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Research support to the Fagerberg Committee

Volume 2. International comparison of goal-orientated public governance in research policy – Country reports

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1.1.1 Overview of public funding flows for research

Figure 1 shows the evolution of GDP dedicated to GERD over the past decade

Figure 1 Percentage of Canadian GDP dedicated to GERD (1998-2008)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
% of GDP dedicated to GERD	1.76%	1.8%	1.91%	2.09%	2.04%	2.04%	2.07%	2.05%	1.97%	1.9%	1.84%

Source: OECD Science, Technology and R&D Statistics

Canada is a decentralised federation of ten provinces and three territories, and, as such, the organisation of research policy varies from the one in centralised countries. The three principal levels of government are national, provincial, and municipal (the latter under provincial jurisdiction). Spheres of responsibility are set out constitutionally. In practice, the federal and provincial governments are each highly involved in S&T policy, some provinces more than others. Although education falls under provincial jurisdiction, the federal government supports the bulk of R&D in the higher education sector in Canada.

Given the wide scope of the study, the focus is put in the present report on the federal level and the main federal departments and agencies involved in S&T policy constitute. It intends to give an overview of the Canadian goal-orientated governance of research policy. Aggregate data on research in Canada are limited and difficult to reconstruct because of the disaggregated approach to funding (i.e. not only between provincial and federal level, but also inside the federal level itself with the variety of funding and mechanisms) and the opacity of some funding arrangements.

1.1.1.1 Policy advice for S&T

In the Canadian federal government, centralised decision-making rests with the Prime Minister and the Cabinet of Ministers. Each department has a Minister of Parliament. Research policy in Canada is tightly linked to innovation policy. Until the end of the 1980s, science and technology was under one roof, the independent Ministry of Science and Technology. In 1989, it was brought into the Department of Industry and therefore falls under a number of federal departments and agencies. In June 1994, the federal government launched an S&T Review of all federal departments and agencies involved in the S&T policy and put in place a new horizontal governance structure across the government, made up of fifteen departments and agencies.[1] The Canadian structures of research funders is therefore highly decentralised and based on a disciplinary separation of labour among the granting councils and other federal department and agencies.

The federal government of Canada was before 2007 advised by various S&T advisory bodies.

- The Council of Science and Technology Advisors (est. 1998) was set up in response to the Government's 1996 S&T Strategy. It provided advice to the federal government on management of S&T. Members were drawn from private, non-profit and academic sectors; Ministers of the science-based departments appointed members. The Council reported directly to the Federal Cabinet

[1]Erawatch, research inventory, Canada, November 2009, online: http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=4&countryCode=CA (consulted November 2010)

- The Advisory Council on Science and Technology (est.1996) was an outcome of the strategic review. It provides the Prime Minister with non-partisan advice on national S&T policies
- The Assistant Deputy Ministers Committee on Science and Technology: science ADMS met on a regular basis to implement cross-government S&T innovation and R&D strategy. The committee developed proposals and advice for horizontal S&T policy issues and provided a forum for interdepartmental discussions.
- The National Science Advisor (est. 2004): a position created for an advisor reporting to the Prime Minister. The Advisor's role includes:
  - Providing sound non-partisan advice on key S&T priorities
  - Provide input for future directions for science and R&D
  - Provide advice on commercialisation and the innovation gap and suggest ways of closing it
  - Assessing Canada's role in international S&T
  - Identifying barriers to horizontal collaborations and remove barriers; help build partnerships throughout the departments, agencies, foundations and institutions in the S&T community
  - Developing a framework for evaluating 'big science'
  - Providing foresight advice on future impacts of S&T in Canada.

As part of its 2007 Science and Technology Strategy, the Canadian federal government consolidated the roles and responsibilities of these various bodies into a new Science, Technology and Innovation Council (STIC), reporting to the Minister of Industry. The STIC is an advisory body that provides the Government of Canada with external policy advice on science and technology issues, and produces regular national reports that measure Canada's science and technology performance against international standards of excellence (e.g State of the Nation 2008, Canada's Science, Technology and Innovation System). It consists of a Chair and 17 members whose work is supported by a Secretariat housed within Industry Canada.[2] The Council of Canadian Academies is also an occasional provider of S&T policy advice. It is a not-for-profit corporation that operates since 2005 and supports expert assessments and studies that inform public policy development in Canada.[3]

