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Evaluation of the Research Council of Norway

Background Report No 5 - Implementing and Adding Value to National Priorities and Developing the National Research and Innovation System

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Summary

This report looks at the way RCN implemented national priorities, including the plans of its principals, the ministries, and maps out the instruments and policy mix adopted by RCN to fulfil its strategic responsibilities towards the Norwegian R&I communities. It also looks into the added value of RCN's activities, including the outcomes and potential effects on the National Research and Innovation System (NRIS).

We analysed the patterns in RCN's funding allocations from an intervention logic perspective, i.e. restructuring and analysing the data to explore how funding was used to implement policy.

The context

The White Paper 'Commitment to Research' (2004-2005) constituted the strategic background for most of RCN's activities in the period subject to this evaluation (2004-2010). Priorities were defined in three dimensions.

- Structural priorities included internationalisation, basic research, and research-based innovation and development
- Thematic priorities were: Energy and environment, Food, Oceans, and Healthcare
- Technological priorities were: ICT, Biotechnology and New materials and nanotechnologies

Over the last decade, and especially since 2005, there has been a considerable increase in Government Expenditure for R&D in Norway. The Council receives funding from 16 Ministries; the most important contributors are the Ministry of Education and the Ministry of Industry and Trade. Ministries increasingly used RCN as a channel for R&D funding and there was an increase in the co-funding of programmes. Approximately 30% of the state budget for R&D is channelled through the Council.

The research budget

The increase in RCN's overall income went entirely to the research budget. Management costs that are covered through this budget stayed at a stable 3%, mainly thanks to RCN's efforts to enhance efficiency in programme management. There was a fairly stable level of investment in the outsourcing of strategic intelligence studies, while funding for evaluations was limited.

Part of the research budget (17%) was dedicated to 'non-competitive' funding of support for the R&I system, i.e. institutional funding that ministries channel through RCN to specific institutions in their sphere of competence. The remaining 80% was allocated for the competitive funding of support to the R&I system, an increase compared to the 70% in 2000 and 75% in 2004. Most of this competitive support was used to fund research; ~20% was invested in systemic interventions.

Main trends in the programme and instrument portfolio

RCN funding of the *Innovation System* grew over the last decade. Centres support was expanded via the launch of two Competence Centre programmes. Innovation-orientated research accounted for nearly half of the research-funding budget in 2010. Investment in mission-orientated research also grew (~30%). Funding of support for international cooperation increased strongly in 2004/2005. The level of funding for basic research (programmes and bottom-up funding) remained fairly stable throughout the decade in real terms and accounted for 25% of the budget in 2010. According to RCN data, the ratio basic/applied research was ~40%/60% in 2010, compared to ~45%/55% in 2006.

There was also a clear trend of *de-programming*, especially in innovation-oriented research where RCN adopted response mode funding more extensively through its BIA programme. A similar development took place for the FRIPRO programme in the field of basic research.

The shares of RCN's Divisions in the research budget illustrate the *strategic importance of the National Priorities* in RCN's programme portfolio: as of 2006, the Division for Strategic Priorities had the highest competitive funding budget, a position that was previously taken up by the Science Division. The Large-scale programmes, implementing the National Priorities, constituted the largest programme category in 2010, closely followed by the user-directed innovation programmes.

The increase in focus on *larger (collaborative) research projects* was a key development in RCN's instrument portfolio. Funding of individual grants drastically decreased. Those that remained targeted excellent young researchers, industry-science relationships, and inward mobility. The *Centres programmes* constituted the core of the *systemic initiatives policy mix*, accounting for ~40% of the funding for systemic initiatives in 2010.

Focus of the research

Technology was and still is the major disciplinary focus of research funded by the RCN. Since 2007, it received 40% to 45% of RCN's funding. *Maths & Natural Sciences* and *Medical Sciences* received higher funding levels from 2006. Funding for research in Humanities remained fairly stable, while research in *Social Sciences* saw a slight reduction in support. Research in Humanities was almost entirely funded through basic research; research in Social sciences was strongly mission-oriented.

Research increasingly addressed the national priorities in *Energy and environment, Health, and Biotechnologies*. Research in ICT and Food was less funded and there was little investment also for new materials and nanotechnologies and Welfare & social challenges.

Funding of *interdisciplinary research* increased significantly in 2003/2004, but not thereafter, with a decrease in 2006/2008. There are major differences among the different programmes, with the share of interdisciplinary projects ranging from ~20% of the funding in the Basic research and Policy-oriented programmes to ~8% in the bottom-up basic research and user-directed innovation programmes.

The low level of interdisciplinary research in the Large-scale programmes is surprising: an average 5% of the funding, with a slight growth in the last years up to 7%.

Stakeholder involvement

Industry and the Research Institutes significantly increased their participation in RCN-funded research. The involvement of the Universities was rather variable, but they continued to constitute RCN's most important beneficiary community. Industry accounted for ~20% of the competitive funding at the end of the 2000s, research institutes for ~25%, and universities for ~30%. Institutes with research, university colleges, actors in the public sector, research associations and so on were the beneficiaries of the remaining 25% of the funding.

Throughout the decade there was a fairly stable distribution of R&D funding among the regions. The capital region received the most, followed by Central Norway and Western Norway. There was an increase in budget for regions such as Agder and Innlandet in the most recent years, but the overall level of RCN funding in those regions remained very small.

Steering the system

RCN uses its instrument portfolio to implement its strategic responsibilities and steer the R&I system re-structuring, through the use of financial incentives. Feedback from

the stakeholder communities suggests that RCN was effective in reaching these strategic objectives, within the limits of its remit.

Increasing research projects size was an effective way to foster the development of research groups and change research practice. The Centres were flagship examples of the broader efforts to enhance cross-institutional collaborations. International cooperation was significantly enhanced through the use of specific instruments and schemes, which stakeholder communities regard as critical to FP participation.

The instrument portfolio for research-based innovation increasingly included measures with a longer-term perspective and since the mid 2000s, the RCN required more research to be collaborative in order to increase quality and facilitate interdisciplinary research. This led to a strengthening of *industry-research and public-sector-science & industry collaborations*. Foreign institutions were increasingly involved in mainstream research. Inter-regional collaboration was also enhanced. Feedback from interviewees suggested that these effects are sustainable.

RCN's efforts to foster higher gender equality were effective in the case of individual grants but more disappointing in relation to the share of projects that are led by female researchers. This is partly attributed to the low level of female researchers in the technical research areas that dominate RCN expenditure.

Supporting the system

In the **Universities**, RCN supported R&D through fostering participation in mission-oriented research and providing a higher level of *systemic support*. Basic research remained the major area of university participation. There was a slight increase in support through funding bottom-up research.

University participation tended to reflect their research strengths in the national priorities. Their involvement in innovation-oriented research was minimal, as was the support they received for international cooperation. Collaborative research funding had only a limited impact on university researchers' behaviour.

A large number of university researchers appreciated the opportunity offered by RCN-funded research to explore new research areas 'of significant importance for their future research activities' and they also valued the opportunity to conduct *interdisciplinary research*. The majority indicated positive outcomes of their RCN-funded research, including impacts on their level of publications. They had a positive view on the effectiveness of RCN's strategies in *anticipating changes* in science priorities and dynamics, but curiously they often questioned the alignment of RCN's strategies with the development needs of the research community. They said that RCN's funding of interdisciplinary research, scientific/technological risky research, long-term exploratory research, and research in disruptive technologies had little effect on the character of their own research.

Research institutes saw a rise in RCN-funding through their participation in innovation-oriented research. Technology/Industrial research institutes were the main beneficiaries followed by the Primary industry institutes and in more recent years, the Environmental institutes. The National Social sciences institutes enjoyed a stable level of funding throughout the decade; the funding trend for the Regional institutes was particularly negative.

Researchers said RCN funding improved their overall research and innovation capabilities. In several cases, the project also led or contributed to innovation (improved products, processes or organisational methods). They valued the opportunity to access complementary expertise as well as the opportunity for conducting interdisciplinary research. They shared the relatively negative view of their peers in the universities about the extent to which RCN funding enabled more interdisciplinary research and found that RCN did not provide sufficient opportunities to conducting scientifically or technologically risky research.

In the second half of the 2000s, RCN supported **industry-R&D** to almost an equal extent in the Services and Manufacturing sectors. There was a stronger involvement by companies in knowledge-intensive sectors that develop or install large IT or manufacturing systems as well as of private companies conducting *Scientific R&D*¹, most often SMEs active, e.g., in the biotech or biomed sectors.

Companies mainly sought RCN funding in order to solve technological problems. Few interviewees saw RCN projects as a way to *reduce commercial risks*, or to *design or develop products*. The ultimate objective of the research was to *reduce technological risks*. Access to complementary expertise was an objective especially for the smaller companies; larger companies often used RCN-funded projects as a base for recruitment. Capacity development of company staff was an indirect effect for most.

Analysis of industry involvement at the level of sectors compared to their importance in terms of R&D expenditure at the national level suggests some gaps in RCN's funding of industry R&D, in particular regarding the high-tech sectors manufacturing Computer, electronic and optical products or developing software.

In some industry sectors, the availability of bottom-up funding of innovation-oriented research compensated for a reduction in programme funding. In most cases, however, the bottom-up funding acted as a supplement to programme funding.

RCN competitive funding in an international context

The breadth of RCN's instrument mix is broadly in line with international practice, with the exception of funding schemes targeting specific groups in the business enterprise sector. Common international practice is to develop specific support schemes for (innovative) SMEs and/or start-up companies.

Research infrastructure projects were larger than the average while bottom-up projects – both basic and innovation-oriented – tended to be smaller. The former needs to be set against the context of the persisting systemic failures in the R&I system; the latter is closely related to the modalities of Ministry steering in Norway, focused at the level of programmes rather than goals and performance objectives.

Norway has a high level of Government funding of Higher Education research through institutional funding (GUF), which is often considered to compensate for the limited level of basic research funding through RCN. We show that, in fact, countries with similar GUF levels distribute their funding budget between the Research Councils and Innovation Agencies in proportions that are in line with RCN's funding allocations between the Science and Innovation/Strategic Priorities divisions.

The evaluation record

Below we briefly summarise key outcomes of our review of programme and instrument evaluations

- A major outcome of the FRIPRO evaluation was that the programme helped to fund research business-as-usual rather than change, operating as a complement to university core research funding and enabling a higher rate of quality-assured scientific production than would be possible without it.
- The evaluation of the Centre of Excellence scheme (SFF) stated that funding had modest positive effects on collaboration, including with other Centres. In line with the structural need, the programme affected the division of labour among Norwegian research-performing organisations and increased researchers' international collaboration. They clearly affected university strategy and have had some positive influence on universities' research management capabilities.
- The mid-term evaluation of the Competence Centre scheme SFI concluded that the programme “demonstrably has benefited supported industries and

¹ We remind that these are not research institutes, a sector that we considered separately

- organisations in the public sector by providing ideas for enhancement of processes and development of improved and new products”.
- The panel conducting the mid-term evaluation of the Large-scale programmes observed that these programmes were agglomerations of earlier, smaller efforts and that their funding was a “patchwork” from many sources. A consequence was that only incremental changes could be made during their life. It seemed to be hard to get additional value from the large programme idea at the industrial level, but there was development and capacity building in the knowledge infrastructure. The evaluations of the FUGE, NANOMAT, PETROMAKS and RENERGI illustrate the importance of links to users and applications even in designing programmes that are intended to have a ‘technology push’ element, developing key technologies ahead of commercial demand.
 - The evaluation of the User-directed innovation programme BIA shows that there are not only short term private returns to user-directed R&D (which are useful to society in the sense that they trigger increased employment, more payment of tax and so on) but more important that there are significant externalities that benefit Norwegian industry and society.
 - The component of the evaluation that deals with the added value of RCN funding shows that RCN does not ‘crowd out’ private investment; and that we can expect the same high rates of private return from all kinds of R&D.
 - A conclusion of the FORNY programme evaluation was that the knowledge infrastructure should engage in a much broader range of cooperative knowledge transfer activities in order to play its role in spreading as well as producing knowledge.

Conclusions

RCN has introduced some important changes in the Norwegian RIS during the last decade, including new longer-term programmes to increase research excellence and industry-science collaboration (the Centres programmes and research infrastructures). RCN instruments have encouraged research management to become more strategic and induced changes in research practice.

RCN increased the share of its funding devoted to innovation, both overall and in the thematic programmes. The Council spent a growing proportion of the budget on implementing the national priorities at the same time as satisfying the needs of the sector ministries. Bottom-up schemes such as BIA and FRIPRO were intended to complement the programmes, providing opportunities for research in areas that were not covered by them. Increases in the size of these bottom-up schemes were made possible partly by reducing the number and scope of programmes in the Science and Innovation Divisions.

No system is perfect and there is room for improvement in the following areas.

Support for internationalisation and interdisciplinary research – both of which are important for raising the quality and competitiveness of Norwegian research – increased rapidly around 2003/2005 but has since remained rather flat. The low level of interdisciplinary research in the Large-scale programmes is surprising and requires urgent consideration.

The pervasiveness of the national priorities in RCN’s activities implies that disciplinary fields that were less targeted in the thematic programmes encountered particularly high levels of competition for bottom-up basic research funding. Actors in industry sectors that were no longer targeted in the industry-oriented programmes often dropped out. The effects of ‘exclusion’ of these actors in the NRIS go well beyond the financial dimension; it implies a reduced role for RCN in maintaining disciplinary health in Norwegian basic research and a restriction of its potential impact on the fostering of industry R&D.

The research community tended to feel that RCN funding did not enable enough risky research to be done to meet present and future needs. Institutes needed to do more

risky research than is possible using funding from their customers, so they looked to RCN for this. In particular the core funding of the Technical/Industrial and Environmental institutes was too low for them to fund such work themselves.

Targeted instruments should complement the current instrument portfolio, focusing on types of companies, such as innovative SMEs or start-up companies, or actors in specific industry sectors that are of particular importance for the Norwegian economy from an innovation and future competitive advantage perspective.

Finally, several evaluations of RCN programmes and funding schemes question the instruments' effectiveness in reaching the intended strategic objectives. Adequate user involvement in programme design is critical for the alignment of research with market and user needs, setting the basis for future impact achievement. Equally important is the flexibility of the programmes to adjust to changes in market or research developments and needs, from a systemic as well as thematic/disciplinary perspective. A less rigid distinction between science and innovation would be beneficial, involving industry players more often in the design of programmes that focus on R&D in the early stages of development, and researchers active in basic research in the design of innovation- and industry-oriented programmes. Creation and use of strategic intelligence, including impact evaluations of RCN's activities and a close monitoring of project outputs and outcomes (beyond the number of publications and patents), should complement the view of the stakeholders.

1. Introduction

This report looks at the way RCN implemented national priorities, including the plans of its principals, the ministries, and maps out the instruments and policy mix it adopted to fulfil its strategic responsibilities to the Norwegian R&I communities. It analyses the patterns in RCN's funding allocations from an intervention logic perspective, i.e. restructuring and analysing data based on their policy rationales and intended outcomes. It also looks into the added value of RCN's activities, their outcomes and potential effects on the research performing sectors, the NRIS, and society as a whole.

The composition and portfolio analysis focuses on the time period 2004-2010, as requested in the Terms of Reference. In most of our graphs we provide a view on funding patterns since 2000, in order to situate the data within their historical contexts.

Our analysis is based on a projects database provided by RCN (as at January 20, 2012). In general, we express funding data in fixed, 2000 prices, in order better to identify trends.

The report is structured as follows.

In Section 2 we describe the context in which RCN operates and give an overview of the main factors that influence its funding decisions.

In Section 3 we describe the main funding trends during the last decade and then cover in more detail the funding patterns in the Divisions, programmes and instruments and the funding distribution across scientific disciplines, priority areas and stakeholders.

In Section 4 we discuss the added value of RCN's activities, describe outcomes and effects, and set RCN's instrument portfolio and funding modes in the international context.

We draw overall conclusions in Section 5.

In the Annex to this report (separate volume), we describe the structure of the RCN database, i.e. how RCN categorised its funding activities. We then give a view on how we restructured the data in order to reflect the intervention logic, i.e. the rationale for the policy interventions. We give a full description of the new categories of instruments and projects that form the basis for the composition and portfolio analysis in this report.

In the second Section of the Appendix, we provide more detailed information on the instrument portfolios in 6 Research Councils and 3 Innovation Agencies in other countries; this information formed the basis for our analysis in Section 4.3.

The Appendix also provides details on the source for the calculations of the real prices.

2. The Context

In this Section we describe the policy and socio-economic context for our analysis. We first briefly describe the main factors that influence RCN’s funding decisions, i.e. the national policy papers and their diagnosis of systemic failures in the NRIS (Section 2.1). Then we look at the overall R&D Expenditure in Norway, the trends, funding sources, research performing sectors and type of research conducted (Section 2.2), and describe RCN’s sources of income (Section 2.3). The last section covers RCN’s research budget and its components: the budget for the management costs, the non-competitive funding budget, and the competitive funding budget. The analysis in the rest of the report focuses on the competitive funding budget.

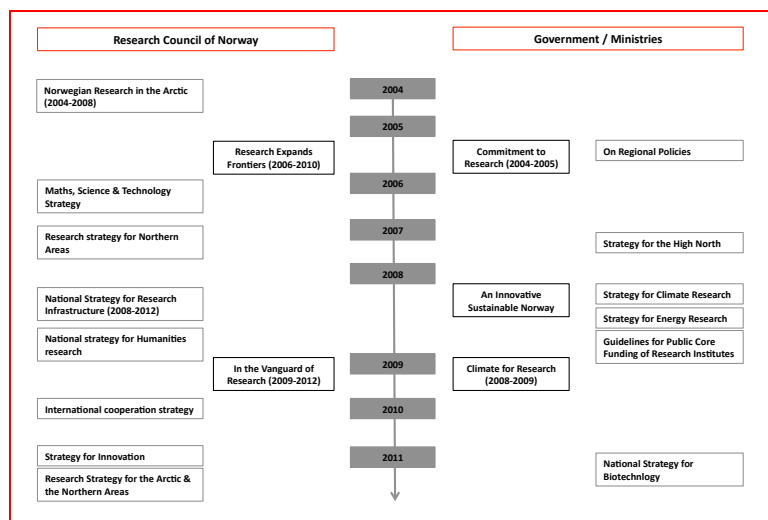
2.1 The policy background

In the last decade or so, Norwegian R&D policy and funding has been guided by a number of government White Papers and related strategies, as well as by strategies of individual Ministries.

RCN reflects the National Strategies in its own ones, complementing them with additional policy papers on specific fields or topics. This involves two-way communication, with Government and Ministry strategies influencing RCN and vice-versa. Figure 1 maps the main strategy documents in 2004-2010.

The White Paper ‘**Commitment to Research**’ (2004-2005) constituted the **strategic background** for most of RCN’s activities during the period in scope to this evaluation (2004-2010). It was itself a development of the preceding White Paper 1998-1999 and was ‘followed up’ by the White Paper Climate for Research (2008/2009) and the White Paper for Innovation (2008/2009).

Figure 1 Mapping of National/Ministry and RCN strategies



2.1.1 White Paper ‘Research at a watershed’, 1998-1999

In this White paper, the Bondevik administration introduced the goal of bringing Norway’s investment in R&D as a proportion of GDP up to the OECD average in within the next five years. It also established the Fund for Research and Innovation (Fondet for Forskning og Nyskaping) to contribute to increasing public research spending, initially in long-term basic research and in the ‘grey zones’ between sector ministry priorities and later to achieve wider purposed in research and innovation support.

The White Paper identified a set of thematic priority areas, ie fields “in which there is already a strong Norwegian research and industry presence [e.g. marine] or where there is long-term potential to build an internationally competitive research and innovation sector”. Marine research, ICT, medicine and health, and crosscutting research in energy and environment were defined as the areas of focus for strengthening competence in the Norwegian R&D communities.

Alongside the thematic areas, the White Paper highlighted public efforts into strengthening the competitiveness of research – by enhancing the quality of the research and promoting long-term and basic research – and Norwegian industry. The policy intended to contribute to the renewal of Norwegian industry.

“Globalisation and international competition are two large challenges facing today’s industry. If we are to meet these challenges, the ability to innovate and make use of new advanced technology is vital [...] Research should also contribute to developing tomorrow’s industry. In this light, long-term research becomes important. Furthermore, a strong knowledge base and suitable framework conditions for investments in research are two preconditions for international businesses locating their research operations in Norway”^{2 3}.

The White Paper specifically mentioned [increasing] the use of tax incentives to encourage more industrial R&D and the need to introduce a research levy in the fisheries and aquaculture industry.

Competitiveness and quality were also foci to be taken up by the Norwegian HEI sector, with core funding becoming less driven by student numbers and more responsive to changes in measures of quality and strength in research. HEIs were particularly encouraged to specialise and expected to develop specific R&D strategies.

Internationalisation of Norwegian research was another pillar of the 1998-99 White Paper. This was largely expressed as a need to build and promote Norwegian research and research policy in the Nordic, European and international communities and was also expected to help enhance Norwegian research capacity and the quality of the research conducted.

2.1.2 White Paper ‘Commitment to Research’, 2004-2005

The White Paper ‘Commitment to Research’ was published by a second Bondevik administration in 2004-2005. It reported a real increase in public research funding of 27 per cent since 1999, as well as a significant improvement of the quality of Norwegian research internationally (based on citations of scientific articles), which it suggested was the result of increased spending on basic research.⁴

Priorities were defined in three dimensions:

- Structural priorities included internationalisation, basic research, and research-based innovation and development
- Thematic priorities were: Energy and environment, Food, Oceans, and Healthcare
- Technological priorities were: ICT, Biotechnology and New materials and nanotechnologies

The White Paper modified the R&D expenditure goal of the 1998 report, to align it with European Union ambitions, ie to spend 3% of GDP on research by 2010.

The most notable development in the structural priorities was the aim of providing support for the reorganisation and renewal of *public sector* research performers,

² www.regjeringen.no/nb/dep/kd/dok/regpubl/stmeld/19981999/stmeld-nr-39-1999-/1.html?id=192406

³ Our translation

⁴ Norwegian Ministry of Education and Research Commitment to Research, Summary in English: Report no.20 to the Storting (2004-2005)

alongside increased attention to innovation in the Norwegian industry sector. Support for basic research accentuated the *promotion of quality* rather than the more general ‘capacity building’. It articulated the need to improve *research infrastructure* and basic *STEM research* clearly. As was previously the case, thematic research was to encompass both basic and applied research and industrial applications in e.g. the fisheries and health sectors.

The White Paper also expressed the aim of generating better *collaboration between the various research sectors* and stimulating *increased R&D investment by Norwegian industry* via strengthened support for user-initiated research, a scheme for industrial PhDs and regional innovation centres, the ongoing Skattefunn scheme for tax relief, international activities such as the European Technology Platforms, EUREKA etc.

The *internationalisation* aspiration was articulated in more detail, emphasising the attractiveness of Norway as a destination for international researchers, Norway’s relationship with the European research community, an active involvement in the planning for FP7, striving towards coherence between national and international activities, strengthening bilateral relationships and an eventual opening up of national research programmes internationally. The ethics aspect of research and the importance of dissemination of results were further articulated.

This called for change in the division of labour between RCN and the research performers. RCN’s role was to fund larger-scale projects, leaving smaller research projects to be supported by universities’ operational budget, which in turn would be shored up by a government scheme (2006-2010). RCN had a strategic role to play in the institute sector, a role that should be further strengthened – partly by developing a performance-based core funding system.

2.1.3 RCN strategy 2006-2010 ‘Research Expands Frontiers’

This overall RCN strategy covered the period 2006-2010. It responded to the Government White Paper by promoting basic sciences in all areas, along with specific support to policy themes: marine research, medicine and health, ICT and energy/environmental research. RCN also developed its own priorities in petroleum, materials and biotechnology research.

The strategy aimed to achieve the following goals by 2010.

- Quality: Norwegian research should match that of the other Nordic countries in scientific publication and citation rates. Evaluations should conclude that Norwegian research has increased in quality and quantity. Moreover, Norwegian research groups should be world leading in prioritised areas – marine and petroleum.
- More research for innovation: Research in industry should have increased considerably and innovation rates should match those in the other Nordic countries. Norwegian research groups should be world leading in prioritised areas of importance to industry. The Research Institutes should have a bigger role to play in supporting industry. Public services should work more closely with research environments, and R&D play a more prominent role in public procurement.
- A closer dialogue between research and society: Research in societal important fields should be markedly strengthened. In central fields, Norwegian research should contribute to research and innovation policy. Places for dialogue including researchers and society should be further developed in order to facilitate ethical research.
- Increased internationalisation of Norwegian research: A considerably larger number of foreign researchers should work in Norwegian – public and private – R&D. International funding should increasingly support Norwegian research. Collaboration between Norwegian researchers and international researchers

should have increased significantly. RCN should contribute more to ERA and EU action plans.

- Better use of research talent: The number of postdoc positions should 'have increased considerably' and more women should be among the recruited. A considerably better mobility of researchers between industry, research institutes and management. More resources should be allocated per R&D man-year and match the OECD average. Generally, better conditions for research shall create more attractive research environments.
- An improved Research Council: RCN also has internal goals relating to transparency, advisory role (clarity), inclusiveness and integration, efficiency and competence.

2.1.4 White Paper 'Climate for Research', 2008-2009

Following a change in administration, the 2004-05 White Paper was replaced by the Stoltenberg government's Climate for Research in 2008-2009⁵. To an extent this continued the former administration's research policy but it placed more emphasis on performance and impacts – highlighted by a NIFU publication⁶. New foci included more research for innovation, reflecting the government's desire to stimulate more research in industry. The goals of the renewed – and current – research policy were to contribute to

- Solving global challenges, in particular in relation to the environment (notably in the High North), climate, marine issues, food safety and energy research – areas in which Norway has developed specific competences or competitive advantages
- Public health, reduced social health-related inequalities and improved quality in health care. Norwegian medicine and health research have seen large increases in investment since 2003, and is being given continued support
- A research based welfare policy and its implementation. This is a cross-cutting theme, incorporating education, working life and migration
- Norwegian knowledge-based industry. This goal is also outlined in the Innovation White Paper⁷, mirroring the Climate for Research White Paper. The strategy is mainly based on a continuation of existing policies – notably Skattefunn – in addition to a drive in encouraging the recruitment of researchers in industry and the funding of a new Centre for Research-based Innovation scheme
- Industry-relevant research in the areas of food, marine, maritime, tourism, energy, environment, biotechnology, ICT and new materials and nanotechnology – in continuation of the preceding White Paper.

The cross cutting themes also remain – promoting quality and internationalisation. The Climate for Research document adds to these the importance of the effective use of research resources and results, and of maintaining a well-functioning research system. The additional systemic goals reflect the new, more autonomous role of the research institutes; the higher profile of regional research policy – through the regional research funds; and the more competitive stance taken by the HEI sector.

2.1.5 Systemic failures and the policy response

Systemic failures such as the fragmentation of the research and innovation system and the need to enhance the quality of research, intra- and inter-institutional collaboration in research, and the creation of critical mass were issues throughout the decade.

RCN commissions discipline specific evaluations, which are evaluation studies done by expert groups, that focus on one or a few scientific disciplines and which happen

⁵ St.meld. nr. 30 (2008-2009) Klima for forskning

⁶ Aris Kaloudis, Stig Slipersøter and Lehmann Sundnes, *Indikatorer for prioritering i norsk forskning*, Rapport 20/2010, Oslo: NIFU-STEP, 2010

⁷ Report no. 7 (2008-2009) An Innovative and Sustainable Norway

approximately every 10 years. We mapped what were perceived as recurring failures highlighted by the studies, and summarised these on an aggregate level. These include

- A lack of critical mass A limited size of the research system, and a lack of research groups and scientific disciplines large enough to be described as having reached critical mass. A relatively low production of scientific publications may also be an issue.
- A lack of mobility, leading to scientific inbreeding. The lack of mobility of researchers is not helped by the organisation of research education, which is frequently pointed out as an area that could usefully be improved. Other comments are directed to the relative old age of larger proportions of Norwegian scientists, as well as lower levels of networking and collaboration.
- Fragmented relationships in the national research system, with higher education institutions operating in traditional ways, not always with adequate management structures in place, often separately from the research institutes and with limited interaction with Norwegian or international industry.
- Locked in funding structures A large proportion of RCN funds are channelled through programmes, leading to a possible constraint to basic research activities.

The Norwegian government tackled these systemic issues through two major policy interventions: on the one hand, the public research actors were granted a higher level of **autonomy**; on the other hand, funding was increasingly provided in **open competition** – based on quality and relevance.

The government introduced performance-based funding models (PBRF) for core government-supported Higher Education and Research institutions. In both cases, the key intent was to enhance quality of research and induce behavioural changes in research strategies and practice.

- The criteria for the Universities, fully implemented in 2006, are the number of PhD students, the scores for publications, and the level of public competitive funding (from the RCN and from the EU).
- The PBRF model for the research institutes was introduced in 2009 and is currently in a pilot phase. The criteria are publication scores, collaboration with universities and university-colleges (expressed in terms of number of completed PhDs and shared positions of researchers in institutes and HEI) and the revenue from competitive funding (national and international).

The Government wanted to achieve a **‘bottom-up’ restructuring of the research system** (rather than top-down) and gave RCN a key role in fostering this through the use of funding incentives. In the 2008 White Paper Climate for Research⁸, the Government stated, “Better quality, concentration, coordination, and reorganisation of Norwegian research should primarily be a *result* of the Research Council organised competitions.”

2.2 R&D Expenditure in Norway⁹

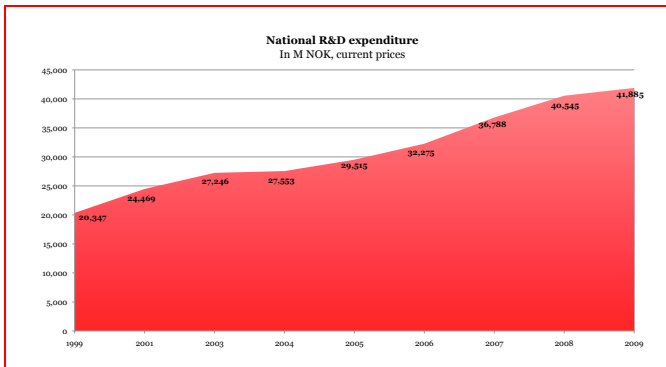
2.2.1 Total R&D expenditure

Over the last decade, gross expenditure on research and development (R&D) in Norway has doubled, from 20,347 M NOK in 1999 to 41,885 M NOK in 2009.

⁸ Klima for forskning, St.meld. nr. 30 (2008–2009), Kunnskapsdepartementet, Oslo: 2009

⁹ Unless otherwise stated, this section is based on the 2011 R&D Indicators Report, RCN-NIFU

Figure 2 National R&D expenditure in Norway, current prices



Source: NIFU/SSB, R&D Statistics

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 was mainly due to the considerable decline in GDP between 2008 and 2009.

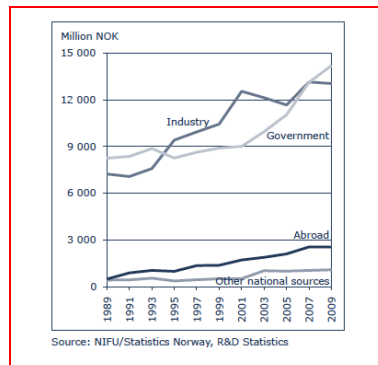
Norway nonetheless remains below the OECD average level of R&D spending as a share of GDP. However, it is well above the OECD average in terms of per capita spending. In 2009, Norway spent just under 9 000 NOK per capita, compared with the OECD average of under 7 000 NOK, and the country has been above the OECD average on this measurement since 2001.

