require more than the standard time to complete their studies.

2.1.3 Doctoral degrees in Norway

Completing graduate master exams is a prerequisite for a student to begin a doctoral program, but the proportion of such students who go on to undertake a doctoral program also varies by subject area. While about one in five of those with a master in natural science continue to a doctoral degree, the proportion is one in ten among graduates from the social sciences and humanities, or medicine and health sciences. Among law graduates only one per cent take up doctoral studies.

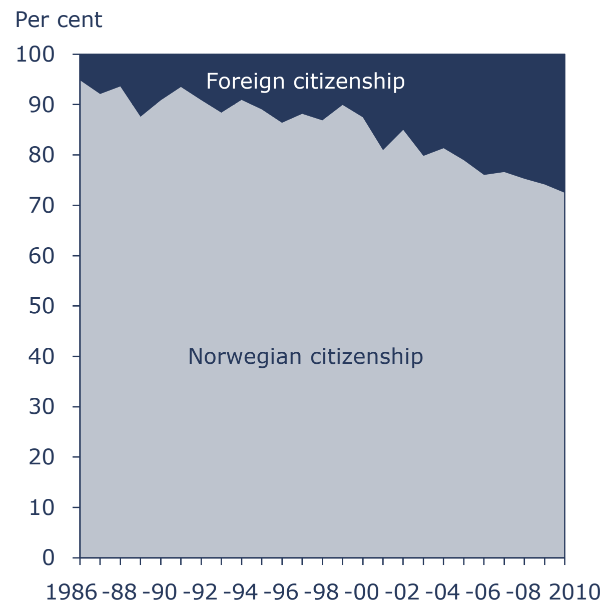
By the end of 2010, well over 20 000 doctoral degrees had been awarded at Norwegian universities and high schools since such qualifications were intro-

Figure 2.3
Awarded doctoral degrees in Norway by gender: 1970–2010.



Source: NIFU, Doctoral Degree Register

Figure 2.4
Awarded doctoral degrees in Norway by citizenship of doctorate holder: 1986–2009.



Source: NIFU, Doctoral Degree Register

duced in 1817. Many of these doctorates (40 per cent) have been completed at the University of Oslo, with Norwegian University of Science and Technology (NTNU) contributing another 25 per cent. The last four decades have seen the number of new doctorates increase, from around 1 000 during the 1970s to nearly 10 000 in the years since 2000. The proportion of women in doctorate-level courses has also increased over time. In 1970, just 7 per cent of doctoral degrees were completed by women, but by 1990 this had risen to 17 per cent, and since 2006, the proportion of women has remained stable at 45–46 per cent (Figure 2.3).

About 34 per cent of all doctoral degrees awarded in 2010 in Norway were in natural science or technological subjects, a far lower proportion than in 1990, when these two areas together accounted for more than half of all doctorates awarded. Among the other doctoral degrees in 2010, 33 per cent were in medical and health sciences, 21 per cent in social sciences, 8 per cent in the humanities and 4 per cent in agricultural science/veterinary medicine. From 2000 to 2010, the number of doctoral degrees has increased by 6 per cent on average per year. The increase was strongest in medicine and health sciences with 11 per cent annual average growth, while in technology, numbers have not grown, but remained steady.

The average age of those completing their doctorate dissertation is about 38 years, and this has changed little in recent years. However this average age varies between disciplines. In 2010 the average age was just 33 in natural sciences and technology, 37 in agricultural science/veterinary medicine, 40 in the humanities and social sciences and 41 in medicine and health sciences.

The number of people with foreign citizenship completing doctoral courses at Norwegian institutions has risen rapidly (see Figure 2.4). In 2010 non-Norwegians accounted for 28 per cent of doctorate graduates, up from under 10 per cent at the beginning of the 1990s. In 2010 the share of non-Norwegian students was highest in technology, at 43 per cent, while only 15 per cent of humanities doctorates were taken by those with foreign citizenship. The majority of these foreign doctoral candidates are from another European country, with Germany the most strongly represented country in recent years.

A 2002 evaluation of Norwegian researcher education found that progression through doctorate courses was still not satisfactory, that too few completed their studies and that those who did complete and defended a thesis took too long to do so.[1] However, more recent

[1] The Research Council of Norway (2002): Evaluation of Norwegian research. The Research Council has recently announced a new evaluation of doctoral education in Norway, which commenced in autumn 2011.

research suggests that progression and completion rates have risen considerably.[2]

There has been a long-term trend whereby a rising percentage of students take up three-and four-year research fellowships to study for their doctoral degree. Among the 1980/1981 cohort, 30 per cent completed and defended within 5 years, 38 per cent within 7 years and 45 per cent within 9 years. Among the cohort from 2000/2001 59 per cent defended within 5 years, 72 per cent within 7 years and 76 per cent within 9 years. The pace of completion also varies by subject area. For the 2001/2002 cohort, about 80 per cent of those studying mathematics and science, technology, agriculture, or medicine/health completed a doctoral degree within 9 years.[3] In the humanities and social sciences, the corresponding share was just under 70 per cent.

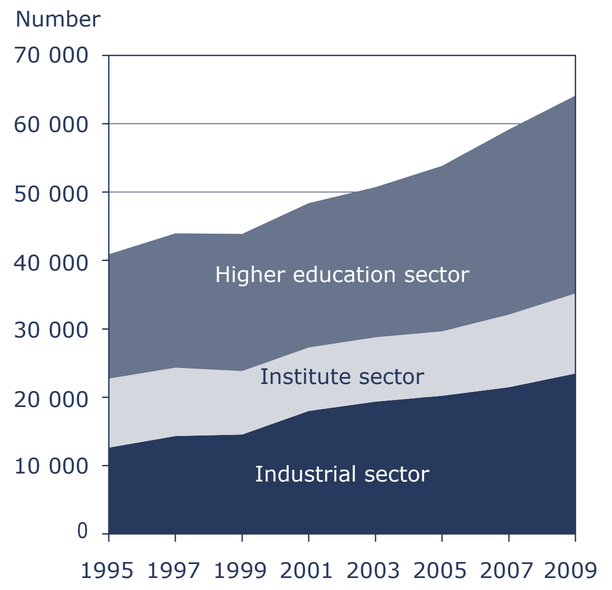
2.1.4 R&D personnel and Full-Time Equivalents (FTEs)

In 2009, 64 000 persons participated in R&D activity in Norway; nearly 45 000 of these were researchers, while approximately 19 000 were in technical or administrative positions. Higher education was the largest R&D sector measured in terms of the number of persons participating in R&D, accounting for 45 per cent of all Norwegian R&D personnel. The industrial sector accounted for 37 per cent, and the institute sector 18 per cent. The number of R&D personnel increased by about 10 000 in both the industrial and the higher education sector between 1995 and 2009, while the institute sector had only a moderate growth in numbers of 1 600 people (see Figure 2.5). See the text box regarding the Norwegian R&D performing sectors.

The share of researchers among all R&D personnel also varies between the different performing sectors. In the higher education sector, researchers accounted for 79 per cent of all R&D personnel in 2009, while the corresponding figures for the institute sector and the industrial sector were 72 and 69 per cent respectively.

Figure 2.6 shows the number of researchers among the R&D performing sectors measured both as head count and full-time equivalents (FTEs). Norwegian R&D personnel performed the equivalent of 36 000 FTEs in 2009, an increase of 2 000 from 2007. In the higher education sector, the total amount of R&D work measured by FTEs increased from 2008 to

Figure 2.5
R&D personnel in Norway by performing sector: 1995–2009. Head count.



Source: NIFU/Statistics Norway, R&D Statistics

2009, while the industrial sector experienced a decline of 2 per cent. Of all FTEs, more than 26 000 were conducted by those employed as researchers in 2009, making up 73 per cent of all FTEs, a share that has been relatively stable throughout the last decade.

Academic staff at universities and colleges are usually responsible for other tasks besides R&D activities. For teaching staff, such as full professors, associate professors and university and college lecturers, a major part of working hours are spent on teaching, advising students or on administrative tasks. Researchers at research institutes and enterprises will also spend time on tasks that are not classified as R&D, such as administration and management. When it comes to technical or administrative personnel and support staff, only time spent supporting R&D activities will be counted. Full-time equivalents are therefore a measure of the time R&D personnel actually spend on research and development.

Time studies at universities and university colleges (detailed surveys investigating how employees use their working hours) mean that R&D ratios for the higher education sector can be calculated for a specific institution, field of science and occupation in the higher education sector. Since the early 1980s, NIFU has conducted surveys to map the time spent on R&D among tenured academic staff at universities. In addition, two studies have been conducted at university colleges, in 1995 and 2005. The results from these studies have been stable, and show that about 30 per

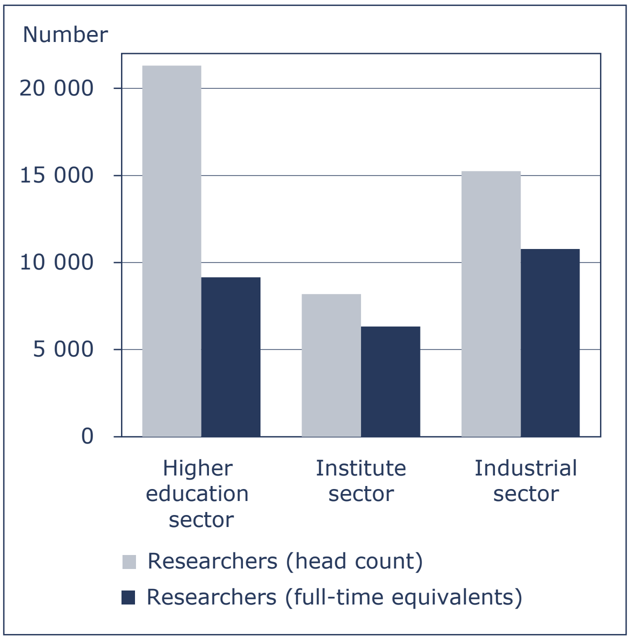
2 See NIFU STEP report 40/2009: Kyvik, S. and Olsen, T. B. (2009): Gjennomstrømning i doktorgradsutdanningen.

3 All figures based on NIFU's register of Doctoral Degrees.

Norwegian R&D performing sectors

OECD's sectors	Units	Norwegian sectors
Higher education sector	Universities, specialized university institutions, university colleges, art colleges and other colleges. Health trusts - university hospitals	Higher education sector
Government sector	- other hospitals Research institutes and other governmental bodies with R&D, i.e. units that are mainly controlled and financed by the government.	Institute sector
Private non-profit sector - PNP	Individuals, households and private non-profit institutions. (There are very few units that perform R&D in this sector in Norway. These are included in the government sector, and Norway does not report R&D statistics for the PNP sector).	
Business enterprise sector	Private research institutes serving enterprises; mainly industry research institutes and business-oriented contract research institutes.	
	All enterprises with 50 or more employees. In addition, a selection of enterprises with down to 10 employees is included.	Industrial sector

Figure 2.6
Researchers by sector of performance, 2009. Head count and FTEs.



Source: NIFU/Statistics Norway, R&D Statistics

cent of working hours are spent on R&D activities, on average. An overall time study for all institutions in the higher education sector was conducted in 2011, and the results will be ready by the end of the year.

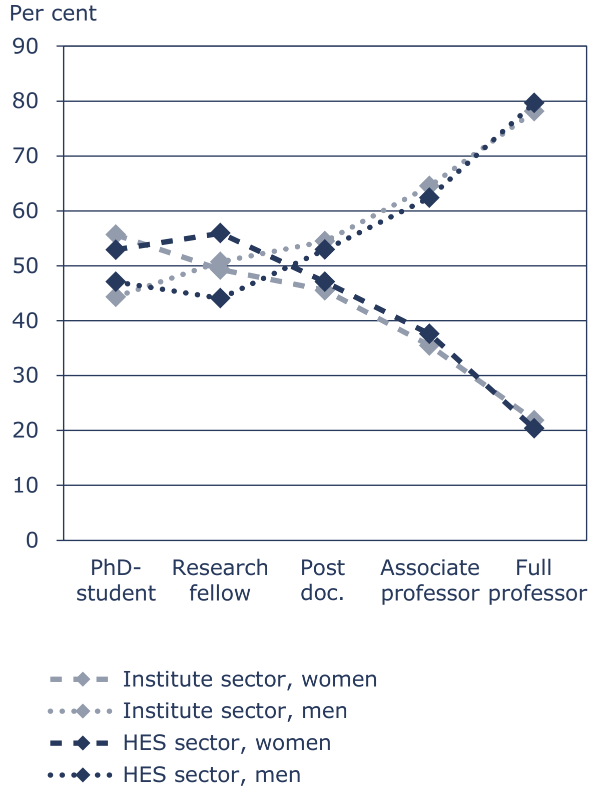
As of 2009, 30 per cent of researchers in Norway held a doctoral degree. The institute sector had the highest share of researchers with a doctoral degree, at 41 per cent, while the share in the higher education sector was 39 per cent. This lower share in the higher education sector is due to the high number of research fellows and those in other positions that do not require a doctoral degree. If research fellows are excluded, the share of researchers in the higher education sector with a doctoral degree increases to 51 per cent and to 44 per cent in the institute sector.

In 2009, a total of 1 600 researcher in the industrial sector had a doctoral degree, amounting to just 10 per cent of all researchers in the sector. The share of researchers with a doctoral degree in the industrial sector has been relatively stable for the last decade. Researchers in the industrial sector who hold a doctoral degree performed 1 300 FTEs in 2009, 8 per cent of the total R&D FTEs in the industrial sector in Norway in 2009.

In 2009 there were 16 000 female researchers who participated in R&D in Norway. The share of women in Norwegian research has increased from 24 per cent in 1995 to 35 per cent in 2009. In that same period the share of women increased in the higher education sector from 29 to 44 per cent, in the institute sector from 26 to 39 per cent and in the industrial sector from 15 to 21. The number of women researchers is especially high in positions that do not require a doctoral degree.

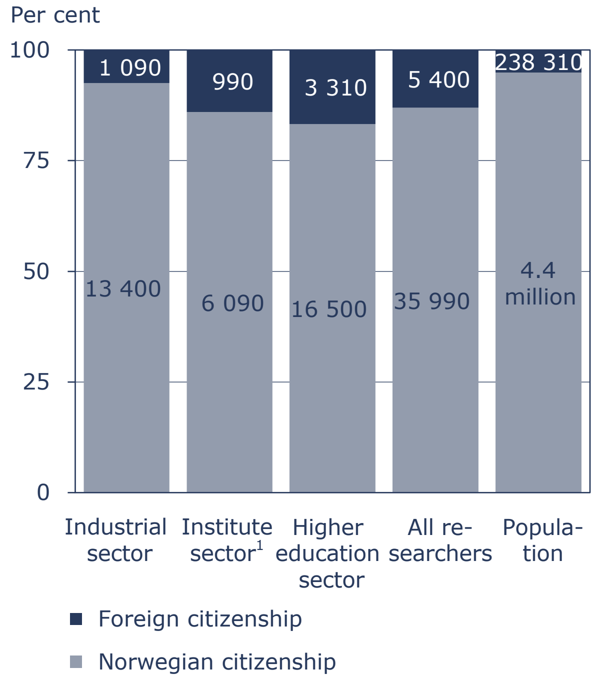
Figure 2.7 shows the proportion of men and women in the positions that make up a typical academic career in the higher education sector, and the equivalent figures for the same career levels in the institute sector, as the situation stood in 2009. The higher education sector and the institute sector differ when it comes to the structure of positions, as the institute sector is a heterogeneous group of institutions, with different aims and tasks. This makes it difficult to directly compare occupation structures between the two sectors. To enable a reasonable comparison, NIFU has made a three-level model for researcher positions, based on the structure used in the social sciences research institutes: Researcher 1, Researcher 2 and Researcher 3. Researcher 1 roles have an equivalent level to a full professor, and some of those in Researcher 1 roles would be employed as a professor II in the higher education sector, as they have doctoral qualifications or a long career in the research system. Researcher 2 roles involve equivalent competence to PhD level-positions in higher education (e.g. associate professor), while Researcher 3 roles have competence equivalent to the master's level (e.g. lecturers). Post

Figure 2.7
Proportion of women and men for typical career steps in the institute sector and the higher education sector, 2009.



Source: NIFU, Register of Research Personnel

Figure 2.8
Citizenship amongst researchers in Norway by sector of performance, 2007.



[1] Personnel at the health trusts, a total of 382 persons, are not included in these numbers.

Source: Statistics Norway/NIFU, Register of Research Personnel

doctorate (post doc) and research fellow positions will tend to have the same employment terms in both sectors.

Women accounted for 20 per cent of full professors in the higher education sector, and 22 per cent of Researcher 1 positions in the institute sector. At the associate professor/Researcher 2 level, the share of women was 38 per cent in the higher education sector and 35 per cent in the institute sector. The difference between the two sectors were most clear in the third layer, of other tenured positions/Researcher 3 roles, where women make up 56 in the higher education sector and 46 per cent in the institute sector.

The number of researchers in Norway with foreign citizenship has increased during recent decades. In 2007, foreign citizens accounted for 13 per cent of the total number of researchers, up from nine per cent in 1997. The share of non-Norwegian researchers was 16 per cent in the higher education and institute sector together (see Figure 2.8).

Among the researchers with foreign citizenship in the higher education sector, 26 per cent came from one of the other Nordic countries and 48 per cent from another European country. A further 10 per cent of these researchers came from the USA, Canada, Australia or New Zealand, while 12 per cent came from Asia, 3 per cent from Africa and 1 per cent from Latin America. From 1997 to 2007, the EU and Asia have increased their shares of foreign citizens working as researchers, while the shares from the USA and Canada have declined.

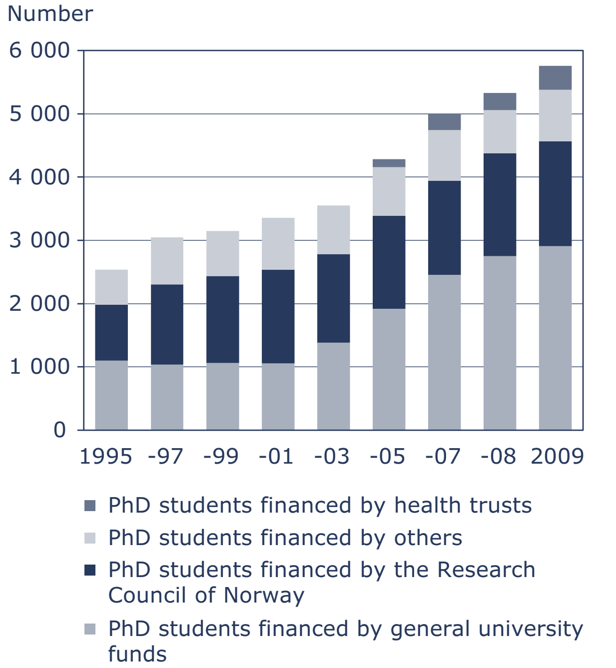
The highest number of foreign researchers in Norway came from Germany, followed by Sweden, Denmark, Great Britain and the USA. Among non-western countries, China and Russia had the highest number of researchers registered in Norway.

A total of 11 700 people participated in R&D in the institute sector in 2009, an increase of 600 from 2008, mainly due to the re-classification of some research units from the higher education to the institute sector. R&D personnel at health trusts without university hospital functions were also included in the institute sector from 2008, and accounted for 800 persons in 2009, of which 480 were employed as researchers. Researchers accounted for 70 per cent of R&D personnel in the institute sector in 2009, as they had in the three previous years.

Reduced bureaucracy for foreign citizens working in Norway

The Norwegian Immigration Regulations set rules regarding residence permits for skilled workers and specialists, and doctoral candidates clearly fall within this definition. The regulations were amended in 2009, making it easier to recruit and retain specialists. Previously there were strict requirements for documentation regarding the education and competence of specialists from countries outside the EEA. These requirements have been relaxed, while new requirements have been introduced related to minimum wages for such employees, and demonstrating that such positions cannot be filled using employees from Norway or the EEA/EFTA area. Graduates and researchers can also be granted a temporary stay of six months to seek work as a skilled worker. An annual quota of 5 000 skilled workers or specialists from countries outside the EEA or EFTA area, has also been established by the Ministry of Labour in partnership with Ministry of Trade and Industry and Ministry of Finance.

Figure 2.9
Number of PhD students in the higher education sector and the institute sector by source of funds: 1999–2009.



Source: NIFU, Register of Research Personnel

In the higher education sector, there were 29 000 persons participating in R&D in 2009. Of these, 21 300 were researchers and 7 600 support staff. Health trusts with university hospital function are included in the higher education sector, and had approximately 4 400 R&D personnel in 2009, of which 3 000 were researchers.