All provinces have Ministries of Education, since education falls under provincial jurisdiction. Several also have specialised ministries of higher education, research and S&T, although the S&T portfolio is sometimes found in ministries of industry. What is more, several provinces have specialised scholarly granting agencies and advisory organisations. For instance, Ontario is Canada's industrial centre and has put in place an array of S&T programmes that support research and the commercialisation of research. Ontario operates five centres of excellence in energy, communication and information technology, earth and space technology, materials, and photonics, as well as an institute for cancer research. It has established a commercialisation framework based on "regional innovation networks". The Ontario government has recently established a Ministry of Research and Innovation (MRI). At the end of 2006 MRI released a research and innovation strategic plan, which particularly emphasises partnerships and research driven by industrial needs. Likewise, the Québec Province has a longstanding involvement in STI policy that dates from the 1960s. It has developed a consistent stream of policy thinking about science, technology, and innovation, as well as a wide range of institutional arrangements in support of STI. The *Conseil de la science et de la technologie* (CSTQ) is one of Canada's oldest S&T advisory bodies. It enjoys a broad mandate, which tends to focus on innovation and all the reports and discussions that it published are available online. [4]

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[2] STIC website: http://www.stic-csti.ca/eic/site/stic-csti.nsf/eng/Home (consulted November 2010)

[3] Council of Canadian Academies website: http://www.scienceadvice.ca/en.aspx (consulted November 2010)

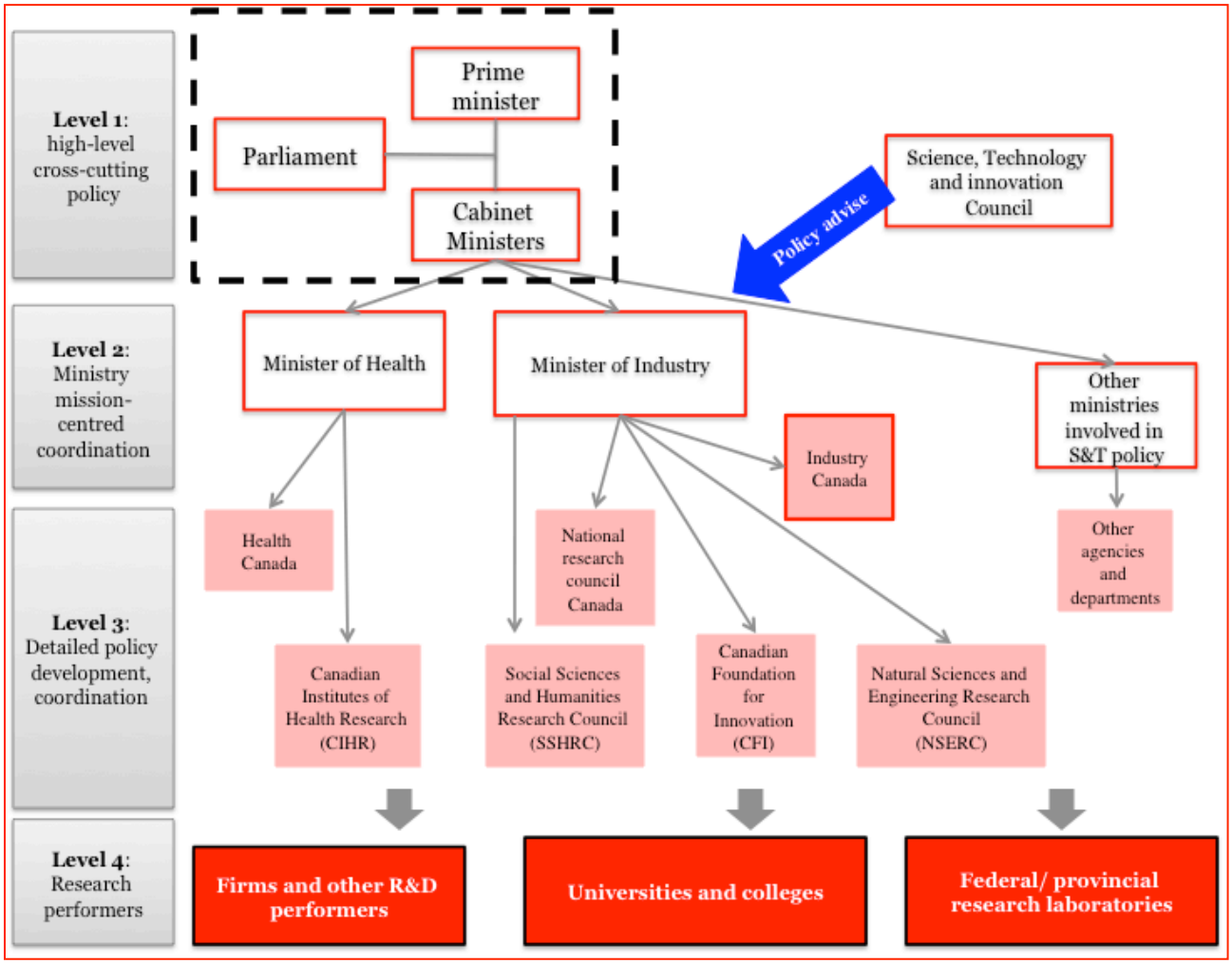
[4] Erawatch Research inventory, Canada (2009)