2.2.2 Sources of R&D funding

There have been significant changes in funding sources of Norwegian R&D in the last decade. Until 2007, *industry* was the most important funding source; from 2007 onwards, Government took up this position. Funding from abroad became more important, while funding from other national sources remained small (Figure 3).

In 2011, *Government R&D Expenditure* was 23.5 billion NOK according to the GBAORD estimate, i.e 3.7% of the overall Norwegian Government budget and an estimated 0.87% of Norway's GDP. The 2011 Indicators report points out that the overall proportion of R&D expenditure funded by public sources is relatively high in Norway at nearly 47% compared to the OECD average of 28% in 2008. The report also says that, "The budgetary increase seen over the last 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 (KD)*, whose GBAORD spending amounts to 12 billion NOK. This made up more than half the Norwegian GBAORD spending in 2011, which makes KD the largest R&D funding ministry by far. The *Ministry of Health and Care Services (HOD)* ranked second with 3.1 billion NOK, followed by the *Ministry of Trade and Industry (NHD)* with 1.9 billion NOK. These three ministries accounted for 72 per cent of all GBAORD spending."

Figure 3 R&D expenditure in Norway by primary source of funds, Million NOK: 1989–2009. Real prices, fixed-2000



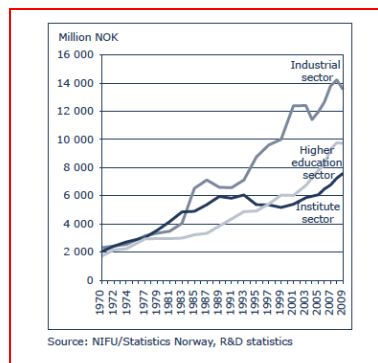
2.2.3 The research performing sectors

R&D expenditure in the Higher Education sector grew as a share of the total during the last decade. In 2009, this sector accounted for 32% of the total R&D effort, compared to 29% in 1999. The 2011 R&D Indicators Report attributes this development partly to the number of PhD students, postdocs and other temporary posts in higher education that have risen considerably in the period.

Industry remained the largest R&D performing sector throughout the decade with expenditures of 18.2 billion NOK in 2009 or 43% of the total. This constituted, however, a *drop in share* compared to the 47% share in 1999. We note an increase especially as of 2005/2006.

The Institutes sector saw significant growth in R&D expenditure between 2005 and 2009, when it accounted for 10.3 billion NOK, representing one fourth of the total and confirming the important role of these institutions in the Norwegian R&D system.

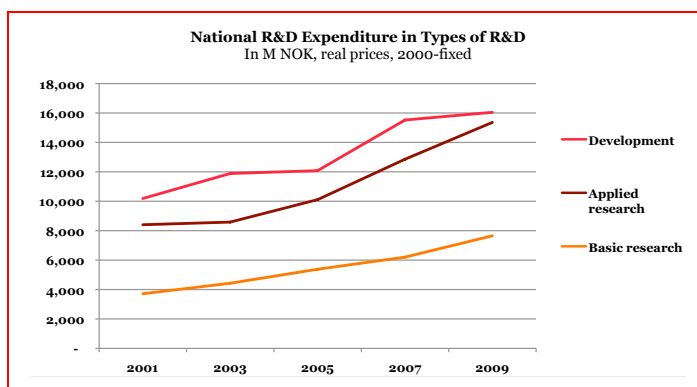
Figure 4 R&D expenditure in Norway by sector of performance, 1970–2009. Real prices, fixed-2000



2.2.4 Type of research conducted

Data on National R&D expenditure by type of research show a sharp increase in applied research from 2003 onwards, reaching the same level of spending as development activities, i.e. 40% of the expenditures (Figure 5) in 2009. In an international context, in 2009, Norway has a similar research profile to Austria, with a relatively high share of R&D expenditure for basic research (Table 1).

Figure 5 Trends in types of research conducted, 1999-2009



Source: NIFU R&D Statistics Bank, 2011 – Technopolis analysis

Table 1 National R&D expenditure in terms of type of research, 2009

	Basic research	Applied research	Experimental development
Norway	20%	39%	41%
Denmark	17%	27%	57%
France	26%	40%	34%
Austria	19%	34%	45%
United Kingdom	9%	41%	51%

Source: Eurostat – data for year 2009

The division of labour between the various research performing sectors remained fairly stable over the decade. Research conducted in the Higher Education sector is predominantly basic, while research institutes focus on applied research. However, through the decade, the distinction became less rigid. The research institutes increased their focus on applied research, reducing their involvement in development. They also focused more on basic research, especially the research institutes in the government sector. The Higher Education sector’s effort in applied research also grew.

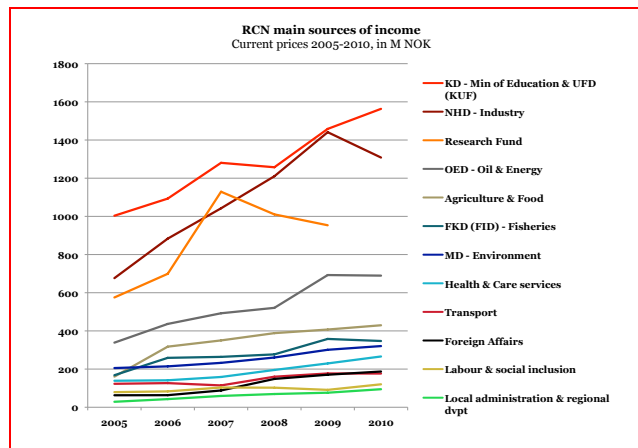
These trends need to be set against the background of increasing competition for funding between these two sectors, spurred by the national R&D policy to make the division of labour in the research system more ‘dynamic’ by means of an open competition for funding “based on quality and relevance”. Universities and colleges started focusing more on the commercialisation of their research results and cooperation with business and industry. In the same period, many institutes became independent legal entities and were to a greater extent reliant on project and contract funding.

2.3 RCN sources of income

RCN receives funding from 16 Ministries. The most important contributors are the Ministry of Education and the Ministry of Industry and Trade. The Ministries of Oil & Energy, Agriculture & Food, Fisheries, and Foreign Affairs increased their funding of RCN’s activities in the period 2005-2006 (Figure 6).

The contribution from the Fund for Research and Innovation increased strongly between 2002 and 2006 (from 90 million NOK in 2000 to over 700 million NOK in 2006). Its share in the overall funding of RCN’s activities peaked in 2007 when it rose from 15% to 20%, but it dropped back to 15% in 2009. Dramatically reduced interest rates as a result of the financial crisis meant it then stopped being a useful source of funding and it has been replaced by a line in KD’s annual budget.

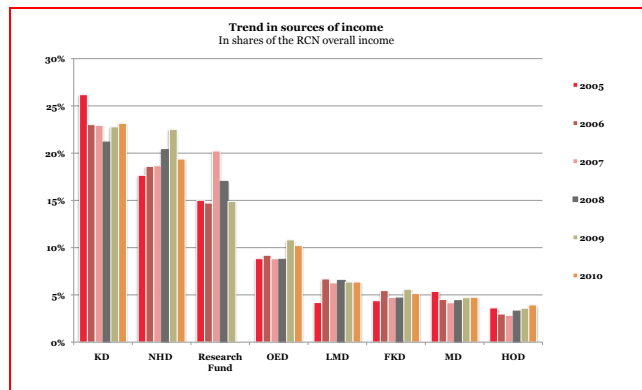
Figure 6 Trend in ministry funding, MNOK, current prices, 2005-2010



Source: RCN, 2011; only showing data for Ministries funding above MNOK 50 in 2010

Individual ministries' shares in RCN's budget are overall fairly stable in 2005-2010: KD (Education) accounted for close to 25% of the RCN budget, NHD (Industry) for approximately 20%, OED (Oil & Energy) for about 10%, and the LMD (Agriculture), FKD (Fisheries), MD (Environment) and HOD (Health) for about 5% each (Figure 7). There were however increase in share for the ministries of Agriculture (LMD) and Fisheries (FKD) starting in 2006; for the ministry of Industry (NHD) as of 2007; and for the ministry of Oil & Energy (OED) as of 2009.

Figure 7 Share of ministry funding in RCN overall income



Source: NIFU, 2011 – Technopolis analysis

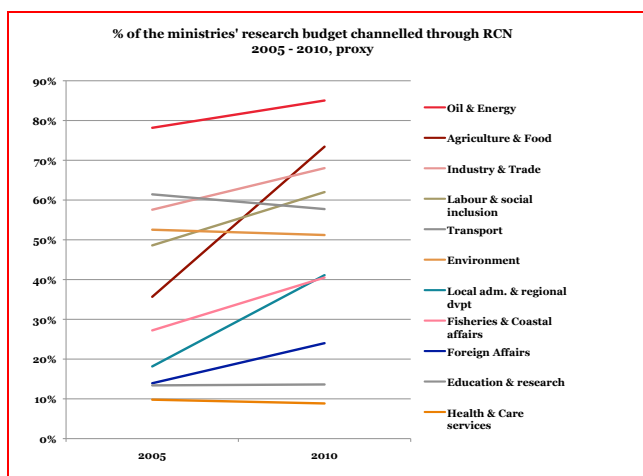
Increasing use of RCN as channel for R&D funding

Overall, approximately 30% of the state budget for R&D is channelled through RCN.

In 2010, the Ministries of Oil & Energy (OED), Agriculture (LMD), and Industry & Trade (NHD) allocated approximately 70% of their R&D budget to the RCN; for the Ministries of Education (KD) and Health (HOD), the proportion is 10%.

Most ministries increased the proportion of their R&D funding budget that was allocated to the RCN in the last 5 years, – in particular the Ministries of Agriculture (LMD), Local Government & Regional Development (KRD), Foreign Affairs (UD) and Fisheries (FKD). Only minor changes took place in the ministries of Education (KD), Health (HOD), Transport and Environment (MD).

Figure 8 Percentage of the Ministries' budget channelled through RCN



Source: Technopolis – based on NIFU and RCN data

Over the last decade, RCN’s programmes have become increasingly cross sector. The percentage of programmes in its portfolio co-funded by different ministries grew from 36% of the programmes in 2003 and 45% in 2007 to 57% in 2011 (Table 2).

Table 2 Co-funding of RCN programmes

	2003	2007	2011
More than 3 funding ministries	9%	10%	13%
3 funding ministries	8%	12%	8%
2 funding ministries	19%	23%	37%
1 funding ministries	64%	55%	43%
Total programmes	100%	100%	100%
	112	81	62

Source: RCN budgets 2003, 2007, 2011

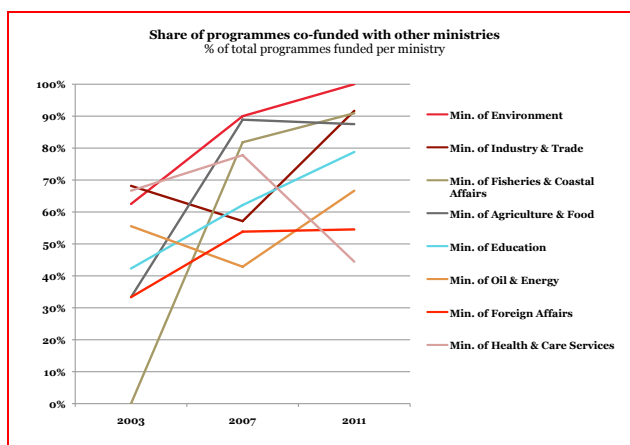
Ministries spread their funding over a *broader range of programmes* in 2007 and 2011 compared to 2003, despite the reduction of the overall number of programmes. This was especially the case for the Ministries of Fisheries and Coastal Affairs, Foreign Affairs, Health, and Education.

This change was strongly driven by a change in behaviour among the ‘larger’ funding Ministries. In 2003, the ‘smaller’ funding ministries already had a strong culture of co-funding of their programmes, with the exception of the Ministry of Local Government & Regional Development, which joined the other ‘small’ ministries in this practice only in 2011. (In 2007, only half of its programmes were co-funded.)

The change in funding pattern in the period 2003-2007 was especially pronounced for the *Ministries of Fisheries and Agriculture*. In the period 2007-2011, the growth is sharpest for the *Ministries of Industry & Trade* and *Oil & Energy*. A slightly more gradual increase took place for the Ministries of Education and Environment. The only Ministry that reduced its participation in cross-sector programmes was the Ministry of Health.

In 2011, all the programmes funded by the Ministry of Environment and 90% of those funded by the Ministries of Industry & Trade, Fisheries, and Agriculture & Food also involved other Ministries.

Figure 9 Percentage of the Ministries' programmes co-funded with other ministries



Note: Included are ministries that funded a minimum of 6 programmes in 2011 (min. 10% of the overall programmes)

Source: RCN budgets, 2003 – 2007 - 2011

Programmes funded by the Ministry of Fisheries often involved the Ministry of Industry & Trade, but also the Ministry of Agriculture & Food, Oil & Energy, Environment, and Health. Both the Ministries of Agriculture & Food and the Ministry of Energy have programmes in common with all other major funding Ministries as well as with the Ministry of Transport, Foreign Affairs, and the Ministry for Regional Development. The Ministry of Education is a key 'funding partner' for the Ministries of Industry & Trade and Health – for the latter, often the sole partner.

Scrutiny of the funding trends for programmes over time shows that the Ministry of Education often acts as central actor, 'launching' a programme, and then gradually other Ministries join in. This was especially the case for programmes starting before 2007.

In the period 2007-2011, programmes have been rather stable in their funding pattern. After the first period of radical change in funding patterns, due to the Large-scale programmes and an overall change of culture, the increase in co-funded programmes is predominantly due to the *launch of new programmes that from the start are co-funded by multiple ministries*.

This emerging pattern highlights the role of RCN and its budget proposals. Setting this finding against the context of the recent practice of national strategy-building processes launched by multiple ministries (biotechnology, nanotechnologies, the HAV21 forum), it also indicates increasing coordination and co-operation among the ministries.

2.4 The Research Budget

The Ministry of Education and Research (KD) provides RCN with an *administrative budget* to cover its operational costs¹⁰; together with 15 other Ministries it also provides RCN with a *research budget*. Part of this research budget is intended to cover management costs. We discuss the use of the administrative budget in the background report on RCN Governance and Administration.

In this report we focus on the research budget. We identified three main budget lines: the budget for the competitive funding of research; the budget for non-competitive support to the R&I system; and a budget for management costs. Management costs

¹⁰ The administrative budget covers management costs that are directly related to RCN's organisational functioning.

that are included in the research budget are not inherent to RCN's organisational functioning or are related to services from external organisations.

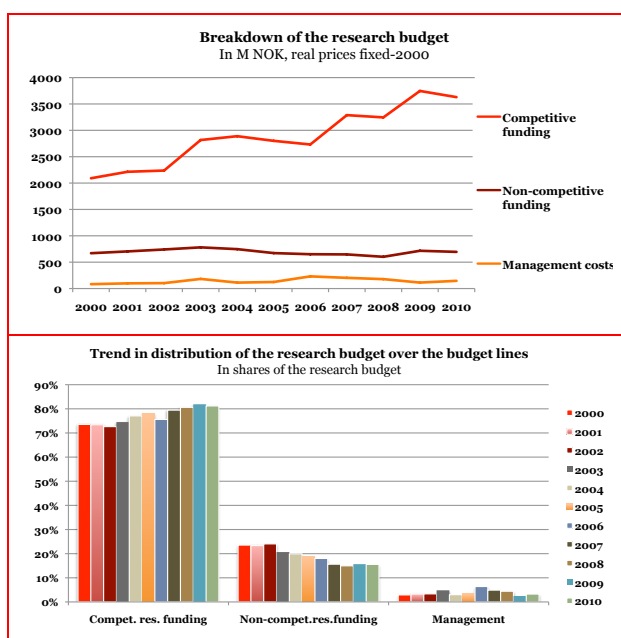
2.4.1 Overview

There was a considerable increase in RCN's overall income during the last decade, in line with the overall rise in government-expenditure for R&D. This went entirely to the research budget.

Funding of support to the R&I system was **increasingly competitive** (Figure 10). Most of the rise in research budget was allocated to *competitive funding*, which increased its share in the research budget from ~70% in 2000 to ~75% in 2004 and ~80% in 2010.

Management costs constituted a fairly stable 3% of the research budget – but slightly more in 2006/2007. The budget line for non-competitive funding remained fairly stable, in real-prices.

Figure 10 The main components of the research budget



Source: RCN database, January 2012 – Technopolis analysis

2.4.2 Management costs

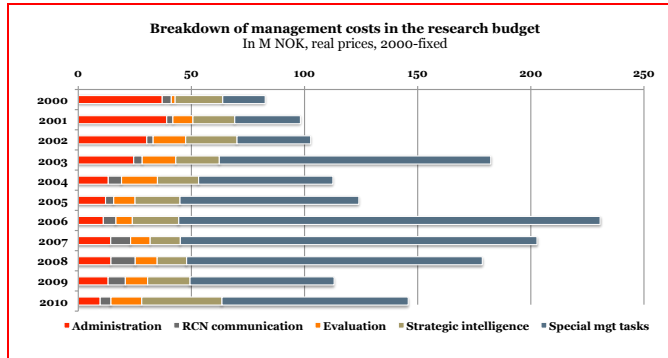
We divided management costs in the research budget into five categories:

- *Administration costs* cover programme management and administration of international cooperation efforts (participation in or contributions to international fora, national experts in the European Commission etc).
- RCN *communication costs* are close-to-exclusively related to the organisation of events for educational or public awareness purposes
- *Strategic intelligence* includes the outsourcing of studies creating strategic intelligence or contributing to RCN's operational capacities from this perspective
- *Evaluation costs* cover two main categories
 - Evaluations that assess *non-R&D policy initiatives* for which Ministries use RCN. As a procurement agent. Examples are the National Labour and Welfare Administration Reform (EVANAV), the Norwegian Breast Cancer Screening Programme, and the evaluation of the Hospital Reform
 - Evaluations that address *RCN's responsibilities*, eg programme/instrument or evaluations informing R&D policy-making such as the scientific discipline evaluations

- *Special management tasks.* This budget line includes RCN’s handling of the funding process for Ministry research funds or programmes on an ad-hoc basis. In these cases, RCN acted as an executive agency. Major examples are the Forest Fund, the Broadband programme, and actions related to the Financial Market

Figure 11 illustrates the main trends in these specific cost lines in the research budget.

Figure 11 Management costs covered by the research budget

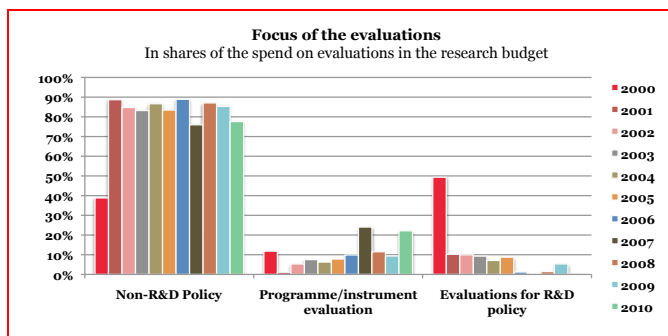


Source: RCN database, January 2012 – Technopolis analysis

We note that

- RCN considerably decreased its costs for administration as a proportion of its overall budget, predominantly by limiting the use of external experts for programme management tasks. Such experts are now involved by RCN only in those cases where specific expertise is required that is not available in-house. RCN used the budget saved to cover costs related to international cooperation and on studies for the creation of strategic intelligence. It slightly increased its spending on communication on research, in particular in 2006-2008.
- The outsourcing of strategic intelligence studies showed a fairly stable level of investment
- Funding for evaluations was limited (in average ~20% of the management costs); it was slightly reduced in the 2005-2008 but reached its 2002 level again in 2009-2010. Spending on evaluations was predominantly focused on evaluations of non-R&D related policies, commissioned by the ministries. These evaluations accounted on average for ~80% of the overall evaluation spend in 2004-2010 (Figure 12).
- Special management tasks were given to RCN, especially in 2006-2007, causing the higher-than-average management costs in those years. In 2006/2007 the special management tasks accounted for ~80% of the management costs in the research budget (compared with ~55% in 2010)

Figure 12 Expenditure for evaluations in the research budget

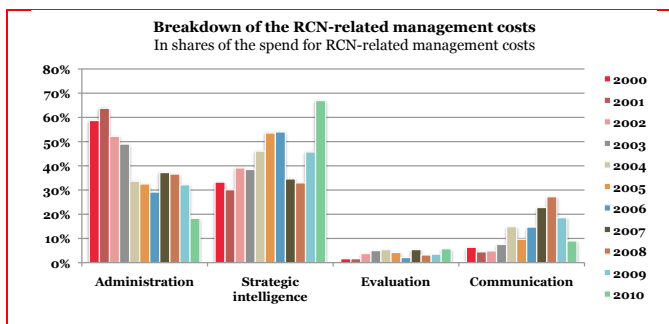


Source: RCN database, January 2012 – Technopolis analysis

In total, management costs that were not related to RCN activities accounted for ~70% of the management costs budget line in the 2004-2010 period, with peaks of 80% to 85% in 2006-2008. RCN-related management costs decreased in 2000-2010, but increased again in 2010 (63 M NOK in 2000, ~39 M NOK in 2004-2009, and 53 M NOK in 2010, real prices).

Administration accounted for 18% in 2010 (a decrease from 59% in 2000 and 34% in 2004); the share for evaluation was fairly stable at around 5% (in 2004-2010 - Figure 13). The shares for strategic intelligence studies and communication both increased: communication costs ranged between 10% and 20% of the RCN-related costs; those for strategic intelligence studies took up 40% to 60%.

Figure 13 Breakdown of the RCN-related management costs



Source: RCN database, January 2012 – Technopolis analysis

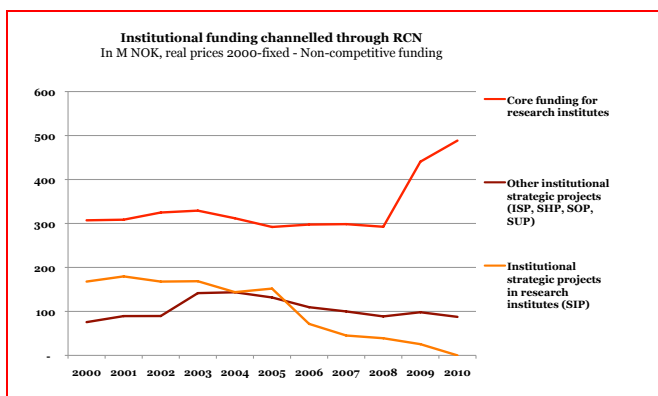
2.4.3 Non-competitive funding

‘Non-competitive funding’ comprises institutional funding that ministries channel through RCN to specific institutions of their sphere of competence. It includes the core funding for research institutes and the funding for institutional strategic research projects – for both research institutes and the HEI (universities and university colleges). This funding for strategic projects is semi-competitive, ie competition is restricted to institutions in a specific field or sector. A new system for the strategic projects funding was discussed and agreed upon in 2008, but has so far only been implemented by the Ministry of Environment.

Figure 10 depicts the fairly stable level of the ‘non-competitive’ funding cost line in the research budget. Its share in the research budget decreased from 26% in 2000 and 20% in 2004 to 16% in 2010, due to the rise in the overall funding. Figure 14 shows the trend in funding for the three components of the non-competitive funding budget line.

Funding for strategic projects in research institutes declined to zero across the period 2000-2010. There was a rise in core funding for the research institutes from 2008 onwards, partly compensating the drop in funding for the strategic projects in these institutions.

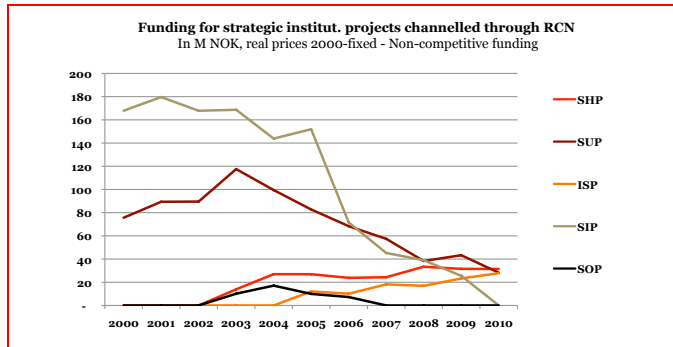
Figure 14 Breakdown of the non-competitive funding budget



Source: RCN database, January 2012 – Technopolis analysis

The funding of the other institutional strategic projects remained at a fairly stable level throughout the decade. However, the scope for funding changed (Figure 15) with the launch of strategic projects in university colleges (SHP) and for the funding of ISP, ie projects funding the development of strategic international inter-institutional collaboration.

Figure 15 Funding for the ‘other’ institutional strategic projects

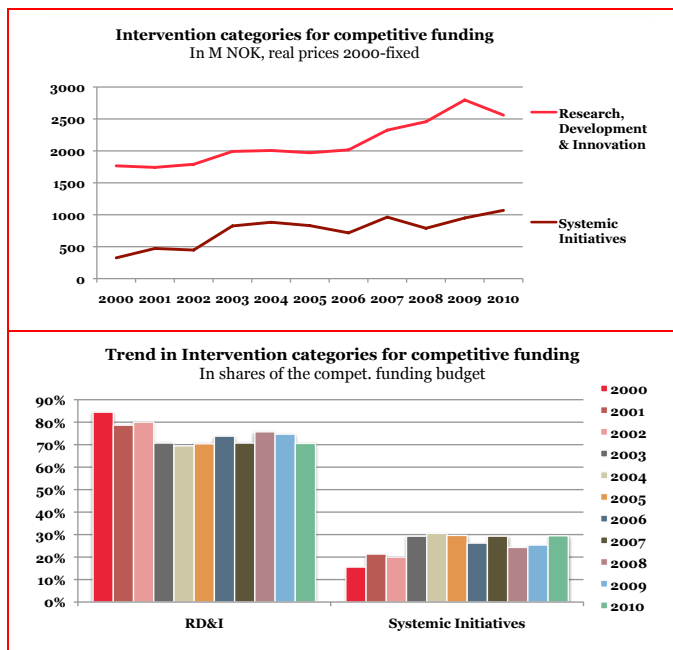


Source: RCN database, January 2012 – Technopolis analysis

2.4.4 Competitive funding

We grouped the competitive funding measures into 2 major ‘intervention categories’: activities supporting R&I (‘research activities’) and activities constituting systemic interventions (‘systemic initiatives’). Both of these categories saw a similar rise in funding, with that for the research activities being more pronounced in 2008/2009 (Figure 16). The division of budget between the two categories is fairly stable: ~75%/80% is dedicated to research, ~20%/25% to systemic interventions. The relative decrease in funding in 2010 was taken up by the research activities. In 2010, the budget for R&I funding was 3,935 M NOK; funding for the systemic initiatives was 1315.7 M NOK (current prices; in fixed-2000 real prices ~2,700 M NOK and ~900 M NOK respectively.)

Figure 16 Intervention categories for competitive funding



Source: RCN database, January 2012 – Technopolis analysis

3. Composition and Portfolio Analysis

This Section reports on the main results of the composition and portfolio analysis of RCN's projects and activities. We first describe the major trends in the competitive funding, the policy mix and the funding modes (Section 3.1). In Section 3.2 we analyse the funding patterns in the 3 Divisions in the period 2004-2010 and then describe the trends in programme funding in Section 3.3. Section 3.4 gives a detailed description of the instrument portfolio. We cover the funding trends for research in the disciplinary areas in Section 3.5 and the national priorities in Section 3.6. Section 3.7 describes the level and focus of stakeholder involvement as well as the trend in regional participation. In Section 3.8 we summarise our main findings and provide some first reflections.

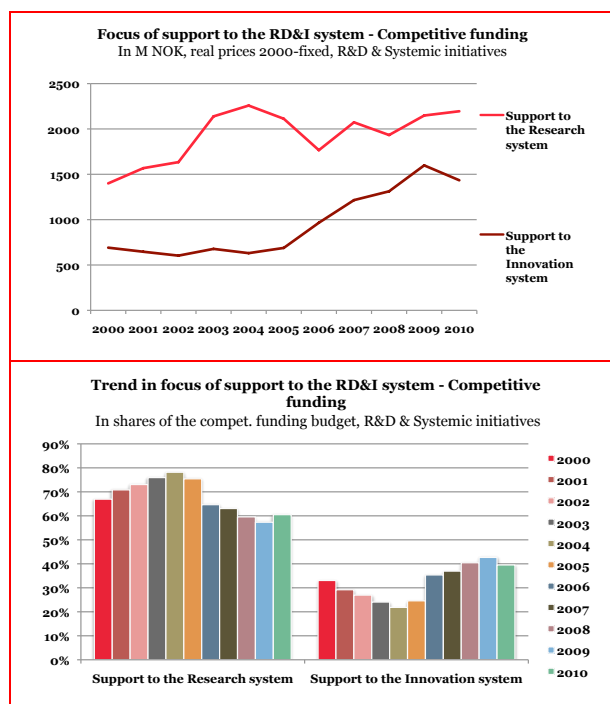
3.1 Major trends in funding

3.1.1 Overview

The last decade was marked by two major trends in the funding pattern.

- **More competitive funding**, which was especially intended as a policy tool for the enhancement of the quality of research (see Section 2.1.5), and
- A more pronounced focus on the **Innovation System**, to sustain research-based innovation: measures for the research system accounted for 60% in 2010, compared to 78% in 2004. Measures focused on the innovation system grew their share of competitive funding from 22% in 2004 to 40% in 2010 (Figure 17).

Figure 17 Focus of support to the RD&I system – competitive funding



Notes: data refer to competitive funding only¹¹

Source: RCN database, January 2012 – Technopolis analysis

¹¹ We grouped as support for the research system the funding for basic & mission-oriented research, the Centres of Excellence, support for international cooperation, and systemic measures focusing on research competence development. The funding for innovation-oriented research, the Competence Centres (SFI and FME) and the systemic initiatives focusing on innovation capacity building constitute the support for

The trends in funding show an increase especially for **innovation-oriented research**, **mission-oriented research** and the **Centres programme** (Figure 18).¹²

- *Innovation-oriented research* showed the strongest growth pattern, in particular since 2006
- There was a resurgence of *mission-oriented research* activity (as of 2006)
- The increase in funding for the *Centres programmes* (also from 2006) was due to the launch of the Competence Centres (SFI and FME)
- *Basic research* received a fairly stable level of funding throughout the decade (in real terms)
- Support for *competence development in research* fluctuated, with higher levels in 2003-2005, 2007 and 2010, in particular due to increased investment in research infrastructure and scientific equipment
- Support for *international cooperation* and for *innovation capacity building* got less of the increase in budget than the other policy mix categories

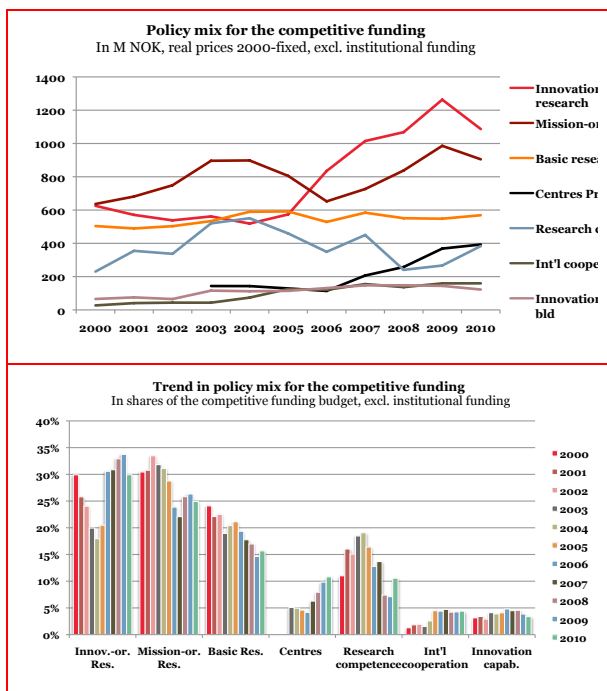
In terms of shares of the overall competitive funding budget

- Funding for *innovation-oriented research* returned to the level of 2000, about 30%
- *Mission-oriented research* accounted for 25% of the competitive funding in 2010, compared to 30% in 2000
- The *Centres programmes* constituted ~10% of the budget in 2010
- The increase in funding for the other research categories implied that the share of the budget for *basic research* decreased from ~25% in 2000 to ~20% in 2004 and ~15% in 2010.
- In 2010, support for *competence development in research* accounted for 10% of the budget
- Support for *international cooperation* and for *innovation capacity building* accounted for ~5% of the competitive funding in 2010, each

the innovation system. Research conducted in the context of international cooperation is excluded from these data due to the difficulty of categorising the support provided along indicators of type of research.