There were approximately 5 800 research fellows working in the higher education and institute sectors in 2009, an increase of 1 300 since 2007 (Figure 2.9). Growth in the number of research fellows has been twice as high as for other academic staff. The increase has occurred in all categories of research fellows, but the number of research fellows financed through general university funds (GUF) shows the highest growth, and by 2009, 2 900 research fellows were financed by GUF.

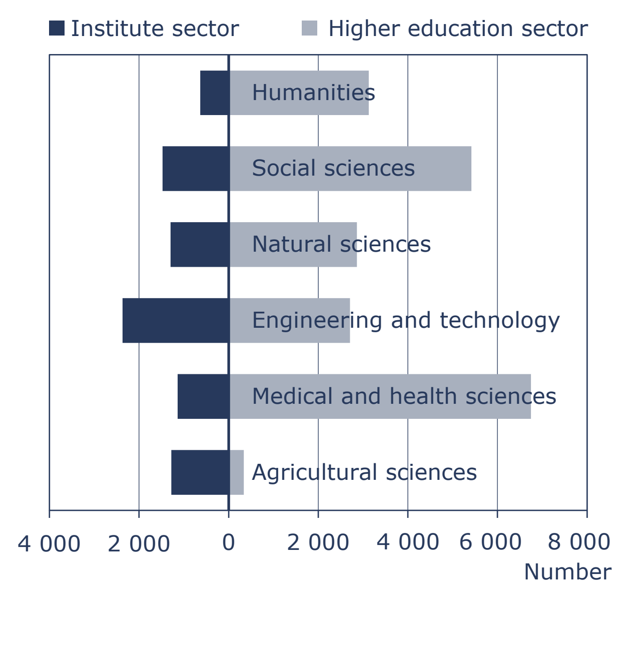
There are more doctoral students than research fellows in Norway. Although a research fellowship remains the most common way to achieve a doctoral degree in Norway, there are others who pursue a PhD while working as researchers at research institutes or researchers based in enterprises in the industrial sector. However, everyone who intends to submit a dissertation for a PhD, has to be enrolled in a PhD program, and must sign a doctoral agreement with a university or university college. Statistics regarding doctoral contracts show that there were a total of 8 377 such contracts in 2009. This suggests that the number of doctoral students is somewhat around 2 600 higher than the number of research fellows in NIFU's Register of Research Personnel.

If we look at the institute sector and the higher education sector as a whole, the medical and health sciences had the highest number of researchers active in Norway, with approximately 7 900 people in 2009 (see Figure 2.10). The vast majority of these, approximately 85 per cent, were employed in the higher education sector. Nearly 3 500 of these researchers in medical and health sciences were found at the health trusts.

After medical and health sciences, social sciences was the second largest field for researchers, accounting for almost 6 900 people in 2009. Engineering and technology was third with a little over 5 000 researchers in 2009, of which 2 300 were in the institute sector and 2 700 were in the higher education sector. Agricultural sciences within the higher education sector was the only field where the number of researchers decreased from 2007 to 2009.

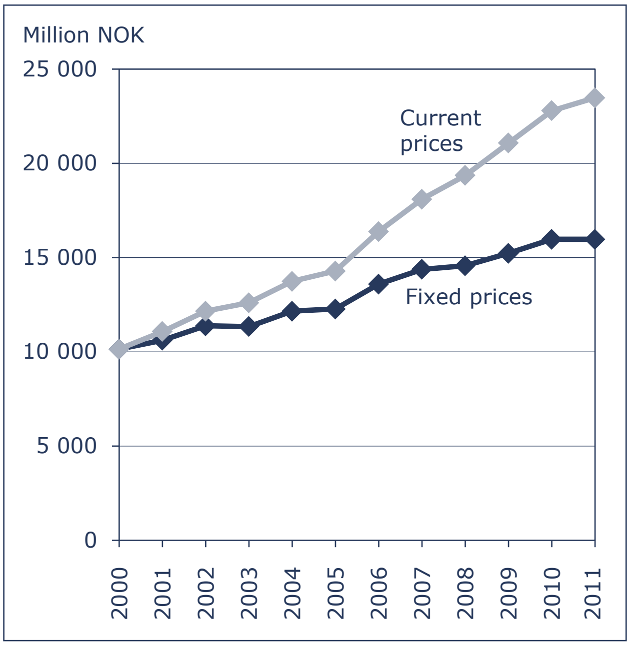
R&D personnel in the industrial sector added up to approximately 23 500 persons in 2009, the same level as in 2008. Just under two thirds of these R&D personnel had higher education. In the industrial sector

Figure 2.10
Researchers in the higher education and institute sector by field of science, 2009.



Source: NIFU, Register of Research Personnel

Figure 2.11
Estimated R&D allocations in the Norwegian State Budget in current prices and fixed 2000-prices: 2000–2011.



Source: NIFU

the category researcher includes all R&D personnel with higher education, unlike in the higher education sector and institute sector, where a researcher is defined by position. The manufactoring sector employed 42 per cent of the R&D personnel in the industrial sector, while the service industries employed 50 per cent.

FTEs in the industrial sector reduced from 16 000 in 2008 to 15 700 in 2009. 6 700 FTEs were carried out in the manufactoring sector and 7 800 in the service sector, a decline of 3.2 per cent for both the main industries. Companies in other industries (including *oil and gas*), had an increase of 7 per cent.

Almost 3 800 FTEs were performed in foreign-controlled enterprises in 2008, which is the last year there is data available on this level. This accounted for 27 per cent of total FTEs in the industrial sector this year. The foreign-controlled enterprises' share of the total R&D personnel is somewhat lower, at 23 per cent. This means that R&D personnel in foreign-controlled companies on average use more of their working time on R&D activities than the R&D personnel in the Norwegian-controlled enterprises. On average the proportion of researchers was 75 per cent in foreign-controlled enterprises in 2008, higher than among Norwegian enterprises, where the average proportion was 68 per cent.

2.2 Government Budget Appropriations for R&D

Analyses of Government Budget Appropriations or Outlays for R&D (GBAORD) have been conducted annually by NIFU since 1970. These analyses rely primarily on budgetary document information but also draw on additional sources of information, in particular performer-based R&D statistics. Estimations of GBAORD assume that institutional R&D levels are relatively stable over two-year periods. So, while the budget-based estimation method only measures government spending intentions, actual R&D spending is measured ex post by surveying R&D performers. There are several important differences between the GBAORD method and the performer-based R&D surveys method. While the former provides more rapid results, the latter gives more detail and precision. Furthermore, while budget analysis includes R&D grants to recipients abroad, the performer-based method is limited to activity within Norway. A final difference is that resources from counties and municipalities are not included in the GBAORD budget analysis but are accounted for (via government funds received) in the performer based R&D statistics.

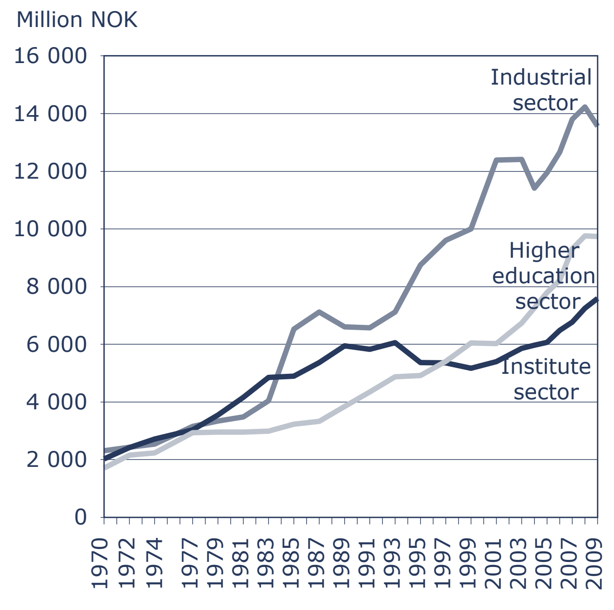
Norwegian government R&D allocations amounted to 23.5 billion NOK, according to the GBAORD estimate for 2011. This marks an increase of a little less than 300 million NOK compared to the final budget for 2010, resulting in zero growth in these appropriations. Growth this low has not been seen in the appropriations for R&D since 2003. Figure 2.11 compares the development of GBAORD in Norway in current and fixed prices.

According to the GBAORD measure, government R&D allocations accounted for 3.7 per cent of the overall Norwegian government budget in 2011. This represents a slight decrease relative to 2010, when the share was 3.8 per cent. The Norwegian government R&D allocations correspond to an estimated 0.87 per cent of Norway's GDP, a slight decrease from the historical high of 0.91 per cent in 2010.

The budgetary increase seen over the preceding years was mainly attributable to an increase in appropriations to universities and other higher education institutions, as well as to increased international R&D collaboration, particularly through the EU Framework Programmes. Both categories of expenditure are in the portfolio of the Ministry of Education and Research, whose GBAORD spending amounts to 12 billion NOK. This made up more than half the Norwegian GBAORD spending in 2011, which makes this the largest R&D funding ministry by far. The Ministry of Health and Care Services ranked second with 3.1 billion NOK, followed by the Ministry of Trade and Industry with 1.9 billion NOK. These three ministries accounted for 72 per cent of all GBAORD spending.

At the sub-ministerial level the dominant recipients of GBAORD were higher education institutions, which received approximately two fifths of the funds, while other research institutions received approximately 10 per cent of the funds. This means that more than half of all GBAORD is allocated directly to institutions where research is one of the primary purposes.

Figure 2.12
R&D expenditure in Norway by sector of performance. 1970–2009. Fixed 2000-prices.



Source: NIFU/Statistics Norway, R&D statistics

2.3 Total resources for R&D and innovation

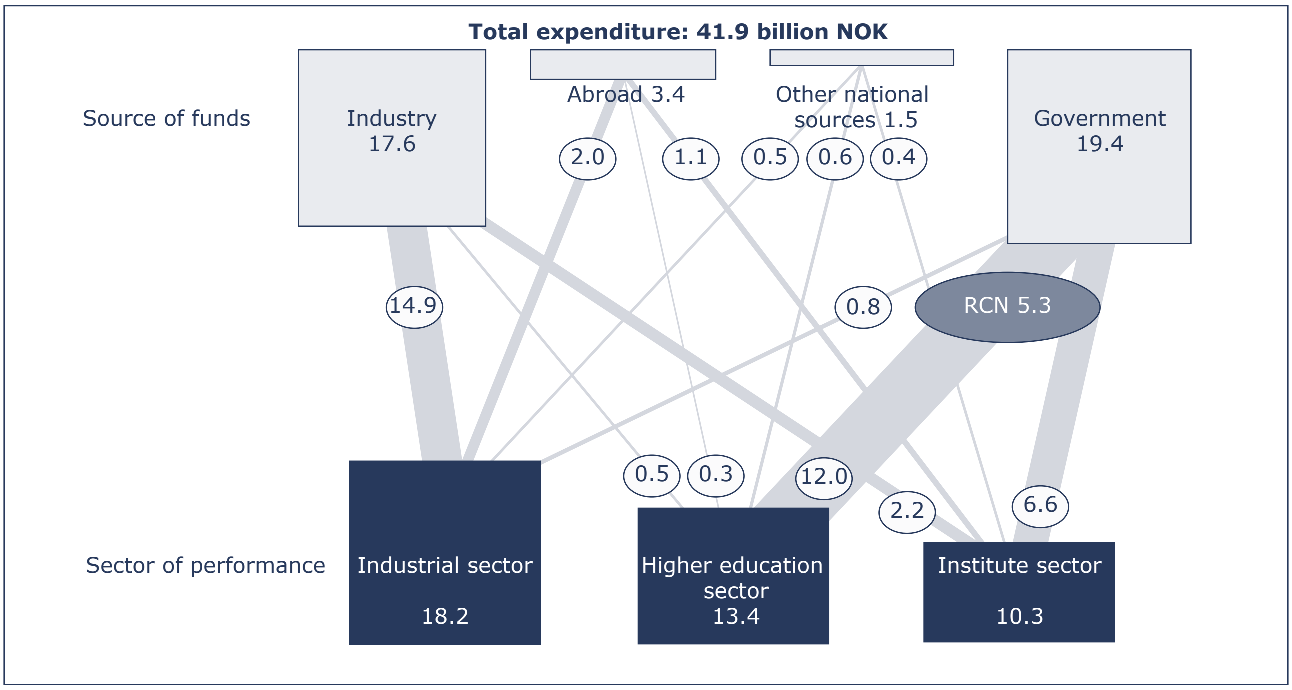
Total expenditure on research and development (R&D) in Norway amounted to 42 billion NOK in 2009. This represents an increase of over 5.1 billion from 2007 and 1.3 billion from 2008. From 2007 to 2009, R&D expenditure increased by 1.4 billion in the industrial sector, 2.0 billion in the institute sector and 1.7 billion in the higher education sector. Measured in fixed 2000-prices, there was a total decrease of 0.3 per cent from 2008 to 2009, which means that all the increase occurred from 2007 to 2008.

R&D expenditure accounted for 1.80 per cent of Norwegian gross domestic product (GDP) in 2009, up from 1.61 per cent in 2007. This increase is mainly due to the considerable decline in GDP from 2008 to 2009. Government funded R&D stood at 0.83 per cent of GDP in 2009, compared to 0.96 for R&D funded by industry, from abroad and from other sources. The corresponding figures in 2007 were 0.73 per cent and 0.91 per cent respectively.

Norway was among the first countries to produce R&D statistics, and so has a long timeline for such statistics, as shown in Figure 2.12. In 1970, the three performing sectors were of roughly equal size. Until the end of the 1970s, there was steady growth in all three sectors, and their relative proportions remained about the same. The higher education sector saw relatively steady growth in R&D expenditure from the end of the 1980s until the turn of the millennium. Up until 1997 the higher education sector was the smallest of the R&D-performing sectors, but from 2001 to 2007 increases in the R&D expenditure in this sector have accelerated. This is partly due to the number of PhD students, postdocs and other temporary jobs in higher education having risen considerably in the period.

The institute sector was the largest R&D performing sector until the 1980s, when there was significant growth in the industrial sector. The institute sector experienced a recession in the late 1990s, before beginning to grow again in the early 2000s. From 2005 to 2009 there was significant growth in R&D expenditure in the institute sector.

Figure 2.13
R&D expenditure in Norway by source of funds and sector of performance, 2009. Billion NOK.



Source: NIFU/Statistics Norway, R&D statistics

As for the industrial sector, there have been two major extensions in the coverage of the R&D survey – in 1985 and 1995 – when a number of new enterprises and industries were included.

Sources of R&D funding

Norwegian national R&D statistics are based on the following funding categories:

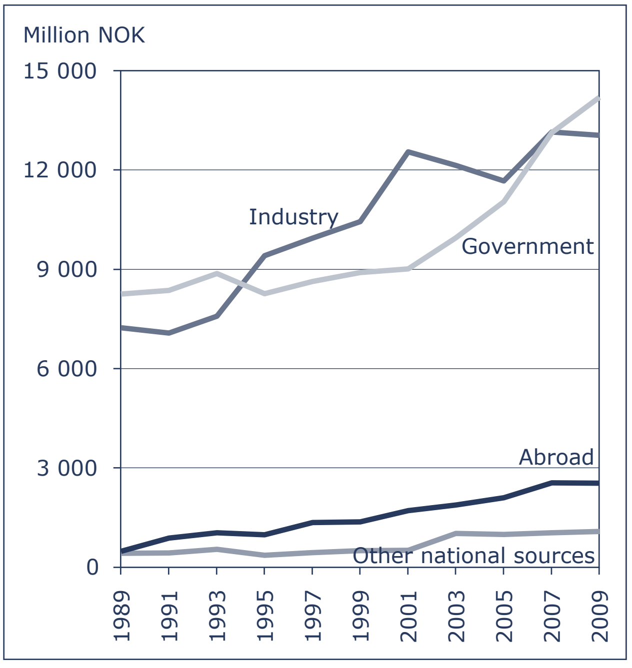
- Industrial sources: expenditure made by business enterprises or other industrial activity, in most cases for R&D activities within the enterprise itself.
- Government sources: expenditure made by the government, especially contributions by the Norwegian ministries directly to universities and other R&D institutions, as well as contributions channeled through the Research Council of Norway. A small proportion also comes from county and municipal administrations.
- Other national sources: private trusts, gifts, loans, grants from voluntary organizations and own funds in the higher education and institute sectors and SkatteFUNN (Tax deduction system for R&D) in the industrial sector.
- Sources from abroad: contributions made by foreign enterprises, institutions and foreign trusts as well as those from the EU, Nordic and other international organizations.

Industry funded 42 per cent of all R&D expenditure in 2009, while government sources accounted for just over 46 per cent. The rest came from abroad and other national sources as shown in Figure 2.13.

Nearly 82 per cent of the R&D activity in the business enterprise sector was funded by industry itself. Government financed 78 per cent of the R&D activities in the higher education sector and institute sector. Nearly 22 per cent of funding from government sources was channeled through the Research Council of Norway (RCN). The figure also shows that industry does not represent an important source of funds for the higher education sector, but has more importance for the research institutes. Funding from abroad accounted for 8 per cent of the total R&D expenditure in Norway in 2009, and funding from the EU Commission accounted for 17 per cent of the total funding from abroad. Funding through the tax deduction scheme, SkatteFUNN, is recorded under 'Other national sources'.

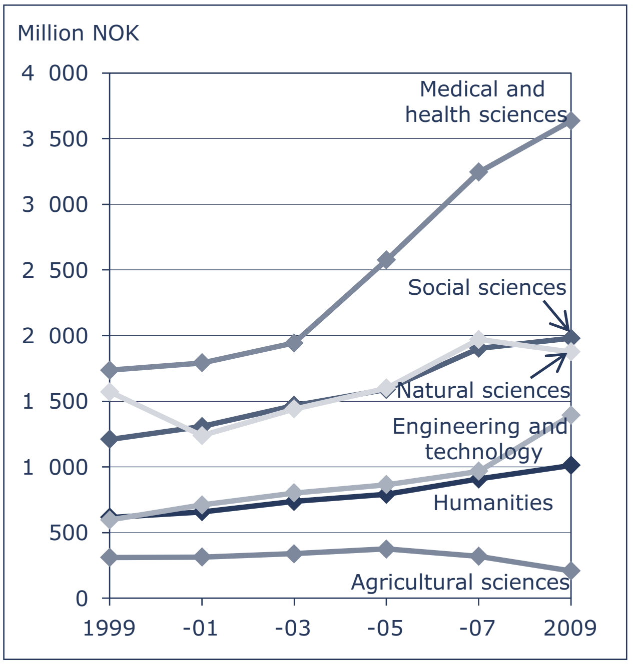
During the last 20 years there have been large changes in funding sources of Norwegian R&D, as shown in Figure 2.14. From the early 1990s till 2007 funding from industry was the most important source of funds. According to the figure this is about to change, as government sources were larger in 2009. Funding from abroad has also become a more important source of R&D funding, with a fivefold increase,

Figure 2.14
R&D expenditure in Norway by primary source of funds. Million NOK: 1989–2009. Fixed 2000-prices.



Source: NIFU/Statistics Norway, R&D Statistics

Figure 2.15
Current expenditure on R&D in the higher education sector by field of science: 1999–2009. Fixed 2000–prices.



Source: NIFU, R&D Statistics

while funding from other national sources has only doubled since 1989.

2.3.1 R&D in the higher education sector

In 2009 R&D expenditure in the higher education sector in Norway amounted to 13.4 billion NOK, which corresponds to a 32 per cent share of total annual R&D spending. The universities' (incl. university hospitals) share was almost 85 per cent, while university colleges and specialised university colleges had shares of 9 and 6 per cent, respectively.

From 2007 to 2009 there was a real growth of 4.5 per cent in total R&D expenditure in the higher education sector. University hospitals are included here and experienced a small decline in real expenditures over this same period, due to lower levels of investment in scientific equipment.