¹² In the Appendix to this report (separate report) we provide a detailed description of these policy mix categories

Figure 18 Policy mix for the competitive funding



Source: RCN database, January 2012 – Technopolis analysis

3.1.2 Types of research supported

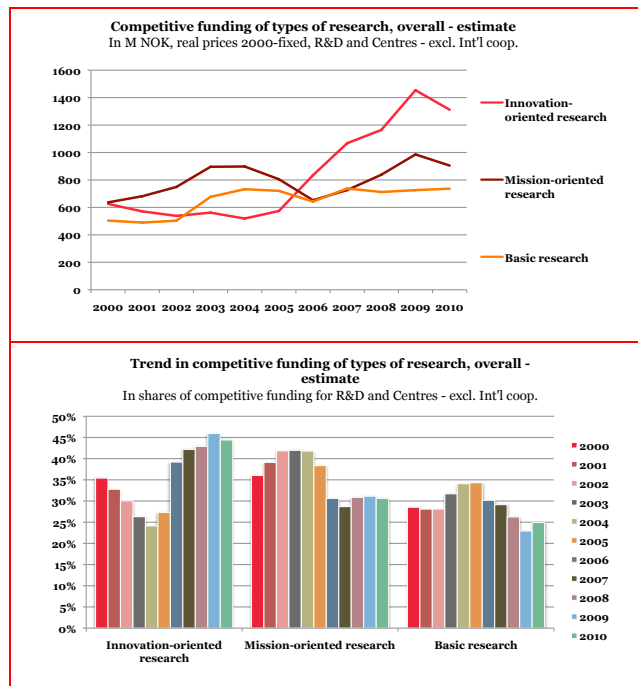
In addition to the research funded in the programmes or schemes, we also considered the Centres of Excellence (SFF) and the Competence Centres (SFI) as instruments for the funding of research, respectively basic and innovation-oriented research.

Adding the funding for the Centres programme to the funding for research projects, we can conclude that in 2010 ~45% of RCN competitive funding was to support *innovation-oriented research*. *Basic research* consumed ~25% of the budget; *mission-oriented research* received the remaining 30%.¹³

Compared to the levels in 2004, the overall funding for support to innovation-oriented research increased by ~20%; the share of two other research types decreased by ~10% each.

¹³ This calculation includes the funding of the Centres and excludes funding for international cooperation

Figure 19 Competitive funding of types of research – an estimate



Source: RCN database, 2012 – Technopolis analysis

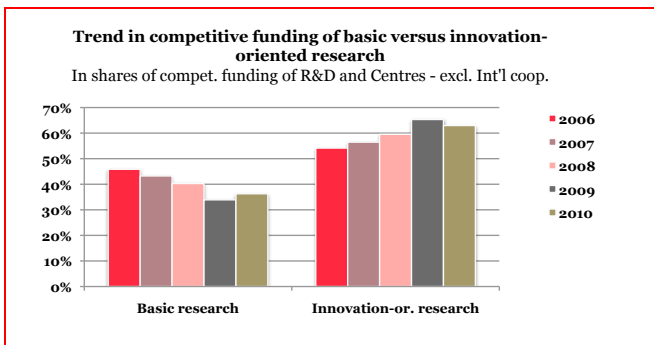
The data shown above should be considered an estimate for the purpose of defining the funding patterns for basic versus applied research. They are based on a categorisation of the research activities into basic, mission-oriented and innovation-oriented research on the basis of project/proposal types and types of programmes in the RCN database. Essentially we proceeded through exclusion: the only fairly clear indication that we obtained from the RCN data related to the funding for industry-oriented research ('innovation-oriented' research) and the funding for the basic research programmes (including the 'free' basic research). We grouped all other research that was conducted in the context of the Large-scale and Policy-oriented programmes in the category "mission-oriented" research.

The labels in the RCN database about projects' relation to the national priorities are another source for the definition of the share of basic versus applied research, covering the time periods 2006-2009 and 2009-2010. The major limit of this source lays in the often-questionable accuracy of these labels, in particular during the earlier years (2006-2008). We minimally cleaned these data, including the categorisation of all user-directed innovation projects as 'innovation-oriented' and projects funded in the basic research programmes as 'basic research'.

RCN's original data confirm the downward trend in its funding of basic research shown above, albeit to a lesser degree. RCN data indicated that in 2010, the share of *basic versus applied research funding* was ~40%/60%, compared to ~45%/55% in 2006 (Figure 24).

Trends in programme funding that influenced this picture were the increase in funding for the Centres programme (see Section 3.4.4) and the increasing share in funding for the User-directed innovation programmes and especially the Large-scale programmes (see Section 3.3).

Figure 20 Trend in competitive funding of basic versus innovation-oriented research



Notes: the proportion basic/innovation-oriented research is similar when not including the Centres Programme

Source: RCN data on the national priorities, 2012 – Technopolis analysis

3.1.3 Mode of funding

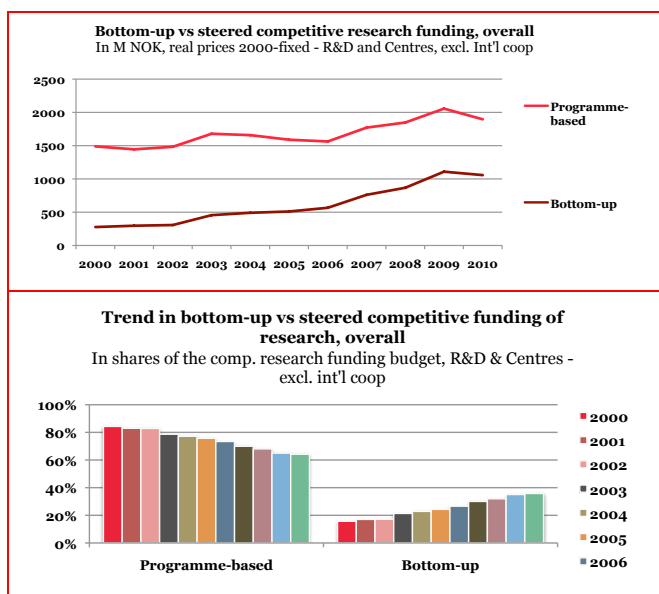
For our analysis of the trends in modes of funding, we made a distinction between bottom-up and programmed research.

- *Bottom-up* research or innovation has no ‘thematic’ steering. It includes the BIA programme and the industry PhDs for innovation-oriented research and the FRIPRO programme and YFF grants for basic research
- *Programme-based* is research or innovation that is funded in the context of thematically defined programmes. This includes the basic research programmes (except FRIPRO), the User-directed innovation programmes (except BIA), the Policy-oriented programmes, and the Large-scale programmes

Our analysis shows an trend towards more bottom-up funding, i.e. a **trend of de-programming**: in 2010, ~40% of the R&D funding was for bottom-up research, compared to ~25% in 2004¹⁴ (Figure 21).

¹⁴ This analysis includes funding data for R&D and the Centres. Research in the Centres is classified as bottom-up. Funding for international cooperation is excluded from this analysis, because it is not definable according to these criteria. Omitting the Centres from this analysis, the level of bottom-up funding was ~25% in 2010, compared to 17% in 2004

Figure 21 Bottom-up versus steered funding in RCN



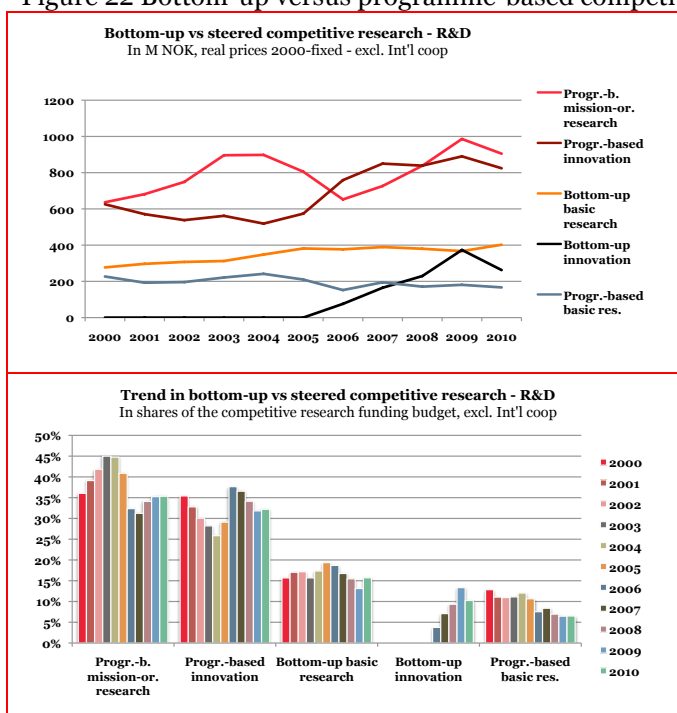
Source: RCN database, 2012 – Technopolis analysis

The rise in bottom-up funding was particularly pronounced for **innovation-oriented research**, but there was also an increase in bottom-up funding for **basic research** (Figure 22). Programme-based basic research received a fairly stable level of funding, while there was a considerable increase in funding for programme-based innovation research. Programme-based mission-oriented research received most funding in 2010.

In terms of shares in the R&D funding budget

- Bottom-up basic research accounted for 15% in 2010
- Bottom-up innovation-oriented research had a share of ~10%
- Programme-based basic research decreased its share of R&D funding from ~10% in 2004 to ~5% in 2010
- The share of funding for programme-based innovation fell back to its 2002 level (~30%), after a peak in funding share in 2007/2009
- Programme-based mission-oriented research had a share of 35%

Figure 22 Bottom-up versus programme-based competitive research



Source: RCN database, January 2012 – Technopolis analysis

3.2 Funding in the Divisions

In 2004, RCN reviewed its organisational structure and set up 3 research divisions: the Science Division, the Innovation Division, and the Division for Strategic Priorities.¹⁵

- The *Division for Science* focused on funding long-term and basic research and was also charged with promoting applied research in medical and health science fields. From a systemic perspective it was responsible for research-related infrastructure and professional development
- The *Division for Innovation* was responsible for the management of industry-oriented research as well as the support schemes for innovation, such as the tax incentive scheme Skattefunn
- The *Division for Strategic Priorities* was intended to exploit synergies between basic research and industrial research through crosscutting initiatives (the Large-scale Programmes) focusing on societal challenges and was to set up programmes in specific policy spheres, focusing on areas of particular importance for Norwegian research, and was to follow up RCN’s initiative for the High North

The *Director’s office* was made responsible for the coordination of all ‘international affairs’.

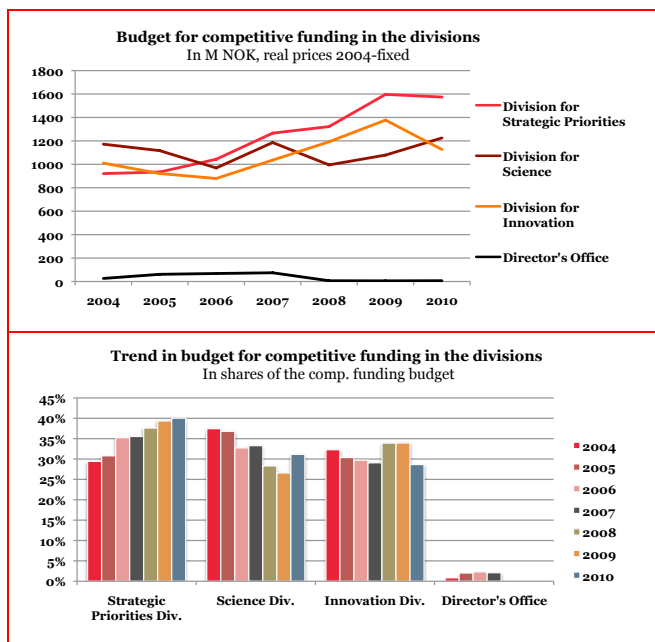
As of 2006, the **Division for Strategic Priorities** had the highest competitive funding budget, a position that was previously taken up by the Science Division (Figure 23). In 2010, the Strategic Priorities Division accounted for ~40% of the competitive funding budget, compared to ~30% for each of the two other research divisions

- The growth pattern in the budget of the Strategic Priorities Division was close to parallel to the one for the Innovation Division - until 2010 when more funding was allocated to the Science Division

¹⁵ See also the Background report on RCN governance & administration

- The Science Division had rather unstable competitive funding budget availability, with a peak in funding in 2007 (after an initial drop) and returning in 2010 to the level of 2004 and 2007 (in real terms)
- The budget shown for the Director's office budget is the part of its budget for funding international cooperation activities, prior to 2008

Figure 23 Budget for competitive funding in the divisions (2004-2010)



Source: RCN database, January 2012 – Technopolis analysis

The **Policy Mix** in the research divisions reflected their systemic and disciplinary mandates.

- The Science Division focused on basic research and invested ~35% of its budget in systemic interventions in the research communities, i.e. in average ~20% for research competence development and ~15% for the Centres of Excellence (SFF)
- The Innovation Division used a fairly constant ~70% of its budget for funding research, in particular innovation-oriented research. The remaining 30% was allocated to research competence development activities (research infrastructures), innovation-capacity building activities, and the SFI competence centres. In 2010, these 3 activities accounted for ~10% of the budget each
- The Division for Strategic Priorities almost exclusively funded research. This changed in 2008 with the launch of the Competence Centres in the field of environment (FME), accounting for ~10% of the division's budget in 2010.

The **de-programming of research** was a trend in the Division for Science and, in particular, the Division for Innovation (Figure 24).

Figure 24 Bottom-up versus steered research funding in the Divisions



Notes: Funding for basic research by the Division for Strategic Priorities refers to some ‘independent projects’ and research funded in the context of the International Polar Year.

Source: RCN database, January 2012 – Technopolis analysis

The **disciplinary focus of research** funded in the Divisions is closely linked to their specific mandate. We see the following patterns (Table 2).

- The Division for Innovation increasingly focused on *Technology* and *Maths & Natural Sciences*
- The Science Division was almost the only funder of research in the *Medical sciences* – which has been growing since 2006. It also funded more research in *Maths & Natural sciences*. In 2010, research in *Social Sciences* returned to its funding level of 2004 within the Science Division, after some years of lower funding. *Humanities* is a field that is funded close-to-exclusively by the Science Division, with a slight decrease since 2004. Humanities funding remains very small
- Funding in the Division for Strategic Priorities was focused on research in the *Technology* area, but the Division increasingly also funded research in *Maths & Natural sciences*. This division’s spending on research in *Social Sciences* saw a slight increase
- The field of *Agriculture & Fisheries* had a slight rise in funding in the Innovation and Strategic Priorities divisions and was barely funded by the Science Division

Table 3 provides an overview of the average share of funding per disciplinary area in the divisions in 2004-2010.

Table 3 Funding of disciplinary research in the divisions - share in the budget for 2004-2010

	Division for Science	Division for Innovation	Division for Strategic Priorities
Technology	5%	70%	44%
Maths & Natural Sc.	32%	1%	22%
Social Sc.	17%	8%	19%
Agric. & Fisheries	0%	17%	10%
Medical Sc.	34%	2%	4%
Humanities	11%	0%	2%

Source: RCN database, January 2012 – Technopolis analysis

3.3 The programmes

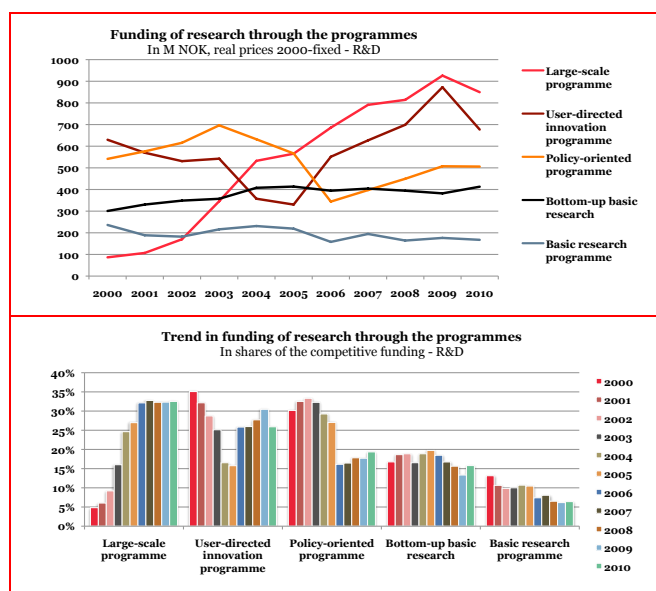
3.3.1 Overview

RCN’s programme portfolio encompasses 4 programme categories: basic research programmes, large-scale programmes, policy-oriented programmes, and user-directed innovation programmes. There is also a category of ‘independent projects’, predominantly for bottom-up basic research.

The growth in the budget for competitive funding of research was mainly used in the **Large-scale programmes** (Figure 25). The *User-directed Innovation programmes* had a close-to-parallel growth pattern. Funding of *Policy-oriented programmes* fell with as funding of the Large-scale programmes rose, then gradually returned to the level of 2000. Funding for *bottom-up basic research* increased slightly as of 2004; support through *basic research programmes* saw a fairly stable level in 2000-2010.

In 2010, the Large-scale programmes were the largest programme category, accounting for ~30% of research funding, closely followed by the user-directed innovation programmes (~25%). Policy-oriented programmes and bottom-up basic research accounted for ~20%, basic research programmes for ~5%.

Figure 25 Funding of research through the programmes



Notes: data include only the funding for research
 Source: RCN database, January 2012 – Technopolis analysis

There was an overall **decrease in number** of programmes and an **increase in size**, pointing to an effort to reduce fragmentation of the funding effort and increase efficiency (Table 4 and Table 5).

Table 4 Trend in number of programmes for research

	Basic research programmes	Bottom-up basic research	Large-scale programmes	Policy-oriented programmes	User-directed innovation programmes	Grand Total
2000	26	48	5	50	24	161
2001	24	48	8	47	23	159
2002	25	34	10	52	17	146
2003	24	33	12	47	15	138
2004	21	26	11	46	11	118
2005	19	24	11	47	11	116
2006	17	23	13	34	15	104
2007	19	20	13	32	17	104
2008	18	11	13	33	15	94
2009	16	11	14	28	13	85
2010	15	12	14	29	11	84

Table 5 Trend in size of the programmes (average cost)

	Basic research programmes	Bottom-up basic research	Large-scale programmes	Policy-oriented programmes	User-directed innovation programmes	Grand Total
2000	8.1	6.1	106.6	12.4	0.8	11
2001	6.9	6.7	70.9	11.9	0.7	11
2002	6.6	10.0	60.5	10.0	0.8	12
2003	8.3	10.1	57.0	11.2	0.6	14
2004	10.2	14.4	56.4	7.7	0.2	17
2005	10.7	16.2	50.5	7.0	0.1	17
2006	8.7	16.6	25.6	15.3	0.1	19
2007	9.8	19.9	29.7	19.0	0.1	22
2008	8.8	35.7	33.3	20.6	0.3	26
2009	10.4	34.7	34.5	30.4	0.2	33
2010	10.4	34.4	33.4	23.2	0.4	30

Notes: Prices are in M NOK, real prices fixed-2000. Data include funding of research only, without the programmes for international cooperation

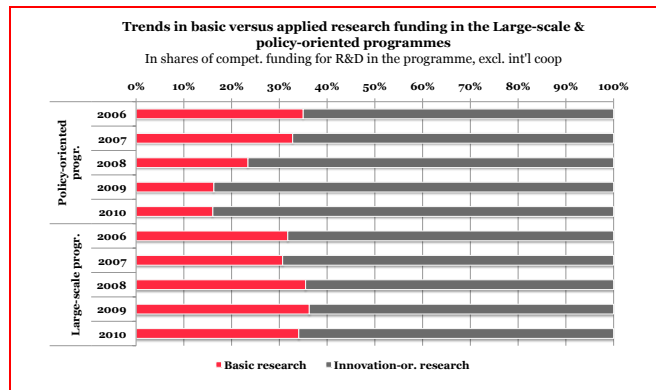
Source: RCN database, January 2012 – Technopolis analysis

3.3.2 Type of research in the Policy-oriented & Large-scale programmes

The increase in funding of innovation-oriented work in the **Policy-oriented programmes** was a major development in the last 5 years – according to RCN's analysis (Figure 26). In these programmes, funding of basic research accounted for ~35% in 2006 and decreased to ~15% in 2010.

In the Large-scale programmes, the share of basic research funding is more or less stable at ~30%.

Figure 26 Trends in basic versus applied research funding in the Large-scale and Policy-oriented programmes

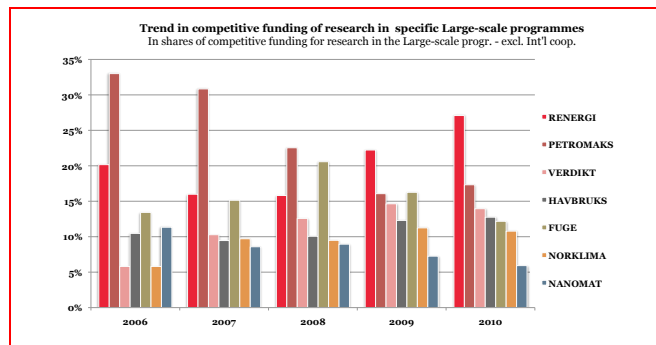


Source: RCN data on the national priorities, 2012 – Technopolis analysis

3.3.3 The Large-scale programmes

The **Large-scale programmes** are expected to play an important role in RCN’s programme portfolio as programmes dedicated to interdisciplinary research bridging all types of research. In total, seven Large-scale programmes were funded in 2004-2010. Figure 27 illustrates the different roles that these programmes had in the overall Large-scale programme research-funding potfolio, and especially, the importance of the industry-oriented RENERGI, PETROMAKS and HAVBRUK programmes.

Figure 27 Trend in funding distribution for research among the Large-scale programmes

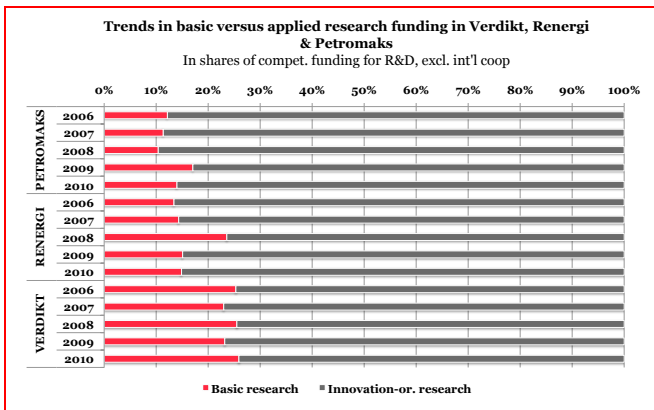


Source: RCN database, January 2012 – Technopolis analysis

Based on RCN’s data on its fulfilment of the national priorities, we can group the specific programmes into 3 categories (Figure 28)

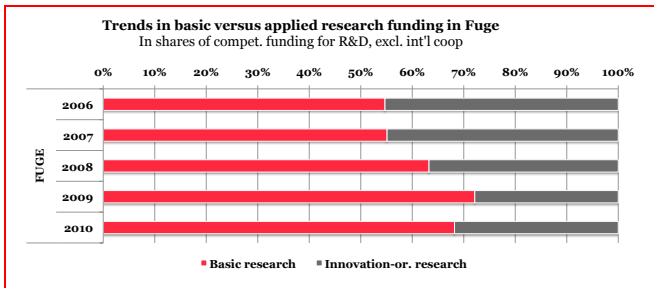
- Programmes that had a strong innovation-orientation from the very start, fairly stable throughout the years: VERDIKT, RENERGI & PETROMAKS (Figure 28)
- The programme that had a strong basic research connotation from the start: FUGE (Figure 29)
- Programmes that show a shift in the type of research: (Figure 30)
 - HARVBRUK - from innovation-oriented towards more basic
 - NORKLIMA & NANOMAT - from basic to more applied research

Figure 28 Trends in basic versus applied research funding in VERDIKT, RENERGI and PETROMAKS



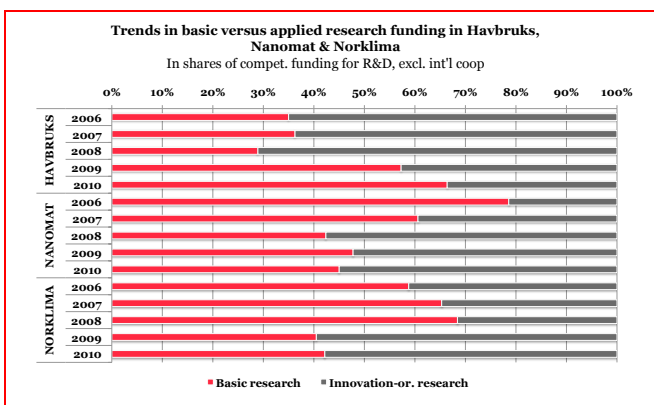
Source: RCN database, January 2012 – Technopolis analysis

Figure 29 Trends in basic versus applied research funding in FUGE



Source: RCN data on the national priorities, 2012 – Technopolis analysis

Figure 30 Trends in basic versus applied research funding in NORKLIMA, NANOMAT and HAVRBUK



Source: RCN data on the national priorities, 2012 – Technopolis analysis

3.4 The instrument portfolio

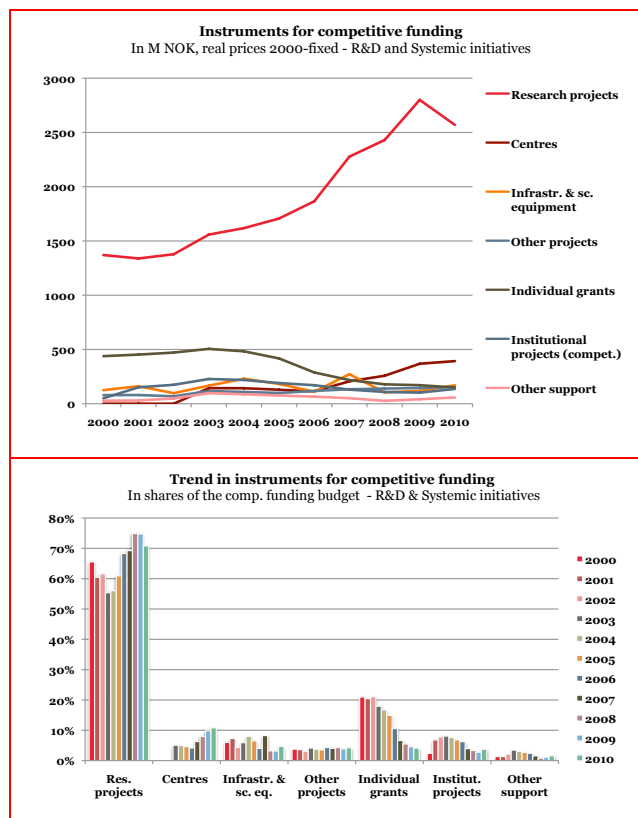
3.4.1 Overview

RCN defined a broad set of instruments (proposal types), which we classified into the following main categories

- Research projects, including basic, applied and innovation-oriented research projects
- Individual grants
- The Centres, grouping the Centres of Excellence (SFF) and the Competence Centres (SFI/FME)
- Projects for infrastructures and scientific equipment
- Projects focusing on a specific institution (competitive funding)
- ‘Other projects include those fostering innovation capacity, funded under eg the FORNY, MOBI and VRI programmes
- ‘Other support’ combines the funding for networking and cooperation measures, scientific publications, and organisation of conferences and events

RCN gradually moved away from the funding of small projects and individual grants and increasingly focused on **large-size (collaborative) research projects**. Funding for individual grants decreased from 2004: from ~500 M NOK in 2000 to ~200 M NOK in 2010. This category of instruments constituted 4% of the competitive funding budget in 2010, compared to 17% in 2004.

Figure 31 Instruments for competitive funding



Source: RCN database, January 2012 – Technopolis analysis

3.4.2 Research projects

The more intensive use of Research projects is closely linked to RCN’s strategic intent to foster collaboration in research – both within and between the research institutions, and towards the end of the decade also internationally.

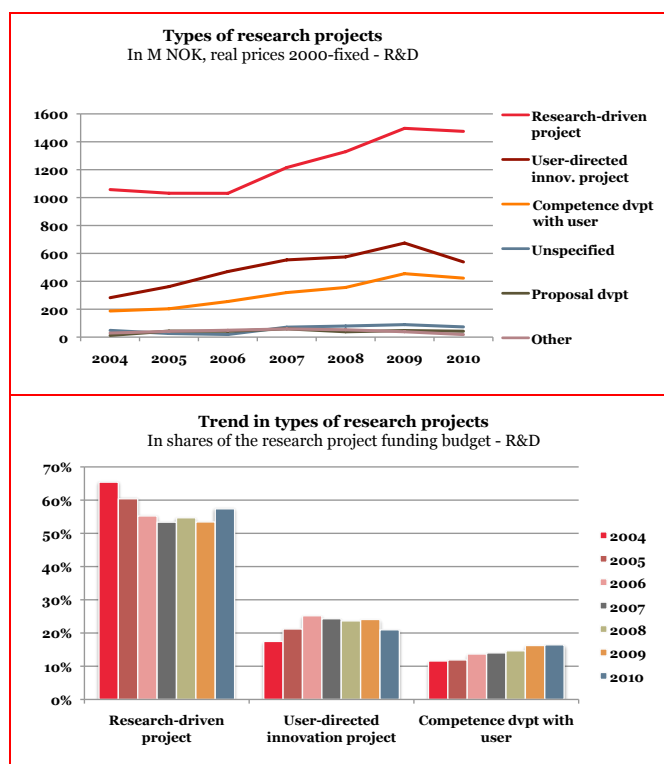
The average size of the research projects grew from 0.56 M NOK in 2000 to 0.83 M NOK in 2004 and 0.86 M NOK in 2010 (real prices, fixed-2000). Individual grants fell in size (0.29 M NOK in 2000, 0.26 M NOK in 2004 and 0.21 M NOK in 2010).

We classified RCN’s project types for research into the following categories.

- ‘Research-driven’ projects, increasingly collaborative
- ‘Competence development with user involvement’ projects, which aim to do industry-oriented work in the higher education and research sector with a somewhat longer perspective to innovation. Often there is also an education component in these projects and industrial partners are required to cover 20% of the project costs
- User-directed innovation projects, which normally aim at short-to-mid term innovation and have often a bottom-up characteristic. Also in this case, industrial partners contribute at least 50% of the project cost
- Proposal development projects, which support setting up project networks and/or proposals
- The ‘other projects’ include the proposal types ‘pre-projects’ and institutional projects (competitive funding).¹⁶

The increase in funding for research projects went predominantly to **research-driven projects** (Figure 32). For the two **innovation-oriented** project types, the rise in funding was less pronounced; jointly, they accounted for ~40% of research project funding in 2010.