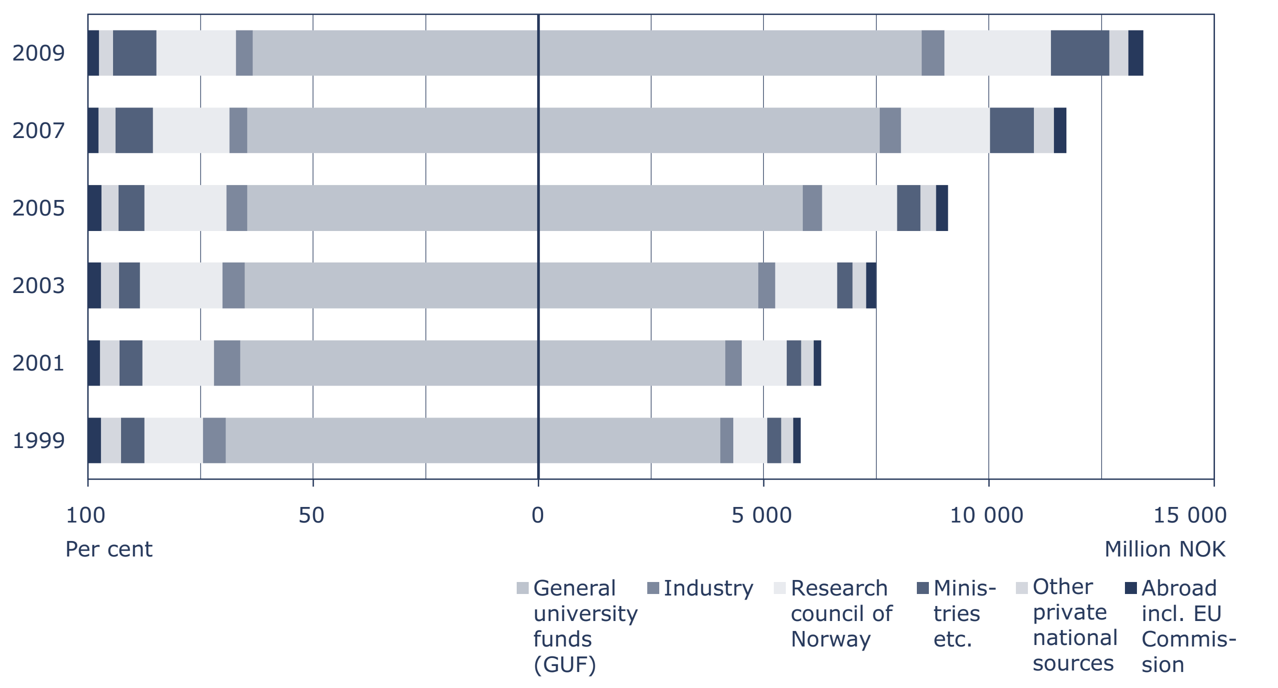
During the ten-year period from 1999 to 2009 there has been extensive growth in expenditure on R&D in medical and health sciences, as shown in Figure 2.15. The growth is partly due to expansions and modifications in R&D survey methods affecting the university hospitals. Nonetheless, medical and health sciences saw an average real annual growth of about 10 per cent during this period.

If we compare fields of science based on the scale of R&D expenditure, the social sciences were the second largest field of science in the Norwegian higher education sector in 2009, and of a similar size to the natural sciences, which have seen a small, real decline in expenditures from 2007 to 2009. At the same time engineering and technology experienced a marked increase in R&D expenditures, while there has been a negative trend for R&D in agricultural sciences over recent years. In the humanities expenditures remained fairly flat from 1999 to 2009.

The most important funding source for R&D in universities and colleges is funding from general university funds (GUF). This funding amounted to two thirds of total R&D funding in 2009, or nearly 9 billion NOK.

Figure 2.16 shows that the share of total R&D expenditure based on GUF was largest by the end of the 1990s, accounting for 70 per cent of total funds. Even though there has been relatively strong growth in GUF funding since then, external funding has increased slightly more rapidly in the period, with annual real growth of 5 per cent. Over the same period, funding from the Research Council of Norway grew at 8 per cent per year and thus increased its share of total R&D funding from 13 per cent in 1999 to 17 per cent in 2009, corresponding to approximately 2.4 billion NOK. In general, public funding has increased more than funding from private sources, and funding from abroad, funding from industry and funding from

Figure 2.16
R&D expenditure in the higher education sector by source of funds: 1999–2009.



Source: NIFU, R&D statistics

other private sources has increased more slowly over the years than total R&D expenditures.

There are large variations in the size of the fields of science in the Norwegian higher education sector: from almost 5 billion NOK in medical and health sciences, to less than 300 million NOK in the agricultural sciences. There are also different modes of R&D funding used across the fields of science. In engineering and technology the share of externally financed R&D can be as high as 50 per cent; in contrast the humanities receive the majority, 76 per cent, of their funding from GUF.

2.3.2 R&D in the institute sector

In 2009, R&D expenditure in the institute sector amounted to more than 10 billion NOK, which accounted for 25 per cent of the total R&D expenditure in Norway. Real growth in the sector from 2007 to 2009 was approximately 4 per cent.

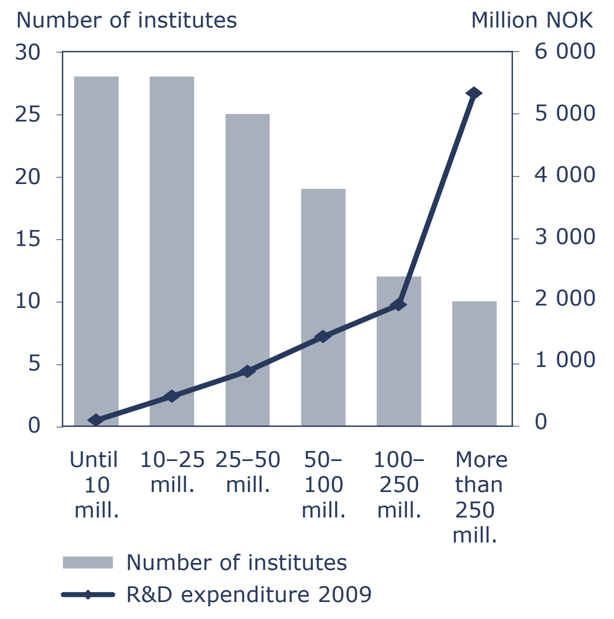
The Norwegian institute sector consists of a heterogeneous group of institutions, among which the common denominator is that they perform R&D on a non-commercial basis, and that they are not part of the organisation of a higher education institution. The academic facilities, R&D intensity and R&D scope of the institutions in the institute sector varies (Figure 2.17).

The units in the sector also differ in relation to which markets they serve or operate within. Business enterprises seek R&D services from the research institutes when they do not have the capacity, expertise or incentive to perform such projects themselves. The government needs R&D as a basis for political decision-making or to solve specific challenges within the community. Research institutes that mainly serve enterprises are classified in the business enterprise sector according to OECD guidelines, while institutes that mainly serve the government or governmental bodies are classified in the government sector. The PNP sector is rather small in Norway, and is therefore classified as part of the government sector (see text box in Chapter 1 of the report).

R&D expenditure for institutes in the government sector amounted to 7 billion NOK in 2009, while research institutes serving enterprises spent 3.4 billion NOK on R&D. From 2008 to 2009, there was a minor growth in R&D expenditure in the institute sector, and all this growth took place in the government sector institutes.

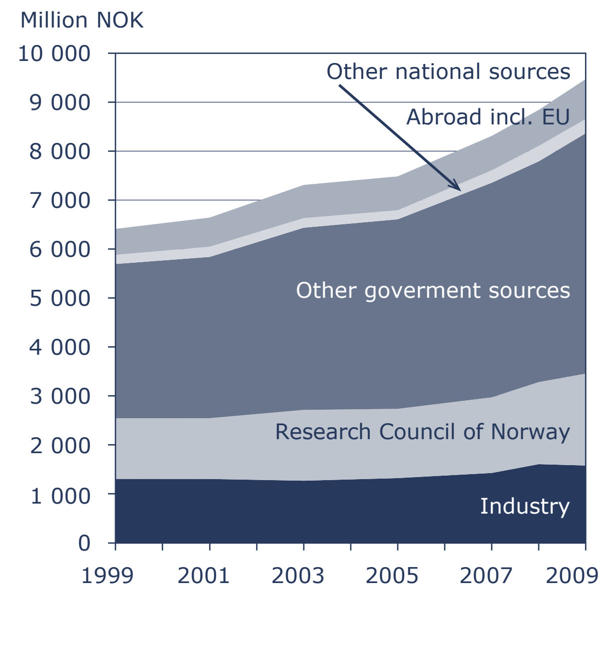
Three fifths of the R&D expenditure in the institute sector, or 6 billion NOK, was performed at institutes subject to guidelines for public funding of re-

Figure 2.17
R&D expenditure in the institute sector by size group of R&D expenditure. Number of institutions per size interval. R&D expenditure per group of institutes, 2009. Million NOK.



Source: NIFU, R&D Statistics

Figure 2.18
R&D expenditure in the institute sector by source of funds: 1999–2009. Fixed 2000-prices.



Source: NIFU, R&D Statistics

search institutes.[4] These research institutes have R&D as their primary task, and receive basic funding from the Research Council of Norway. By the end of 2009 there were 47 research institutes subject to these guidelines. In addition to this, around 70 institutions that perform R&D as a less important part of their activities, are included in the institute sector. On top of this, the institute sector includes estimates for the R&D activity in museums throughout Norway.

The research institutes subject to government guidelines for funding are divided into four 'competition arenas' for allocation of basic funding; technical industrial institutes, primary institutes, environmental institutes and social science institutes. The technical industrial institute group was the largest group of institutes in 2009, with revenues of 3.3 billion NOK. Among these institutes we find SINTEF, one of northern Europe's largest research institutes. Primary institutes accounted for approximately 1.2 billion NOK in 2009, and the environmental institutes for 800 million NOK. Social science institutes are divided into two groups: the 10 national social science institutes performed R&D worth 600 million NOK, while R&D in the 10 regional research institutes within social sciences accounted for 275 million NOK. R&D performed in other institutions in the institute sector amounted to 4 billion NOK in 2009.

The R&D activity in the institute sector is mainly applied research. Two thirds of the current expenditure in the institute sector was categorised as applied research, while 20 per cent was experimental development and 14 per cent was basic research. Research institutes serving enterprises had more applied research than the government institutes, 74 verses 62 per cent. This also implies that there was more basic research at the research institutes in the government sector.

Of the 10.3 billion NOK spent in the institute sector, 64 per cent was funded by the government. Funds through the Research Council of Norway amounted to 2.5 billion NOK, equivalent to 24 per cent of the total expenditure in the sector. Industry funded 20 per cent of the R&D expenditure in the institute sector, while other national sources accounted for 4 per cent and funding from abroad for 10 per cent. A total of 330 million NOK came from the EU Commission.

The funding source that increased most from 2007 to 2009 was the Research Council of Norway, with an increase of 10 per cent annually. Funding from abroad increased by nearly 8 per cent annually from 2007. Figure 2.18 shows developments over the past 10 years. The average annual real growth of total R&D

[4] In Norwegian: Forskningsinstitutter underlagt retningslinjer for statlig basisfinansiering av forskningsinstitutter.

FOKUS BOX NO. 2

Are R&D statistics for Norwegian businesses accurate?

It has been widely noted that Norwegian scores regarding innovation in general, and R&D in particular, are unexpectedly low, especially when viewed in comparison to the other Nordic countries (see chapter 1). Four different explanations are typically put forward for the low scores for R&D in the industrial sector.[1] The first is that the statistics reflect reality: the industrial sector does indeed account for less R&D in Norway than in other countries. The second is of a methodological nature: the low results reflect substantive differences between the industrial structure in Norway and the countries we usually compare ourselves to, and these differences should be adjusted for in international comparisons. An example of this kind of argument is that the pharmaceutical industry, which typically has a high R&D intensity, is only quite small in Norway, while the petroleum and natural gas sector, which is less R&D intensive, is very large. A third explanation is that revenues from petroleum production result in a high GDP, lowering Norway's results in terms of R&D as a percentage of GDP. The fourth and final argument is that Norwegian companies may systematically underreport their R&D efforts when completing the R&D survey conducted by Statistics Norway.

On behalf of the RCN, SINTEF has studied this fourth argument, in the project 'Variations in reporting of R&D statistics from firms in Norway'. This project investigated if R&D in the industrial sector is systematically under- or over-reported, and whether this is of significance on an aggregated level. This hypothesis was investigated through interviews with representatives from firms, covering their perceptions of R&D and how they report it to Statistics Norway. The study focused on large R&D performers (because even small deviations here will have a noticeable impact on the aggregate level) on firms involved in the extraction of petroleum/gas and the maritime sector, since concerns have been expressed about under-reporting in these sectors. A number of other firms were also sampled strategically. The final sample included a total of 19 firms involved in the extraction of petroleum and natural gas (including subcontractors and suppliers), the maritime industry, telecom (both services and equipment), process industry and administrative and support service activities.

There is no systematic international basis for comparing the occurrence of over-/under-reporting of R&D activity. However, we can assume that many of the countries collecting R&D statistics on firms deviate substantially from the standards in the Frascati Manual for preparing and reporting R&D statistics. These variations can go either way, both at the firm level and the aggregated, national level. Therefore, to support the hypothesis set out by the study, the variations found would have to be relatively large, and pull systematically in one direction. Secondly the variations have to be connected to indigenous factors in Norway, which could not be expected to be found to the same degree in other countries.

A general finding of the study is that reporting on R&D has a low priority among firms, because the statistics give little additional value back to those taking part. The few exceptions to this are firms that highlight their R&D efforts in marketing strategies, and so have R&D reporting integrated in their standard administrative routines. Such low priority might result in variations in the accuracy of data, but is not clearly going lead to systematic under-/over-reporting of R&D.

Another important finding is that there is no clear line to separate the concepts of R&D activity and other innovation activity. Depending on the industry or firm strategy, this distinction can be usefully made, or not be valid at all. This issue is a factor effecting reporting of R&D, but the deviations go both ways, offering no basis to believe that this alone causes systematic under-/over-reporting of R&D.

The most interesting and relevant finding is that combinations of at least three out of the four following conditions do seem to lead to under-reporting of R&D activity by firms:

- The firm performs much R&D as an integrated part in problem-solving activity.
- A large part of R&D performed is an integrated part of large projects for clients, and only the firm-determined and firm-funded R&D is reported as R&D.
- The firm's understanding of R&D is narrower than the Frascati-definition; as occurs in R&D departments that only consider their own activity as part of R&D and ignore activities in the wider organization, and when firms without a separate R&D department believe none of their work qualifies as R&D.
- If the firm or company has its own R&D department, but doesn't normally participate in building prototypes and piloting.

Overlaps of these conditions are primarily found in the subcontracting industry/supply industry to the petroleum and gas sector. Thus, a systematic underreporting of R&D can be expected to be found here. To a certain extent, this also applies to the shipbuilding industry.

We have also found indications of systematic over-reporting in firms where little real research is done, and where their concept of R&D extends far into routine development, and where the firm wishes to be perceived as innovative and geared to development. This tends to be the case in services with substantial ICT activity, although the data does not enable us to draw a clear conclusion that this leads to over-reporting on a similar scale to the under-reporting described in other sectors.

It is also possible that the OECD Frascati definition of R&D excludes certain kinds of experimental development that are typical and important in service industries with two main characteristics: firms where experimental development does not take place prior to the service delivery, but is strongly integrated in the process of the delivery; and firms where the production of knowledge is a by-product of establishing new practice, not the main objective (in contrast to a tighter definition of knowledge production as aiming to reduce knowledge-based uncertainties).

The firms studied were very reluctant to estimate the size of the changes they would need to make to correct for the kinds of variations in reporting practices that we established. However, we conclude that the underreporting of R&D may be significant at the aggregate level for national R&D activity. There is much less strong evidence of any systematic over-reporting of R&D. Nonetheless, the effect of such under-/over-reporting of R&D is probably minor in terms of international rankings, compared to the effect of differences in the industrial structure, as shown in other studies.

In light of this work, we believe Statistics Norway should elaborate on their manual for firms, clarifying how they can report R&D in accordance with the intentions of the Frascati Manual. SINTEF has suggested that Statistics Norway work with representatives from selected industries, to see if and how small changes to the questionnaire manual and instructions can address the issues discussed in this study. This would allow for selected businesses or industries to identify specific challenges and use terminology better known to them. A follow-up through industry representatives and official channels might also provide more accurate data.

[1] In the survey all Norwegian businesses are included, but not the special branch institutes and task-oriented industry institutes which are a part of the Norwegian business enterprise sector (see box on international comparisons in Chapter 1).

Håkon Finne, SINTEF

expenditure in the institute sector during this period was almost 4 per cent. All the main funding sources had an average annual real growth of between 4.2 and 4.7 per cent, apart from funding from industry, which increased by 2 per cent annually.

2.3.3 R&D performed in health trusts

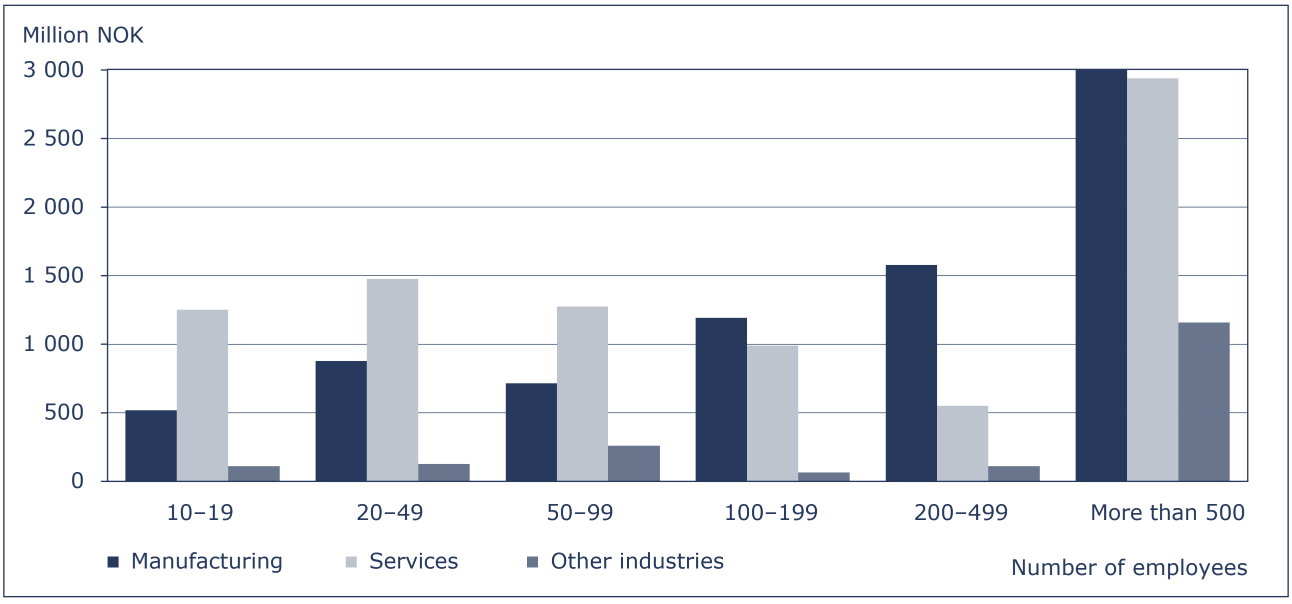
Total R&D expenditure at Norwegian health trusts amounted to 2.4 billion NOK in 2009, or 6 per cent of all R&D expenditure in Norway this year. The annual real growth from 2007 to 2009 was 1 per cent, and most of this growth occurred in health trusts without university hospital functions. There was a small increase in current expenditure both for university hospitals and other hospitals. At the same time, there was a decline in capital expenditure at the university hospitals, mainly for investment in equipment and machinery.

2.1 billion NOK was spent on R&D at university hospitals in 2009, which amounted to 16 per cent of the R&D expenditure in the higher education sector. Other hospitals, or health trusts without university hospital functions, performed R&D worth 340 million NOK, which accounted for 3 per cent of the R&D expenditure in the institute sector.

The main part of the funds used for research in health trusts, is allocated from the state budget as basic funds from the Ministry of Health and Care Services. Basic financing consists of two main components, the basic grants (1.5 billion NOK in 2009) and funds earmarked for research, which represented 20 per cent of total funds in the health trusts.

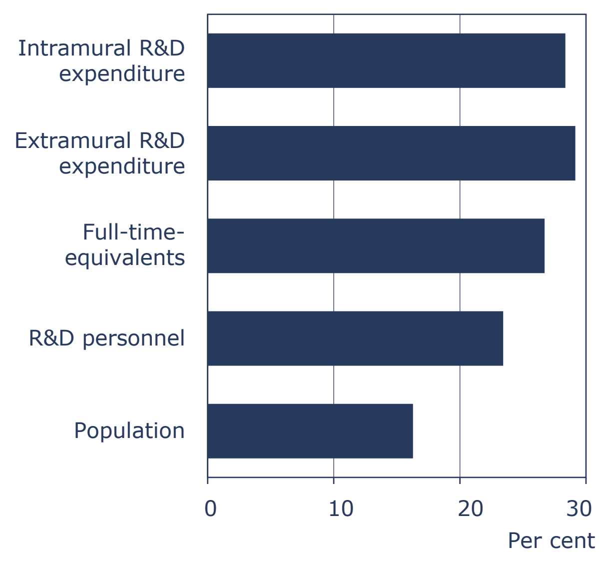
The Research Council funded 133 million NOK R&D in the health trusts in 2009, corresponding to almost 6 per cent of total funding. This is largely through funds allocated by the Ministry of Health and Care Services’. The Research Council of Norway thus plays a relatively modest role in the financing of research in health trusts.