Figure 32 Funding for the research projects



Source: RCN database, January 2012 – Technopolis analysis

¹⁶ A description of all proposal types is provided in the Appendix to the Background report RCN Administration & Governance

The Proposal Development instrument was particularly used to foster and facilitate participation in international cooperation – especially in EU programmes and initiatives.

The sharp rise in RCN funding for international collaboration from 2004 was also linked to the launch of some specific schemes for the co-funding of research. This was the case with the SAM-EU scheme for the research institutes.¹⁷ It intended to ensure fair competition between the Norwegian institutes and their European peers for participation in the FP6 Integrated Projects (IP) and Specific Targeted Research Projects (STREP). It was limited to FP6 and was therefore in the course of conclusion from 2008 onwards. In 2004 there was also co-funding for participation in EUROCORES, a collaborative research programme of the European Science Foundation. Co-funding for participation in *more industry-oriented programmes* started in 2009 with participation in the EU JTIs and the EUROSTARS programme. The latter is a joint programme between EUREKA member states and the European Union, launched in 2008. It offers support for transnational bottom-up research by R&D performing SMEs.

3.4.3 Individual grants

The reduction in funding for individual grants especially related to the **PhD grants** – until 2008 when funding became more stable (Figure 32). In 2010, PhD grants accounted for 10% of individual grant funding, compared to 25% in 2004.

The underlying policy concept was that RCN was responsible (by Government mandate) for larger projects, whereas small research projects were considered to be in the competence - and responsibility - of the research institutions themselves. In this context one should note that the PBRF model for the core funding of both the HEI and the research institutes includes scores related to PhD students.

Funding for individual grants was increasingly geared towards the **award of excellence**, ie PostDoc grants, awarded to ‘outstanding candidates’¹⁸, and grants in the YFF scheme (Young Excellent Researchers). These grants accounted for respectively ~35% and ~25% of the individual grant funding budget.

In 2008/2009, also two new individual grant instruments were launched, geared towards more **structural issues**:

- The grant for **‘inward’ mobility**, providing support for foreign PhDs and PostDocs to conduct research in Norway (maximum duration is 1 year) and partly replacing the ‘old’ guest researcher grant
- The **Industry PhD**, facilitating industry-oriented research ‘on-site’ by a PhD

Each of these new schemes accounted in 2010 for 10% of the individual grant funding.

¹⁷ RCN funded 25% of the project costs (provided that RCN funding together with Commission funding did not exceed 75% of the overall R&D costs), compensating for the fact that Norwegian research institutes, by law private entities, were entitled to Commission funding for only 50% of their project costs

¹⁸ In the Background report on RCN Organisation and Governance (WP2), we relate on a RCN presentation of the FRIBIO scheme which suggests that PostDoc grants and female researchers are among the core funding criteria of proposals – apart of the overall scientific merit

Figure 33 Funding of types of individual grants



Notes: Data are reported only from 2006 onwards because of data limitations at this level of detail for the preceding years

Source: RCN database, January 2012 – Technopolis analysis

3.4.4 Instruments for the systemic initiatives

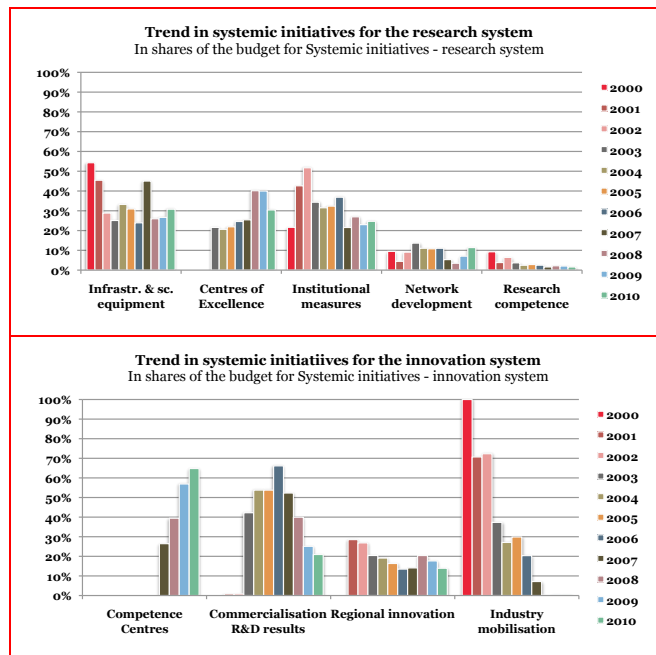
The **Centres programmes** were the core of the *systemic initiatives policy mix*, accounting for ~40% of the funding for systemic initiatives in 2010. The costs for the Centres implied a lower share in funding for research competence development (~40% in 2010, compared to 80% in 2000). Support for innovation capacity building was reduced to a share of 10% in 2010.

In the Centres programme, funding was increasingly geared towards support for innovation-oriented research. The addition of the two Competence Centre instruments (the SFI and the FME) implied that in 2010, the Centres of Excellence accounted for (only) 25% of the funding in this area, compared to 100% in 2006.

In the field of systemic initiatives for the research system, support for **research infrastructures** and scientific equipment was a continuing focus for research competence development (Figure 34). Support for individual institutions fell, changed its focus, and was partly substituted by broader systemic instruments. The strategic intent was to support the creation of (inter-institutional) research groups and centres, with particular focus on the Centres of Excellence.

In the field of innovation capacity building, a historical focus is raising industry awareness about opportunities for research-based innovation. Regional innovation is another major - and returning - focus of the initiatives. The **Competence Centres** (SFI/FME) became the major instrument for investment.

Figure 34 Trend in systemic initiatives for the research and innovation system



Source: RCN database, January 2012 – Technopolis analysis

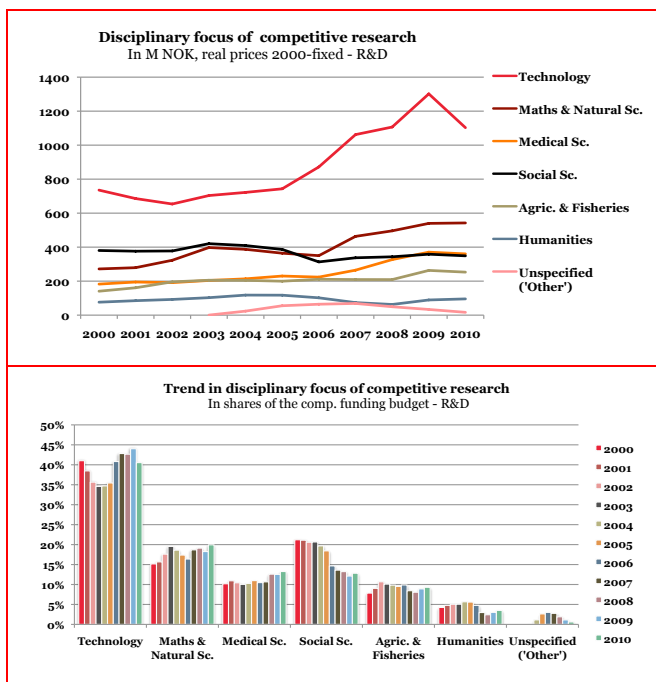
3.5 Disciplinary focus of the research

3.5.1 Overview

The major scientific focus of the competitive research funded by the RCN was and still is **Technology**. Since 2007, it constituted 40%/45% of RCN's funding of research (Figure 35). Funding levels for **Maths & Natural Sciences** and **Medical Sciences** also grew from 2006. In 2008, **Agriculture and Fisheries** received more funding than in previous years.

Funding for research in **Humanities** remained fairly stable, while research in **Social Sciences** saw a slight reduction in support. As a result of the increase in funding for the other disciplinary areas, the share of these two disciplines in the research-funding budget fell sharply.

Figure 35 Disciplinary focus of competitive research



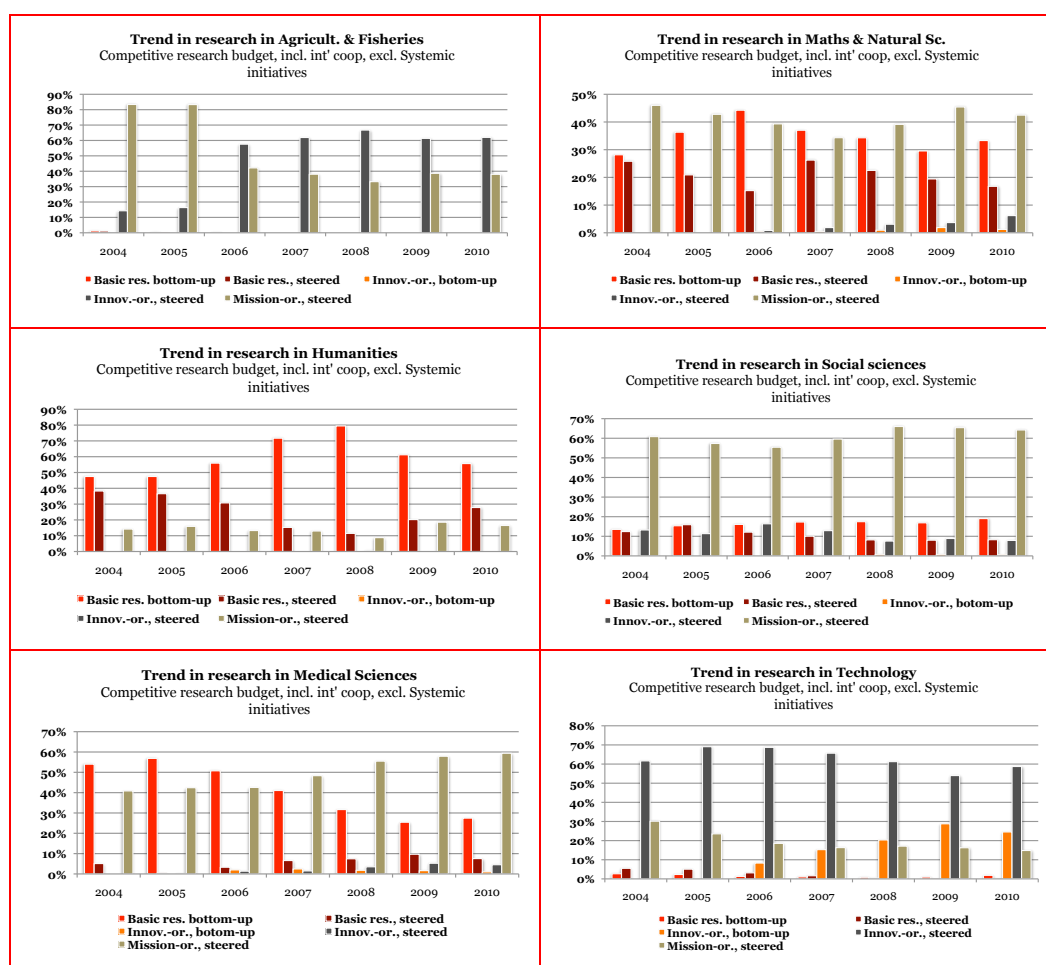
Source: RCN database, January 2012 – Technopolis analysis

3.5.2 Disciplinary focus & types of research

We observed the following trends in **funding modes** and **type of research** funded.

- For research in Agriculture & Fisheries, there is a clear shift from mission-oriented (basic/applied) research to innovation-oriented research, and a halt to funding in basic research
- In the field of Maths & Natural sciences, we see a fairly stable mix of basic & mission-oriented research, with a start of innovation-oriented programme-based research in the more recent years
- Research in Humanities is close-to-uniquely basic research funded
- Research in Social sciences is strongly mission-oriented; there was a small but reducing amount of basic research funded in the field and a little innovation-oriented research (also declining)
- For research in Medical sciences there was a shift from basic bottom-up research to mission-oriented research; we also note the beginning of some innovation-oriented research funded
- Research in Technology is strongly innovation-oriented and increasingly bottom-up. There is almost no basic research funded in the field and little mission-oriented research (basic/applied)

Figure 36 Trend in funding patterns at disciplinary level

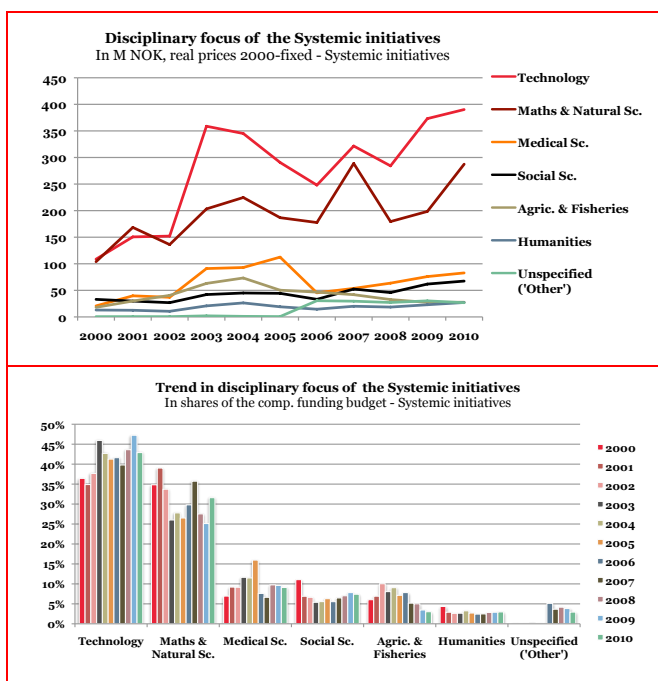


Source: RCN database, January 2012 – Technopolis analysis

3.5.3 Disciplinary focus of the systemic initiatives

The Systemic initiatives tended to support institutions or research groups/centres with **Technology** and **Maths & Natural sciences** in their research portfolio. Research focusing on Maths & Natural sciences also seems to have received the lion's share of investments made in 2007 and 2010 for the improvement of research infrastructures and scientific equipment. Research in **Medical Sciences** received higher levels of 'systemic' support in 2003-2005. A similar trend is visible for the **Social Sciences**, from 2006 onwards. However, the support for these disciplines in this category of funding was at a minimal level.

Figure 37 Disciplinary focus of the Systemic initiatives



Source: RCN database, January 2012 – Technopolis analysis

3.5.4 Disciplinary focus & interdisciplinary research in the programmes

The trends in disciplinary focus of research at the level of programme categories reflect the overall picture of **increasing focus on Technology and Maths & Natural sciences**:

- The key focus of the research funded in the Basic research programmes is research in Maths & Natural Sciences
- Bottom-up basic research has a similar core focus but also includes a considerable amount of research in the Medical sciences
- Large-scale programmes and User-directed innovation programmes both focus on Technology
- Policy-oriented programmes focus more on Social sciences, but have a substantial share of research also in the Medical sciences area

Funding of **interdisciplinary research** saw **significant growth in 2003/2004**, when it accounted for ~14% of the research funding in the programmes, compared to 7% in the preceding years. Since then, however, the share of interdisciplinary research remained fairly stable – though with a decrease in funding in 2006-2008 (11% of the funding in those years).

Interdisciplinary research (as indicated by the project leaders, within or between the specific discipline areas) accounted for on average ~20% for the basic research and policy-oriented programmes, with an increasing trend in both programme categories.

Table 6 Disciplinary focus & level of interdisciplinary research in the programmes

Basic research progr.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% in average
Agric. & Fisheries		6	5	4	2	0						1%
Humanities	20	16	12	25	39	39	28	11	7	17	26	12%
Maths & Natural SC.	88	75	88	104	95	72	51	117	109	101	86	50%
Medical Sc.	13	0	1	0			6	9	11	21	16	4%
Social Sc.	49	44	32	38	40	56	35	32	27	27	28	21%
Technology	40	25	27	28	39	37	27	17	5	0	1	12%
Total	210	166	164	199	215	203	147	186	158	166	156	
of which Interdisciplinary	45.2	20.0	19.0	27.5	37.5	39.9	29.2	27.1	38.3	43.1	45.2	
	22%	12%	12%	14%	17%	20%	20%	15%	24%	26%	29%	19%

Bottom-up basic research	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% in average
Agric. & Fisheries	1	1	1	3	2	1	0.5					0%
Humanities	44	52	59	55	62	57	57	51	48	52	51	15%
Maths & Natural SC.	88	89	98	101	103	124	148	166	165	153	170	35%
Medical Sc.	98	107	104	102	124	130	113	114	113	106	108	30%
Unspecified							2					0%
Social Sc.	47	59	61	59	64	60	50	57	58	59	65	16%
Technology	16	15	16	15	19	17	11	11	9	12	19	4%
Total	294	323	339	335	375	389	381	398	393	382	413	
of which Interdisciplinary	7.0	13.7	23.4	30.5	30.0	30.0	25.3	29.9	35.4	39.1	51.3	
	2%	4%	7%	9%	8%	8%	7%	8%	9%	10%	12%	8%

Large-scale programmes	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% in average
Agric. & Fisheries	51	55	72	74	75	79	98	89	81	110	107	21%
Maths & Natural SC.	0	0	1	5	7	6	5	8	12	16	23	2%
Medical Sc.	29	30	34	58	77	73	71	82	105	141	127	20%
Social Sc.	0	0	0	0	0	5	4	18	48	61	50	4%
Technology	2	10	16	15	131	206	301	387	362	381	377	52%
Total	82	95	122	152	291	370	479	584	609	709	684	
of which Interdisciplinary	1.5	4.6	4.7	4.8	11.9	17.0	25.1	29.4	38.6	52.9	46.9	
	2%	5%	4%	3%	4%	5%	5%	5%	6%	7%	7%	5%

Policy-oriented programme	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% in average
Agric. & Fisheries	86	97	117	122	121	113	13	12	10	10	6	12%
Humanities	8	9	10	11	12	13	14	15	16	17	18	2%
Maths & Natural SC.	49	62	82	115	92	73	60	71	85	97	93	15%
Medical Sc.	64	70	71	87	86	97	93	118	142	171	177	21%
Social Sc.	251	229	216	247	230	193	152	172	189	187	173	39%
Technology	75	96	101	97	82	69	6	5	3	3	3	10%
Total	532	563	597	679	623	558	339	394	445	485	471	
of which Interdisciplinary	49.7	65.6	79.4	118.4	124.0	116.9	89.6	114.1	111.7	120.1	144.5	
	9%	12%	13%	17%	20%	21%	26%	29%	25%	25%	31%	20%

User-directed innov. Progr.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% in average
Agric. & Fisheries	0				1	1	97	104	112	132	128	9%
Humanities			1						0			0%
Maths & Natural SC.	5	4	0	0			2	4	7	13	13	1%
Medical Sc.	6	12	12	14			7	10	13	16	15	2%
Social Sc.	14	16	33	50	51	35	46	31	16	16	11	5%
Technology	591	527	477	464	303	293	368	458	531	674	507	83%
Total	616	558	522	528	355	329	521	607	679	851	674	
of which Interdisciplinary	9.4	20.4	43.3	60.9	53.4	41.1	40.4	31.3	30.2	45.2	46.3	
	2%	4%	8%	12%	15%	13%	8%	5%	4%	5%	7%	7%

Notes: Real prices fixed-2000 in M NOK; funding for research only, excl. international cooperation

Source: RCN database, January 2012 – Technopolis analysis

The relatively low level of interdisciplinary research in bottom-up basic research (overall 8%) seems to confirm difficulties in the appraisal of this type of research proposals. Nevertheless, we note improvement in the more recent years, with interdisciplinary research accounting for 12% of the funding in 2010.

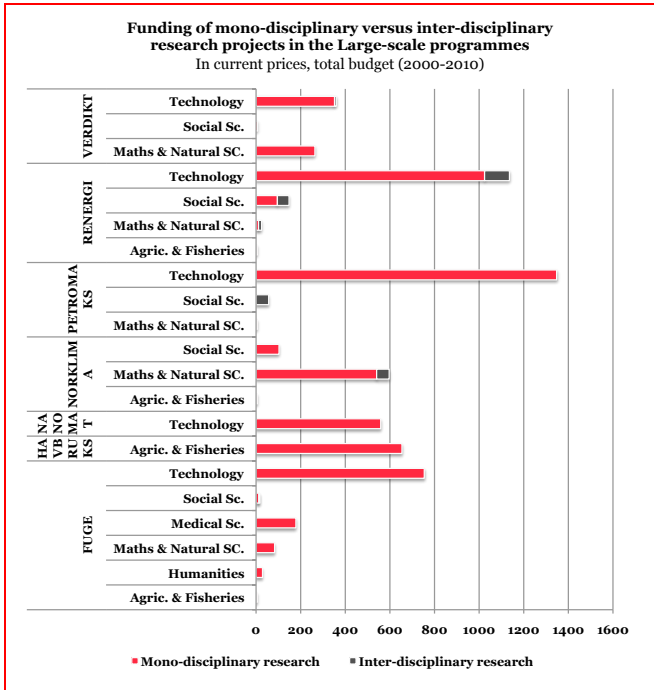
The low level of interdisciplinary research in the Large-Scale programmes, is surprising: on average 5% of the funding – with a slight growth in the last years up to 7%, bringing the interdisciplinary spending up to similar levels to the user-directed innovation programmes and bottom-up basic research.

Research was classed as interdisciplinary only in some of the Large-scale programmes (Figure 38).

- In the RENERGI programme, interdisciplinary research was conducted in the areas of Technology, Maths & natural sciences, and Social sciences, accounting in total for ~15% of the funding
- In the PETROMAKS programme, the disciplinary research was in the area of Social sciences, accounting for ~5% of the funding

- In the NORKLIMA programme, in the Maths & Natural Sciences area, accounting for 8% of the funding

Figure 38 Funding of mono- versus inter-disciplinary research projects in the specific Large-scale programmes



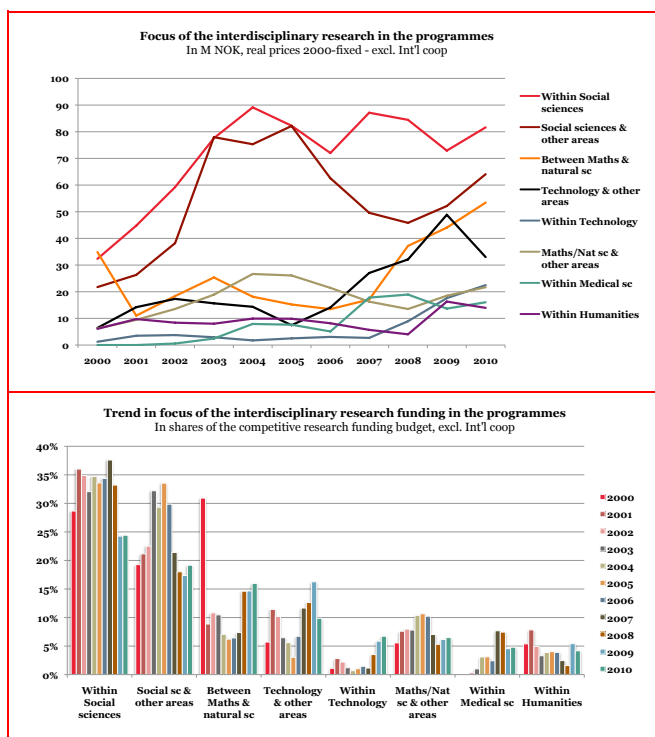
Notes: Funding for research only, excl. international cooperation

Source: RCN database, January 2012 – Technopolis analysis

Areas of interdisciplinary research funding in the beginning of the 2000s were in the field of **Social sciences** - within the field and with other areas - and between Maths and Natural sciences (Figure 39). There was particular growth in interdisciplinary research in the Social sciences and – more recently – in **Maths & natural sciences**. The interconnection between this disciplinary area to the other areas peaked briefly in 2004/2005.

The only ‘new’ area where there was a sharp growth in funding for interdisciplinary research was **Technology** (from 2005 onwards).

Figure 39 Focus of the interdisciplinary research funded in the programmes



Source: RCN database, January 2012 – Technopolis analysis

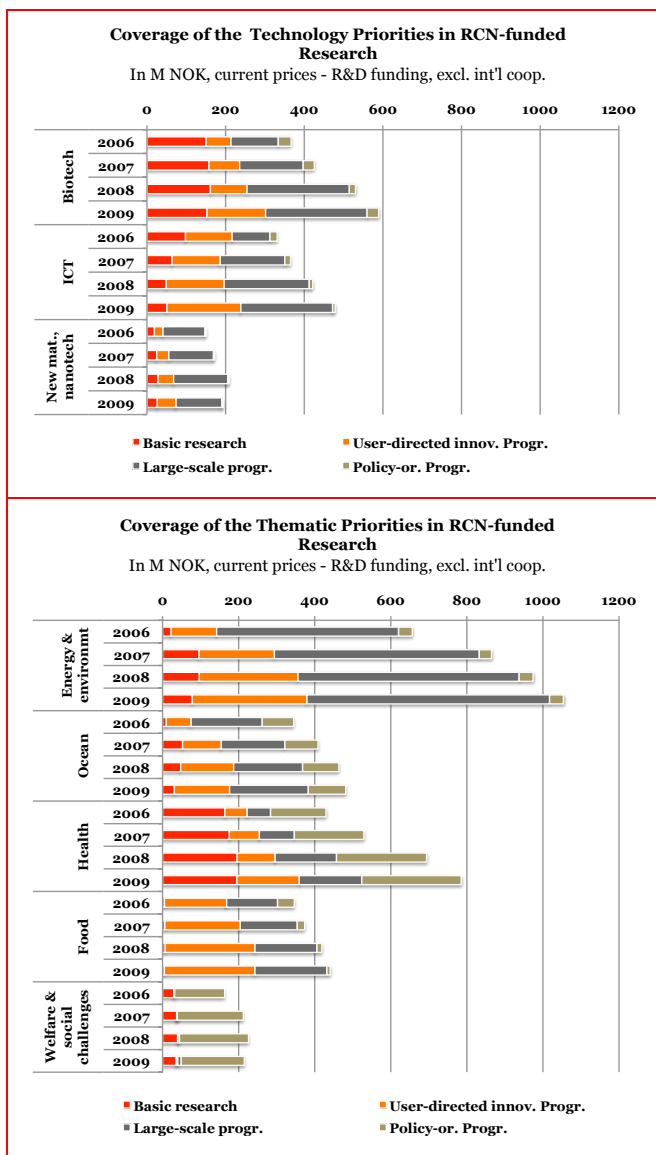
3.6 Research on the national priorities

3.6.1 Overview

In 2004-2005 the national R&D policy defined technology priority areas for R&I (Biotechnology, ICT, and New materials & nanotechnology), as well as a range of crosscutting thematic themes (Energy & environment, Oceans, Health, Food, and Welfare & social challenges). The underlying strategic intent was to strengthen the societal relevance of research. The focus was on areas of societal challenge and/or potential economic development, building upon Norwegian research and industrial strengths. From a systemic perspective, the intent was to stimulate industry R&D and building critical mass in research in areas of particular importance for Norway, and to enhance the quality of research in these fields, amongst other means through interdisciplinary research and reduced fragmentation.

Figure 40 illustrates the high level of investment in research for **Energy and environment, Health, and Biotechnologies**, all of increasing importance. ICT and Food constitute areas of more reduced focus; the level of investment for New materials and nanotechnologies as well as Welfare & social challenges is relatively limited. The data are based on RCN's indications of its fulfilment of the national priorities.

Figure 40 Coverage of the national priorities for R&D in the programmes



Source: RCN data, 2012 – Technopolis analysis

Figure 40 also identifies the programmes in which the research for the priority areas is funded. There is a clear division of roles, determined amongst others by the level of maturity in the research/technology and the need for interdisciplinary research:

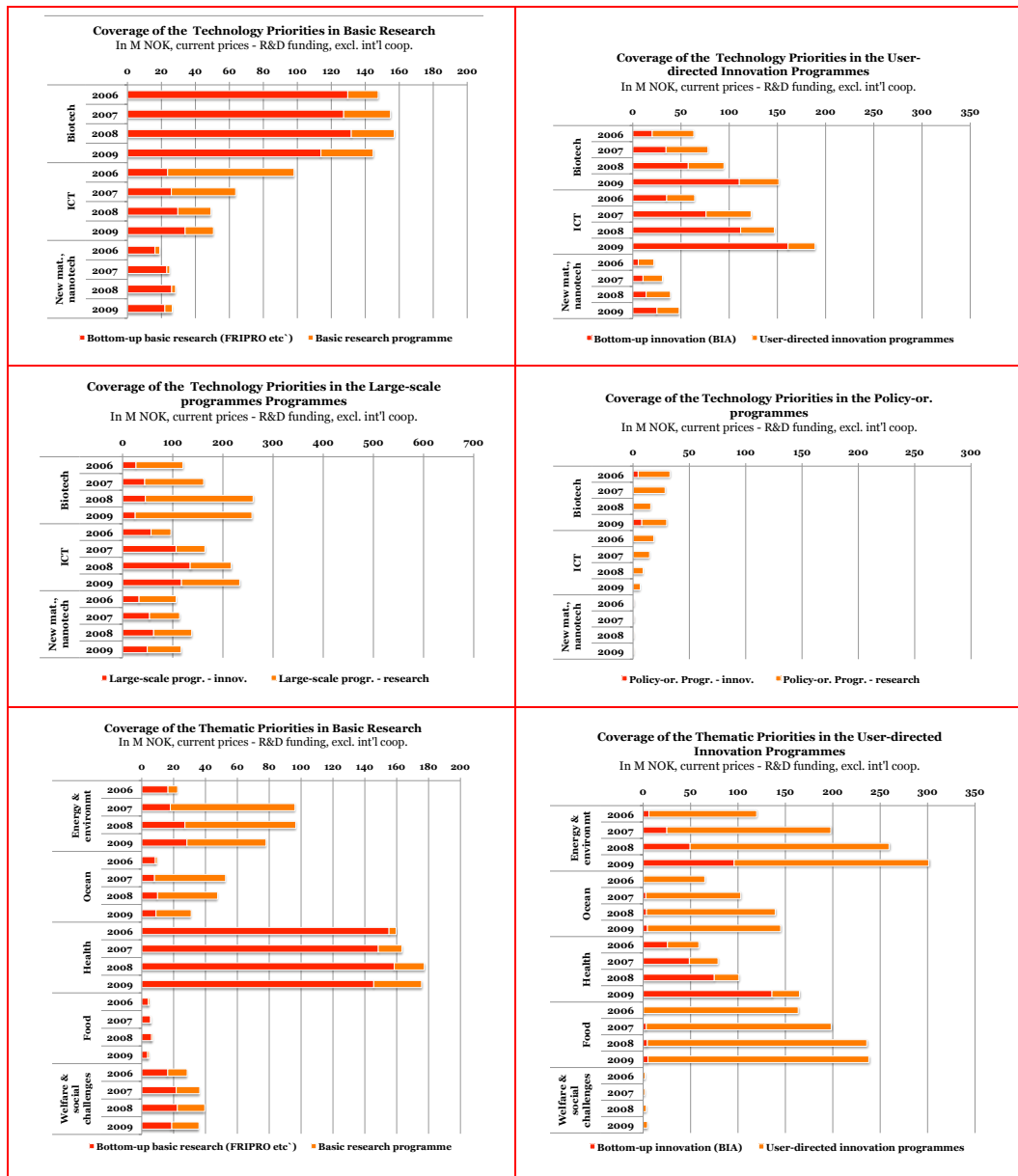
- Biotechnology is funded by the basic research & large-scale programmes
- Health is covered through the basic research & policy-oriented programmes
- ICT & Energy/environment is a key topic for user-directed & large-scale programmes
- Research for the Food priority is especially funded in user-directed programmes
- New materials and nanotechnology is a topic for the large-scale programmes, with growth of coverage in both basic and user-directed research
- Research in the sphere of Welfare and social challenges is focused in the policy-oriented programmes

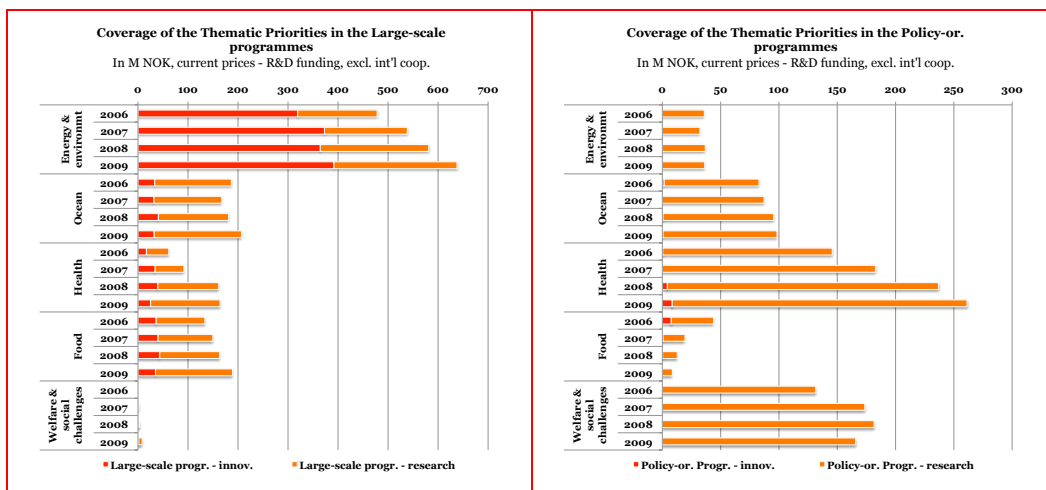
3.6.2 Mode of funding

The mode of funding of the research – ‘free’ bottom-up or steered (‘programme-based’) – illustrates the **general trend of de-programming** (Figure 41).

- In the *Basic research programmes*, the focus is in particular on Biotechnology (biotech) and Health (especially biomed), covered predominantly through bottom-up research. Research related to Energy and the environment (eg climate research) is programme-based
- In the *User-directed programmes* there is a difference between the technology and thematic priorities: funding for ICT & Biotech is bottom-up (in the BIA programme), coverage of the thematic priorities is programme-based - with the exception of the industry-oriented research for Health
- The *Large-scale programmes* fund equally (industry-oriented) research in the ICT & Energy/environment areas in bottom-up mode; research in the other areas is programme-based
- *Policy-oriented programmes* fund only programme-based research

Figure 41 Mode of funding for research in the priority areas





Source: RCN data, 2012 – Technopolis analysis

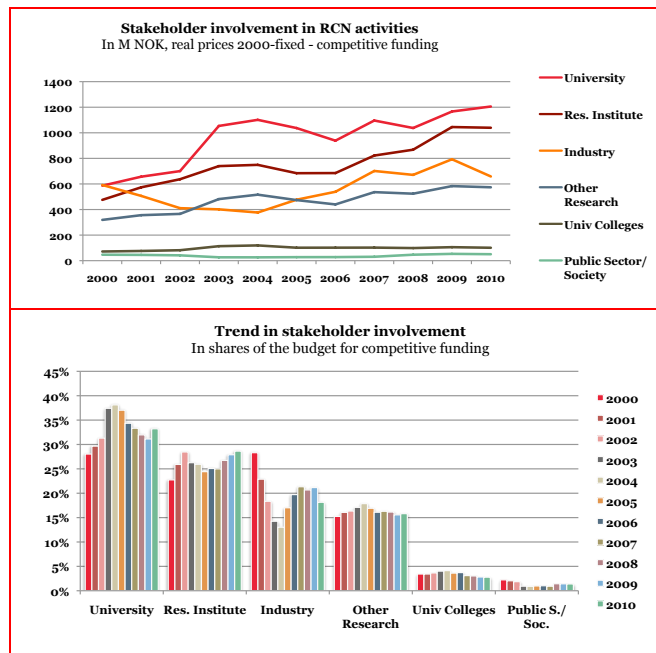
3.7 Stakeholders involved

3.7.1 Overview

The major trend in stakeholder involvement is the increase in participation by **industry** in competitive funding (i.e. joint research funding and funding for systemic initiatives - Figure 42). Competitive funding for the institute sector increased since 2006, reflecting their relevance for industry-oriented research in the R&I system. Universities received a less stable level of support. The increase in the more recent years is due to a higher involvement of the university hospitals in health-related research and in particular to a higher level of support from systemic point of view. ‘Institutes with research’ saw a slight increase in overall support, in particular thanks to their involvement in mission-oriented research. University colleges and the public sector received a little (as project leaders).

The industry sector accounted for ~20% of the overall competitive funding at the end of the 2000s, research institutes for ~25%, and universities for ~30%. The category of ‘institutes with research’ was the fourth major beneficiary of RCN’s activities – accounting for a fairly stable 15% of the overall competitive funding.

Figure 42 Stakeholder involvement in RCN-funded activities

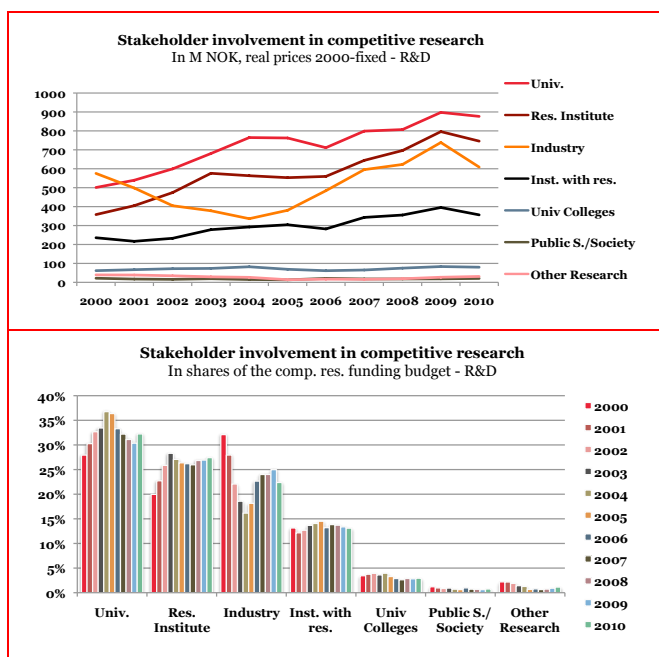


Notes: data related to funding for stakeholder groups are limited to the project leaders
Source: RCN database, January 2012 – Technopolis analysis

3.7.2 Stakeholder involvement in competitive research

Stakeholder involvement in RCN-funded competitive research reflects the overall pattern: a rise in funding for research by the industry sector from 2004 onwards, since 2006 close-to-parallel to the growth in funding for research in the research institutes. The university sector is still the main beneficiary; due to the increased involvement of the two other major research-performing sectors as of 2006, its share in the research funding returned to the level at the beginning of the 2000s, ~30%). The research institutes and industry sector accounted for ~25% each in most recent years. The share of the ‘institutes with research’ was fairly stable (~15%).

Figure 43 Stakeholder involvement in competitive research

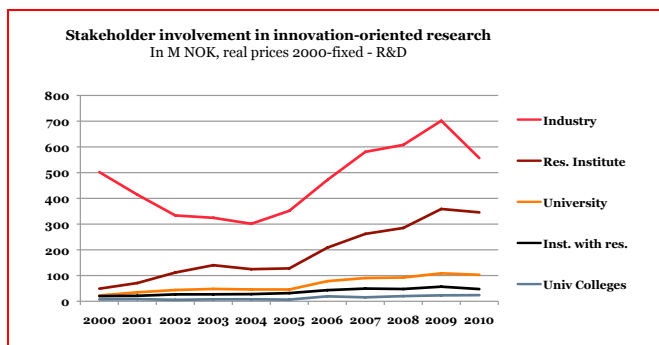


Source: RCN database, January 2012 – Technopolis analysis

The profile of the stakeholders involved in RCN-funded research is dependent on both the type and thematic focus of the research

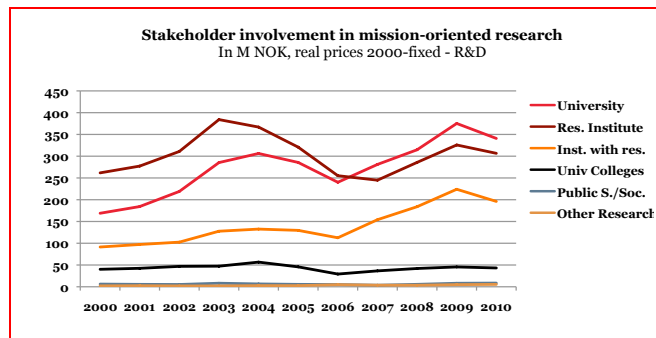
- Innovation-oriented research attracts the industry sector and the research institutes. Universities, institutes with research and university colleges were involved only to a limited extent (Figure 44)
- From 2006, there was more involvement by Universities than by Research Institutes in Mission-oriented research, thanks also to an increase in participation by the university hospitals. ‘Institutes with research’ were more frequently involved, reflecting the public service orientation of research funded by the policy-oriented programmes (Figure 45). The category ‘Other research’ stands here predominantly for ‘other research institutions’, eg the RF - Norwegian Radium Hospital Research Foundation. Industry was not involved
- The university sector is the key actor in RCN-funded basic research (Figure 46), though there is also some involvement by the research institutes and university colleges

Figure 44 Stakeholder involvement in innovation-oriented research



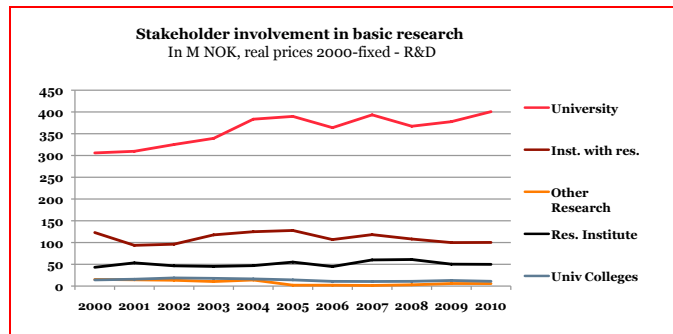
Source: RCN database, January 2012 – Technopolis analysis

Figure 45 Stakeholder involvement in mission-oriented research



Source: RCN database, January 2012 – Technopolis analysis

Figure 46 Stakeholder involvement in basic research

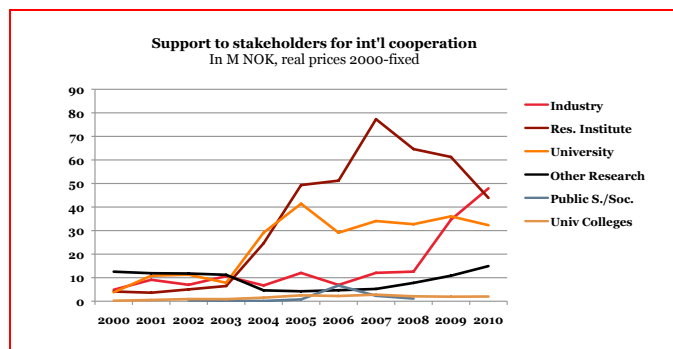


Source: RCN database, January 2012 – Technopolis analysis

Major findings about the trends in stakeholder involvement in **international cooperation activities** are

- There was a decrease in funding of individual researchers ('Other research'), especially in 2000-2004, but a slight recovery in the last years of the decade
- The Institutes sector became the most active player in 2003, with a steady increase in its participation up to 2007 and an equally steady abandoning of international work in the most recent years. These trends can at least partly be attributed to the co-funding for FP participation through the SAM-EU scheme and its gradual conclusion
- Since 2009 there is a considerable rise in involvement of industry, attributable to the co-funding of the JTIs and EUROSTARS programme
- Universities have a fairly stable level/ share of funding as of 2004
- University colleges are barely involved

Figure 47 Involvement of stakeholders in international cooperation activities

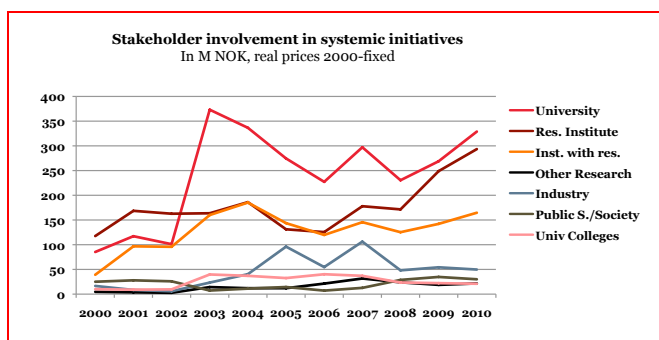


Source: RCN database, January 2012 – Technopolis analysis

3.7.3 Stakeholder involvement in the systemic initiatives

A major trend for the stakeholder involvement in the systemic initiatives is the increased level of support to the **research institutes**, which reached the same level as the universities in 2010. This was partly due to the launch of the Competence Centres and the involvement of the research institutes in those measures. The level of support for the ‘institutes with research’ remained fairly stable, after an initial increase in the beginning of the 2000s. There are some peaks of support to the industry sector in 2005 and 2007, but overall support to these stakeholders was fairly limited .

Figure 48 Stakeholder involvement in the Systemic initiatives



Source: RCN database, January 2012 – Technopolis analysis

3.7.4 Distribution of research funding over the regions

In the last decade, Norwegian policy-makers increasingly sought regionalisation of the research effort. In this analysis we look at the distribution of RCN funding among the regions in Norway, grouping the counties as illustrated in the table below.

Table 7 Grouping of Norwegian regions

Region	Agder	Hovedstaden	Innlandet	Midt-Norge	Nord-Norge	Oslofjord fondet	Vestlandet
Counties	Aust-Agder	Akershus	Hedmark	Nord-Trøndelag	Troms	Østfold	Rogaland
	Vest-Agder	Oslo	Oppland	Sør-Trøndelag	Svalbard	Buskerud	Hordaland
				Møre og Romsdal	Finnmark	Telemark	Sogn og Fjordane
					Nordland	Vestfold	

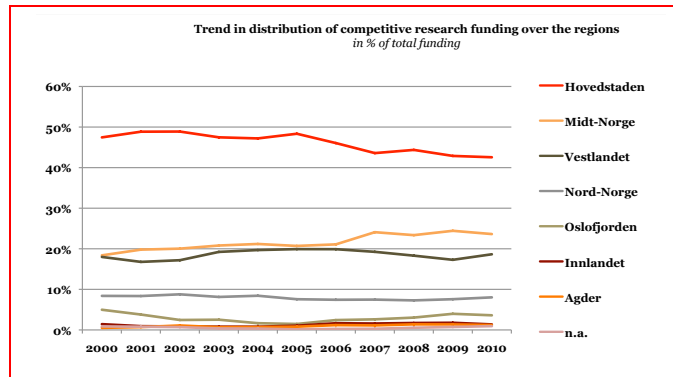
‘Hovedstaden’ is the region of the capital Oslo, while ‘Midt-Norge’ includes Trondheim – and thus the Norwegian University of Science and Technology (NTNU). ‘Vestlandet’ (Western Norway) is the region where the University of Bergen and the University of Stavanger are located, while the University of Tromsø is in ‘Nord-Norge’ (Northern Norway). No university is located in the regions ‘Innlandet’ and ‘Oslofjorden’; in these regions, the only research and education institutions are university colleges.

Throughout the decade we see at the aggregated level a **fairly stable distribution** of R&D funding over the regions: the capital region (‘Hovedstaden’) received the larger budget, followed by Central Norway (Midt-Norge, Trondheim), and Western Norway (Vestlandet, Bergen). There was an increase in budget for regions such as Agder and Innlandet Especially in the last years of the decade, (for the former, funding tripled in 2010 compared to 2000); however, the overall level of RCN funding for R&D in those regions is still tiny.

All regions benefited from the increase in R&D funding channelled through the RCN. However, there was a slight decrease in share of funding for research in the capital region, predominantly to the benefit of the Midt-Norge region (Hovedstaden – from 47% in 2000 to 43% in 2010, Trondheim – from 18% to 24% - Figure 49). This

reflects the pronounced industry-oriented research specialisation in the research institutions located in the region of Trondheim.

Figure 49 Distribution of competitive research funding across regions - in %



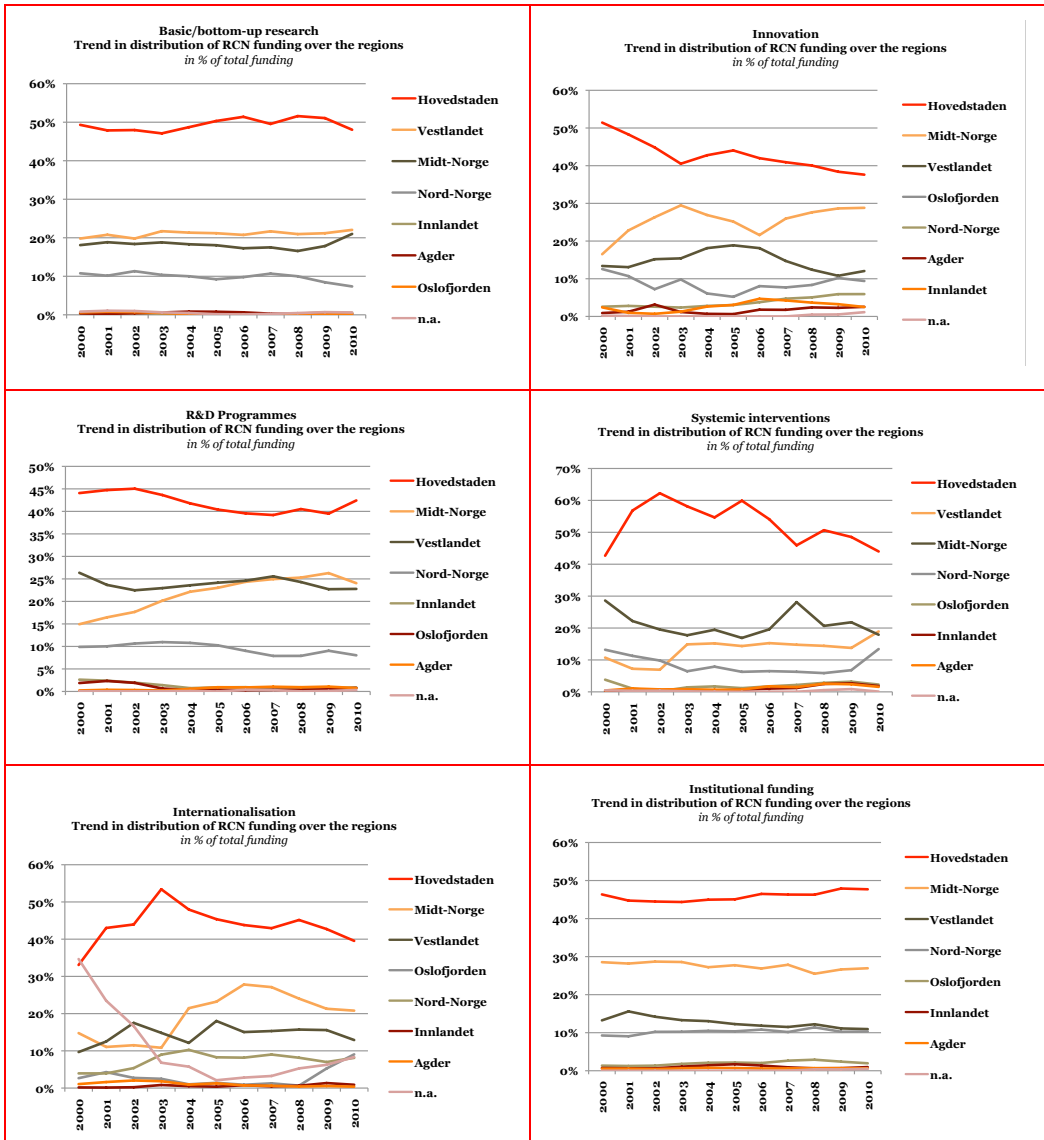
Notes: Data refer to competitive funding; the identification of the region is determined by the location of the project 'owner'

Source: RCN database, January 2012 – Technopolis analysis

There were some major developments in the funding patterns for the regions (Figure 50)

- Researchers in the Midt-Norge region received a higher share of funding especially for *innovation-oriented and mission-oriented research* as well as for Basic/bottom-up research and Internationalisation
- The Vestlandet region saw a higher share in funding for *Basic/bottom-up research* and was in particular supported through the Systemic initiatives
- For research in Northern Norway, support increased for *Systemic initiatives, innovation-oriented research* and the funding for *Internationalisation*
- *Internationalisation* was a field of increased support also for the region Oslofjorden
- Research institutions in the Agder and Innlandet increased their share of funding in RCN activities related to *Innovation and Systemic initiatives*

Figure 50 Funding distribution across the regions at the measures level, in %



Notes: The identification of the region is determined by the location of the project 'owner'
 Source: RCN database, January 2012 – Technopolis analysis

3.8 Main findings

In the last decade, the competitive funding of research-related activities was geared towards increased support for the **Innovation system**. The overall increase in RCN's research funding budget predominantly benefited *innovation-oriented research* and two *Competence Centre schemes* were launched, taking over a significant share of the overall funding in the sphere of systemic initiatives.

The funding patterns for the programmes illustrate the increasing focus on the **national priorities** and **innovation-oriented research**. In 2010, the *Large-scale programmes* accounted for ~30% of the budget for research funding, closely followed by the *user-directed innovation programmes* (~25%). Funding of *Policy-oriented programmes* fell with the rise of the Large-scale programmes, but gradually returned to the level of 2000 and accounted for ~20% of the research funding budget in 2010. Funding for *basic research programmes* and *bottom-up basic research schemes* was fairly stable throughout the decade; the increase in funding for the other programmes reduced their share in the budget to ~20% in 2010.

Basic research was also funded in the Policy-oriented and especially the Large-scale programmes. Nevertheless, RCN data confirm the trend towards **more applied research funding** and the overall downwards trend in the share of basic research in the research funding budget: they indicate that in 2010, the ratio basic/applied research was ~40%/60%, compared to ~45%/55% in 2006.

The trend towards more innovation-oriented research was visible in the Policy-oriented programmes (predominantly related to research in the Medical sciences) and especially in the Large-scale programmes where the more industry-oriented programmes took on the major share of investment. According to RCN data, ~30% of the funding in the Large-scale programmes went to basic research. The funding of basic research is predominantly in the FUGE programme focusing on genomics; apart of the recent trend in the HAVBRUK programme, in the other Large-scale programmes the focus remains on innovation-oriented/applied research and its share of the total programme activity is tending to increase.

There was a trend toward **de-programming** in the basic research programmes and in particular the user-directed innovation programmes. This was intended to provide more funding opportunities for research that was not targeted by the thematic programmes (i.e. the Large-scale or Policy-oriented programmes).

Predominantly, research in Technology, Maths & Natural sciences, and Medical sciences was funded. For Technology and Maths & Natural sciences, this was the case in both research funding and the support for systemic initiatives (i.e. the Competence Centres).

There was a growth in **interdisciplinary research**, predominantly in the field of Social sciences (within the area and with other areas), but also to a more limited extent within the Maths & Natural sciences and in the field of Technology. Such interdisciplinary research represented ~20% of the funding in the Basic research and Policy-oriented programmes. The Large-scale programmes was involved a surprisingly low level of interdisciplinary research (on average 5%).

A major trend in the use of **instruments** was the shift towards funding research projects rather than individuals. There was a significant drop in funding of grants for PhD students and a stronger focus on rewarding excellence (PostDoc and YFF grants); new schemes are geared towards enhancing research-industry relationships (Industry PhDs) and inward mobility. Also the support for research competence development shifted focus, from support to individual institutions to a more pronounced focus on framework conditions, ie research infrastructures and scientific equipment.

4. The Added Value, Outcomes & Impacts

In this Section we discuss the effects of RCN's funding activities. Our analysis is based on the evidence reported in the preceding sections and in other background reports, as well as on input provided by interviewees.

Section 4.1 covers RCN's strategic role in steering the NRIS, the modalities, instruments and effects. In Section 4.2 we discuss the Council's effectiveness in supporting the research and innovation system and focus on the funding patterns and outcomes for the main research performing sectors, i.e. Universities, Research Institutes and Industry. Section 4.3 sets RCN's instrument portfolio, mode and focus of funding in international context and in Section 4.4 we report on the outcomes of our meta-evaluation of RCN's programme and instrument evaluations.

4.1 Steering the system

4.1.1 *The crucial role of the instrument portfolio*

RCN uses its instrument portfolio to address its strategic responsibilities and steer the re-structuring of the R&I system through the use of financial incentives.¹⁹ RCN monitors the instrument portfolio in its programmes closely and adjusts it on an annual basis, based on emerging needs and failures in the system.

Feedback from the stakeholder communities on the instrument portfolio²⁰ shows that RCN is effective in reaching its strategic objectives and fosters re-structuring of the R&I communities – within the limits of the 'soft' bottom-up steering approach. The most important measures are

- The increasing focus on larger projects was an effective way to promote creation of research groups and **change in the practice of research** – with more cooperation and interdisciplinary research than was previously the case. The enhanced focus on collaborative research (Section 4.1.2) was important in this respect, as was the shift in focus for the support in the systemic initiatives
- The Centres are flagship examples of the broader efforts to enhance **cross-institutional collaboration**. The systemic initiatives were increasingly focused on support for inter-institutional cooperation (inter-institutional research groups, the creation of centres, research schools etc) and such cooperation is a requirement also for the funding of projects in the research infrastructure programme.
- **International cooperation** was significantly enhanced through the use of specific instruments and schemes, which the stakeholder communities considered critical to facilitate participation. International mobility and cooperation, including 'inward mobility', are now increasing. A new instrument from this perspective is the individual Mobility grant, as well as the requirement in several programmes to include international partners in 'mainstream' RCN-funded research. Interviewees indicated that this strengthened their strategic research partnerships with foreign institutions and improved the standing of their institution and/or research group in the international community. Participation in EU-funded research was generally seen as critical for success in research
- **RCN broadened its instrument portfolio for research-based innovation** via measures with a longer-term perspective and consideration for building critical

¹⁹ See also Section 3.4

²⁰ We collected this feedback through interviews and surveys to research and industry stakeholders – see the background reports for WP5a and WP5b

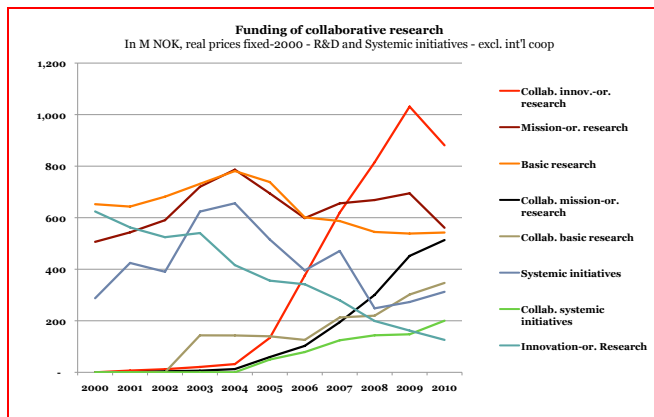
mass (the Competence development projects). Feedback from the industry community was highly positive about these and also in relation to the new industry-PhD instrument

4.1.2 *Fostering networks and strategic partnerships in research*

Since the mid 2000s, RCN increasingly used collaborative research to increase networking, the quality and relevance of research, and to facilitate interdisciplinary research.

Collaborative research surely existed also before 2007. However, limitations in the RCN database, in terms of completeness of the information gathered, enable a proper analysis only from that date onwards. In 2010, collaborative research accounted for 56% of the competitive research funding for ‘national’ initiatives, i.e. excluding support for international collaborations. Most of this funding was focused on innovation (Figure 51).

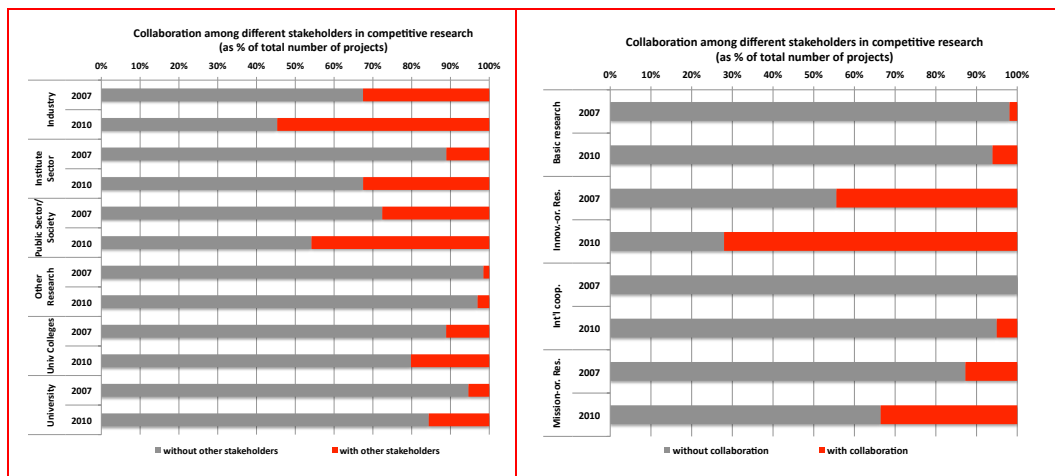
Figure 51 Funding of collaborative research



Source: RCN database, January 2012 – Technopolis analysis

The increasing trend in collaborations since 2007 is especially visible in **innovation-oriented** and **mission-oriented research**. Major beneficiaries of this trend were industry, the institute sector, and the public sector (Figure 52). Collaboration of Universities with other stakeholders was relatively limited, but was on an upward trend.

Figure 52 Patterns in collaborative research



Source: RCN database, January 2012 – Technopolis analysis

Industry-institute sector collaborations, public sector/industry collaborations and public sector/institute sector collaboration all grew (Table 8). Compared to 2007,

industry actors and research institutes more often involved foreign partners, industry started collaborating more with the HEI and the Institute sector, and public sector organisations partnered more often with university colleges and the institute sector (Table 9).

Table 8 Collaboration in competitive research projects – 2010

Project 'owners'	Partners							Total projects	% with collab.
	Foreign	Univ. Colleges	University	Industry	Institute Sector	Other Research	Public Sector/ Society		
Univ. Colleges	6%		4%	9%	7%	0%	2%	213	20%
University	5%	1%		6%	9%	0%	1%	1,307	16%
Industry	14%	6%	14%		36%	2%	5%	869	55%
Institute Sector	11%	4%	11%	18%		1%	4%	1,513	33%
Other Research	0%	0%	1%	2%	2%		1%	332	3%
Public Sector/Society	2%	21%	4%	29%	27%	2%		48	46%

Source: RCN database, January 2012 – Technopolis analysis

Table 9 Change compared to 2007 in terms of % of total projects with collaboration

Project 'owners'	Partners						
	Foreign	Univ. Colleges	HEI	Industry	Institute Sector	Other Research	Public Sector/ Society
Univ. Colleges	5%		3%	4%	3%	=	-2%
University	5%	1%		2%	7%	=	=
Industry	14%	1%	10%		11%	=	2%
Institute Sector	11%	3%	9%	10%		1%	2%
Other Research	-2%	=	1%	1%	1%		1%
Public Sector/Society	2%	10%	4%	8%	12%	2%	

Source: RCN database, January 2012 – Technopolis analysis

Table 10 shows the **involvement of foreign partners** in collaborative research for each of the intervention types.