Figure 2.19
Intramural R&D expenditure by main industry and size class, 2009.



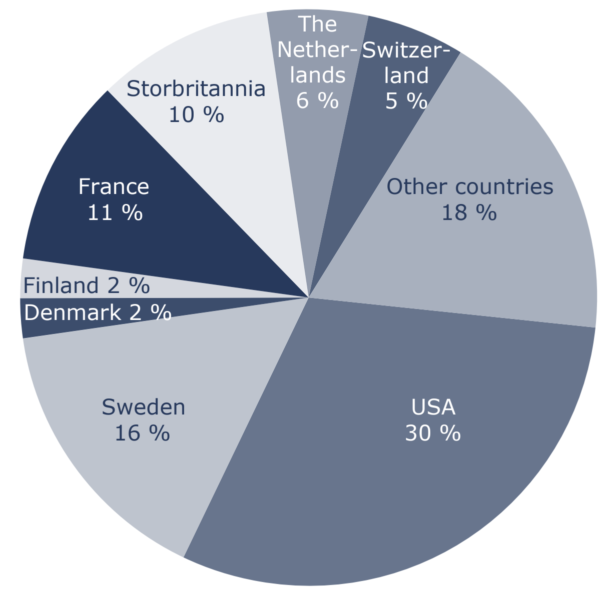
Source: Statistics Norway, R&D statistics

Figure 2.20
Foreign controlled enterprises' share of R&D expenditure, R&D personnel, R&D FTEs and population, 2008.



Source: Statistics Norway, R&D statistics

Figure 2.21
Intramural R&D expenditure in foreign-controlled enterprises by country, 2008.



Source: Statistics Norway, R&D statistics

2.3.4 R&D in the industrial sector

The industrial sector spent 18.2 billion NOK on intramural R&D in 2009. This means there was very little change in spending compared to 2008, with only a small decrease of 93 million NOK. In fixed prices, this is equivalent to a reduction of 3.7 per cent.

After four years of growth in R&D activity in the industrial sector, this trend was broken in 2009. The business enterprise sector as a whole does not expect any marked growth in 2010 either. The estimates provided by enterprises in the second quarter of 2010 indicate that they expect a weak increase of 2–3 per cent in R&D expenditure, and no change in the number of R&D person-years performed.

Despite unchanged intramural R&D expenditures, employee compensation costs increased by 4 per cent, to 12 billion NOK in 2009. Meanwhile, costs for both hired personnel and other current costs decreased by 5 per cent. Investments in buildings and machinery accounted for 1 billion NOK, a decrease of about 340 million NOK compared to spending in 2008.

The manufacturing industries performed R&D worth almost 7.9 billion NOK in 2009, accounting for 43 per cent of the industrial sector's total R&D activity. The service industries performed more R&D than the manufacturing industries, and made up 47 per cent of total R&D activity, accounting for 8.5 billion NOK of expenditures. For both main industries, these spending levels are almost unchanged compared to 2008.

In addition to intramural R&D, Norwegian enterprises spent 5.6 billion NOK in 2009 on R&D services performed by others. This is an increase of 4 per cent compared to 2008, although this is considerably less than the growth seen in recent years. It is the service industries that contributed most to this growth, with an increase of 319 million NOK in spending on external R&D services.

The largest enterprises are important for the industrial sector's overall R&D activity. Enterprises with more than 500 employees provide almost 40 per cent of the sector's R&D expenditure. This is visible in all the three main industries and especially so in other industries (including *extraction of oil and gas*) where enterprises with more than 500 employees accounted for 63 per cent of R&D spending, see Figure 2.19.

The share of enterprises with R&D activity is also markedly higher among large enterprises. About 15 per cent of enterprises with less than 50 employees reported R&D activity, while this rises to about 50 per cent for enterprises with more than 500 employees.

Enterprises reporting R&D activity have higher average value added than other enterprises. If the extraction industry is excluded, enterprises with R&D have 1 020 000 NOK in average value added per employee, while enterprises without R&D have 716 000 NOK. These conditions are typical for most of the industries and for the group of large enterprises (more than 50 employees). For enterprises with less than 50 employees this tendency does not seem to apply.

FOKUS BOX NO. 3

R&D areas of special priority

The Norwegian government has a special focus on R&D in certain areas considered important for the country. The regular R&D surveys therefore include questions on the share of R&D in these thematic and technological priorities. However, the R&D statistics are not a sufficient data source for detailed studies of the R&D efforts within the government's prioritized areas. One reason for this is the fact that these areas have a multidisciplinary character. They are defined rather widely, they are partly overlapping, and they cannot be limited to a specific industry in the business enterprise sector. Such conditions make it impossible to establish detailed descriptions of resources in these R&D areas, based on the main R&D surveys.

Against this background the R&D surveys have been supplied with additional questionnaires for the purpose of monitoring areas important in an R&D policy context. Examples of R&D indicators derived from the additional questions directed towards units known to perform R&D in the actual field are:

- Distribution of R&D expenditure on subfields in the prioritised areas.
- Distribution of the areas of priority by source of funds.
- The number of researchers involved in R&D in the certain area.
- PhDs and master degrees related to the R&D area.
- National and international cooperation.
- Assessment of the recruitment situation.
- Commercialisation, results, patenting.

The Ministry of Education and Research and the Research Council of Norway have a special need for this kind of knowledge, and that is the reason that over the years NIFU has carried out these mappings in areas of special research policy importance. The mappings are closely related to the ordinary R&D surveys in the higher education and institute sectors, in that they combine data from the mappings with results from the R&D surveys for the actual year. This has resulted in an extensive data set on R&D resources, as illustrated above. In this way the priorities in Norwegian research policy are monitored over time, and it is possible to get an impression of the success of the special efforts put into these areas.

The mappings related to the R&D statistics include the following areas, sectors and years:

- Marine R&D and fish farming R&D are mapped together in one survey and include the three Norwegian R&D performing sectors – the industrial sector, higher education sector and institute sector. Marine R&D has been mapped biannually from 1999 on, and fish farming from 2001 on, both on commission from the Research Council of Norway.
- Biotechnological R&D covers the higher education sector (incl. university hospitals) and the institute sector, but only totals are available for the industrial sector. R&D in biotechnology has been mapped biannually from 2003 on, commission by the Research Council of Norway.
- Agricultural and food related R&D was mapped for the first time in 2007, and all sectors are included. The project is based on the Ministry of Agriculture and Food's R&D strategy and is managed by the Research Council of Norway, under an initiative from the Ministry.
- Educational research was surveyed for the first time in 2007 and covers the higher education sector and the institute sector. In 2009 R&D on nursery schools was included as a separate part. The commissioner is the Ministry of Education and Research.

Susanne Lehmann Sundnes, NIFU

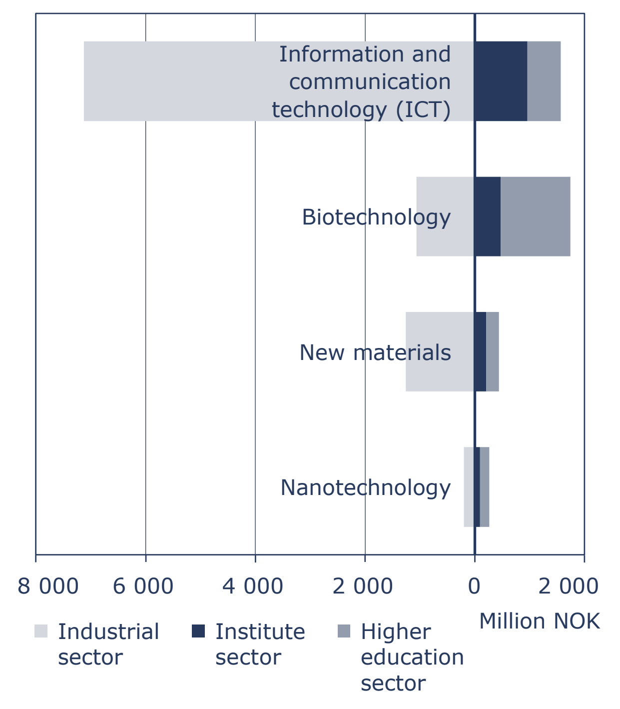
Certain sections of the Norwegian industrial sector are controlled by foreign groups or companies. An enterprise is defined as foreign-controlled if more than 50 per cent of it is owned directly or indirectly by an actor based abroad. Among the population of the Norwegian R&D survey, 16 per cent of enterprises were foreign-controlled.

These foreign-controlled enterprises differ from Norwegian enterprises, in having higher average turnover and more employees. Foreign controlled enterprises accounted for 27 per cent of the total number of employees and 30 per cent of total turnover in the industrial sector in 2008 (Figure 2.20). Foreign-controlled enterprises also differ from Norwegian enterprises regarding their R&D activity.

On average, foreign-controlled enterprises have more R&D activity than Norwegian enterprises. This is likely to be a result of the low share of small organisations among foreign-controlled enterprises, as small enterprises often have low R&D activity. R&D worth about 4.5 billion NOK was performed in foreign-controlled enterprises in 2008, constituting 28 per cent of total R&D expenditures in the industrial sector, see Figure 2.20. In the period 2003–2008, foreign-controlled enterprises had a lower share of total R&D expenditure than of total turnover. In other words, R&D activity is slightly less dominated by foreign-controlled enterprises than their total activities which contribute to turnover.

In addition to intramural R&D, foreign-controlled enterprises spent almost 1.3 billion NOK on R&D services performed by others in 2008. This accounted for 29 per cent of all R&D services in the industrial sector, about the same as the share of R&D they performed themselves.

Figure 2.22
Current R&D expenditureby prioritised technology area and sector of performance, 2009.



Source: Statistics Norway, R&D statistics

Most of the foreign-controlled enterprises in Norway have ultimate owners based in European countries or the USA. Almost 26 per cent of foreign-controlled enterprises were controlled from Sweden in 2008. These Swedish controlled enterprises contributed about 16 per cent of the total for R&D expenditures in foreign-controlled enterprises. U.S. owners account for 13 per cent of foreign-controlled enterprises, and also represent 30 per cent of their R&D expenditure. Figure 2.21 shows that enterprises controlled from France, the United Kingdom, the Netherlands and Switzerland also contributed considerably to R&D activity in 2008.

2.3.5 Thematic priorities and technology areas

The Norwegian government set out nine goals for Norwegian research in the white paper "Climate for research" (St. meld. nr 30 (2008–2009)). Four of these are cross-cutting; high quality in research, internationalisation of research, a well-functioning research system and efficient utilization of results and resources. These goals have both quantitative and qualitative elements, which make them difficult to measure in full. The five other goals are strategic, and these are included in measures built into the Norwegian R&D surveys.

Respondents in 2009 were asked to calculate the share of their unit's total R&D expenditure which is spent on research and development relevant to eight thematic priorities and four technology areas. Questions about the thematic priorities and technology areas have been included in the R&D survey since 2005, but due to changes in politics and policies, there have been alterations in the definitions of some of the areas. This makes it difficult to track developments over time. In 2009, thematic priorities included Global Challenges (formerly Energy and Enviroment, with the addition of Development studies), Health, Oceans – which was divided into Marine R&D and Maritime R&D, Food, Welfare, Educational Research and Tourism. There are also differences in the coverage of the R&D performing sectors, as the survey in the industrial sector does not include Welfare, Educational Research and Tourism, and has not expanded the thematic priority Energy and Environment with Development research.

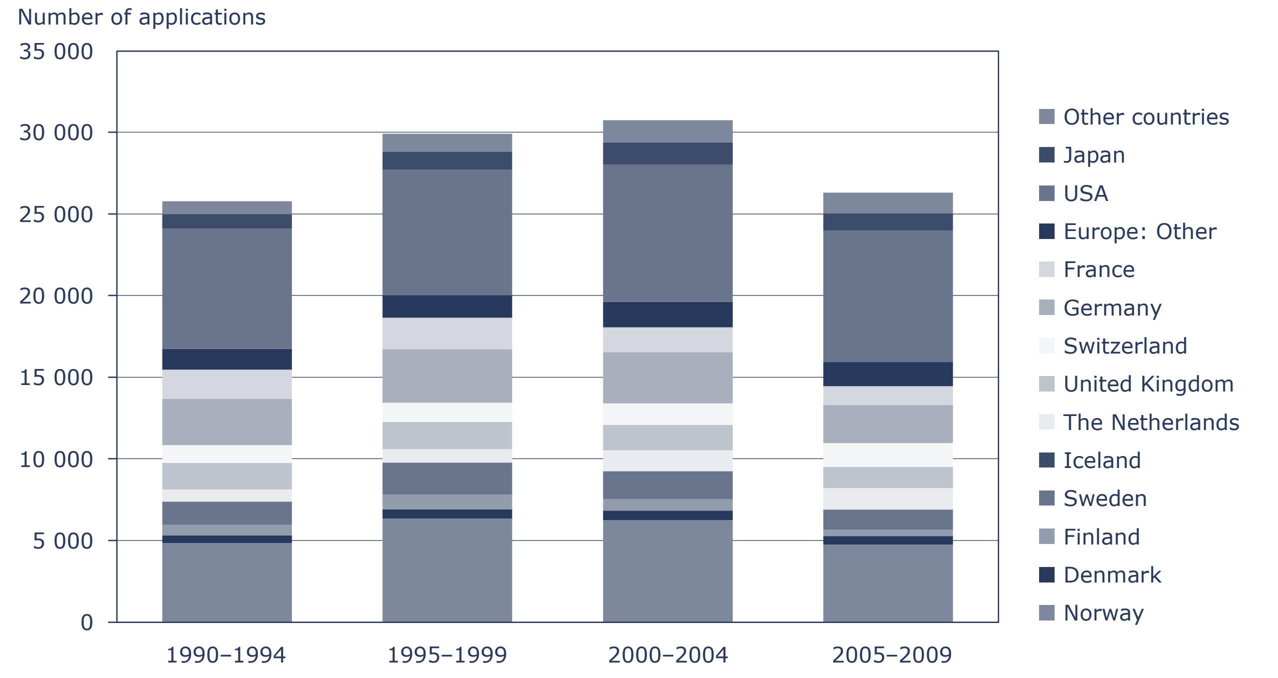
The most substantial thematic priority (in terms of related investment) in 2009 was Global Challenges. The current expenditure on R&D amounted to approximately 10 billion NOK, of which half was spent in the industrial sector. The thematic priority was the largest both in the industrial sector and the institute sector, as well as the second largest in the higher education sector. Global Challenges is divided into eight sub-themes, of which Petroleum was the biggest, followed by Renewable Energy and Other Environmental Research.

Health was the second most significant thematic priority in 2009, with an R&D-effort amounting to 7 billion NOK. The higher education sector dominated this thematic priority, with university hospitals/health trusts with university hospital functions as the most important performers.

Educational Research was the third largest thematic priority in the higher education sector, whereas Food ranked third in the industrial sector. In the institute sector, Marine R&D was second, followed by Health and Food.

The R&D survey also measures activity across four technology areas: information and communication technology (ICT), biotechnology, nanotechnology and new materials, see Figure 2.22. The largest area, ICT, amounted to approximately 9 billion NOK of R&D in 2009, of which 80 per cent was performed in the industrial sector. Of the 7 billion NOK spent on ICT R&D in the industrial sector in 2009, 5.3 billion

Figure 2.23
Patent applications[1] in Norway by country of origin. Four periods of five years: 1990–2009.



[1] A total of 163 applications lacks national affiliation.
Source: NIFU/Norwegian Industrial Property Office

NOK were spent in the service sector, with ICT services and software as the largest industries. Biotechnology accounted for 3 billion NOK of R&D expenditure across all sectors, and was the only technology area which was not dominated by the industrial sector.

The definition of the technology areas provided in the R&D survey was the same in 2007 and 2009, so results from these two years can be compared. There have only been minor changes in the relative size of the technology areas; ICT was the largest area in both years, nanotechnology the smallest. Biotechnology was the only technology area with real growth in current expenditure on R&D from 2007 to 2009, all other areas saw a decline. The decline was largest for nanotechnology, at 13 per cent. The growth in biotechnology was mainly in the higher education sector, as there was also a decline in all technology areas in the industrial sector.

The R&D survey gives an overview of the R&D efforts in relation to the Norwegian government's strategic priorities. However, the dataset provided by the R&D survey is not sufficient for a more detailed study of each of the thematic priorities or technology areas. NIFU therefore conducts special surveys in some of these areas, see focus box.

2.4 Results of R&D and innovation

2.4.1 Patenting in Norway

Patents are an important indicator in making international comparisons regarding the results of research and innovation activities (see chapter 1 for further details). It is also interesting to look at patents from a national perspective, and this chapter looks at patents applied for in Norway, joint patent applications between different actors and the distribution of patent applications received by the Norwegian Patent Office, across various technology areas.

Norwegian companies will probably continue to be primarily focused on the domestic market when it comes to seeking patents. However, it is anticipated that patterns of foreign application will be altered as a result of Norway's transition to the EPC in 2008. Figure 2.23 illustrates patent applications in Norway over the past 20 years by country of origin (tied to each applicant and normalized[5]) and shows the development over four, five-year periods. It shows a fairly stable

[5] This means that each application is only counted once: if several applicants are collaborating, the application is split into a fraction and divided across them.

Classification of patent applications by Nace industrial areas

Patent applications that arrive in the Patent Office in Norway are classified according to IPC classification (International Patent Class). IPC classes representing specific technical disciplines in which the invention that is the subject of the application creates a need for this new development. The classification is dynamic and includes 120 classes, 630 subclasses and numerous subgroups. There have been attempts to make this complicated classification system better suited to the interpretation of underlying research activities and the applicability of inventions. The system uses a process developed by Schmoch et al. (2003) that connects the IPC classifications to the Standard Industrial Classification (NACE rev1.1). The method is based on a comprehensive analysis of the industrial affiliation of companies that apply for patents and the type of patents. This system for linking patents to areas therefore gives an indication of the economic activity the invention is applicable to.

system, where Norwegian applications account for approximately 20 per cent of the total application portfolio.

Demand for patent protection is sensitive to fluctuations in international markets. The financial crisis in 2008–2009 led to a decrease in the number of patent applications internationally. In Norway, this effect has been reinforced by the fact that Norway has entered the EPC. The total volume of applications fell by about 10 per cent in the last five years from a historically high level around the turn of the millennium. Norwegian actors accounted for 20 per cent of the total volume of applications throughout the period. Nine per cent of applications came from other Nordic countries, 33 per cent from the rest of Europe and 37 per cent from the rest of the world (these being heavily dominated by US applications).

The largest share of Norwegian applications are for machinery and equipment (32 per cent), followed by technology, which includes ICT, electrical goods and instruments (23 per cent). Transport equipment and parts, and industrial areas that includes shipyards, accounted for a further 10 per cent.

Actors rarely innovate alone. Innovation often implies cooperation between different actors with different knowledge. Joint patenting, where several actors take part in a patent application, provides a glimpse of such cooperation in action.

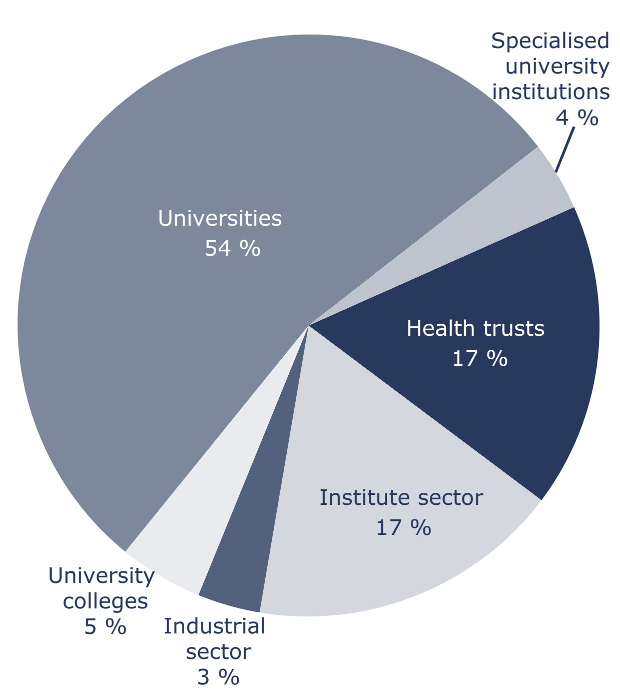
A patent application often represents some form of innovation co-operation, the aim being to develop and commercialise an invention. Two types of partners are typically involved in this partnership and mentioned in the patent document: the first is the inventor, the second is the applicant. All the individual players who were directly involved in the development of any invention should be mentioned in the patent application as inventors. The total number of players involved in Norwegian patent applications provides a sense of the changes in joint patenting that have taken place over time. The number of Norwegian and foreign companies that, on average, have contributed to Norwegian domestic patents (where at least one applicant and/or inventor has a Norwegian address) increased from 2.5 in 2000 to 2.9 in 2009. The overall percentage of foreign applications for patents in Norway has also increased during the same period. Both of these underscore the impression that Norwegian companies are innovating more with foreign players now than they did as recently as the 1990s.

2.4.2 Scientific publications and citations

This chapter provides an overview of the national scientific publishing profile. See Chapter 1 for a more detailed description of the data and methodology for the analysis.

As described in chapter 1, Norwegian researchers contributed to more than 9 300 articles in scientific journals in 2010. Based on the author addresses listed in these articles, we have calculated the distribution by sector. The result is shown in Figure 2.24. Universities and university colleges account for the majority of Norwegian scientific journal publishing, with a share of 62 percent. The universities' share is 54 per cent, while specialised university institutions and university colleges provided 5 and 4 per cent respectively. University hospitals and other hospitals, accounted for 17 per cent of the total scientific journal publications. While the industrial sector is by far the largest sector in terms of R&D efforts, little of this effort results in scientific publications. The industrial sector accounted for around 3 per cent of the national publication in international scientific journals in 2010. The institute sector with its applied focus generally has a publishing pattern with a lower proportion of publishing in scientific journals; this sector contributed 17 per cent of the Norwegian article production. From 2009 on, most of the research institutes in Norway received part of their basic funding through a new performance-based funding scheme. The background for this scheme was the government's efforts to enhance the institutes' research capacity and char-

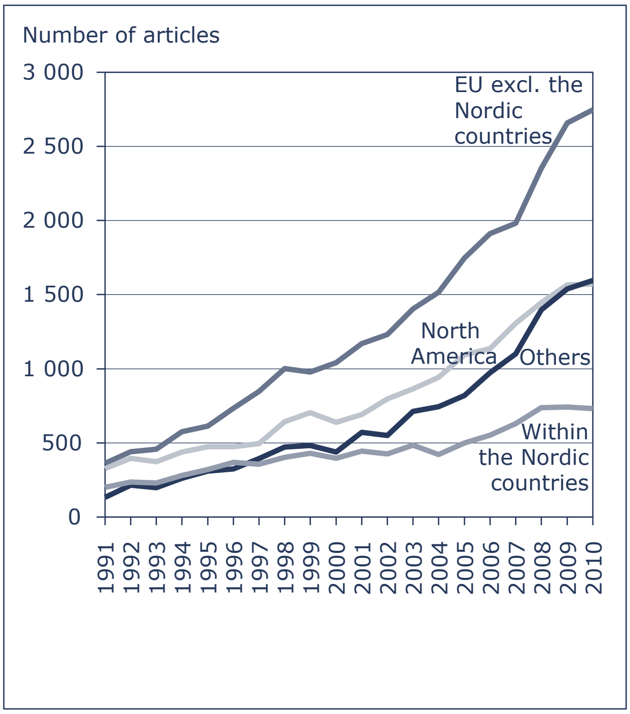
Figure 2.24
Scientific publishing in Norway, share of articles by sector,[1] 2010.



[1] In the calculation every article is fractionalised according to its relative contribution (number of addresses). The classification is based on the accreditation of each institution in 2010. Both public and private institutions are included in the numbers for university colleges and specialised university institutions.

Source: National Citation Report/Thomson Reuters/NIFU

Figure 2.25
Number of Norwegian articles involving international cooperation: 1991–2010.



Source: Thomson Reuters/NIFU

acter. In the new funding system, scientific publishing is one of five indicators.

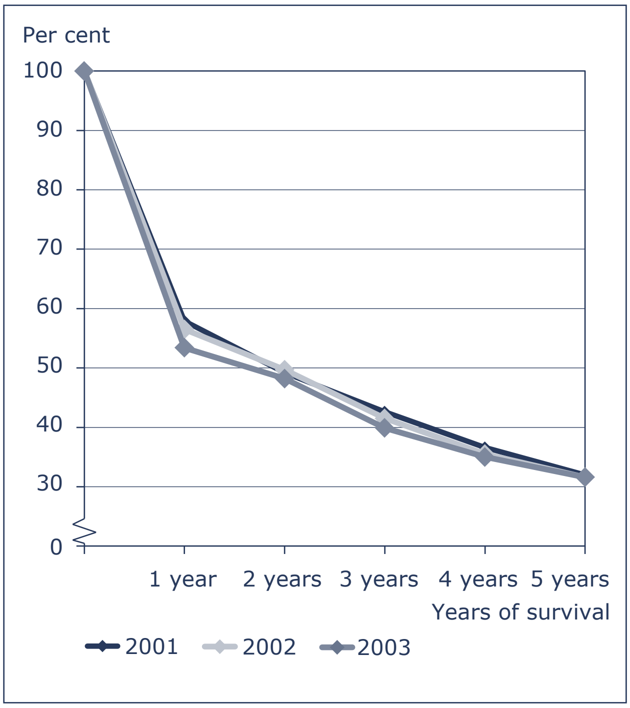
International research can be observed in scientific journal articles where threre are co-authors from different countries. The authors publish their institutional affiliations in the journals, and these addresses are in turn recorded in the bibliographic database ISI Web of Science (Thomson Reuters). From Thomson Reuters, NIFU has provided a database of 112 893 scientific journal articles that were registered over twenty years, 1991–2010, and which have at least one author address from Norway. An increasing proportion of these articles have author addresses from other countries in addition to Norway. In 1991, there was international co-authorship in 28 per cent of the articles. Ten years later, the percentage increased to 46 per cent, and in 2010, 56 per cent of the articles had combinations of Norway and other countries in the addresses. The increase was most pronounced in the 1990s.

The percentage of articles with international co-authorship is usually higher in small countries than in large countries. It has also been increasing throughout the world. The trend of international integration in science publishing is itself international. In recent years, the increase in Norway has been greater than in the neighbouring Nordic countries. Collaboration with researchers from the EU countries has increased more than collaboration with researchers from the USA and Canada, and multilateral cooperations between several countries' researchers have increased more than the bilateral cooperations.

Twenty years ago, five countries dominated in the Norwegian cooperation articles: the USA, Sweden, the UK, Germany and Denmark. These are also the main partners today, but the collaboration profile has become broader. Within the Nordic countries, Finland and Iceland had the greatest percentage growth in the number of joint papers with Norway. Among the EU countries outside the Nordic countries, there have been significant increases in cooperation with France, the Netherlands, Italy, Spain and Belgium. There have also been significant increases in cooperation with Canada, China, Australia and South Africa. In the period 1991–1995, there was cooperation with 94 countries, while the number was 162 in 2006–2010. The general tendency is that Norway's collaboration profile is getting wider at the same time that the cooperation rate increases.

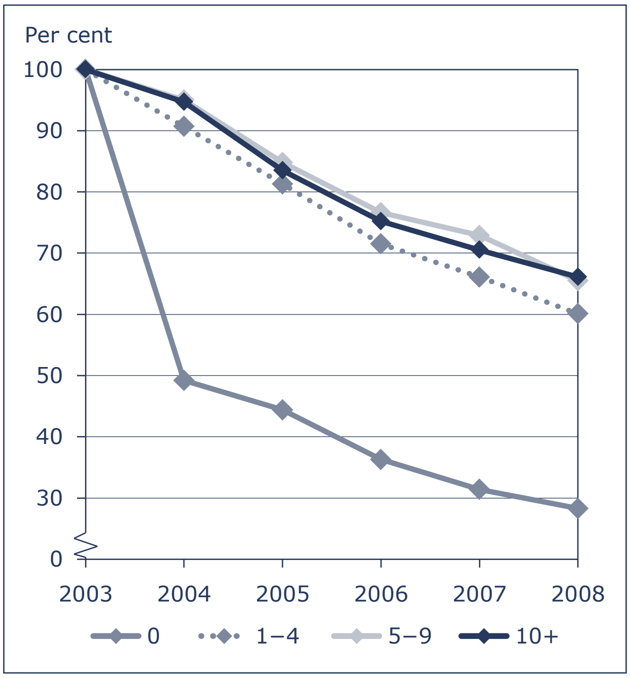
Figure 2.25 shows the annual number of Norwegian cooperation articles in four geopolitical

Figure 2.26
Five year survival rates of newly established enterprises: 2001–2003.



Source: Statistics Norway

Figure 2.27
Newly established enterprises, 2003 by survival rate: 2004–2008 and the number of employees as of December 2003.



Source: Statistics Norway

regions. The 'EU'-category represents the current 27 members of the European Union (new members are considered as EU countries in the period). Denmark, Finland, Sweden and Iceland are counted in the category 'Nordic'. The USA and Canada are represented in the category 'North America'. Twenty years ago, the cooperation between North America and Nordic countries was relatively important for Norwegian researchers. Later, the Nordic collaboration lost relative importance, while EU cooperation has increased much more than cooperation with North America. Outside Europe, the collaboration profile has broadened: new countries of cooperation have a greater relative significance. The increase in European cooperation is particularly evident from 1994 on, and can be viewed in the context of the EEA Agreement and Norway's participation in EU Framework programmes for research.

2.4.3 Survival in newly established enterprises

This section presents the five year survival rates of newly established Norwegian enterprises in 2001, 2002 and 2003. An enterprise established in year t is considered to have survived in year t+1 if it was active in terms of turnover or employment in t+1. Growth is measured in the number of persons employed from the year of establishing to the survival year.

Almost one third of the newly established enterprises in 2001–2003 survived five years (Figure 2.26). One half of the enterprises did not survive the first year. The five year survival rates of the newly established enterprises in 2001–2003 are quite similar.

The survival rate varies among the different economic activitiy areas. Enterprises within manufacturing had the highest survival rate for newly established enterprises in 2003. Almost half of the manufacturing enterprises were still active in 2008, compared to only one third of the newly established enterprises within real estate and business areas. The five year survival rate of enterprises within construction was 40 per cent.

Employment in newly established enterprises tends to be low. Only ten per cent of the newly established enterprises in 2003 had employees as of December 2003. The survival rate increases with the number of employees. More than 60 per cent of the newly established enterprises in 2003 which had employees as of December 2003 survived five years, whereas only 28 per cent of the enterprises with no employees as of December 2003 were still active in 2008 (Figure 2.27).

3 Regional comparisons of Norwegian R&D and innovation

Highlights

- R&D activities in Norway are geographically concentrated in the university cities and surrounding areas, as well as around some industrial clusters.

Human resources in the counties

- The counties with the largest cities and the biggest educational institutions also have the highest proportion of employees with higher education.
- The highest concentration of employees with higher education was in Oslo (14.6 per cent), followed by Sør-Trøndelag (9.7 per cent) and Akershus (9.5 per cent).
- In 2009, almost one third of all R&D personnel had employment in Oslo. Of these, nearly half were employed in the higher education sector, a third in the industrial sector, and the rest in the institute sector.
- The highest share of researchers with a PhD are found in Telemark, Sogn og Fjordane, Sør-Trøndelag and Østfold.

Expenditure on R&D and innovation by county

- In 2009, 45 per cent of the R&D activity was concentrated in the capital region.
- More than half of the counties account for only minimal shares of R&D expenditures (below 3 per cent of Norway's total R&D expenditures).
- Sør-Trøndelag had the highest R&D expenditure per employee in 2009, followed by Akershus and Oslo.
- In 2007, the highest R&D expenditures as a proportion of gross regional product were to be found in Sør-Trøndelag (7 per cent), followed by Troms (4 per cent) and Oslo and Akershus (3 per cent).
- From 2007 to 2009, Oslo saw the biggest growth in R&D expenditure of all the counties, followed by Akershus, Sør-Trøndelag, Troms and Telemark. In 8 counties there was a real-terms decline in R&D expenditure (Hordaland, Rogaland, Buskerud, Oppland, Østfold, Nord-Trøndelag and Hedmark).
- Svalbard, Sør-Trøndelag, Møre og Romsdal, Aust-Agder and Oslo had the largest share of enterprises with R&D in 2009.
- In the higher education sector 11 counties accounted for a total of only 5 per cent of the R&D expenditures.
- In terms of the proportion of extramural R&D in the industrial sector in 2009, Rogaland was the leading county at 40 per cent, Nordland and Vest-Agder had the lowest share.
- The percentage of enterprises with innovation activities was highest in Oslo, Akershus, Vestfold and Hordaland.

Characteristics of regional innovation

- The most innovative economic regions are: the capital region, Kongsberg (Buskerud), Ørsta-Volda (Møre og Romsdal) and Alta (Finnmark).
- Some common features of the innovative regions are: specialisation in knowledge intensive industries; relatively high R&D investment in the industrial sector; and, R&D and/or higher education institutions in the surrounding area.

In Norway R&D activities are mainly concentrated around the university cities, their surrounding areas and some industrial clusters. This will be clearly illustrated by the statistics and indicators in this chapter. The chapter includes a section that analyzes variations in regional innovation in the industrial sector based on a study conducted by the Norwegian Institute for Urban and Regional Research (NIBR). Different conditions in each area mean that business-, research- and innovation policy have to be adjusted to the specific challenges and possibilities in each region. This was an important premise and argument for the creation of the Regional Research Funds (see the introduction on the Norwegian innovation system).

In the industrial sector, there are several companies whose headquarters and research centers are based in Oslo or overseas, but who have a large share of their employment in business enterprises located throughout various counties in Norway. This affects the distribution of R&D resources for this sector. The institute sector also has several units with headquarter based in one region, but scientists and R&D activities spread across several parts of the country. In these cases, the activity is distributed by county by using allocation keys for each activity. In the higher education sector, each department and branch is connected to a county number, so that this sector has detailed listings for activity on the county level.

3.1 Human resources in R&D by county

In Norway the central regions, the counties where the largest cities and major educational institutions are located, which have the highest proportion of highly educated people. In particular, university counties have a high proportion of employees with higher education. In 2009, Oslo was clearly on top, followed by Sør-Trøndelag, Akershus, Nordland, Hordaland and Rogaland. The rating of these counties was mainly the same in 1999 as in 2009.

An essential element for understanding the distribution of employed persons with higher education is the business structure. The proportion of highly educated employees varies significantly accross industries. The Oslo area (or the capital region) is distinguished by having the highest proportion of those with post-graduate education in all industries. This region also contains nearly 13 per cent of employees with higher education. In the capital region, we find the highest proportion of those with higher education in the industries *oil and gas* and *professional, scientific and technical services*.

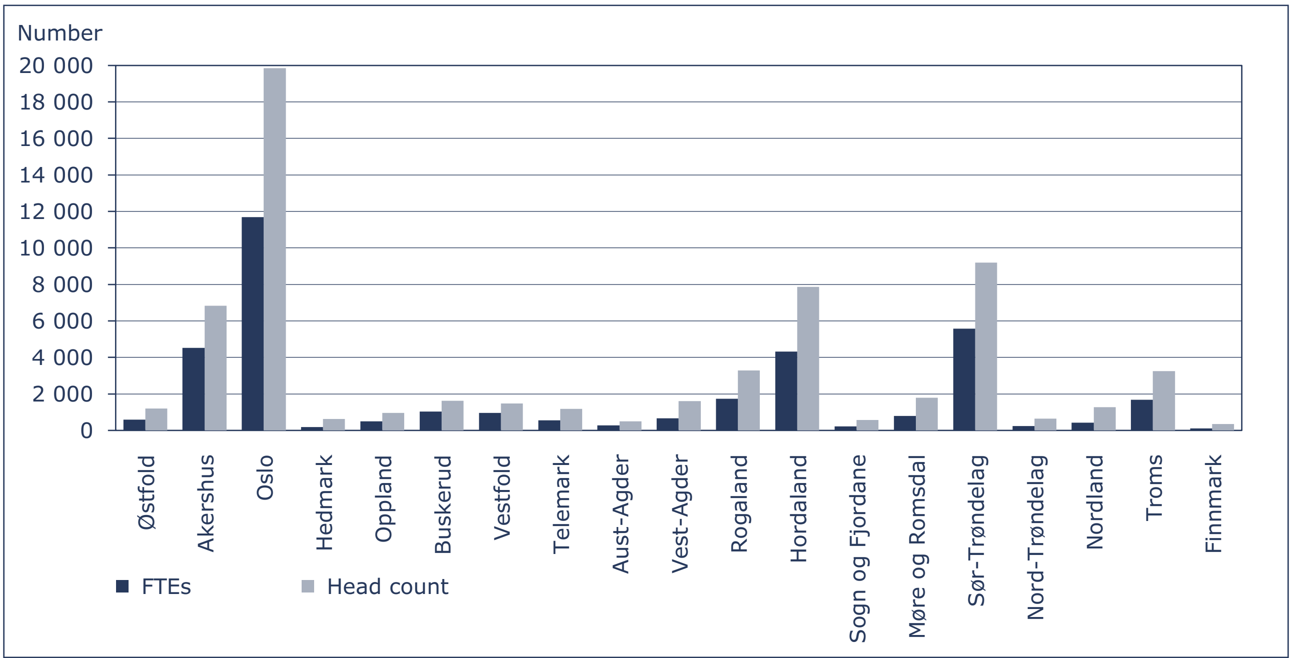
When you see the industries as a whole, it is mainly western Norway or mid-Norway which takes second and third. place in the ranking of regions by highly educated employees. Western Norway also sees a concentration of highly educated workers within the *oil and gas*, as well as the *professional, scientific, technical services*. Central Norway has the lowest percentages of those with a higher education in more industries than any of the other regions. Agder follows closely behind western and central Norway, but had the second highest proportion of jobs in the *electricity and water supply*, behind the capital region. In northern Norway, it is the *oil and gas* and *professional, scientific and technical services* sectors that have the highest proportions with higher education.

3.1.2 R&D Personnel and R&D FTE

In 2009, a total of 64 000 people worked on R&D activities in Norway. Almost a third of these were employed by an institution or business in Oslo. The second largest county for R&D work was Sør-Trøndelag, with 14 per cent of all R&D personnel, closely followed by Hordaland and Akershus, with 12 and 11 per cent respectively. These are all university counties.

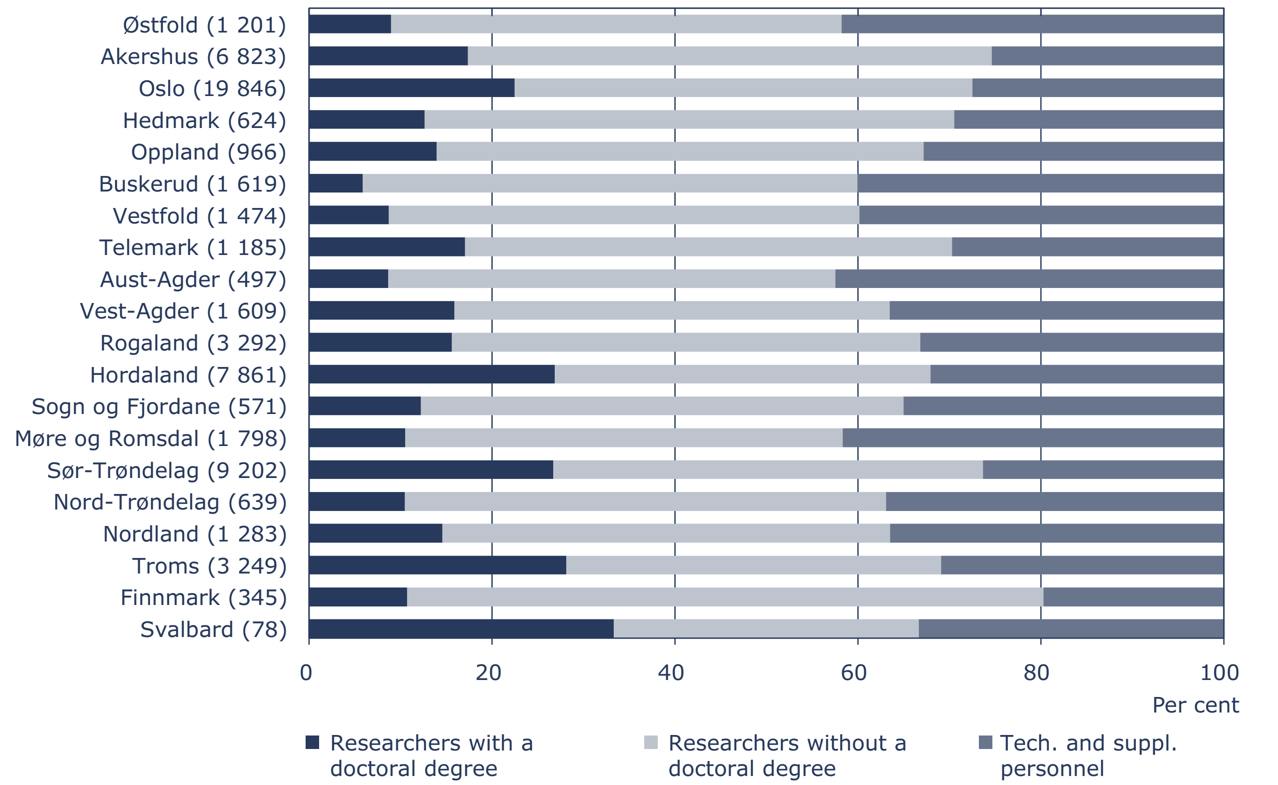
R&D personnel in Norway carried out 36 100 R&D full-time equivalents.– FTEs – in 2009. In Figure 3.1 the regional distribution of norwegian R&D personnel in 2009 is shown, by head count and FTEs. About a third of FTEs were conducted in Oslo, while Sør-Trøndelag, Akershus and Hordaland performed respectively 15, 13 and 12 per cent of total FTEs. Oslo had the highest number of R&D personnel in all research-performing sectors. Almost half of the R&D staff in Oslo were employed at an educational institution or health trust, while about a third were employed in the industrial sector. R&D personnel in the institute

Figure 3.1
R&D personnel by county, 2009. Head count and full-time equivalents (FTEs).