- The highest share of foreign institutions is in Instruments or programmes fostering internationalisation, where about half of the partners are foreign
- The degree of internationalisation of basic research in Norway has increased fast. In 2008, in the Basic/bottom-up research programmes or initiatives only 5% of participations were foreign, while by 2010 this share had increased to 32%
- The share of foreign partners in mission-oriented research increased in 2008-2010 from 14% to 24%
- The foreign share of participations in initiatives and programmes fostering innovation grew from 7% in 2008 to 11% in 2010

The programme categories with the highest share of foreign involvement across the 3 years were the bottom-up basic research and the Policy-oriented programmes. The greatest *increase* in foreign participation, however, was in the Basic research programmes.

Table 10 Involvement of foreign partners in ‘mainstream’ collaborative research programmes

	Foreign share – 2008	Foreign share – 2009	Foreign share – 2010
Other independent projects	5%	6%	10%
User-directed innovation programme	8%	9%	12%
Free projects support	38%	47%	55%
Basic research programmes	2%	5%	14%
Policy-oriented programmes	29%	29%	42%
Centres of Excellence (SFF/SFI/FME)	0%	0%	2%
Large-scale programmes	8%	12%	14%
Overall	10%	12%	17%

Note: Percentages in terms of share of total number of participations by partners in that given year - 100% = all partners excluding coordinators - The analysis was limited to years 2008-2010 due to data limitations.

Source: RCN database, January 2012 – Technopolis analysis

Table 11 shows the level of involvement by foreign partners in collaborative research by scientific area. The areas with highest share of foreign involvement across the 3 years were *Medical science* and *Social sciences*. Foreign partner participation in RCN-funded research in the field of *Maths and Natural sciences* increased in the last two years. In contrast, the share of foreign participation in research in *Humanities* decreased in 2009/2010.

Table 11 Involvement of foreign partners in collaborative research per scientific discipline (share of total number of participations by partners in that given year)

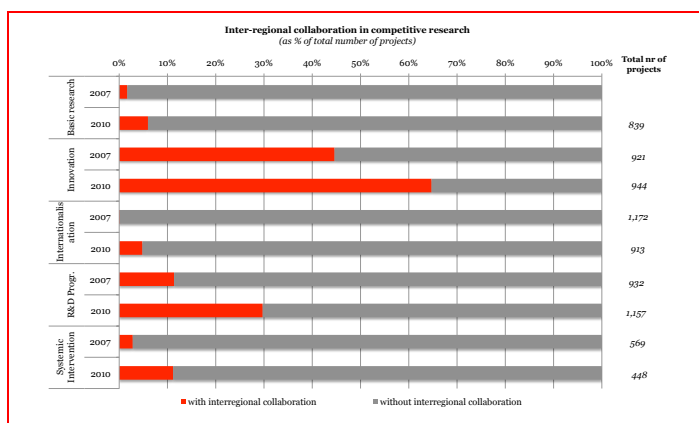
	Foreign share – 2008	Foreign share – 2009	Foreign share – 2010
Agric. & Fisheries	15%	16%	15%
Humanities	40%	16%	21%
Maths & Natural Sc.	13%	20%	23%
Medical Sc.	30%	32%	37%
Social Sc.	4%	14%	29%
Technology	7%	8%	12%
Overall	10%	12%	17%

Note: Percentages in terms of share of total number of participations by partners in that given year - 100% = all partners excluding coordinators - The analysis was limited to years 2008-2010 due to data limitations.

Source: RCN database, January 2012 – Technopolis analysis

There was an overall increase in **inter-regional collaboration** - from 12% of the total number of competitive research projects in 2007 to 26% in 2010. The increase is particularly marked in research activities focusing on Innovation and those funded under the Large-scale and policy-oriented programmes (Figure 53).

Figure 53 Inter-regional research collaboration, 2007-2010



Source: RCN database, January 2012 – Technopolis analysis

More in-depth analysis shows that project ‘owners’ from all regions set up collaborations in particular with partner organisations in the Hovedstaden, Midt-Norge and Vestlandet regions, i.e. those of the major research actors in the Norwegian system (resp. the university in Oslo, Trondheim and Bergen). Table 13 highlights the changes in collaboration preferences in 2010 compared to 2007 and shows that in RCN-funded competitive research projects, the creation of research partnerships with organisations located in these key regions is an continuing pattern.

Table 12 Inter-regional research collaborations – project ‘owners’ versus partners, 2010

Region project ‘owner’ – base (nr. of interregional collaborative projects)	Partners						
	Hovedstaden	Midt-Norge	Vestlandet	Oslofjorden	Nord-Norge	Innlandet	Agder
Hovedstaden	429	41%	27%	12%	12%	8%	4%
Midt-Norge	276	65%	39%	18%	14%	11%	7%
Vestlandet	197	54%	30%	6%	13%	2%	4%
Oslofjorden	75	67%	33%	23%	1%	11%	1%
Nord-Norge	69	61%	38%	25%	1%	1%	0%
Innlandet	34	50%	56%	6%	12%	12%	0%
Agder	25	36%	36%	16%	8%	8%	

Table 13 Inter-regional research collaborations –2010, in % of change compared to 2007

	Hovedstaden	Midt-Norge	Vestlandet	Oslofjorden	Nord-Norge	Innlandet	Agder
Hovedstaden		5%	3%	1%	1%	1%	=
Midt-Norge	10%		8%	3%	2%	3%	1%
Vestlandet	8%	4%		1%	2%	=	=
Oslofjorden	13%	1%	2%		1%	2%	-1%
Nord-Norge	7%	7%	3%	=		-2%	=
Innlandet	4%	8%	-1%	4%	4%		-1%
Agder	-1%	5%	7%	2%	1%	-3%	

Source: RCN database, January 2012 – Technopolis analysis

4.1.3 Fostering gender equality in research

RCN has a strategy on gender equality and closely monitors its funding, aiming to stimulate gender equality in the overall R&I system. Gender equality is a specific criterion for the funding of project proposals.

We conducted our analysis of RCN’s achievement in relation to gender equality based on RCN’s data as published on its website. This suggests that RCN takes the criterion of gender equality properly into account. A fairly constant level of 40% of FTE funding in the form of individual grants allocated to female researchers (Figure 54).

The level of funded projects that are led by female researchers is more disappointing (20%). This results from the low level of female project leaders in the Mathematics &

natural sciences and Technology areas. In the other disciplinary areas, ratios of female project leadership were about 30%.

Figure 54 Gender equality in the individual grants

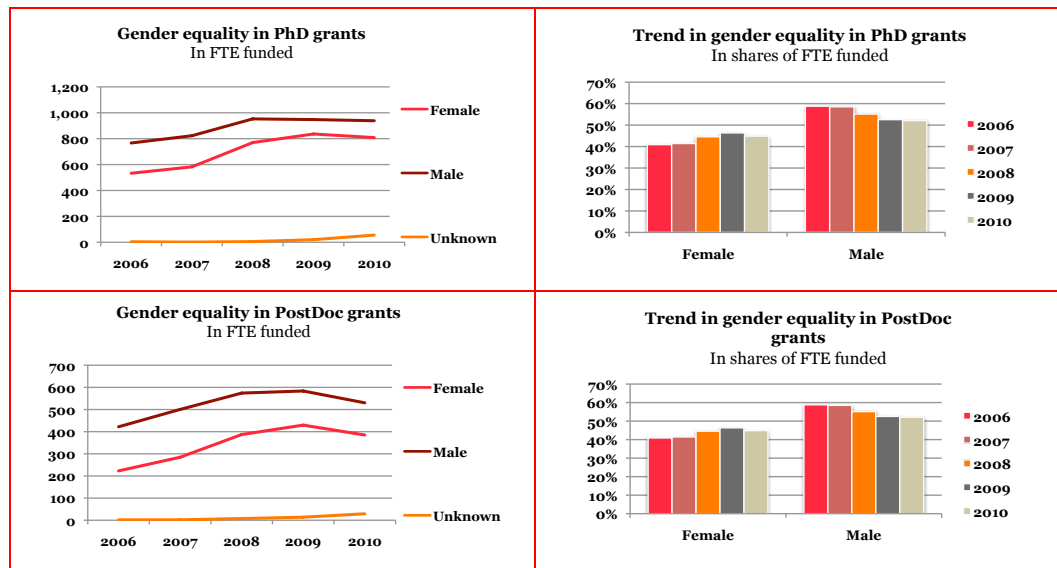
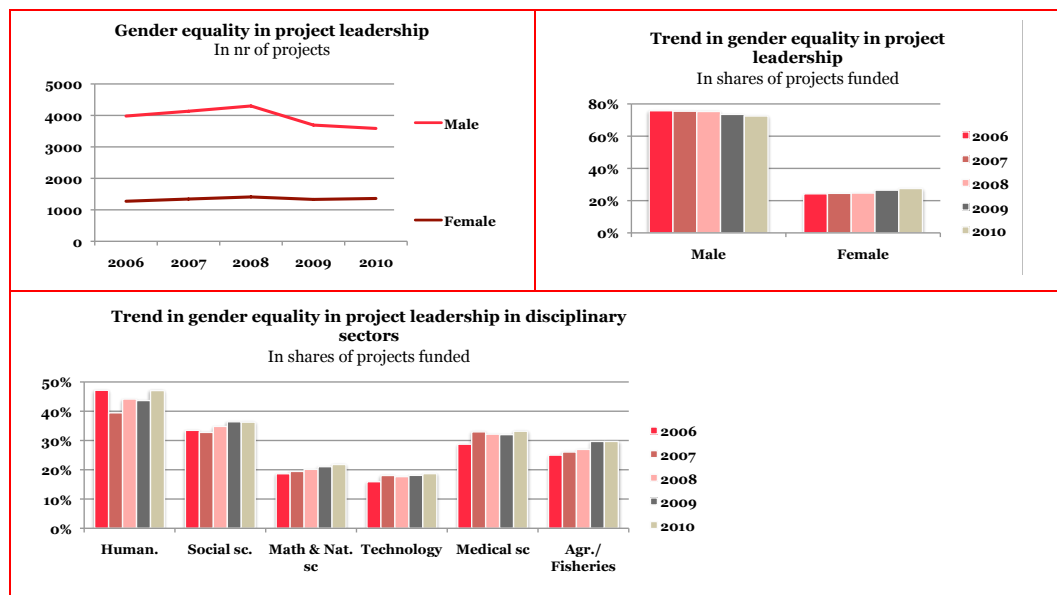


Figure 55 Gender equality in project leadership



Source: RCN database, January 2012 – Technopolis analysis

4.2 Supporting the system

4.2.1 Support for R&D in the Universities

Context²¹

The Higher Education sector comprises 8 universities, 6 specialised universities, and 25 university colleges. Research in this sector accounts for about 32% of the GERD. This is high compared to other countries: the OECD average was 17% (in 2008). In 2009, the universities' (incl. university hospitals) share of R&D expenditure in the higher education sector was *almost 85%*, while university colleges and specialised university colleges had shares of 9 and 6%, respectively.

The biggest funding source for R&D in universities and colleges is the general university funds (GUF), accounting for two thirds of total R&D funding in 2009. From 1999 to 2009, funding from the *Research Council of Norway* increased its share in the total R&D funding of the HES from 13% in 1999 to 17% in 2009.

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%; in contrast the humanities receive the majority, 76%, of their funding from the GUF.

In terms of scientific focus for R&D expenditure in the higher education sector, during the ten-year period from 1999 to 2009 there has been extensive growth in expenditure on R&D in *medical and health sciences*, with an average real annual growth of about 10%. The social sciences were the second largest field in 2009, and of a similar size to the natural sciences. 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.

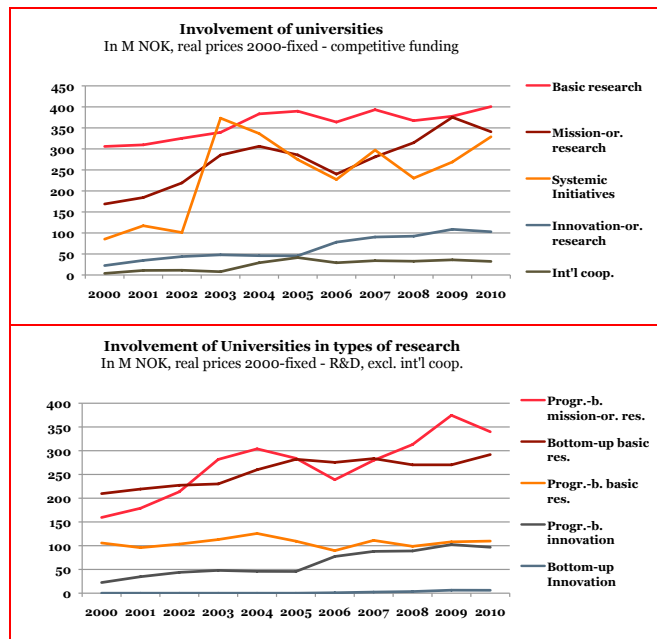
Support through competitive funding: trends & effects

RCN supported R&D in the Universities especially through fostering their participation in **mission-oriented research**; universities also received a higher level of *systemic support*, predominantly focused on support for an improvement of their framework conditions (research infrastructures) and the Centres of Excellence programme. **Basic research** remained the major area of university participation and there was a slight increase in support, in particular through more funding of bottom-up research.

The involvement of these research actors in innovation-oriented research was minimal, as was the support provided for international cooperation; for both of these categories, however, we see a slight increase towards the mid 2000s, subsequently remaining at a fairly stable level.

²¹ Unless otherwise stated, this section is based on the 2011 R&D Indicators Report, RCN-NIFU

Figure 56 Support to universities through competitive funding



Source: RCN database, January 2012 – Technopolis analysis

The analysis in the preceding section showed that collaborative research funding had only a limited effect on strengthening collaborations with other organisations and in particular on the creation or strengthening of industry-university partnerships. This limited effect was closely linked to the participation patterns of these institutions: only in the most recent years did the universities start participating in innovation-oriented research, launching ‘Competence development with user-involvement’ projects (i.e. projects focused on industry-oriented research of a slightly longer-term nature than the user-directed innovation ones).

There appears to be limited interest in collaborative research among university researchers, based upon the input provided by these researchers in both our surveys and through interviews. The opportunity offered by RCN to share and gain access to complementary expertise in other institutions was considered less important by these researchers than by their peers in the other institutions. The overall image emerging was one of a quite internally focused research community, interested predominantly in gaining funding for their own research activities. There are nonetheless changes in train. Survey participants saw RCN funding as strategically important. Interviewees as well as survey participants pointed to behavioural additionality induced by RCN funding and its instruments (such as the Centres), i.e. a change in the way research is conducted in the universities, more often setting up research groups and intra-university collaboration. They also pointed to an improvement in research and innovation management skills.

Many university researchers appreciated the opportunity offered by RCN-funded research to explore new research areas ‘of significant importance for their future research activities’ and they attributed high importance to the opportunity to conduct interdisciplinary research. Section 3.5.4 shows that RCN programmes with high levels of university participation, i.e. the Basic research programmes and the Policy-oriented ones, tend also to have higher than average levels of interdisciplinary research.

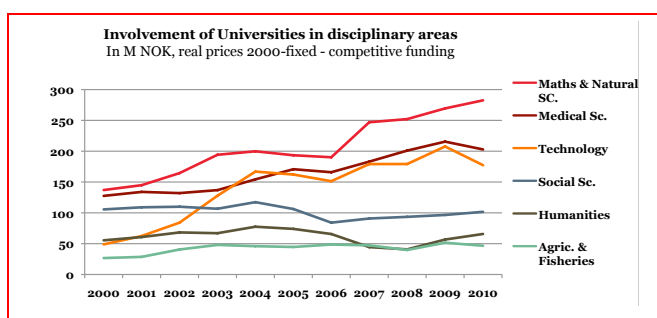
Figure 56 shows that university researchers are not much involved in activities launched by RCN to support **international cooperation**. Nevertheless, these researchers valued the possibility of creating or strengthening international networks and the opportunity of conducting research in collaboration with key international institutions.

Universities benefited from the mainstreaming of international cooperation in recent years by involving foreign institutions in their research – especially in medical sciences, social sciences, and basic (bottom-up) research (see Section 4.1.2). At least in the first stage, spillovers from the mainstreaming of international cooperation will primarily benefit the university sector. These can be expected to involve strengthening of international strategic partnerships and improved access to complementary expertise – ultimately improving the quality of research.

Most of the increase in support went to university departments focusing on Maths & Natural sciences, Medical sciences and Technology – both through research funding and systemic initiatives.

In the field of Medical sciences, the University hospitals received increased RCN funding from 2004. In 2010, University Hospitals accounted for 25% of the university research funding in this field, compared to 12% in 2004. Their increased participation was in the Policy-oriented and Large-scale programmes.

Figure 57 Involvement of universities in disciplinary research



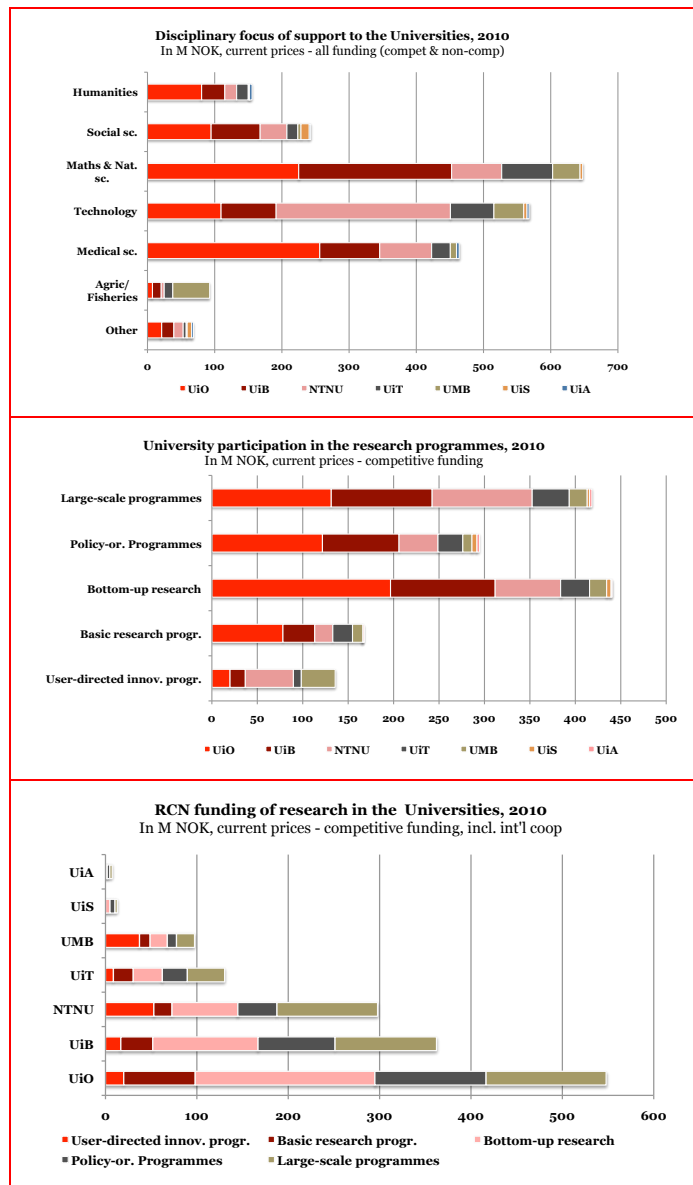
Source: RCN database, January 2012 – Technopolis analysis

Universities’ participation patterns reflected their research strengths in the national priorities. The University of Oslo was the major actor in research on Medical sciences; Oslo and Bergen were the major actors in Maths & Natural sciences; NTNU received most funding in the field of Technology.

Funding through the Large-scale programmes was predominantly shared among the University of Oslo, the University of Bergen, and the NTNU; the former two universities also shared most of the funding in the Policy-oriented programmes. The University of Oslo was the main actor in Basic research (both bottom-up and especially in programmes).

The University of Oslo and the University of Bergen relied heavily on the RCN basic research funding (respectively 50% and 40% of their research funding). A similar pattern is visible also for the University of Tromsø (~40%). The NTNU and the UMB, instead, received the majority of their RCN funding through the User-directed innovation and Large-scale programmes (~55% of the funding for the NTNU; ~60% for the UMB).

Figure 58 Focus of the research supported in the Universities, 2010



Source: RCN data, 2011 – Technopolis analysis

The majority of the researchers in the Universities said there were **positive outcomes** of their RCN-funded research, including impacts on their level of publications. Nevertheless, they were highly critical of the **focus and mode of the research funding**.

Our analysis indicates that the national and ministry priorities mean that funding went to those departments and universities with relevant expertise while research in other areas was directed towards the bottom-up schemes - in the case of the universities, in particular, towards bottom-up basic research. It is therefore not surprising that researchers in Universities said that the lack of a funding scheme that fit their needs was the main reason for non-participation in RCN-funded research. They also said there was a *lack of balance between 'free' and 'programmed' research*. Most important, researchers in Universities saw little added value in RCN's funding of interdisciplinary research, scientific/technological risky research, and long-term exploratory research, and they questioned RCN's strategies and funding mechanisms for research in disruptive technologies.

University researchers thought that RCN's strategies were good at *anticipating changes* in science priorities and dynamics. However, they were often negative view about the alignment of RCN's strategies with the **development needs of the research communities**. This feedback should be read in the context of the criticism by participants in RCN's boards indicating that their input had limited influence on changes in RCN policy or processes (see also the Background report on RCN Government and administration). Interviewees endorsed this criticism, wishing for a more pro-active attitude by RCN in suggesting changes in research focus or new areas for research to the funding Ministries.

4.2.2 Support for R&D in the Research Institutes

Context²²

In Norway, the Institute sector encompasses about 130 institutes and accounts for *about 25% of Norway's R&D expenditures*. In 2009, the 60 research institutes that have R&D as their primary focus accounted for about 60% of the R&D expenditures in the Institutes sector. Public administrative agencies, museums and archives, health institutions, etc carried out the remaining 40%.

In 2009, close to 40% of the research in the Institute sector was in engineering and technology. Natural sciences, social sciences and agricultural sciences accounted for about 20% each. The major trends in the last decade were an increase in the share of R&D in Medicine & health sciences since 2003, reaching about 17% of expenditure in 2009.

R&D in the Institutes sector was mostly funded from public sources in 2009. The Ministries funded 40% of the expenditures and RCN 24%. Industry funded 20% of the research while funding from abroad accounted for 10%. The funding source that increased most from 2007 to 2009 was the RCN, with an increase of 10% annually. Funding from abroad increased by nearly 8% annually from 2007.

In this section we focus our analysis on the Research Institutes that have R&D as their primary focus, and in particular on the institutes that receive their core funding through RCN and are subject to the new partly performance-based funding model. In the Background report on Strategic Intelligence and Advice we highlighted the different levels of dependence on government funding in the 'competition arenas' in which these institutes are grouped.

- Contract research for industry is an important source of income for the Technical/Industrial institutes, and plays an important role also for the Primary industry and Regional research institutes
- Environmental research and Regional research institutes are particularly dependent on funding from the public sector
- Technical/Industrial and Environmental institutes are the ones receiving most funding from abroad
- The National Social sciences research institutes are the most dependent on RCN funding for their income

Support through competitive funding: trends & effects

The fastest-growing form of competitive RCN funding for the institutes was **innovation-oriented research**. RCN also provided significant systemic support for this sector through the launch of the *Competence Centres* (SFI and FME - Figure 59).

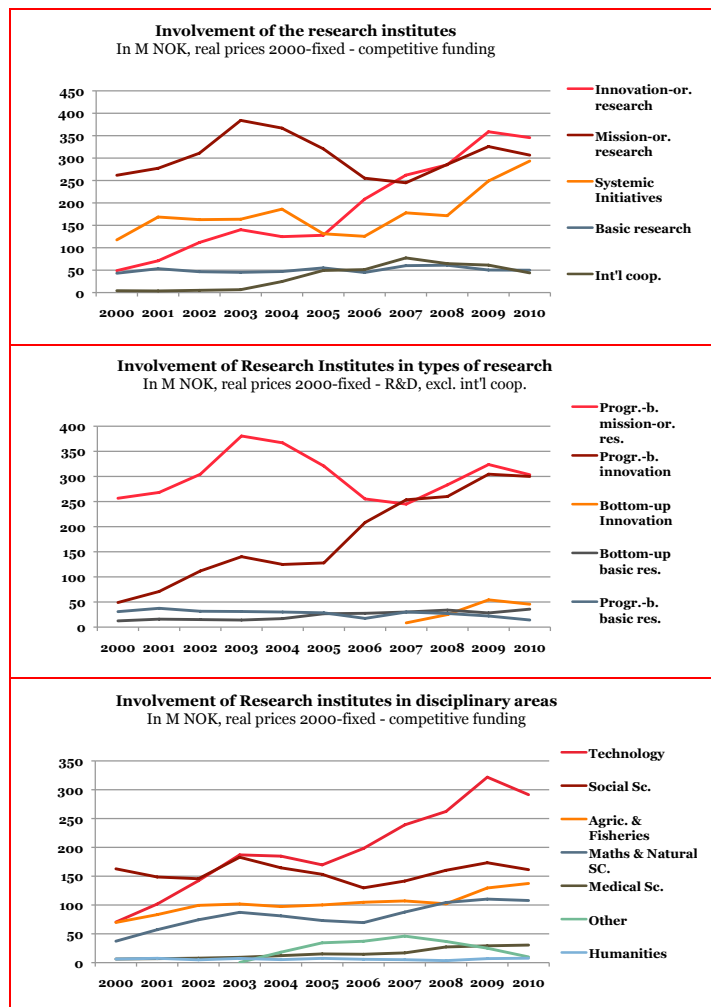
²² Unless otherwise stated, this section is based on the 2011 R&D Indicators Report, RCN-NIFU

The research institutes were predominantly involved in programme-based competitive funding rather than in bottom-up research schemes, though there has been some recent growth in bottom-up innovation funding of the institutes as a result of ‘deprogramming’ in the Innovation Division.

Researchers in the Institute sector indicated that their participation improved their overall research and innovation capabilities. In several cases, the project also led or contributed to innovation (improved products, processes or organisational methods).

The rise in Institute involvement was predominantly in the **Technology area**, reflecting the overall focus of the growth in RCN funding. In the more recent years, there was also an increase in participation in research on Agriculture & fisheries and Maths & Natural sciences.

Figure 59 Competitive funding to the benefit of the research institutes



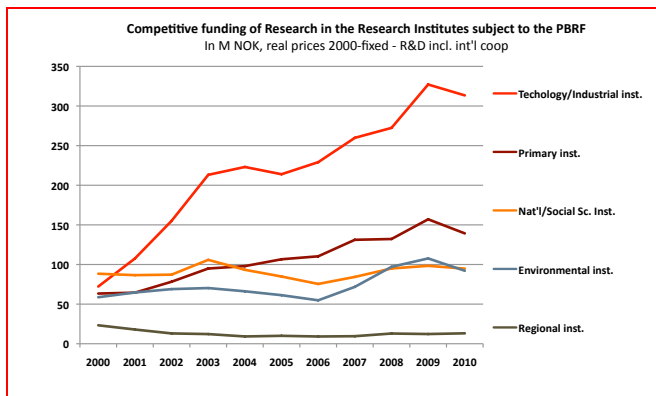
Source: RCN database, January 2012 – Technopolis analysis

Hence, at the level of the ‘competition arenas’, **Technology/Industrial research institutes** were the main beneficiaries of the increase in competitive research funding (Figure 60). The **Primary industry institutes** also received more funding and in more recent years, the **Environmental institutes**. The latter were mostly involved in mission-orientated research, while the former two were predominantly involved in innovation-orientated research.

Funding for the National Social sciences institutes was fairly through the decade, participating in both mission-oriented and basic research programmes and schemes. Funding for the Regional institutes declined from a low level, with a considerable

reduction in their involvement in mission-oriented research, but showed a slight recovery in the more recent years.

Figure 60 Competitive funding of the research institute arenas



Source: RCN database, January 2012 – Technopolis analysis

Starting in 2004, the institutes received a higher level of support for their **international cooperation** in research, especially through RCN co-funding of their FP6 research. The major beneficiaries were the Technical/Industrial, Environmental, and Primary industry institutes. According to the researchers, this improved their international standing and quality and an extended the scope of their international cooperation networks. The *Primary industry institutes* should get the most visible benefits from this, giving their lower levels of income from abroad.

The Technical/industrial and Primary industry research institutes focused on innovation-oriented research funding and are the main potential beneficiaries of enhanced of **industry-institute collaboration**. Given their already strong industry orientation, the effect can be expected to be in *strengthening* existing industry-institute partnerships rather than creating new ones.

However, the effects of collaborative research went well beyond the institute-industry relations to give institute researchers access to **complementary expertise** and scientific excellence, broadening their fields of expertise.

Like their peers in the Universities, researchers in the institutes valued the opportunity to conduct **interdisciplinary research** and they shared the relatively negative view on the added value of RCN's projects for this. They experienced a lack of opportunities to conduct **scientific/technological risky research** and questioned whether projects' budgets were big enough to address the intended needs. Overall, however, they said that RCN's policies were well aligned with societal and industrial needs. They particularly valued the opportunity offered by RCN to conduct **basic and long-term research**, for which their institutions otherwise rely on institutional funding. The National Social research institutes benefited particularly in this respect.

Figure 61 shows the respective importance of RCN's **competitive** and **non-competitive institutional funding** for the research institutes. The latter includes both core funding and the (semi-competitive) funding for strategic institutional projects.

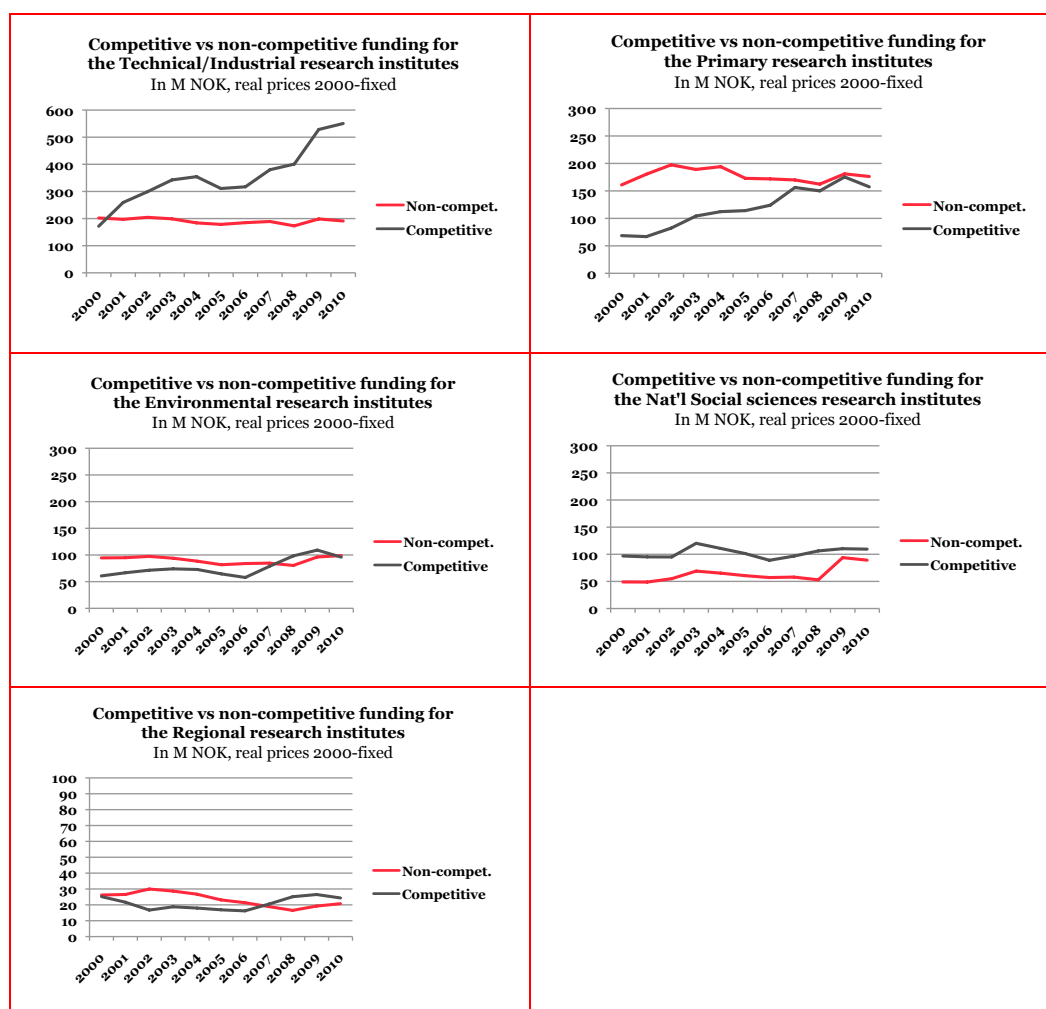
Except in the Regional research institutes, the level of non-competitive funding was fairly flat – though there were fluctuations in the Primary research institutes. Non-competitive funding of all institutes rose in 2009/2010, especially in the National Social research institutes.