Source: Statistics Norway/NIFU, Register of Research Personnel

Figure 3.2
R&D personnel in Norway by educational level and county, 2009. Percentages with actual number of R&D-personnel in paranthesis.



Source: Statistics Norway/NIFU, R&D statistics

sector accounted for 19 per cent of total R&D personnel in Oslo, and about a third of all R&D personnel in the institute sector, in 2009. This emphasises the role of Oslo and the capital area, as the hub of Norway's R&D activity.

Counties with universities contained a total of 82 per cent of all R&D personnel in Norway in 2009. Nearly 80 per cent of employees with higher education were employed at an institution or business in the university counties. The higher education sector was also largest (measured in the number of R&D personnel) in the more established university counties of Oslo, Sør-Trøndelag, Hordaland and Nordland. The institute sector was also concentrated locations near the major universities. The institute sector was largest in Oslo, Sør-Trøndelag, Akershus and Hordaland, and 86 per cent of all R&D personnel in the institute sector were employed at departments in these university counties.

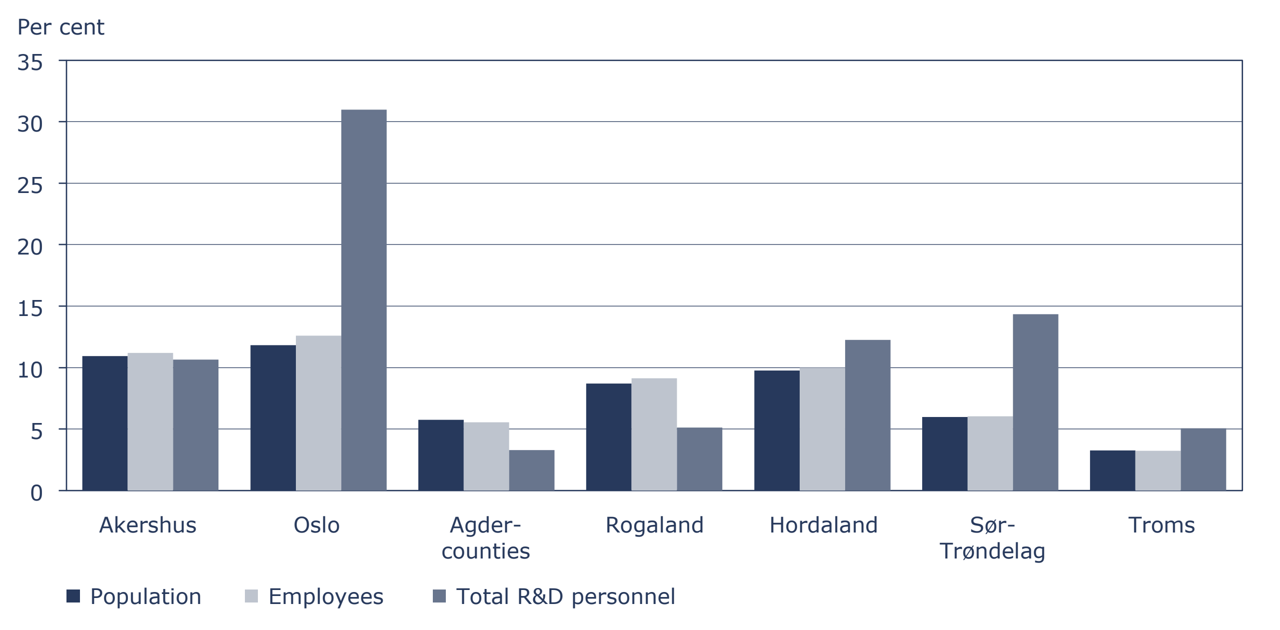
Buskerud had the highest concentration of R&D personnel outside the university counties. Among the counties without a university, the industrial sector was largest in Buskerud, Møre og Romsdal and Vestfold. The higher education sector was the largest sector in Nordland, Møre og Romsdal and Telemark, and institute sector was highest in Østfold, Møre og Romsdal and Nordland. The country's fifth largest university college in 2009, Bodø University College, received university status in 2010 under the name University of Nordland.

Another indicator related to human resources is the distribution of formal competences (Figure 3.2). The statistics show that counties with a small business sector have the highest proportion of researchers among the R&D personnel.

The overall proportion of R&D personnel with a PhD was almost 30 per cent at universities, colleges and research institutes, while the industrial sector had a share of just under seven per cent.

More than half of the Norwegian population, (56 per cent) were living in one of the eight university counties, and 58 per cent of the workforce were employed within these counties. Furthermore, 82 per cent of all R&D personnel work within one of the university counties. Indeed, Oslo's share of R&D personnel is three times as high as its share of the overall population. The proportion of R&D personnel was also high compared with the overall proportion of em-

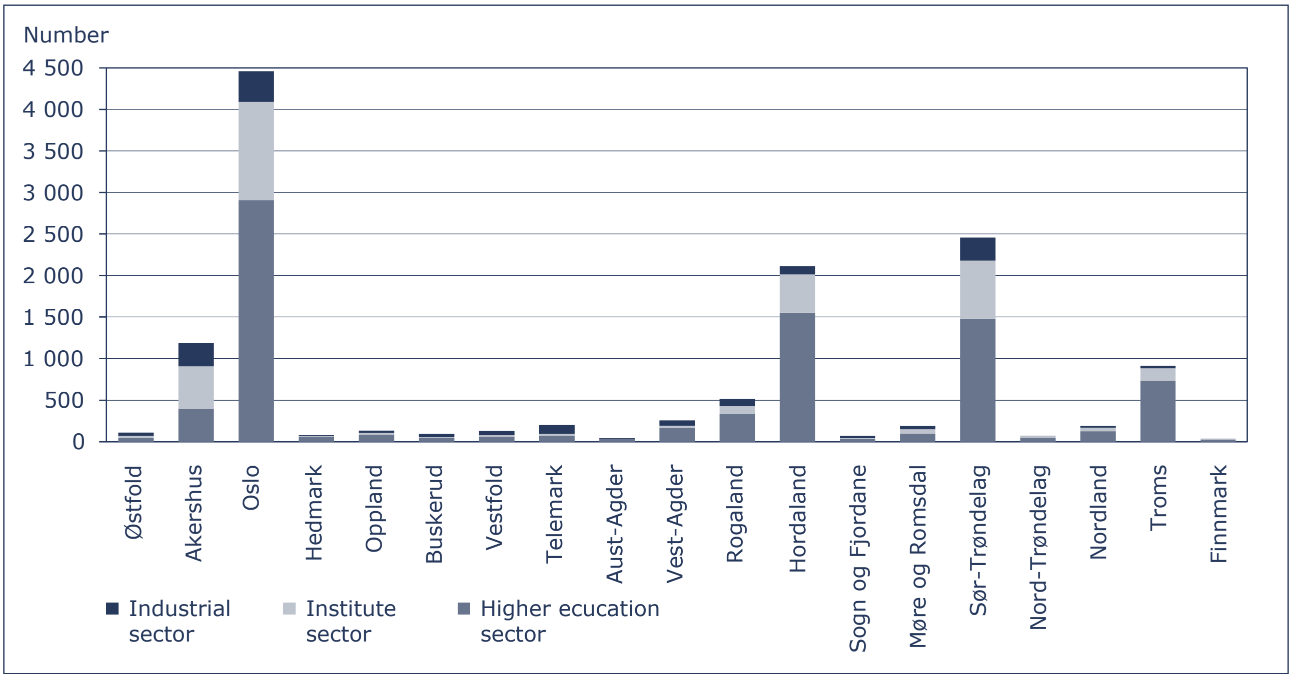
Figure 3.3
Comparison of the university counties' share of inhabitants, employees and R&D personnel (of national totals), 2009.



Source: Statistics Norway/NIFU, Register of Research Personnel

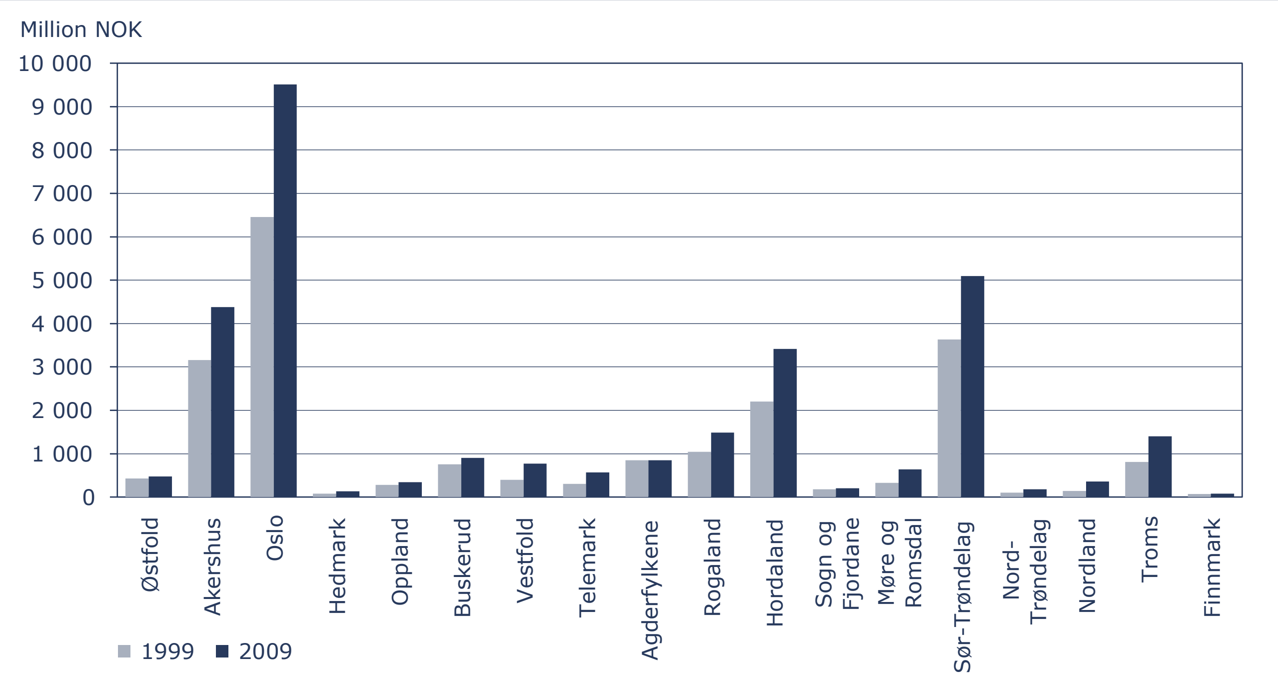
ployees/citizens in Sør-Trøndelag, as shown in Figure 3.3. Oslo, Akershus, Rogaland and Hordaland County account for a higher proportion of employment than might be expected from their overall share of the population. This may indicate that these areas experience labour migration, but it may also be related to demographic factors, such as a greater proportion of the population being of working age.

Figure 3.4
Number of doctoral degrees by county and sector of performance, 2009.



Source: NIFU, Register of Doctoral Degrees

Figure 3.5
Total Norwegian R&D expenditure by county, 1999 and 2009. Million NOK. Fixed 2000-prices.



Source: Statistics Norway/NIFU, R&D statistics

A total of 13 232 researchers with a PhD participated in R&D activities in Norway in 2009. The industrial sector accounted for 12 per cent all all researchers with a doctoral degree, the higher education sector for 63 per cent, and the institute sector for 25 per cent respectively. Naturally, those counties with large educational institutions and research institutes had the highest shares of researchers with a PhD (Figure 3.4).

Despite the fact that there has been a sharp rise in the number of those with a doctoral degrees in Norway, the proportion employed in the business community has only increased modestly. In Norway, as in the rest of Europe, many of those with a doctoral degree working in enterprises are based in the larger cities. But the proportion of researchers with a PhD in the Norwegian business sector is low when compared to many countries in Europe, at just 10 per cent. Taking 2007, as an example, there were three times as many doctoral degrees among those in the business enterprise sector in the Copenhagen region compared to Norway's Capital Region, even when adjusting for the population size (source: Statistics Denmark and Statistics Norway).

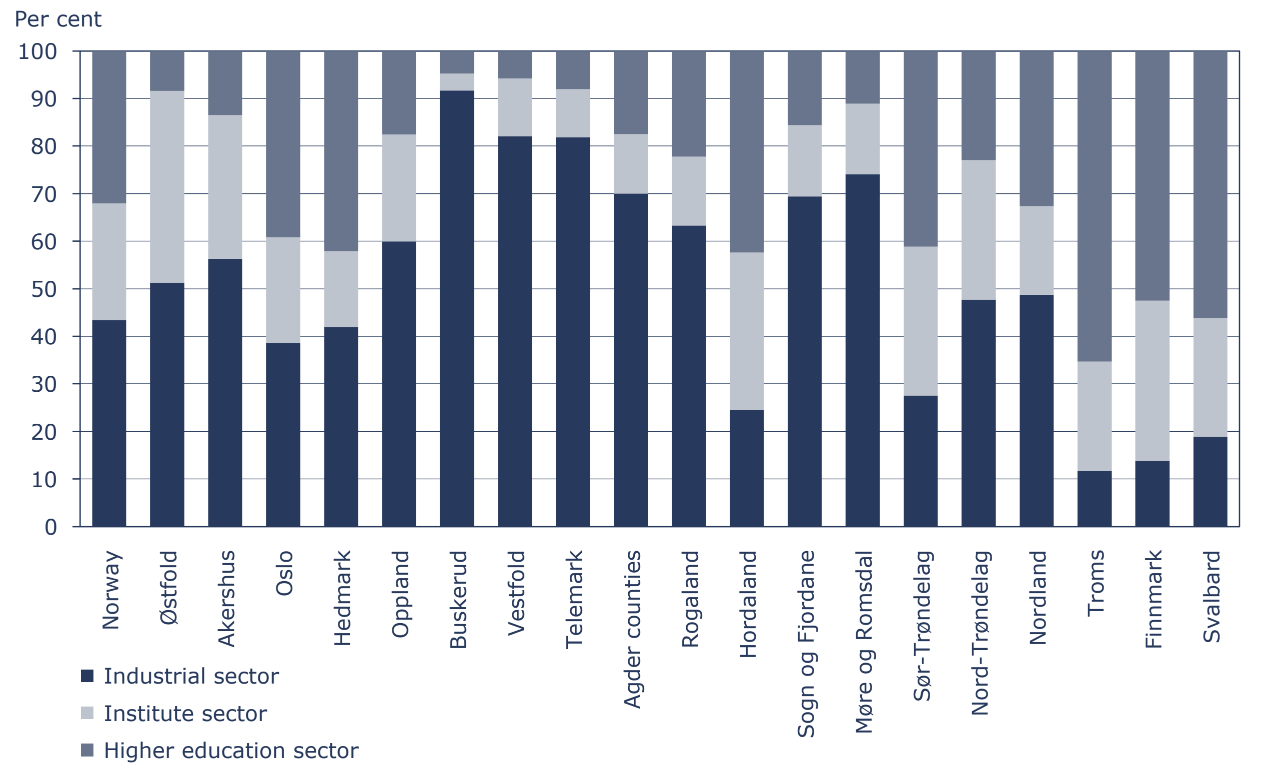
3.2 R&D and innovation expenditure by county

As shown earlier in this chapter a characteristic of Norwegian R&D is that it is centred in and around the major university towns. This relates first and foremost to activity in the higher education sector, but also to research institutes, as most of the major research institutes are located in close proximity to a university. R&D activity in the business sector is, however, distributed somewhat differently and related largely to so-called business clusters which are found around the country. It is perhaps in this sector where we find the most interesting findings and changes, and where R&D activities vary most from one year to the next.

3.2.1 R&D and innovation expenditures by county

There are large variations between counties in terms of how much R&D is performed, as measured by expenditure. R&D expenditure in Norway is geographically concentrated in the capital region, where 45 per cent of the country's total R&D expenditure was spent in 2009. This corresponds to almost 19 billion NOK of the 42 billion NOK total R&D expenditures for Norway that year. Moreover, 85 per cent of all Norwegian R&D expenditures were spent in counties

Figure 3.6
Norwegian R&D expenditure by county and sector of performance, 2009.



Source: Statistics Norway/NIFU, R&D statistics

that have a university. In the established university counties, spending on research in the higher education sector and the institute sector dominates the industrial sector, with the exception of Akershus, where industry accounts for over half of R&D expenditure. In Troms business R&D accounts for only 12 per cent of all R&D in the county. In counties without established universities the industrial sector is usually the heaviest R&D performer.

Oslo had the highest total R&D expenditures in both 1999 and 2009, followed by Sør-Trøndelag, Akershus and Hordaland (Figure 3.5). The counties with the lowest R&D efforts in 1999 were Finnmark, Hedmark, Nord-Trøndelag and Nordland. In 2009, Finnmark, Hedmark and Nord-Trøndelag were still at the bottom of the scale, while Nordland had the highest annual real growth of all counties during this period.

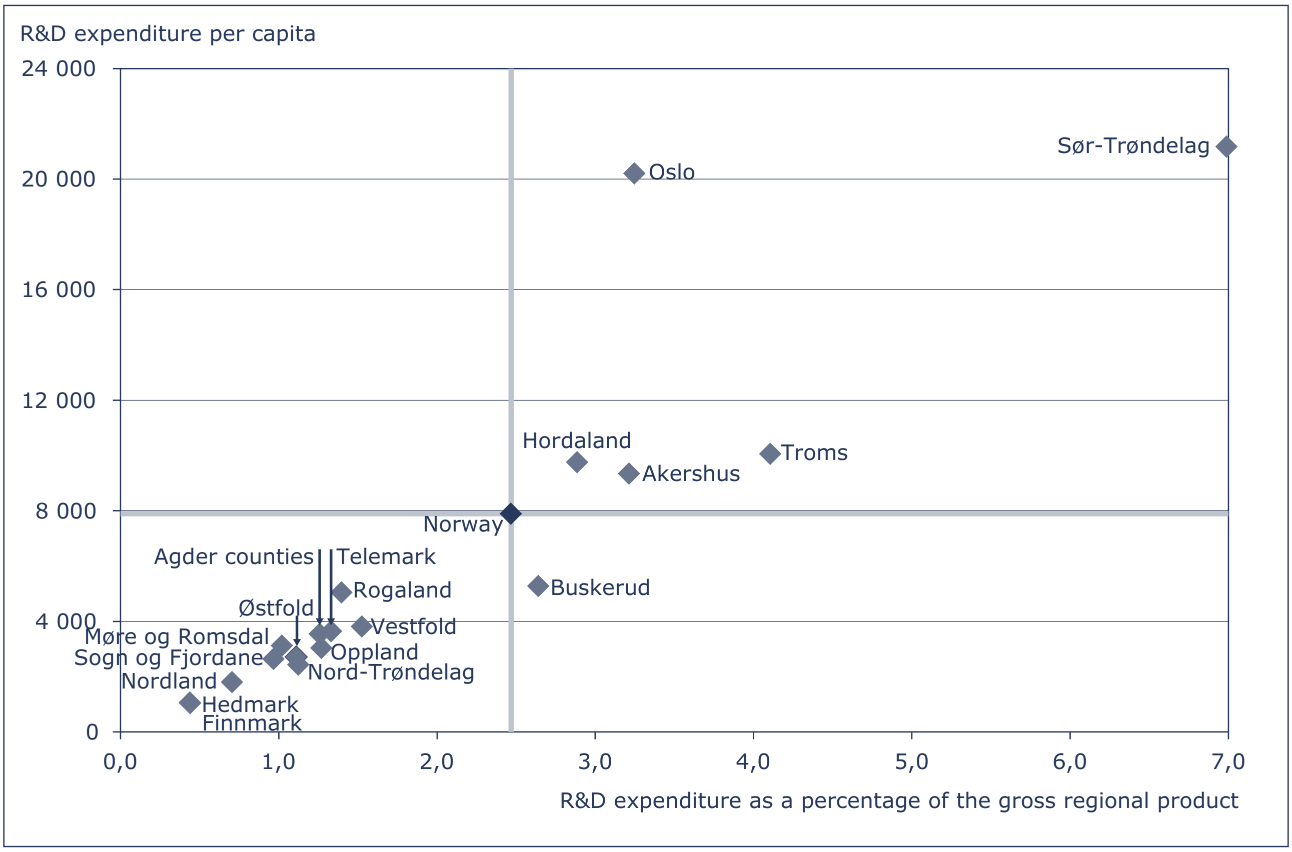
From 1999 to 2009, Oslo saw real growth in R&D expenditure of 4 per cent per a year on average. This was the same rate as real growth for Norway as a whole, while Sør-Trøndelag and Akershus both had an annual average real growth of just over 3 per cent in this ten year period.