Technical/industrial research institutes close to doubled their competitive funding through RCN's programmes in 2010 compared to 2004. Among the Primary research institutes, competitive funding rose to a similar level to the non-competitive funding while among the Environmental research institutes it grew to exceed the non-competitive funding.

For the National Social research institutes, the level of competitive funding was fairly stable and historically higher than their non-competitive funding, until 2009. For the Regional research institutes, the recovery in competitive funding in the more recent years compensated for the declining trend in non-competitive funding since 2003.

The effect of a higher or lower involvement in RCN-funded research on individual institutes' core funding is limited, since under the current PBRF scheme the level of funding from RCN determines at the most 1% of the institutes' core funding.

Figure 61 Competitive versus non-competitive funding in the research institute 'competition arenas'



Source: RCN database, January 2012 – Technopolis analysis

4.2.3 Support to industry R&D

Context²³

Industry carries out *almost 52 per cent of Norwegian R&D activity*. The lower R&D intensity of Norway's major industry sectors compared to industries such as pharmaceuticals and ICT partly explain why R&D expenditures in the business enterprise sector accounted for 0.92% of GDP in 2010²⁴. Traditional industrial activities making up for a large share of the Norwegian economy are related to the

²³ Unless otherwise stated, this section is based on the 2011 R&D Indicators Report, RCN-NIFU

²⁴ OECD, *Main Science and Technology Indicators*, 2012

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. Large enterprises (more than 500 employees) are important for the industrial sector's overall R&D activity, accounting for almost 40 per cent of the sector's R&D expenditure.

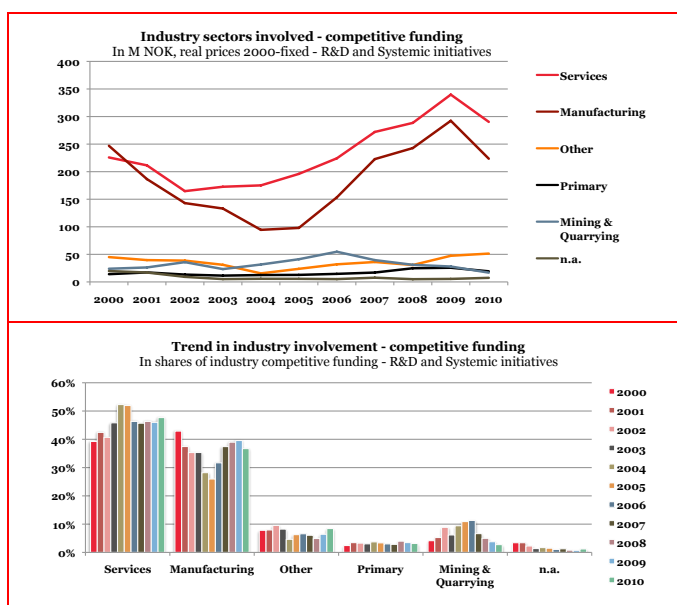
The industrial sector spent 18.2 billion NOK on *intramural R&D* in 2009, only slightly more than in 2008, thus stopping the growth trend that was registered in the preceding 4 years. The business enterprise sector as a whole does not expect any marked growth in 2010 either. The manufacturing industries accounted for 43% of the industrial sector's total R&D activity, the service industries for 47%.

Norwegian enterprises spent an additional 5.6 billion NOK in 2009 on *R&D performed by others*. This is an increase of 4% compared to 2008, a lower growth rate than the one registered in the preceding years. The service industries contributed the most to this growth.

Support through competitive funding: trends & effects

In the second half of the 2000s, RCN supported somewhat more industry R&D in Services than in Manufacturing (Figure 62).

Figure 62 Involvement of the industry sectors in competitive-funded initiatives



Source: RCN database, January 2012 – Technopolis analysis

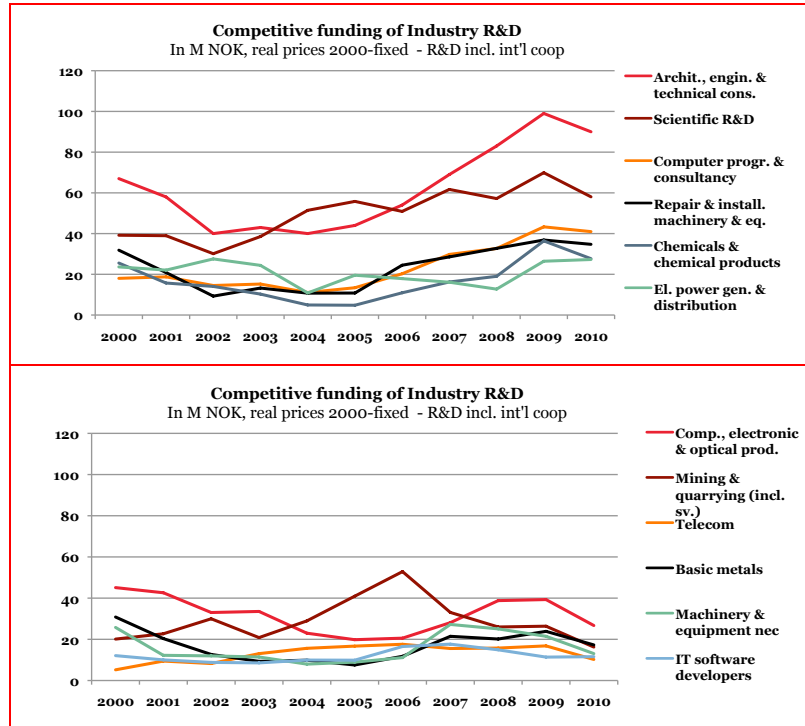
Overall the Business enterprises were mostly involved in **innovation-oriented research**, i.e. the User-driven innovation projects and ‘Competence-development with user involvement’.

RCN increased the involvement of companies in knowledge-intensive sectors developing or installing large IT or manufacturing systems. These include companies offering engineering & technical testing services, computer programming consultancies, and companies active in the ‘repair & installation of machinery and equipment’ sector (Figure 63). In 2010, actors in these industry sectors accounted for respectively 16%, 7% and 6% of the overall funding for industry-R&D. RCN more intensively supported private companies conducting *Scientific R&D*²⁵, most often SMEs active in areas such as biotech or biomed. In 2010, these companies accounted

²⁵ We remind that these are not research institutes, a sector that we considered separately

for 10% of industry's own R&D funding. In the manufacturing sectors, since 2006 innovation-oriented funding particularly attracted companies producing *chemicals and chemical products* (5% of the funding). The *Electrical power generation and distribution companies* attracted 4% of RCN's industry R&D funding in 2010. In 2008/2009 there was a momentary recovery of participation by high-tech manufacturing companies producing computers, electronics and optical products. In 2010, these industry sectors accounted for 4% of the funding.

Figure 63 Industry involvement in RCN-funded research



Notes: 'Other manufacturing' combines a broad range of actors in other sectors; 'other service sectors' refers in this case predominantly to industry associations
 Source: RCN database, January 2012 – Technopolis elaboration

Companies mainly sought RCN funding in order to solve **technological problems**. They most often took the initiative for the project, acting as main source of the project in user-driven innovation projects. Few interviewees saw RCN projects as a way to *reduce commercial risks*, or to *design or develop products*. The ultimate objective of the research was the *reduction of technological risks*, through further development of the technologies that the company uses or an expansion of its knowledge about other potentially useful technologies.

In terms of potential spill-over effects, the added value of RCN's activities can be expected to be the greatest for those companies who looked for an opportunity to gain access to **complementary expertise** and strengthen their relationships with the institute or university sector. These were predominantly small and technologically advanced companies, working for example with biotechnology (e.g. the Scientific R&D sector), or small-to-medium size companies developing technologies for subsequent commercialisation (e.g. computer programming consultancies). The 'Competence-development with user involvement' projects were of particular value from this perspective.

Expected outcomes depended most often on the size of the companies: access to complementary expertise was an important driver for the smaller companies; larger companies often used RCN projects for recruitment and they particularly appreciated the new industry PhD schemes. Capacity development of company staff was for most an indirect effect.

Business enterprises interviewed saw some room for improvement in the breadth of the instruments, in particular expressing the need for demonstration projects and a major support for start-up companies.

Boosting industry R&D has been a major policy objective, especially in the second half of the decade. In order to obtain a view on RCN's potential contribution from this perspective, we mapped RCN's funding patterns at the level of industry sectors against these sectors' overall R&D expenditure.

Table 14 lists the industry sectors in Norway that had high shares in total industry R&D expenditure ('BERD') in 2009 and/or received some funding for their research through RCN. The table also shows the share of the specific sectors in overall Intramural and Extramural R&D. The sectors with the highest shares are highlighted in orange are; sectors with a medium-level of share are highlighted in yellow.

In the last column we indicate the share in RCN competitive funding for research (so excluding funding related to systemic initiatives) for the sector in 2010. We highlighted in red the percent for the sectors where data suggested 'under-investment' compared to the importance of the sector in terms of R&D expenditure. Blue highlights are in sectors where there seemed to be an 'over-investment'.

Table 14 R&D Expenditure in the industry sectors versus RCN funding of industry-R&D

	Total BERD	Intramural R&D	Extramural R&D	RCN funding
Agriculture, forestry and fishing	1%	1%	n.a.	2%
Mining and quarrying (incl. services)	6%	7%	31%	3%
Manufacturing sectors overall	36%	40%	27%	37%
Food products, beverages & tobacco products	3%	4%	2%	1%
Wood, paper, printing and reproduction	1%	1%	1%	2%
Refined petroleum, chemicals & chemical products	2%	n.a.	6%	5%
Basic pharmaceutical products & pharmaceutical preparations	2%	3%	5%	3%
Basic metals	2%	2%	2%	3%
Fabricated metal products, exc. machin. & eq.	3%	3%	1%	1%
Computer, electronic and optical products	9%	8%	6%	4%
Electrical equipment	2%	2%	0%	2%
Machinery and equipment n.e.c.	4%	4%	2%	2%
Motor vehicles, trailers and semi-trailers	1%	1%	0%	3%
Other transport equipment	2%	2%	1%	1%
Furniture	0%	1%	0%	1%
Other manufacturing	1%	1%	1%	1%
Repair & installation of machinery & equipment	1%	1%	0%	6%
Electricity, gas, steam, air conditioning & water supply	1%	1%	5%	4%
Construction	1%	1%	1%	1%
Wholesale and retail trade; repair of motor vehicles and motorcycles	3%	3%	3%	0%
Transportation and storage	1%	0%	2%	3%
Software publishing	6%	6%	1%	2%
Telecommunications	4%	3%	3%	2%
Computer programming, consultancy & related activities	9%	10%	2%	7%
Financial and insurance activities	5%	6%	7%	0%
Architecture, engineering & testing activities	10%	9%	9%	16%
Scientific research and development	17%	11%	5%	10%
Total - All NACE activities	21,601.7	17,050.3	5432.3	607

Source: Total BERD & Intramural R&D: Eurostat, data 2009; Extramural R&D: SSB, data on 2007; RCN database, January 2012 – Technopolis analysis

This overview suggests 'over-investment' in areas that are closely linked to national policy objectives such as Agriculture, forestry and fishing and Electricity power generation & distribution; it also highlights the strong support provided to the sectors developing or installing complex IT and manufacturing systems. Most important, it seems to indicate some significant **gaps** in the support for industry R&D, in particular for the Mining and Quarrying sector (including services), the high-tech manufacturing sector of Computer, electronic and optical products, and the IT software developers and Computer programmers.

The data reported below show that in some industry sectors the bottom-up funding of innovation-oriented research compensated for a reduction in programme funding. In most cases, however, the **bottom-up funding** acted as an **add-on** to the programme funding, especially in sectors with high shares in programme funding, such as the Repair & installation of machinery & equipment and Architectural & engineering activities ones (Figure 64).

Bottom-up funding compensated for decreases in programme funding for companies active in the Chemicals/chemical products, Basic metals, Computers, electronics and optical products, and Scientific R&D service sectors. The funding patterns for the latter two are illustrated in Figure 65. The Mining & Quarrying sector is an example of a sector that experienced a strong decline in support from RCN in recent years and received only limited support through the bottom-up funding programme (Figure 66).

Figure 64 Bottom-up versus programmed innovation-oriented research in the ‘Repair & installation of machinery & equipment’ and ‘Architectural & engineering activities’ sectors

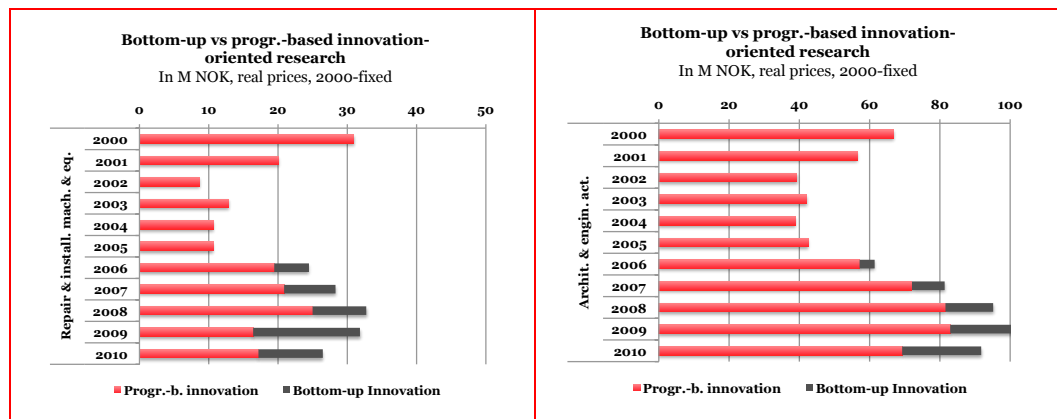


Figure 65 Bottom-up versus programmed innovation-oriented research in the ‘Computer, electronics and optical equipment’ and ‘Scientific R&D’ sectors

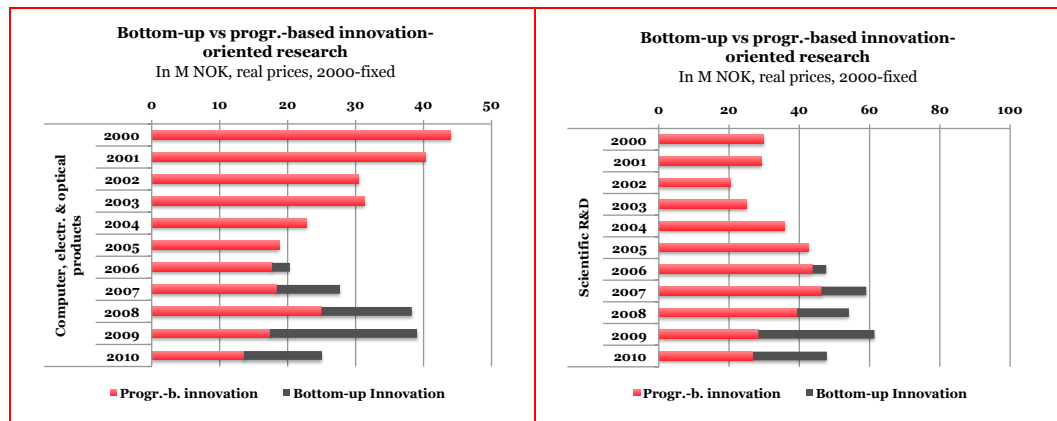
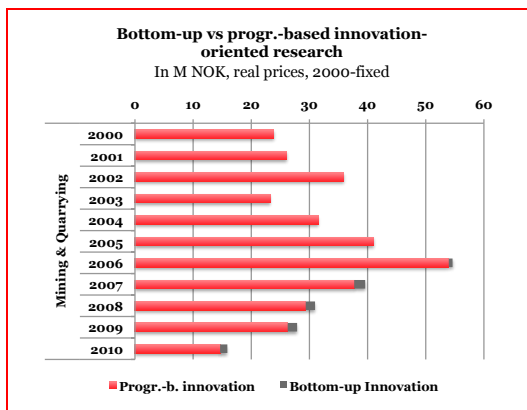


Figure 66 Bottom-up versus programme-based funding in the Mining & Quarrying sector



Source: RCN database, January 2012 – Technopolis analysis

4.2.4 Main findings

The focus of the national and ministry research priorities, combined with the increase in the funding of innovation-oriented research, meant that a specific group of actors in the NRIS that possessed the needed expertise obtained many of the benefits. It implied more support for R&D in universities such as NTNU, university hospitals, technical/industrial as well as primary and environmental research institutes, and business enterprise active in or acting as suppliers for the relevant industry sectors. The question arising is whether the research funding was too much geared towards the fulfilment of the national and ministry priorities or whether other programmes and schemes adequately covered the need for other activities and provided opportunities for an appropriate involvement by other actors in the NRIS. Our analysis suggests that this was only partially the case.

We should stress that the relevance of participation in RCN-funded research goes well beyond the immediate financial benefit or the solution of short-to-medium term technological problems. Important spill-over effects and longer-term impacts can be expected, especially from the effects in the ‘soft’ dimensions, such as the development of networks and strategic partnerships, knowledge sharing, awareness on research and user needs, behavioural changes in the ways research is conducted, the development of new business models etc.

A major critique voiced by the survey participants and interviewees, partly confirmed through our analysis in the previous sections, was the short-to-medium term focus of the research funded. Researchers insisted on the need for more interdisciplinary research and regarded funding for exploratory research, research in disruptive technologies, and scientifically as well as technologically risky research as inadequate. It is surprising to note also that business enterprises rarely conducted commercially risky research. This suggests a lack of strategic perspective, in both basic and industry-oriented research.

4.3 RCN competitive funding in an international context

In this Section we set RCN’s strategic choices for the funding of research in the context of international practice. For this purpose we analysed the instrument portfolio and its implementation in a set of research councils and innovation agencies. The selection of these councils and agencies was based on their international prestige and the breadth of their responsibilities.

Research councils included are the National Natural Science Fund in China (NSFC); the Academy of Finland; the DFG in Germany; the Swedish Research Council (VR); and the British Engineering and Physical Sciences (EPSRC) and Economic and Social

Sciences (ESRC) Research Councils. Innovation agencies are the Austrian FFG, Tekes in Finland, and the Swedish Vinnova.

There is no meaningful comparator for RCN taken as a whole. For this analysis we therefore treated the Science Division, its instruments and budget as the equivalent of a Research council and the Strategic Priorities and Innovation Divisions as together having the function of an Innovation agency.

4.3.1 The Instrument Portfolio

In this Section we discuss the instrument portfolios in the Research Councils and Innovation Agencies; for the RCN, we considered the instrument portfolio in 2010. Table 15 provides an overview of the instruments in the Research Councils; Table 16 covers the instrument portfolio in the Innovation Agencies. We highlighted the areas where RCN's instrument mix is different from common practice in our comparison Councils and Agencies.

The breadth of the **instrument mix** in RCN's Science Division is broadly in line with international practice. It covers bottom-up as well as top-down research, Centres of Excellence, and includes instruments that target the framework conditions for research. RCN distinguishes itself from the other Councils especially in the size of its instruments, more specifically its lower-than-average level of bottom-up funding and in a higher-than-average support for research infrastructures and environments.

A similar observation can be made for the instrument mix from an Innovation Agency perspective: there is a higher-than-average focus on systemic interventions and most important, in international comparison a low investment in bottom-up initiatives and for longer-term industry-science partnership building (through the funding of Competence Centres).

Table 15 Instrument portfolios in the Research Councils

	NSFC (CN)	Academy Finland	DFG (DE)	VR (SE)	EPSRC (UK)	ESRC (UK)	RCN
Bottom-up, individual or projects	30%	65%	46%	64%	44%	28%	36%
Bottom-up industry R&D or cooperation with academia					4%	3%	
Centres of academic excellence		13%	39%	18%	12%	15%	15%
Top-down, thematic	65%	6%	8%		40%	39%	26%
<i>Other</i>							
International cooperation		8%					3%
Research Infrastructures & Environments	5%	7%	7%	18%		15%	20%
Total funding	100%	100%	100%	100%	100%	100%	100%

Notes: RCN funding data are for 2010

Table 16 Instrument portfolios in the Innovation Agencies

	FFG (AT)	Tekes (FI)	Vinnova (SE)	RCN
Bottom-up, individual or projects	64%	40%	36%	11%
Centres of academic-industrial excellence	9%	20%	14%	9%
Top-down, thematic	25%	25%	50%	63%
<i>Other</i>				
Int'l coop	1%			5%
Research Infrastructures & Environments				6%
Industry/innovation-oriented initiatives		15%		5%
Total funding	100%	100%	100%	100%

Levels of investments in **Research Infrastructures and environments** are strongly context dependent and are in the case of RCN directly related to current

systemic failures in the Norwegian R&I system and national policy decisions on how to tackle these.

RCN's higher-than-average investments in Research infrastructures are triggered by the studies and evaluations that repeatedly pointed to an underinvestment in research infrastructures in the Norwegian research system. Its investment in the broader 'research environment' aimed to foster closer cooperation among research-performing institutions and tackle the challenge of fragmentation in the research system. In contrast to, e.g., the Danish government, Norwegian policy-makers decided on a 'bottom-up' approach, i.e. steering through incentives rather than a forced rationalisation of the research institutions.

We discuss the balance between 'free' and 'steered' research (i.e. bottom-up or top-down) in the next Section. Here, we look into the patterns in 'targeted' funding of research, for the benefit of specific actors or groups of actors in the R&I system.

'Targeted' funding instruments are commonly designed for different sub-groups, including

- Professors at universities, SMEs, etc, where allocation is made on the basis of the *type of actors*
- Young researchers, postdoc, professors where the distinction is in terms of the *experience or scientific excellence of the grantee*
- Innovativeness of the research and the research field – selection criterion is the *type of research carried out*
- International researchers or international mobility, i.e. the *rationale for the support*

Some individual grants have a double aim (e.g. EPSRC grant for postdoc mobility).

As indicated in Section 3.4.3, above, RCN has considerably reduced its overall funding of individual grants, targeting its interventions on excellence awards (postdocs and YFF) and mobility and industry-research collaborations (the industry PhDs). The wider policy was to fund larger research projects rather than individuals.

This decision that was similar to the approach adopted by the Academy of Finland. The Academy has increasingly focused on project funding rather than individual grants and in 2010 it established the promotion of professional careers in research and researcher training in the context of research groups as a core criterion for funding, together with the relevance of projects in terms of international cooperation.

We should also point out that when considering only the 'targeted' individual grants, RCN's funding levels are similar to the ones in the other Research Councils, i.e. 11% of the budget (compared to 14% in the Academy of Finland and 11% in the DFG). The Chinese NSFC has the most elaborate set of 'targeted' individual grants, including geographical targets (e.g. Fund for Less developed Region), accounting for 29% of the budget.

The RCN adopted also other 'targeted funding' instruments and schemes, apart of the individual grants. An example is the scheme that allowed for the co-funding of FP6 projects specifically for the Research Institutes. Another example in the sphere of its activities as Innovation Agency is the FORNY programmes (in a most recent version targeting technology transfer offices).

We note, however, the absence of funding schemes targeting specific groups in the business enterprise sector in RCN's instrument portfolio. Common international practice is to develop specific support schemes for (innovative) SMEs and/or start-up companies. Examples of such programmes and schemes in the other Innovation Agencies are the Innovation Vouchers and High-Tech Start-up schemes in the Austrian FFG (3% of the funding); the 'pro-active small-scale initiatives' in TEKES (targeting SMEs, start-ups and 'young innovative companies', ~15% of the funding) and the programmes for individual SMEs in VINNOVA (~12%).

4.3.2 The balance between free and steered funding

The distinction between free and steered funding is subtle and depends on the level of ‘freedom’ granted to researchers:

- ‘Free’ funding is where researchers define the subject of research; in the tables below, this includes bottom-up funding and CoEs/CC programmes funding
- ‘Steered’ funding stands for the funding of research in themes/ programmes defined by the Funding Council (‘top-down’ funding), notwithstanding the different degrees of steering in different programmes/Councils or Agencies

Table 17 and Table 18 show that, despite the trend towards deprogramming in basic research and user-directed innovation, RCN has a **low proportion of funding for ‘free research’**. A note of caution here is that RCN tends to tackle a wider range of sector needs that research councils and innovation agencies abroad, where sector ministries tend to have their own institutes and research funding arrangements.

Table 17 Free versus steered research in the Research Councils

	NSFC (CN)	Academy Finland	DFG (DE)	VR (SE)	EPSRC (UK)	ESRC (UK)	RCN
Free research	30%	78%	85%	82%	60%	46%	51%
Steered research	65%	6%	8%	0%	40%	39%	26%
Other	5%	15%	21%	20%		15%	23%

Table 18 Free versus steered research in the Innovation Agencies

	FFG (AT)	Tekes (FI)	Vinnova (SE)	RCN
Free research	73%	60%	50%	20%
Steered research	25%	25%	50%	63%
Other	1%	15%		16%

The difference is particularly strong compared to the funding patterns in the Innovation Agencies when considering the Competence Centres as tools for bottom-up innovation. The trend in de-programming in TEKES is interesting from this perspective. Traditionally, the TEKES programmes have been the main instruments for this agency, though there has always been a high bottom-up component. These programmes target strategically important areas of R&D or themes that the agency identified together with the business sector and researchers. In recent years, the trend in TEKES funding has been that needs-driven ‘reactive funding’ (ie ‘free funding’) has become more prominent again. Its share increased from ca. 30% in 2008 to 40% in 2012 of TEKES’ total funding. Proactive – steered funding decreased correspondingly.

These funding patterns need to be set against the broader context of **Ministry steering** of the Research Councils and Innovation Agencies. In Norway and Austria, Ministry steering is at the level of programmes and activities; in Germany, Sweden, Finland and the UK, Ministry steering is at the level of goals and performance objectives.

4.3.3 The balance between Basic and Applied research

In this analysis we looked into the budget balance at a national level, comparing the shares of government funding channelled through the Research Councils versus the Innovation Agencies.

The outcome is that RCN’s balance between basic and applied research funding is similar to the one in most of the EU countries where we could find comparable data (Table 19). The only exceptions are the Sweden and the UK, where funding of basic research through the Research Councils was considerably higher than the funding of applied research through the Innovation Agencies.

Table 19 Government funding through the Research Councils and Innovation Agencies, 2010

	Funding through the Research Councils	Funding through the Innovation Agencies
Denmark	37%	63%
Sweden	68%	32%
Finland	38%	62%
Austria	29%	71%
Germany	32%	68%
UK	77%	23%
Norway	30%	70%

Source: ERAWATCH, 2012 – Technopolis analysis

It is often argued that the limited level of free (basic) research funding through RCN should be seen in the context of the relatively high level of government funding for research as a component of the **Universities’ institutional funding (GUF)**, since these are complementary funding sources.

Table 20 shows the share of Government sector funding of R&D expenditure in the Higher Education Sector for a number of countries, including Norway. We colour-coded the countries that have similarly high levels in Government expenditure, more or less depending on the levels of funding through other sources. The analysis shows that the share of Government sector funding in Norway is high but that Norway is not unique in choosing to fund a high proportion of university research through the GUF.

However, a particularly low level of funding from abroad is a major factor that distinguishes the Norwegian Higher Education sector from its peers in the other countries.

Table 20 Shares of the sectors’ funding of R&D expenditure in the Higher Education Sector, 2009

	All sectors	Business enterprise sector	Government sector	Higher education sector	Private non-profit sector	Abroad
Belgium	1643	11%	68%	12%	2%	7%
Denmark	2022	3%	82%		8%	6%
Ireland	829	3%	85%	4%	2%	6%
Germany	11808	14%	81%	0%	0%	4%
Spain	4058	8%	74%	12%	1%	5%
France	8845	2%	90%	5%	0%	2%
Italy	5812	1%	90%	4%	2%	4%
Austria	1952	5%	87%	2%	1%	4%
Finland	1283	6%	81%	1%	3%	9%
Sweden	2641	4%	77%	2%	9%	7%
United Kingdom	8113	4%	68%	4%	13%	10%
Iceland	67	8%	82%	0%	1%	9%
Switzerland (2008)	2482	7%	81%	9%	0%	3%
Russia	785	22%	70%	5%	0%	2%
Japan (2008)	13264	3%	52%	44%	1%	0%
Norway	1,538	4%	90%	1%	3%	2%

Source: Eurostat, funding in millions of € - Technopolis analysis, 2012

Table 21 breaks the Government sector funding down into General University Funds (GUF) and Direct government funding, i.e. project funding – most often competitive. In this table we colour coded the comparison countries. Those with similarly high levels of GUF are coded green; those with more competitive funding by the government are highlighted orange.

Table 21 Share of GUF versus direct government funding of R&D expenditure in the Higher Education Sector, 2009

	Government sector funding	General university funds (GUF)	Direct government funding (projects)
Belgium	1,117	36%	64%
Denmark	1,653	72%	28%
Ireland	704	31%	69%
Germany (2005)	7,575	71%	29%
Spain	3,012	66%	34%
France	7,972	50%	50%
Italy	5,204	85%	15%
Austria	1,699	76%	24%
Finland	1,033	58%	42%
Sweden	2,041	57%	43%
United Kingdom	5,545	48%	52%
Iceland	55	51%	49%
Switzerland (2008)	2,000	82%	18%
Russia	548	6%	94%
Japan (2008)	6,877	73%	27%
Norway	1,380	73%	27%

Source: Eurostat, funding in millions of € - Technopolis analysis, 2012

The analysis leads to the conclusion that there is a **correlation at international level** between the level of GUF funding and the level of basic research funding through the Research Councils.

Sweden, the UK, and Finland are the countries that fund Higher Education R&D through direct funding (projects) considerably more often than RCN; Sweden and the UK are also the (only) two countries that channel more basic research funding through the Research Councils (see Table 19, above). Finland is an exception in the pattern, funding basic research through its Research Councils at similar low levels as RCN.

In several European countries, policy makers have started adopting more competitive funding in the expectation that this would contribute to an improvement of the quality in research. However, we can see no obvious linkage between funding patterns and performance in the data depicted above.

- Norway is similar to Denmark and Switzerland in its allocation pattern between core and competitive funding for universities. The performance of Norwegian universities is significantly lower (in terms of field-normalised paper citations)
- Finland has increased the proportion of competitive funding, but its publication performance is not better than Norway's

4.4 What the evaluation record tells us

In this section we try to capture the main lines of what programme evaluations can tell us about RCN's impacts. We focus on the major initiatives, covering science, key structural initiatives, the large programmes and user-directed R&D. Overall, RCN's evaluations do not focus much on impacts except in relation to user-directed R&D. The evaluation of the Skattefunn fiscal R&D incentive (which was not commissioned by RCN) means there is quite an interesting body of evaluation of economic impacts. However, if the main body of evaluation focuses on RCN-related process and explores impacts too little, then the reverse is true of the user-directed and tax work, which is almost entirely seen through the lens of economics.