Nationwide, more than 43 per cent of R&D was performed in the industrial sector, representing 18 billion of Norway's nearly 42 billion NOK of R&D expenditure in 2009. R&D expenditure in the institute sector accounted for about 25 per cent of the total, while 32 per cent was performed in the higher education sector. There are considerable variations between counties in the distribution of activity across these sectors.

Figure 3.6 shows the research and development activity by sector of performance in each county. In Oslo, the distribution of activity across sectors is quite similar to the national average, which is to be expected as so much R&D activity takes place here. Buskerud county stands out with a very high proportion (92 per cent) of its research activity taking place in the industrial sector. Other counties that had a high proportion of R&D within the industrial sector were Vestfold, Telemark and Møre and Romsdal, but these are all small counties in terms of their absolute R&D spending. In the two northernmost counties, Troms and Finnmark, a low share of R&D is performed in the industrial sector; in these regions it is the higher education sector where the greatest activity takes place, whith 65 and 53 per cent respectively.

A key indicator to describe a country's R&D activities is R&D expenditures relative to GDP, as shown in Chapter 1. In spite of the stress on this indicator be-

Figure 3.7
R&D expenditure by gross regional product[1] and R&D expenditure per capita by county, 2007.



[1] Only mainland Norway (excl. oil and gas exploration on the continental shelf).
Source: Statistics Norway/NIFU, R&D statistics

ing reduced, in the last White paper to the Norwegian Parliament (Stortinget), this remains a very important indicator for Norwegian research policy. Comparisons between countries are also often based on this indicator. Regional comparisons using this kind of indicator are also informative.

Figure 3.7 shows R&D expenditure as a share of gross regional product[1] per county for 2007, (the latest year these data are available) mapped against county R&D expenditure per capita. There are some counties that clearly stand out. Sør-Trøndelag had the highest R&D expenditure per capita and R&D expenditure amounted to as much as 7 per cent of the gross regional product. Oslo spent almost as much as Sør-Trøndelag in terms of R&D per capita and just over 3 per cent of its gross regional product on research and development. Troms uses just over 4 per cent, but has a much lower level per capita on R&D. On average, 2.5 per cent of regional gross product is spent on R&D in Norway. This must not be confused with R&D as a percentage of national GDP, where *oil and gas exploration* on the continental shelf is included in the calculation.

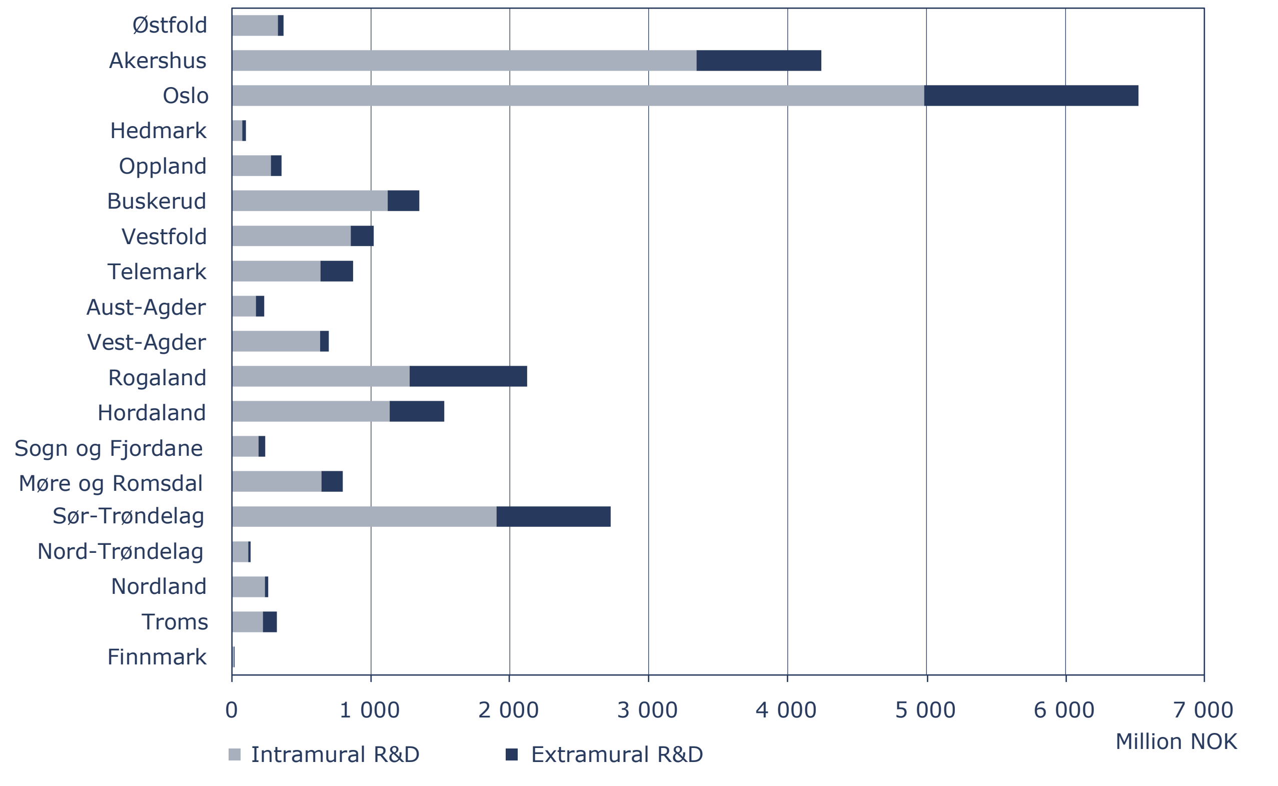
For Norway as a whole, public sources provided 46 per cent of total R&D expenditure in 2009, making them the main funding source for research. The industrial sector accounted for 42 per cent of national funding, while funding from other sources and abroad accounted for 4 and 8 per cent respectively.

At the county level relatively higher shares of public funding were found in Finnmark, Troms, Hordaland, Svalbard and Hedmark. The lowest shares of public funding were in Buskerud, Vestfold, Østfold, Telemark og Romsdal. Oslo had a 53 per cent share of public funding, which was a higher share than the national average, while Akershus with a 33 per cent was relatively low.

Naturally a high proportion of private sector funding is found in counties where a high percentage of R&D takes place within the industrial sector, such as Buskerud, Telemark and Møre og Romsdal. In contrast, Troms, Finnmark and Hordaland had the lowest

[1] For the country as a whole we operate with gross domestic product, while we at the county level must use the gross regional product that only covers mainland Norway, ie oil and gas exploration on the continental shelf are excluded.

Figure 3.8
Intramural and extramural R&D expenditure in the industrial sector by county,[1] 2009.



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

Source: Statistics Norway/NIFU, R&D statistics

proportion of funding from industry. Oslo and Akershus received 37 and 48 per cent of their R&D funding from industry.

When it comes to funding from abroad, five counties had a higher share than the national average: Østfold, Akershus, Vestfold, Oppland and Sør-Trøndelag all received relatively high levels of international funding for R&D.

3.2.2 R&D and innovation expenditures in the industrial sector

Intramural R&D expenditure in the Norwegian industrial sector accounted for just over 18 billion NOK in 2009. An alternative measure of R&D spending in each county can be provided by looking at R&D expenditure per employee. On average, business R&D expenditures per employee amounted to 27 100 NOK in 2009. Enterprises in Sør-Trøndelag had the highest share of R&D expenditures per employee at 50 300 NOK. Sør-Trøndelag is closely followed at Akershus and Oslo, with 46 500 and 37 000 NOK per employee respectively. As shown in Figure 3.8, the lowest R&D effort per employee is found in Finnmark and Hedmark.

From 2008 to 2009, Norwegian R&D expenditures in the industrial sector saw a real decrease of nearly 5 per cent, and most counties saw a similar or greater decline in this period. Among the counties where the industrial sector had R&D expenditures in excess of 300 million NOK in 2009, Troms and Akershus had the largest growth of spending from 2008.

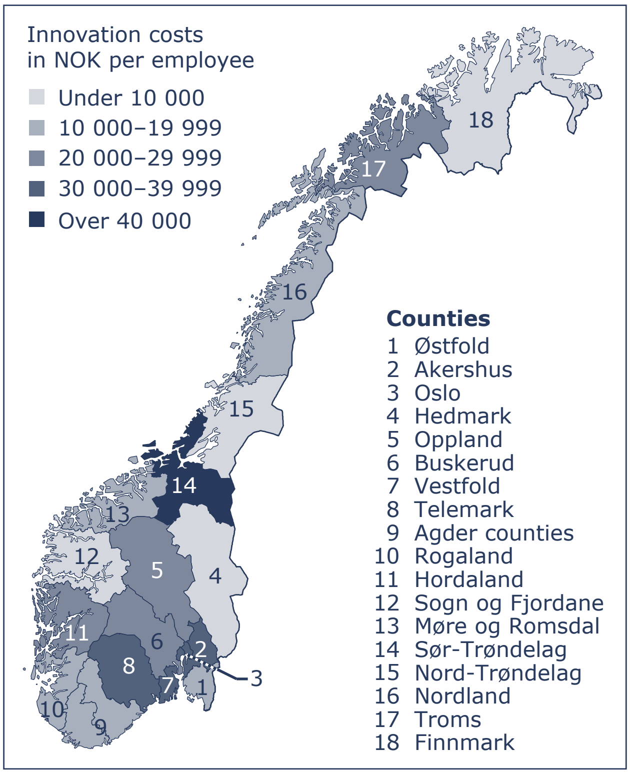
In the decade 1999–2009, business R&D expenditures almost doubled, with an increase in nominell prices from 9.5 to 18.2 billion NOK. Oslo and Akershus had the largest growth in absolute spending, of 2.4 and 1.6 billion NOK respectively. Overall it was a real increase in business R&D expenditure of 36 per cent in this period. Oslo and Akershus were close to the average for Norway. The highest percentage changes in R&D expenditures were found in Nordland, Møre og Romsdal, Telemark and Vest-Agder, all of which saw 100 per cent real growth in the period. These are all small counties when it comes to resources for research. Vest-Agder and Telemark spend most.

Figure 3.8 shows shares for R&D conducted by the industrial sector itself (intramural R&D) and the share of R&D they bought in from other corporations, research institutes or universities and colleges (extramural R&D). When extramural R&D is included, the industrial sector conducted or purchased R&D worth a total of 23.8 billion in 2009, which represents a slight decrease from 2008. On this measure, enterprises in Oslo and Akershus had the highest R&D activity in 2009, with 6.3 and 4.4 billion NOK respectively.

Extramural R&D accounted for almost 24 per cent of total R&D expenditure in 2009. If the relative scale of intramuR&D spending is compared, the business community in Rogaland buys in the most extramural R&D, accounting for nearly 40 per cent of total expenditure, followed by Troms and Sør-Trøndelag where extramural R&D accounted for 32 and 30 per cent respectively. The private sector in Nordland and Vest-Agder buy least extramural R&D relative to total R&D expenditure. Much of the national research and acquisition is related to the oil and gas sector and this may explain why the business community in Rogaland, where a number of oil and gas organisations are based, buys in so much research.

When it comes to innovation costs, these are concentrated in the central areas of the country. In particular, the capital region of Oslo and Akershus stands out from the other counties. This is a pattern we have seen for R&D expenditures alone in the past year, and the innovation survey also makes it clear that innovation costs are dominated by R&D costs. Nearly 42 per cent of total innovation costs in the industrial sector were based within these two counties in 2008. Oslo and Akershus are also among the five counties with the highest innovation costs per employee, as shown in Figure 3.9. Sør-Trøndelag stands out with a significantly higher proportion than any other county. It may be partly due to the presence of some large enterprises, which have headquarters in other parts of the country, but with major R&D sites based around Trondheim.

Figure 3.9
Innovation costs in the industrial sector per employee and by county, 2008.



Source: Statistics Norway, Innovation survey 2008

3.2.3 Characteristics of regional innovation

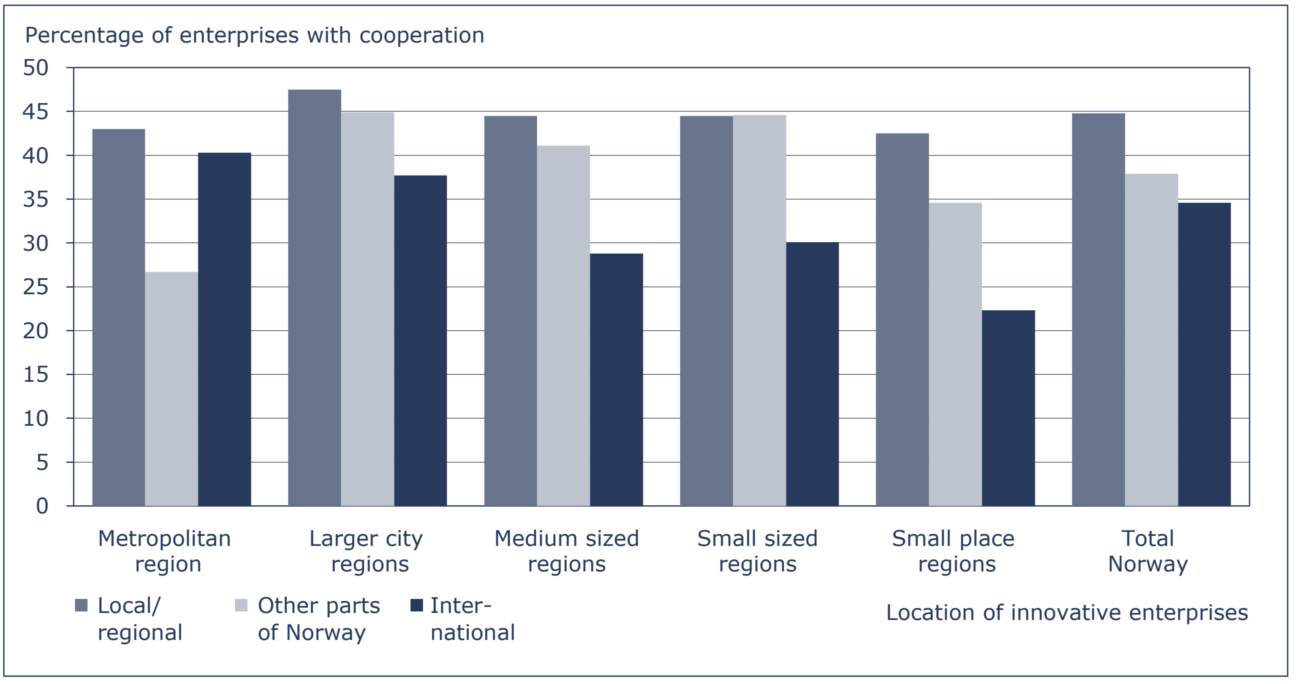
The creation, use and diffusion of knowledge is essential for economic growth and development. Successful innovation policy should not only be developed on the national level, but also adapted to different regional conditions and opportunities. The knowledge base required for such flexible policy will, among other things, need to build on regional analyses of relevant surveys, such as the R&D and innovation survey carried out by Statistics Norway. Data from these surveys were used to analyse regional variations in innovation, in a study published by the Norwegian Institute for Urban and Regional Research (NIBR).[2] The report considers the characteristics and causes of regional innovation patterns in Norway.

When the regions are considered under five groups, of similar sized regions (see Figure 3.10 for an example of these groupings) a systematic pattern of differentiation appears, regarding their resource base and innovation inputs, geographical patterns of cooperation, barriers to innovation and results. As region size increases, the following factors become more prominent: variety in its industrial and knowledge base; a larger proportion of knowledge-intensive industries and R&D institutions; higher R&D investments; and more use of higher educated personal. These regional profiles and patterns in these structures and resources imply that, for some innovation types, the potential for renewal might be higher in more central and larger regions.

In contrast, a region's size does not appear to be very important for cooperation between innovative

[2] Gundersen and Onsager 2011.

Figure 3.10
Enterprises with innovation cooperation as a share of all enterprises with innovation by region,[1] 2008.



[1] Metropolitan region (>500 000 inhabitants, ie only Oslo). Larger city regions (50 000–500 000 inhabitants – eg. Stavanger, Bergen, Trondheim, Drammen, Kristiansand, Nedre Glomma). Medium sized regions (25 000–50 000 – eg.Tromsø, Hamar, Arendal, Haugesund, Molde, Ålesund). Small sized regions (5 000–25 000 – eg. Halden, Kongsberg, Ulsteinvik, Lillehammer, Steinkjer, Bodø, Harstad). Small place regions (<5 000 – eg. Risør, Trysil, Oppdal, Røros, Lærdal, Stryn, Andøy).

Source: Statistics Norway/NIBR

partners. Innovative enterprises in every type of region work consistently with customers, suppliers and knowledge institutions in their innovation activities. International cooperation is more important for innovative enterprises in urban areas than in rural areas, while the opposite pattern applies for national cooperation (see Figure 3.10). The international orientation of the enterprise increases with the centrality of the region, primarily because these firms tend to be larger and have large corporate headquarters and R&D-intensive enterprises. However, the regional neighborhood is the most important area for innovation cooperation, regardless of the size of the region where a enterprise is based. Geographical proximity between parties is still very important for innovation, regardless of the size of the regional environment and their industry specialization.

The data also show that the most innovative companies have complex relationships, cooperating with many different partners (suppliers, customers, knowledge institutions) and across a range of geographical areas/locations (regional, national, international) simultaneously.

A number of factors are anticipated to act to inhibit innovation, in particular a lack of information about technologies, potential markets, past innovations and or a lack of partners. These factors have been found to apply broadly, to innovative enterprises in all types of regions, except for those in small sized towns. Enterprises in small sized towns often report more significant inhibiting factors linked to problems recruiting and retaining qualified employees, and tend to rely more on previous innovations.

There are large and systematic differences in the regions' resource base, which are again related to their size and centrality. Differences are apparent in access to R&D resources, the share of employees with higher education and types of business expertise. There are also significant differences in the regions' results in terms of innovation rates, new ventures and growth rates in employment in innovative sectors; all of these vary by the same regional pattern. However, there are even greater differences in the regions' use of formal innovation resources (R&D investments, employees ith higher education in business enterprises) than in innovation rates (excluding patents). This seems to be because a large proportion of the enterprises mostly perform incremental innovation, based on experience-based knowledge, where formal R&D and having employees with a higher education is less important.

Several of these types of enterprises are located in smaller, less central towns and rural areas.

The study looked more closely at the country's most and least innovative regions and highlighted some similarities and differences between them. The sample for this comparison was based on ranking the nation's *labour market regions* by an innovation indicator.[3] This revealed a fairly large spread of innovativeness across the regions. The Oslo metropolitan area was shown to be by far the most innovative region, followed by the five small sized towns Halden, Kongsberg, Ulsteinvik, Ørsta-Volda and Alta. Five factors distinguish this group of most innovative small sized towns, when compared with the five least innovative regions:

- Stronger industrial specialization.
- A more R&D-intensive industrial base, with a higher share of R&D expenditure financed by the government.
- More innovation cooperations with different partners and in different geographical areas, and a higher proportion of cooperation with customers and knowledge institutions.
- Lower barriers to innovation among innovative companies.
- Higher rates of innovation, new venture rates and growth rates of innovative firms.

More innovative regions tend to have a higher degree of specialisation in knowledge-intensive industries (such as manufacturing or services), higher levels of R&D investment in the industrial sector, R&D and/or higher education institutions located in the area, richer innovation networks, lower innovation barriers and higher rates of growth.

Innovative companies and business environments appear to have a greater potential for growth (measured in growth rates of employment) when they are based in the most innovative regions, compared with the least innovative regions and the country as a whole. This indicates a relationship at the regional level between having a high percentage of innovative firms and high growth rates in employment in innovative companies and possibly even within the industrial environment as a whole. However, the innovative regions are also different from one another when it comes to their: size and centrality, type of industry specialization and expertise, funding profile (public vs. private funding of R&D in the industrial sector) and the importance of international innovation cooperation. This illustrates that there are several ways to target high innovation capacity.