4.4.1 Science

RCN's scientific evaluation effort has mainly involved field or discipline evaluations, using foreign peers to assess the state of development at various Norwegian institutions. The research community and RCN itself use these to develop road maps and plans but they shed no light on the impacts of RCN as a funder. Nor is there any evaluation of RCN's overall effects on the research community or Norwegian science (beyond what is done in this evaluation and in the equivalent exercise a decade ago).

To be fair, internationally, it is relatively unusual for a science research council to undertake such exercises, though interest in doing so is growing. RCN has recently evaluated its FRIPRO scheme²⁶ for researcher-initiated research. The evaluation findings reflect the fact that this is a bottom-up funding scheme operating in a mature research community. Hence, there is no evident effect of FRIPRO funding on beneficiaries' citation performance, though successful applicants tend to have higher field-normalised impact scores than unsuccessful ones, meaning that their work is of higher quality, measured in bibliometric terms. Beneficiaries surveyed say FRIPRO has a positive impact on their careers but this is not observable in the bibliometric record – for example, the amount of international cooperation does not appear to increase. The evaluators say

The FRIPRO scheme is found to achieve its central objectives concerning supporting basic research of high scientific quality and which is internationally orientated (ensured by selecting the applicants with the best track record). Moreover, FRIPRO appears to be having an important impact on research recruitment and to be good at providing opportunities for female researchers. Results are somewhat mixed concerning scientific renewal. Funded applicants more often characterise their FRIPRO projects as more scientifically risky and more multidisciplinary than their other projects, but in general the applicants do not rate FRIPRO highly on facilitating high-risk and interdisciplinary research.

Thus, FRIPRO helps fund research business-as-usual rather than change, operating as a complement to university core research funding and enabling a higher rate of quality-assured scientific production than would be possible without it. There is no programme-level evaluation of RCN's basic research programmes. Their most likely effects are similar to FRIPRO – but with the additional dimension of building and maintaining capacity in prioritised fields and disciplines. The gradual 'de-programming' of basic research implies a reduced role for RCN in maintaining disciplinary health in Norwegian basic research, with this effectively becoming the responsibility of the autonomous research-performing organisations.

4.4.2 Structural measures

The 2010 SFF evaluation²⁷ was based on a questionnaire to both successful and unsuccessful competitors in the first SFF competition. It confirmed that creating centres led to agglomeration by attracting additional non-SFF resources to the winning research groups. SFF raised the ambition levels of both winners and losers in the competition, with losers often going on to use other means to strengthen themselves. SFF centre beneficiaries attracted envy from other academics, and were often perceived to have attracted greater resources from their host institutions, though in practice financial data confirmed this perception only in some cases. SFF funding had modest positive effects on collaboration, including with other Centres. The survey suggests the overall benefits for the centres were significant (Table 22).

²⁶ Liv Langfeldt, Inge Ramberg, Gunnar Sivertsen, Carter Bloch and Dorothy S Olsen, *Evaluation of the Norwegian scheme for independent research projects (FRIPRO)*, Report 8/2012, Oslo: NIFU, 2012

²⁷ Siri Brorstad Borlaug, Magnus Gulbrandsen and Liv Langfeldt, *The Norwegian Centre of Excellence Scheme: Evaluation of Added Value and Financial Aspects*, Science Division, Oslo: RCN, 2010

Table 22 Effects of SFF funding on beneficiaries

How is the situation of the present CoE compared to the situation for the key participants/your research group at time of the applications?	Increased	About the same	Decreased
a. Research resources (funding, infrastructures and equipment)	18	2	0
b. Ability to attract external research funding (apart from CoE funding)	17	3	0
c. Ability to attract young talented researchers	19	1	0
d. Ability to attract distinguished senior researchers	20	0	0
e. Participation in EU projects and other internationally funded projects	14	6	0
f. Collaboration with internationally leading research groups in your field	15	5	0
g. Role in making Norwegian research in your field internationally visible	20	0	0
h. Collaboration with industry or other research users	10	10	0
i. Collaboration with other* research groups/researchers at your department/institute	10	10	0
j. Collaboration with other* Norwegian research groups/researchers in your field	13	7	0
k. Interdisciplinary collaboration	17	3	0
l. Involvement in teaching at undergraduate/bachelor and master level	4	13	3
m. Involvement in PhD education	16	4	0

Source: SFF evaluation *Other=researchers not participating in the SFF centre

In line with the structural need, the programme affected the division of labour among Norwegian research-performing organisations and increased researchers' international collaboration. They clearly affected university strategy: they were sufficiently large that universities had to fit them into their current activities and to make plans for how and whether to continue the centres at the end of their funding period. In this sense, they have had some positive influence on universities' research management capabilities. The evaluation did not deal with effects of the centres on research or the quantity or quality of scientific outputs.

The SFI mid-term evaluation²⁸ (2010) was intended to feed back to RCN about the progress of the centres and their continuing fundability, rather than to assess impacts. It nonetheless concluded that the SFI programme "demonstrably has benefited supported industries and organisations in the public sector by providing ideas for enhancement of processes and development of improved and new products". The evaluators are people with considerable international experience with similar 'competence centre' schemes, so their general approval of the SFI centres and their continued funding implies that they expect the normal benefits of competence centres to result.

It is central to the idea of competence centres that they aim to do more fundamental research than is normally possible in industry, or even in conventional academic/industrial collaboration. Such programmes typically combine academic excellence with industrial needs/problems to focus joint academic industry R&D on areas of high innovation potential. They are a comparatively new form of research alliance that undertakes both fairly fundamental but also more applied, problem-oriented research. Their long-term nature and high rates of subsidy allow them to have

²⁸ Eric Fercher, Silke Stahl-Rolf, Per Stenius and David Williams, *Midway evaluation of the Centres for Research-based innovation (SFI)*, Division for Innovation, Oslo: RCN, 2010

a structuring effect on sub-systems of innovation, generating communities of research practice between research performing institutions and industry and creating common, use-oriented research agendas with potential for significant socio-economic effects. They have some recognisably special features relating to their role. Three partners normally fund them: industry, university and a state agency. They are intended to have an effect on university resource allocation and strategy, in addition to reinforcing university-industry links. They involve long-term contractual arrangements, requiring a bigger commitment than traditional project funding. They create new on-campus structures, and make new organisational and structural demands on the universities. They are interdisciplinary and generally problem-focused in the research they do, demanding horizontal networking. Their long-term presence on campus and engagement with postgraduate education draws them into close contact and co-operation with universities' 'core business' of education and research. They also extend academics' networks into the industrial research community²⁹.

The current generation of regional structural programme – VRI – is under evaluation. Our evaluation of one of the predecessor programme, VS2010³⁰, highlighted important lock-ins. VS2010 involved allocating funding for action-research in innovation to regional actors across Norway, using the structures established by the predecessor programme (BU2000) but shifting the research focus. As a result, the regional research communities had to change direction and enter new areas. The strong role of NHO and especially LO in the governance of the programme (to which they contributed an extremely small part of the funding) meant that it focused on 'organised' and traditional sectors while its regional focus largely excluded the main centre of innovation in Norway, ie Oslo. We concluded that VS 2010

- Has generated useful research
- Has generated valuable benefits in a sub-set of the business community, and it **is** important to value these more traditional industries
- Involves many lock-ins: to mature industries; to less innovative regions (because the cities are not important in the mix); to one particular research tradition; to regional administrative structures; to organised firms; to areas where male employment is important
- Is too broad to be practical. All its goals simply cannot be achieved at once in any project and, arguably, by the combination of projects
- Is unable to deal with new industries and to operate in regions where these are potentially key – and this includes both the southern cities and the far north
- Fails to tackle the important new questions about participation outside unionised structures and to consider what they mean for labour organisation and management in Norway today

We cannot of course comment on VRI, but are aware that its designers have read our evaluation, which serves to highlight the dangers of avoiding competitive processes and allowing stakeholders to become too powerful in programme design and implementation.

4.4.3 Large programmes

RCN asked a Nordic panel to evaluate the large programmes at mid term (2009)³¹. This observed that the large programmes were agglomerations of earlier, smaller efforts and that their funding was a "patchwork" from many sources, though the Fund

²⁹ Paula Knee, Erik Arnold, Patrics Boekholt and Frank Zuijdam, *Evaluation of the Centres for Science, Engineering and Technology Programme*, (forthcoming), Dublin: Forfás, 2012

³⁰ Erik Arnold, Alessandro Muscio, Johanna Nählinder and Alasdair Reid, *Mid-term evaluation of the VS2010 programme*, Brighton: Technopolis, 2005

³¹ Ragnhild Sohlberg et al, *SATS på forandring: Midtveis evaluering av Store programmer*, Oslo: Forskningsrådet, 2009

for Research and Innovation was generally a leading, early contributor, with ministry funding of the programmes growing over time. A consequence of the multi-principal nature of the programmes was that only incremental changes could be made during their life. Industry does not greatly differentiate between user-directed projects in the big programmes and those done in other arenas, so it seemed to be hard to get additional value from the large programme idea at the industrial level. On the other hand, there was development and capacity building in the knowledge infrastructure. The evaluation had little to say about wider impacts.

Four of the programmes have since been evaluated: FUGE (2011), NANOMAT (21011), PETROMAKS and RENERGI (2012). These evaluations illustrate the importance of links to users and applications even in designing programmes that are intended to have a ‘technology push’ element, developing key technologies ahead of commercial demand.

FUGE³² started out as a basic research programme and was transformed into a Large one mid way. It originally set up a large number of ‘technology platforms’ in the academic community to enable functional genomics research, some of which were clearly sub-critical and became out of date, with those that had been located using regional allocation criteria faring worst. The strategy was first to build academic capacity and then to link to innovation. The evaluation confirms that FUGE did increase research capacity and output, though (perhaps not surprisingly) not enough to catch up with Sweden or Denmark in scientific output or productivity. It increased the degree of specialisation and division of labour within the research community. While it succeeded in spending 10% of the budget on user-directed R&D, academic-industry links remained poor – in no small part because of the relative weakness of relevant industry in Norway. There are few industrial effects. The evaluation concludes that FUGE’s limitations result from academic dominance of the programme design.

NANOMAT³³, like FUGE, involved significant infrastructural investment to enable Norway to ‘catch up’. It was redefined from being a basic research programme into a Large one in 2007. It led to a rapid increase in scientific publication and a strategic concentration of effort within the knowledge infrastructure. It established PhD education in the field and increased the amount of international collaboration. Relevant industry is mostly weak and small. While the evaluators say that NANOMAT involved about 100 industry collaborations they also point out that it has produced few commercialisable results, arguing that this results from a lack of suitable funding instruments. They also point out that industry was not involved in programme design or the choice of themes and hence that there was little academic-industrial linkage.

PETROMAKS and RENERGI were evaluated together³⁴. Both built research capacity in areas of national priority within the knowledge infrastructure and industry. They served as ways to focus research attention, effort and capacity on areas of industrial need and developed researchers’ international and end-user linkages. The economic payback from Petromaks is very high, in the form of increased yields from oil and gas reservoirs. Some of this benefit has already been realised but the majority is yet to come. Renergi makes a significant contribution to addressing a global challenge. Both increase the amount of ‘early stage’ R&D in industry, which is likely to increase the innovation rate. (Inherently, of course, early stage research in industry should have high spillovers.) User participation in Renergi is lower than in Petromaks. The evaluators argue that this is because the economic returns to industrial R&D are lower

³² DAMVAD and Econ Pöyry, *Evaluering av FUGE: Forskningsrådets Store program innen funksjonell genomik*, Oslo: Forskningsrådet, 2011

³³ DAMVAD and Econ Pöyry, *Evaluering av NNOMAT: Forskningsrådets Store program innen nanoteknologi og nye materialer*, Oslo: Forskningsrådet, 2011

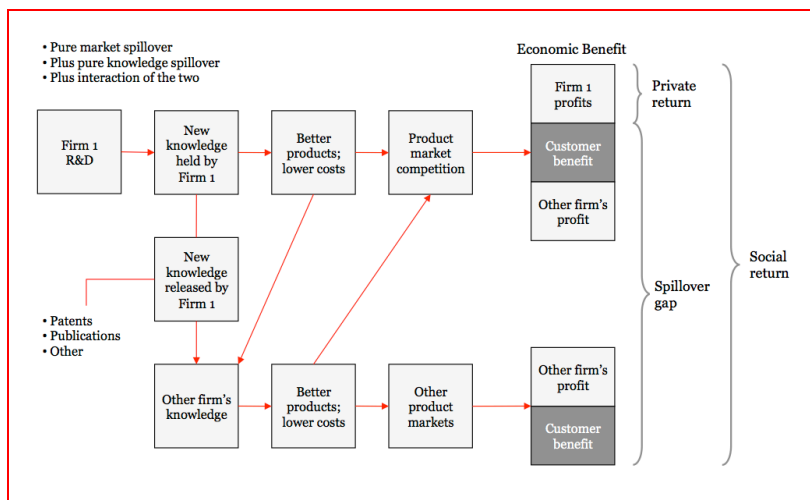
³⁴ Universitetet i Nordland and Ramböll, *Evaluering av Petromaks og Renergi*, (forthcoming 2012)

in renewable energy than in oil and gas. The user community is also likely to be less well defined. It is a pity that the evaluation was unable to tackle industrial and economic impacts more clearly – we would expect these to be very large, especially in the case of Petromaks.

4.4.4 Innovation

RCN has been funding work at Møreforsk that aims to monitor the economic benefits of user-directed R&D projects for some 20 years. Historically, that work was based on the so-called ‘Beta Method’ developed at the University of Strasbourg and has focused on private returns to the beneficiary companies, measured in terms of actual or expected changes in cash flow. In more recent years, the attention has shifted outwards to try to capture some of the benefits to others³⁵. The general approach is shown in Figure 67.

Figure 67 General approach to calculating socio-economic returns



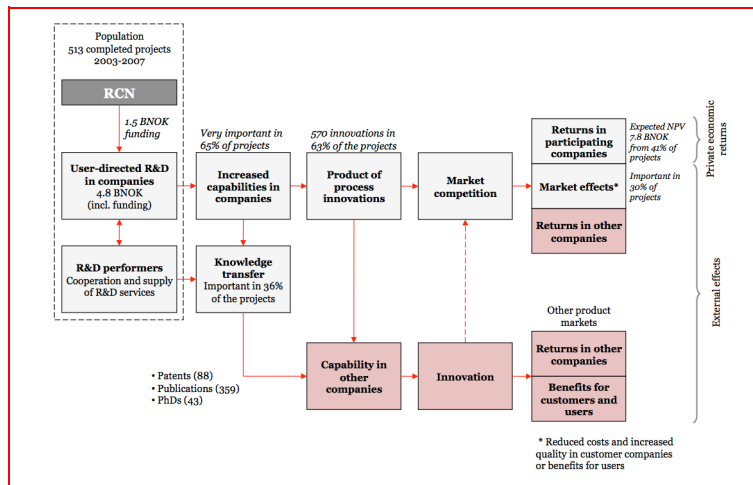
Source: NIST GCR 03-857; cited from the User-directed R&D evaluation

As in previous years, the latest surveys show that there is a good overall return on investment from user-directed R&D projects – measured as monetary benefits to the participating companies – but that returns are extremely skewed, with a handful of projects accounting for the great majority of them. Over the five years studied, 10 of the 110 projects able to quantify benefits accounted for 90% of the returns.

Figure 68 summarises external effects of the projects in addition to the internal ones. A key finding is the importance of externalities – which (far more than private returns) justify state funding, since these are expected to produce the bulk of the societal returns. The interaction among companies and with the knowledge infrastructure is a key benefit for society, which is necessarily hard to monetarise.

³⁵ Arild Hervik, Lasse Bræin and Bjørn G Bergem, *Resultatmåling av brukerstyrt forskning 2010*, Molde: Møreforskning and Høgskolen i Molde, 2012

Figure 68 Indicators from long-term monitoring four years after end of project (n=269)



Source: User-directed R&D evaluation

The extension of the work to consider external benefits allows Hervik and his colleagues to establish that RCN’s assessment tool (PROVIS) is a relatively good predictor of external benefits. It does not predict commercial success very well and we infer that this is because of the highly skewed nature of the rewards to innovation. Irrespective of whether innovation is privately or publicly funded, business outcomes are difficult to predict. If it were otherwise, everyone would be rich. The RCN assessment process appears to reduce technological risks and increase the likelihood of getting the externalities that justify investing on society’s behalf. For the rest, the companies themselves must be the best judges, even if they more often get it wrong than right (as they also do when making fully private R&D investment decisions).

The companies are certainly motivated to **try** to get the commercial dimension right, since they themselves fund the great majority of the project cost. The study shows there is high input additionality. That is, the funding tends to ‘trigger’ the company to invest in the project. There is also considerable ‘behavioural additionality’, where companies learn the benefits of doing more R&D, collaborating with others, linking to the knowledge infrastructure and so on. The study therefore clearly shows that there are not only short term private returns to user-directed R&D (which are useful to society in the sense that they trigger increased employment, more payment of tax and so on) but more important that there are significant externalities that benefit Norwegian industry and society.

The **Skattefunn** scheme offers companies the chance to offset R&D costs against corporation tax and was introduced in 2002. RCN’s role is to decide whether projects meet the criterion of being ‘R&D’. Innovation Norway and the tax authorities handle the rest of the administration. Skattefunn is a ‘volume scheme with a cap’ – meaning that companies can offset R&D costs against corporation tax up to a limit of 4 MNOK per year. If the R&D spend is bigger than the tax, the authorities refund the difference. Some other schemes are ‘incremental’, so that companies get tax relief only for the **increase** in R&D from one year to the next. Skattefunn is intended primarily to get companies to **start** doing R&D. Once they have learnt the benefits, schemes like RCN’s BIA and the large programmes are available that intensify their contact with the knowledge infrastructure, generate larger than normal externalities and encourage R&D relevant to national priorities.

The Skattefunn evaluation³⁶ (2008) found that the ‘input additionality’ of Skattefunn is very high. ‘Input additionality’ is 1 if when the state forgoes 1 krone in tax the company does 1 krone of R&D. The evaluation found a wide range of values (1.3 to 2.9) and provides a central estimate of 2 – which is to say that for each krone of tax the state forgoes the companies put in an average of 2 kroner. This is at the high end of the range of values observed internationally. There is international evidence that incentives for small companies involve greater input additionality than those for large ones³⁷. Or, to put it another way, that larger firms more easily free ride on tax incentives than small ones. The Skattefunn evaluation found that the companies doing the least R&D experienced the greatest behavioural additionality, so the idea that using a tax incentive will ‘teach’ small firms the value of doing R&D seems to be right.

The evaluation shows that use of RCN funding and Skattefunn are complementary – companies that get one tend to go on to get the other. One set of calculations suggests that input additionality for tax incentives below 4 MNOK is 2.55, compared with 2.07 for funding from RCN and 1.45 for tax incentives otherwise. But Skattefunn causes little change in companies’ relationships with institutes or other companies, so it brings fewer externalities than RCN funding. Hence, the evaluation argues that it is reasonable to accept lower input additionality with RCN funding. If we recall that the input additionality of tax incentives also goes down as the volume of the tax incentive goes up, then the division of labour between Skattefunn and the RCN programmes seems reasonable. Moving resources from RCN programmes to a Skattefunn scheme with a higher ceiling would decrease the input additionality of the fiscal incentive and sacrifice the externalities associated with RCN funding.

Another very interesting finding of the Skattefunn evaluation is that it makes little difference to the private returns to innovation whether the investment is made privately, with Skattefunn money or with the support of RCN. The best returns are to private money followed by Skattefunn and then RCN – but the differences are small. On the other hand the **social** returns probably rank in the opposite order.

It is perhaps also useful to recall that while the statistical calculations involved here **look** precise, they are far from being so. We can see this in the wide ranges of estimates given not only in the Skattefunn evaluation but also in the international literature on the subject. The skewed economic effects of innovation described in the user-directed R&D evaluation may provide one explanation among others of why different studies (and approaches within studies) produce such widely differing estimates.

The component of this evaluation of RCN that deals with the added value of RCN funding in the company sector³⁸ adds two crucial pieces of evidence to our understanding of the effects of RCN funding in industry. It shows that RCN does not ‘crowd out’ private investment; and that we can expect the same high rates of private return from all kinds of R&D. Societal returns to RCN-subsidised R&D have not been analysed but there are no reasons to believe that RCN-funded R&D have lower societal returns than non-RCN-funded R&D when private returns are quite similar. On the contrary, the Skattefunn evaluation suggests that social returns are higher in the RCN case than with other funding.

³⁶ Ådne Cappelen, Erik Fjærli, Frank Foyn, Torbjørn Hægeland, Jarle Møen, Arvid Raknerud and Marina Rybalka, *Evaluering av Skattefunn – Sluttrapport*, Rapport 2008/2, Oslo: SSB, 2008

³⁷ Christian Köhler, Philippe Larédo and Christian Rammer, *Fiscal Incentives for Business R&D: Compendium of Evidence on the Effectiveness of Innovation Policy Intervention*, MIOIR, Manchester university: 2012

³⁸ Ådne Cappelen, Arvid Raknerud and Marina Rybalka, *Returns to R&D in Norway: The role of public grants and subsidies*, Oslo: SSB, 2012

The FORNY evaluation (2009)³⁹ explores the effectiveness of this programme in the latest phase but also looks back to its origins, in the 1990s. Since 1996, FORNY has supported some 300 start-ups, which by 2009 collectively employed about 700 people. Like the user-directed R&D evaluation, it finds that the successfulness of innovation is highly skewed, with employment concentrated in a small number of larger firms. Most FORNY-supported firms have survived, but often as 'one-man-bands' with turnover of 1 MNOK or less and often no formal employment (ie the entrepreneur is still working on it in her or his spare time). The focus on Technology Transfer Offices in the second phase of FORNY needed to be reconsidered as this was not an especially effective channel for knowledge transfer. The knowledge infrastructure should engage in a much broader range of cooperative knowledge transfer activities in order to play its role in spreading as well as producing knowledge. This conclusion is consistent with what we see in the literature about technology transfer from public research organisations and our recent survey of such organisations⁴⁰.

4.4.5 Long-term impacts

We have been able only to identify one long-term study of research impacts undertaken by RCN, namely a description⁴¹ of developments in CO₂ capture and storage over a 20-year period. This sketches a broad history of Norwegian activities in the area, covering companies, institutes and various projects and programmes funded by RCN and others, showing that Norway has played a significant role in developments so far. Unfortunately, the links between the research and wider developments are not very clear – but this is a clearly interesting example where a more systematic technique such as tracing would clarify the role of research in general and RCN-funded research in particular. In the tracing tradition, there are two early landmark studies of the long-term effects of R&D – Hindsight⁴² and TRACES⁴³, both conducted during the 1960s. Their purpose appears to have been to justify the respective research missions of the US Department of Defense (DoD) and the US National Science Foundation (NSF). Both are based on **backwards tracing**, ie identifying innovations of interest and looking backwards in order to identify scientific and technological events, which fed into them.

European interest in long-term R&D funding impact studies began Sweden during the last decade, where VINNOVA funded a series of long-term studies of the effects of user-driven R&D funding programmes. While the research questions for TRACES and Hindsight were conceived in the linear terms current in the 1960s, the VINNOVA studies aim to understand **systemic** impacts. Unlike in the US literature, there is a strong interest in these studies not only in the technological effects of projects but also in the act of programming and in socio-economic impacts.

A recent meta-analysis of the fourteen studies undertaken so far⁴⁴ found that VINNOVA and its predecessors have played important roles in identifying, defining

³⁹ Siri Brorstad Borlaug, Leo Grünfeld, Magnus Gulbrandsen, Einar Rasmussen, Lars Rønning, Olav R Spilling and Evgeni Vinogradov, *Between entrepreneurship and technology transfer: Evaluation of the FORNY programme*, Rapport 19/2009, Oslo: NIFU, 2009

⁴⁰ Erik Arnold, Paula Knee, Neil Brown, Zsuzsa Jávorka, Flora Giarracca and Sabeen Siddiqui, *Knowledge Transfer from Public Research Organisations*, IP/A/STOA/FWC-2008-096/LOT8/C1/SC9, Brussels: STOA, European Parliament, 2012

⁴¹ Forskningsrådet, *Lange spor CO₂: Et temahefte fra Norges Forskningsråd*, Oslo: Forskningsrådet, 2011

⁴² RS Iserson, *Project Hindsight (Final Report)*. Washington, D. C.: Department of Defense, Office of the Director of Defense Research and Engineering, 1967

⁴³ H Loellbach, (Ed.) *Technology in retrospect and critical events in sciences (TRACES)*. Vol. I. Chicago: Illinois Institute of Technology Research Institute, Contract NSF-C535 with the National Science Foundation, 1968; and Vol II, 1969

⁴⁴ Lennart Elg and Staffan Håkansson *När Staten Spelat Roll: Lärdomar av VINNOVAs Effektstudier*, VINNOVA Analys, VA 2011:10, Stockholm: VINNOVA, 2011

and growing new areas of needs-driven R&D in dialogue with the research and industrial communities. This involved a combination of 'bottom-up', responsive mode funding and programming that permits promising areas to be scaled up and would not have been achieved had the funding been under the unique control of either the research or the industrial community. Programmes need to be flexible and 'patient': long programmes have greater effects on beneficiaries' strategies and learning than short ones. Often, 10-20 years elapse before socio-economic effects of any size are visible. It is important to avoid the 'project fallacy' (the idea that the contractually-defined project is necessarily a meaningful entity to the research performer). Rather, longer-term interactions allow beneficiaries to pursue their 'real projects' and strategies. Key effects of funding have been the development of new clusters of human capital and organisational learning so as to develop the capacity and capabilities of the innovation system, not just to underpin individual innovations. While in many cases major economic effects have been obtained in large, existing companies, the creation of new firms is necessary in order to create a varied selection environment. Where R&D programmes address societal needs, they have to connect with effective demand. We suspect that many of these conclusions would apply also in Norway but at present there is no local evidence to support such a claim.

4.4.6 Conclusions

We have had to squeeze the evaluations quite hard to find conclusions on impact. The picture that emerges is nonetheless interesting and in a number of respects positive, though there are clearly also lessons to be learnt.

RCN's primary role in 'basic' research is as an 'aggregation machine' – responsively funding proposals and imposing a quality threshold that raises the average quality of Norwegian research. Nothing in the evaluation record suggests that RCN is a change agent here or that it systematically funds disruptive research. Both FUGE and NANOMAT began life as basic research programmes intended to help the research community 'catch up' with international developments in two of the three technologies that the rest of the world has long regarded as generic. Hence there is at least anecdotal evidence that the aggregation machine role is not enough to keep Norwegian science in constant motion.

The centres programmes appear to have started to induce more strategic research management and some restructuring, especially in the universities. It is reasonable to expect that at least the SFIs will also improve industry-academic cooperation and industrial innovation.

VS-2010 is an extreme (and in its nature untypical) example that underscores the importance of competition, not only to maintain or improve quality but also to prevent lock-in. While the involvement of stakeholders and users is necessary as a 'focusing device' to make sure that appropriate research activities are connected to needs and markets, there must also be countervailing forces to avoid moral hazard and prevent adverse selection. RCN's increased efforts to contain conflict of interest show that it is acutely aware of this issue. Nonetheless, as the NANOMAT and FUGE evaluations show, under-involving potential users leaves the programme designers with too few signals about what is important if the research community is to be built up in areas of relevance and if research is to connect with practice. That PETROMAKS appears likely to have very large economic impacts is closely related to the key role that users have played in its design.

The evaluations show that user-directed R&D is a useful instrument that increases business expenditure of R&D, leads to industrial innovation (enough of which is economically successful to generate significant private returns), generates important knowledge and capability spillovers and leads companies (especially smaller ones) to want to do more R&D (behavioural additionality). The private and public returns to industrial R&D are both high. While economists often like to speculate that state funding of industrial R&D will crowd out private investment and induce companies to invest in the wrong things ('picking winners'), the evidence shows the opposite. RCN

funding ‘crowds in’ private investment; the private returns induced are about the same as companies get from their own investments in R&D; and the societal returns are higher. The Skattefunn fiscal incentive is a useful way to help small companies do more R&D, generating high private returns but limited externalities. As their R&D expenditures rise, RCN’s selective approach becomes more appropriate because it increases externalities, it can support agglomeration (including around national priorities) and it avoids the problem that at larger volumes companies tend to free ride on tax incentives so that they become economically inefficient.

Commercialisation, and more generally ‘technology push’ efforts do not work well – either at the level of technology transfer (FORNY) or large programmes (FUGE and NANOMAT). A more integrated approach to knowledge exchange is needed.

Finally, there is reason to believe that the longer-term impacts of R&D funding are extremely important and that important lessons can be learnt from studying them. RCN is well behind the curve here.

5. Overall Conclusions

RCN has introduced some important changes in the Norwegian research and innovation system during the last decade, including new longer-term structures to enhance research excellence and industry-science collaboration (the Centres programmes and research infrastructures). RCN instruments have encouraged research management to become more strategic and induced changes in research practice.

RCN increased the share of its funding devoted to innovation, both overall and in the thematic programmes. The Council spent a growing proportion of its budget on implementing the national priorities at the same time as satisfying the needs of the sector ministries. Bottom-up schemes such as BIA and FRIPRO were intended to complement the programmes, providing opportunities for research in areas that were not covered by them. Increases in the size of these bottom-up schemes were made possible partly by reducing the number and scope of programmes in the Science and Innovation Divisions.

Support for internationalisation and interdisciplinary research – both of which are important for raising the quality and competitiveness of Norwegian research – increased rapidly around 2003/2004 but has since remained rather flat. The low level of interdisciplinary research in the Large-scale programmes is surprising and requires urgent consideration.

The pervasiveness of the national priorities in RCN's activities implies that proposals in fields that were not targeted in the thematic programmes encountered particularly high levels of competition for bottom-up basic research funding. Actors in industry sectors that were no longer targeted in the industry-oriented programmes often dropped out. The effects of 'exclusion' of these actors in the NRIS go well beyond the financial dimension; it implies a reduced role for RCN in maintaining disciplinary health in Norwegian basic research and a restriction of its potential impact on industrial R&D.

The research community tended to feel that RCN funding did not enable enough risky research to be done to meet present and future needs. Institutes needed to do more risky research than is possible using funding from their customers, so they looked to RCN for this but they felt that the needed risk-willing funding was not available. The core funding of the Technical/Industrial and Environmental institutes is in our view too low for them to fund much work of this type themselves.

Targeted instruments should complement the current instrument portfolio, focusing on types of companies, such as innovative SMEs or start-up companies, or actors in specific industry sectors that are of particular importance for the Norwegian economy from an innovation and future competitive advantage perspective.

Finally, several evaluations of RCN programmes and funding schemes question their effectiveness in reaching the intended strategic objectives. Adequate user involvement in programme design is critical for the alignment of research with market and user needs, creating the basis for future impact achievement. Equally important is the flexibility of the programmes to adjust to changes in market or research developments and needs, from a systemic as well as thematic/disciplinary perspective. A less rigid distinction between science and innovation would be beneficial, more often involving industry players in the design of programmes that focus on R&D in the early stages of development, and researchers active in basic research in the design of innovation- and industry-oriented programmes. More creation and use of strategic intelligence, including impact evaluations of RCN's activities and a close monitoring of project outputs and outcomes (beyond the number of publications and patents), should complement the view of the stakeholders.

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