Public financing of R&D expenditures (particularly that from ministries, directorates and counties) appears to be higher in the most innovative small sized towns when compared with the least innovative small sized towns and the Oslo metropolitan area. Business communities in innovative small sized towns thus benefit from good access to both private and public R&D funding. This is caused by a combination of intentional regional and district policy, and the unintended regional effects of national business-oriented R&D programs (especially those under the auspices of ministries/directorates and the Research Council of Norway).

Norway shows some similarities with other countries in terms of its regional innovation pattern: as in many other countries there appears to be a innovative central core, with less innovative peripheral areas around it. At the same time, the regional differences involved in the Norwegian 'centre and periphery' are not as great as those often found in international studies. One reason for this is that the many of the most innovative companies and milieus in Norway are scattered across the country in small sized towns and rural areas. These business communities developed through historical processes, rooted in particular, local resource industries and their related technology industries. Over time, these business environments have become strongly integrated into national and global knowledge and innovation networks. Additionally, Norway has developed an extensive institutional apparatus as a part of its knowledge, innovation and regional policy, that helps to support decentralised innovation (see introduction on the Norwegian innovation system).

Large regional variations in the resource base, innovation patterns and barriers to innovation in Norway again emphasize the importance of having a nationally led, but regionally differentiated, innovation policy that can be adapted to very different regions in light of their advantages, barriers and opportunities. The analysis shows that overall development strategies to strengthen regional, national and international cooperation on R&D and innovation, and the flow of information and expertise, should act reasonably well as measures to strengthen the innovation and development capability in all types of regions. A major challenge will be to ensure the recruitment of qualified personnel to innovative companies and institutions located in small sized towns and rural areas. Policies to strengthen the attractiveness of these areas will therefore be an important part of an overall regional innovation and development policy.

3 This innovation indicator is based on the average for the share of innovative enterprises and the share of employees in innovative enterprises of the total sample. Being innovative, means that the firm had product and/or process innovation between 2006 and 2008.

Tables and Figures

Figures

Tables

Appendix Tables

Tables

Table 1
Total R&D expenditure in Norway by sector of performance and source of funds, 2009. Million NOK.

Sector of performance	Total	Industry		Government		Other national sources[1]	Abroad	
		Total	Of which: Oil companies	Total	Of which: Research Council of Norway		Total	Of which: EU-commission
Business enterprise sector	21 601.8	16 331.2	1 745.6	2 063.7	1 277.2	723.4	2 483.5	213.8
Of which industrial sector[1]	18 201.9	14 902.3	1 401.2	754.1	403.7	542.2	2 003.3	52.1
Institutions serving enterprises[2]	3 399.9	1 428.9	344.4	1 309.6	873.5	181.2	480.2	161.7
Government sector	6 862.5	705.9	159.8	5 321.8	1 662.2	212.7	622.1	170.9
Of which Institutions serving government	6 524.8	693.0	159.8	5 011.7	1 655.7	198.9	621.2	170.9
Higher education sector	13 420.2	511.3	98.9	12 042.4	2 366.3	537.6	328.9	203.6
Of which Universities and specialiced								
university institutions	10 105.3	430.9	98.4	2 795.5	2 102.8	292.8	278.2	175.6
university colleges	1 219.1	39.4	0.5	1 135.8	136.8	20.4	23.5	17.5
Totalt	**41 884.5**	**17 548.4**	**2 004.3**	**19 427.9**	**5 305.7**	**1 473.7**	**3 434.5**	**588.3**

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

Source: NIFU/Statistics Norway, R&D statistics

Table 2
Current expenditure on R&D by sector of performance and field of science, 2009. Million NOK.

Field of science	Total	Industrial sector	Institute sector	Higher education sector
Humanities	1 488.9	..	215.6	1 273.3
Social scienes	4 201.2	..	1 685.0	2 516.2
Natural sciences	3 974.0	..	1 885.9	2 088.1
Engineering and technology	5 055.7	..	3 355.7	1 700.0
Medical and health sciences	5 330.8	..	1 076.7	4 254.1
Agricultural sciences	1 830.9	..	1 575.3	255.6
Not elsewhere classified	17 180.2	17 180.2	..	..
Total	**39 061.7**	**17 180.2**	**9 794.2**	**12 087.3**

Source: NIFU/Statistics Norway, R&D statistics

Table 3
Current expenditure on R&D by type of R&D and sector of performance, 2009. Million NOK and per cent.

Sector of performance		Total	Basic research	Applied research	Experimental development
Industrial sector	Million NOK	17 180.0	683.0	4 000.0	12 497.0
	Per cent	100	4	23	73
Institute sector	Million NOK	9 794.2	1 404.4	6 446.7	1 943.1
	Per cent	100	14	66	20
Higher education sector	Million NOK	12 087.3	5 565.4	4 915.2	1 606.7
	Per cent	100	46	41	13
Total	**Million NOK**	**39 061.5**	**7 652.8**	**15 361.9**	**16 046.8**
	Per cent	**100**	**20**	**39**	**41**

Source: NIFU/Statistics Norway, R&D statistics

Table 4
R&D expenditure in Norway by sector of performance and type of cost: 1970–2009. 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
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
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

[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: 1974–2009.

	Total			Industrial sector[1]			Institute sector			Higher education sector		
	Total	Researchers[2]			Researchers[2]		Totalt	Researchers[2]		Totalt	Researchers[2]	
Year		Total	Women	Totalt	Total	Women		Total	Women		Total	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

[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: NIFU/Statistics Norway, R&D statistics

Table 6
R&D personnel (FTE) in Norway by sector of performance: 1970–2009.

	Total			Industrial sector[1]			Institute sector			Hiher 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
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
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

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: NIFU/Statistics Norway, R&D statistics

Table 7
R&D and innovation indicators per county, 2009.

County	R&D expenditure per capita (NOK)	R&D expenditure in the institute sector (Million NOK)	Percentage of innovative companies involved in cooperation on innovation	Percentage of innovative companies	Percentage of employment in the public administration	Researchers per 1 000 capita	Percentage of researchers with a PhD	Percentage of government funded R&D expenditure	Percentage of R&D in the industrial sector	Percentage of R&D in manufacturing and mining
Norway	**8 727**	**4 138**	**38**	**25**	**30**	**18**	**30**	**46**	**43**	**44**
Østfold	2 404	2 239	32	22	30	5	15	20	51	84
Akershus	11 257	7 401	39	29	27	18	23	33	56	40
Oslo	22 412	6 761	34	30	25	46	31	53	39	24
Hedmark	940	336	25	20	35	5	18	62	42	78
Oppland	2 526	1 209	45	23	33	7	21	38	60	89
Buskerud	4 799	363	42	25	29	7	10	11	92	79
Vestfold	4 553	1 233	33	27	30	8	15	19	82	86
Telemark	4 639	1 024	48	20	34	10	24	21	82	58
Aust-Agder	2 525	1 773	46	25	32	5	15	32	63	33
Vest-Agder	5 231	705	34	19	29	12	25	27	72	84
Rogaland	4 799	1 286	33	23	25	10	23	27	63	33
Hordaland	9 855	6 253	39	27	29	21	40	65	25	42
Sogn og Fjordane	2 599	777	60	18	34	7	19	32	69	86
Møre og Romsdal	3 503	1 030	44	25	29	8	18	24	74	77
Sør-Trøndelag	24 094	14 176	50	23	33	45	36	51	28	23
Nord-Trøndelag	1 875	1 186	32	19	33	6	17	55	48	88
Nordland	2 057	791	44	21	38	7	23	49	49	38
Troms	12 187	5 507	41	21	41	28	41	78	12	48
Finnmark	1 498	1 008	36	20	41	7	13	80	14	0

Source: NIFU/Statistics Norway, R&D statistics

Table 8

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

	Indicators	Year of reference	EU 27	Austria	Belgium	Denmark	Estonia	Finland	France	Germany	Iceland	Ireland	Italy	Latvia	Lithuania	The Nether-lands	**Norway**	Poland	Portugal	Spain	Sweden	Switzer-land	United Kingdom	United States
1	**Spending on Human Resources**																							
1.1	Total public expenditure on education as a percentage of GDP (2006)	2008	5.07	5.46	6.46	7.75	5.67	6.13	5.58	4.55	7.57	5.62	4.58	5.71	4.91	5.46	**6.51**	5.09	4.89	4.62	6.74	5.37	5.36	5.40
2	**Gross domestic expenditure on R&D (GERD)**																							
2.1	Percentage of GDP (2007)	2009	2.01	2.75	1.96	3.02	1.42	3.96	2.21	2.82	3.10	1.77	1.27	0.46	0.84	1.84	**1.80**	0.68	1.66	1.38	3.62	:	1.87	2.77
2.2	By source of funds - percentage of GERD financed by industry (2006)	2008	54.7	46.1	61.4	61.0	39.8	70.3	50.7	67.3	50.4	48.6	45.2	27.0	21.4	48.8	**45.3**	30.5	48.1	45.0	62.3	68.2	45.4	67.3
3	**Level of Internet access**																							
3.1	Percentage of households who have Internet access at home (2008)	2010	70	73	73	86	68	81	74	82	92	72	59	60	61	91	**90**	63	54	59	88	:	80	:
4	**Science and technology graduates**																							
4.1	Tertiary graduates in science and technology per 1 000 of population aged 20-29 years (2007)	2009	14.3	14.0	12	15.2	10.8	19.0	20.2	13.5	10.3	17.2	11.3	9.8	18.5	8.9	**9.0**	14.3	14.6	12.5	13.0	18.1	17.5	10.3
5	**Patents**																							
5.1	Number of applications per million inhabitants to EPO (2006)	2008	119.5	232.2	142.4	232.9	25.9	250.3	133.7	298.7	88.8	73.7	89.7	10.4	3.0	226.2	**118.8**	5.9	13.6	34.1	318.9	441.3	90.1	103.8
5.2	Number of patents granted per million inhabitants by USPTO (2003)	2005	37.0	52.0	46.4	64.5	6.0	121.5	44.0	94.1	62.2	43.5	19.7	1.4	8.5	75.3	**42.0**	1.3	1.9	5.3	59.9	120.8	36.5	283.0
6	**Venture capital investments**																							
6.1	Early stage investments - percentage of GDP (2007)	2009	:	0.007	0.039	0.036	:	0.033	0.019	0.018	:	0.018	0.003	:	:	0.019	**0.03**	0.000	0.018	0.004	0.038	0.055	0.026	0.045
7	**ICT expenditure**																							
7.1	Information Technology Expenditure - percentage of GDP (2006)	2008	2.4	2.0	2.3	2.8	1.4	3.2	2.5	2.7	:	2.4	1.5	1.0	1.1	2.8	**1.7**	1.6	2.1	1.7	3.2	2.9	3.7	3.3
8	**E-Commerce**																							
8.1	Percentage of enterprises' total turnover from E-commerce via Internet (2007)	2007	4.2	2.8	3.4	:	:	:	:	3.3	5.6	9.8	0.9	:	5.4	:	**8.5**	3.2	2.7	6.2	:	:	7.0	0.0
9	**Youth education attainment**																							
9.1	Percentage of the population aged 20 to 24 having completed at least upper secondary education (2008)	2010	79.0	85.6	82.5	68.3	83.2	84.2	82.8	74.4	53.4	88.0	76.3	79.9	86.9	77.6	**71.1**	91.1	58.7	61.2	85.9	82.3	80.4	0.0
10	**E-government on-line availability**																							
10.1	Percentage of online availability of 20 basic public services (2007)	2010	84	100	79	95	94	95	85	95	58	100	100	93	72	95	**90**	79	100	95	100	70	98	0
11	**E-government usage by individuals**																							
11.1	Percentage of individuals aged 16 to 74 using the Internet for interaction with public authorities (2008)	2010	32	39	32	72	48	58	37	37	77	27	17	31	22	59	**68**	21	23	32	62	:	40	:
12	**E-government usage by enterprises**																							
12.1	Percentage of enterprises which use the Internet for interaction with public authorities (2008)	2009	72	79	81	90	79	96	75	65	:	89	83	64	91	83	**83**	61	77	65	86	:	68	0
13	**Broadband penetration rate**																							
13.1	Number of broadband access lines per 100 inhabitants (2008)	2010	25.6	23.5	30.0	38.2	26.0	29.1	31.1	31.3	:	22.9	21.3	18.8	19.6	38.5	**:**	14.9	19.1	22.5	31.9	:	30.6	0.0
14	**High-tech exports**																							
14.1	Exports of high technology products as a share of total exports (2006)	2006	16.6	11.2	6.7	12.8	8.0	18.1	17.9	14.1	8.9	29.0	6.4	4.2	4.7	18.3	**3.0**	3.1	7.0	4.9	13.4	21.3	26.5	26.1

Source: Eurostat

Table 9

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

	EU Innovation Union Scoreboard 2010	Year of reference	EU 27	Austria	Belgium	Denmark	Estonia	Finland	France	Germany	Iceland	Ireland	Italy	Latvia	Lithuania	The Nether-lands	**Norway**	Poland	Portugal	Spain	Sweden	Switzer land	United Kingdom
	Composite Innovation-index[1]		0.516	0.591	0.611	0.736	0.466	0.696	0.543	0.696	0.487	0.573	0.421	0.201	0.227	0.578	**0.463**	0.278	0.436	0.395	0.75	0.831	0.618
	ENABLERS																						
	Human resources																						
1.1.1	New doctorate graduates	2008	1.4	2.0	1.4	1.6	0.8	3.0	1.4	2.6	0.5	1.4	1.6	0.4	0.8	1.6	**2.0**	0.9	3.0	0.9	3.2	3.4	2.1
1.1.2	Population completed tertiary education	2009	32.3	23.5	42.0	48.1	35.9	45.9	43.3	29.4	41.8	49.0	19.0	30.1	40.6	40.5	**47.0**	32.8	21.1	39.4	43.9	43.5	41.5
1.1.3	Youth with upper secondary level education	2009	78.6	86.0	83.3	70.1	82.3	85.1	83.6	73.7	53.6	87.0	76.3	80.5	86.9	76.6	**69.7**	91.3	55.5	59.9	86.4	80.2	79.3
	Open, excellent and attractive research systems																						
1.2.1	International scientific co-publications	2008	266	936	1 038	1 301	491	1 113	576	587	:	895	414	132	199	1 059	**:**	186	485	440	1 306	:	841
1.2.2	Scientific publications among top 10% most cited	2007	0.11	0.12	0.13	0.15	0.08	0.11	0.10	0.12	0.13	0.12	0.10	0.02	0.04	0.15	**0.12**	0.04	0.09	0.10	0.12	0.16	0.13
1.2.3	Non-EU doctorate students	2007	19.45	8.47	18.18	14.14	1.82	4.25	31.22	:	14.43	:	4.15	0.28	0.03	:	**23.43**	2.27	7.81	16.78	14.74	45.01	35.85
	Finance and support																						
1.3.1	Public R&D expenditure	2009	0.75	0.81	0.62	0.99	0.76	1.11	0.81	0.90	1.14	0.60	0.58	0.29	0.64	0.96	**0.86**	0.41	0.71	0.67	1.06	0.74	0.67
1.3.2	Venture capital	2009	0.110	0.029	0.141	0.087	:	0.145	0.115	0.057	:	0.031	0.048	:	:	0.110	**0.105**	0.043	0.087	0.072	0.227	0.162	0.263
	FIRM ACTIVITIES																						
	Firm investments																						
2.1.1	Business R&D expenditure	2009	1.25	1.94	1.32	2.02	0.64	2.83	1.37	1.92	1.45	1.17	0.65	0.17	0.20	0.88	**0.95**	0.18	0.78	0.72	2.54	2.20	1.16
2.1.2	Non-R&D innovation expenditure	2008	0.71	0.47	0.57	0.51	1.77	0.57	0.47	0.88	:	1.01	0.61	1.20	0.76	0.52	**0.10**	1.25	0.68	0.46	0.74	1.16	:
	Linkages & entrepreneurship																						
2.2.1	SMEs innovating in-house	2008	30.31	34.37	40.24	40.81	33.97	38.60	29.95	46.03	:	38.76	34.09	14.44	19.39	26.27	**25.42**	13.76	34.10	22.06	37.02	28.20	:
2.2.2	Innovative SMEs collaborating with others	2008	11.16	14.71	22.23	22.68	22.29	15.30	13.52	8.95	14.05	9.82	5.98	3.29	8.03	12.97	**13.06**	6.40	13.31	5.34	16.51	9.40	24.98
2.2.3	Public-private co-publications	2008	36.2	56.3	61.5	123.2	19.0	104.7	31.8	49.5	170.0	25.8	20.7	2.0	3.0	90.0	**110.6**	2.5	8.7	15.9	117.3	198.5	61.7
	Intellectual Assets																						
2.3.1	PCT patent applications	2007	4.00	5.05	3.74	8.02	1.99	9.96	3.86	7.72	2.96	2.63	2.12	0.69	0.35	6.44	**3.08**	0.31	0.53	1.28	11.02	9.13	3.51
2.3.2	PCT patent applications in societal challenges	2007	0.64	0.71	0.64	2.73	0.36	0.54	0.54	1.01	0.53	0.76	0.36	0.26	0.02	1.11	**0.41**	0.06	0.13	0.30	2.01	2.60	0.73
2.3.3	Community trademarks	2009	5.41	9.56	6.00	7.06	4.95	5.63	4.03	7.30	6.43	5.89	5.08	2.40	2.74	7.74	**1.70**	2.82	4.92	6.17	6.99	10.12	4.74
2.3.4	Community designs	2009	4.75	9.19	3.79	7.97	1.82	5.34	3.82	7.89	0.22	2.30	6.85	3.41	0.48	4.56	**0.94**	4.71	5.70	3.37	5.15	8.12	2.35
	OUTPUTS																						
	Innovators																						
3.1.1	SMEs introducing product or process innovations	2008	34.18	39.55	44.01	37.63	43.92	41.83	32.09	53.61	:	27.34	36.91	17.22	21.93	31.58	**28.91**	17.55	47.73	27.50	40.59	57.00	25.10
3.1.2	SMEs introducing marketing/organisational innovations	2008	39.09	42.78	44.08	40.02	34.10	31.49	38.51	68.18	:	41.55	40.62	13.95	21.39	28.62	**30.80**	18.65	43.84	30.35	36.73	:	31.06
	Economic effects																						
3.2.1	Employment in knowledge-intensive activities	2009	13.03	14.04	13.62	15.18	10.76	14.86	13.48	14.46	18.75	18.90	13.32	9.15	7.93	14.82	**15.02**	8.87	8.76	11.34	15.58	19.65	16.69
3.2.2	Medium and high-tech product exports	2009	47.36	52.30	49.84	41.31	34.00	52.31	58.27	62.13	16.7	52.06	51.32	30.46	31.90	40.46	**15.94**	51.06	35.4	49.11	52.17	64.43	51.85
3.2.3	Knowledge-intensive services exports	2008	49.43	30.9	40.84	66.85	42.00	41.33	33.89	58.50	19.55	72.02	35.60	38.11	12.68	35.56	**55.01**	30.6	30.89	:	41.63	33.65	67.97
3.2.4	Sales of new to market and new to firm innovations	2008	13.26	11.24	9.50	11.44	10.23	15.6	13.25	17.38	12.69	11.01	11.79	5.88	9.59	8.85	**3.33**	9.84	15.57	15.91	9.16	24.9	7.31
3.2.5	Licence and patent revenues from abroad	2009	0.21	0.19	0.53	0.74	0.13	0.68	0.34	0.41	0.00	0.74	0.05	0.02	0.00	0.67	**0.14**	0.02	0.07	0.07	1.18	2.46	0.59

[1] The innovation index is composed of 29 different variables ranging from 0 (lowest) to 1 (highest).

Source: DG Enterprise

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	Doctor of Philosophy
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 the Police	Justis- og politidepartementet	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

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The report describes and documents the Norwegian research and innovation system. It is based upon the results from the national 2009 statistical survey on resources devoted to research and experimental development (R&D) and Innovation survey (2008) as well as other statistics and studies. Time-series and international data are also included.

The purpose of the report is to present an overall description for non-Norwegian readers of Norway's performance and activity within science, technology and innovation. The data and analysis are structured around three chapters: The first chapter covers Norwegian research and innovation in international comparisons. The second chapter describes the Norwegian research and innovation system, including data on i.a. expenditure and funding of R&D, human resources, cooperative relations, and results of R&D as measured by publications and citations, patents and innovation in Norwegian industry. The third chapter provides R&D and innovation data on a regional level. Main figures and indicators are also included in an appendix.

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

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