However not only the federal and provincial governments, but also wider stakeholders take part in the design of the Canadian S&T policy. Trade associations also provide S&T related policy advice by lobbying the government. An example of Canadian trade associations that is active in innovation policy is the Canadian Advanced Technology Association. Moreover, the Association of Universities and Colleges of Canada (AUCC) actively monitors policy having to do with higher education, and it maintains considerable internal analytical capability. Various think thanks also influence the S&T policies by providing compelling analyses of issues at stake.

1.1.1.2 Key departments, agencies and ministries involved in S&T policy

Figure 2 gives an overview of the organisational structure for research and innovation policies in Canada. This overview is however limited since provincial government are not included. Provincial actions in matters of research policy are however roughly described in the following subsections. Likewise, the four levels presented in Figure 2 and the relations between them are explained further below.

Figure 2 Organisational structure for federal research policy in Canada



Source: Technopolis

Canada has no central budget for research, but research activities are entailed in many departments, which submits yearly their estimates of expenditures and requests for funding. since the 1994 S&T Review of all federal departments and agencies involved in the S&T policy and as shown in Figure 2, Industry Canada (department) has been identified as the lead department and is in charge within the federal government of the horizontal coordination of the portfolio for science, technology and innovation policy,

which involves fifteen departments and agencies. However, it is also directly involved in the detailed S&T policy development (e.g. grants awards, funding to research programmes, etc) and in that sense is at the border between level 2 and level 3.

Health Canada is the second main department in terms of S&T policy. Other key actors in S&T are as follows:

- The National Research Council (NRC, federal research agency) is the agency of the federal government dedicated to research. It is in charge of undertaking, assisting and promoting scientific and industrial research in different fields of importance to Canada.
- The three granting councils who are in charge of providing grants for basic research to universities, as well as other types of support specified as follows for each council:
  - The Natural Sciences and Engineering Research Council (NSERC, granting council) supports university research through discovery grants and project research through partnerships among universities, governments and the private sector, as well as grants training of highly qualified people;
  - The Social Sciences and Humanities Research Council (SSHRC, granting council) promotes and supports university-based research and training in the social sciences and humanities through grants and fellowships programmes. SSHRC programmes also provide support for research training and research communication activities;
  - The Canadian Institutes of Health Research (CIHR, granting council) mandate entails the creation of new knowledge and its translation into improved health for Canadians, as well as the creation of more effective health services and products and a strengthened Canadian health care system. It funds research projects, partnerships research in view of commercialization and grants for training.
- The Canadian Foundation for Innovation (CFI) is an independent corporation created in 1997 by the Government of Canada to fund research infrastructure. The CFI's mandate is to strengthen the capacity of Canadian universities, colleges, research hospitals, and non-profit research institutions to carry out world-class research and technology development that benefits Canadians. CFI funding architecture involves open competitions for innovative infrastructure projects (primarily through the Leading Edge and New Initiatives funds); a pre-determined allocation-based program that gives universities the flexibility and rapid turnaround time to recruit and retain leading researchers (Leaders Opportunity Fund); a programme that defrays a portion of operating and maintenance expenses to ensure optimal use of CFI-funded infrastructure (Infrastructure Operating Fund).

As shown in Figure 2, the CIHR reports to the Minister of Health, while SSHRC, NSERC, CFI and NRC Canada reports to the Minister of Industry.

1.1.1.3 Distribution of federal expenditures in S&T by main departments, agencies and granting councils

The business enterprises sector is the most important funder of R&D, providing nearly 48% of R&D funds in 2007. The federal government is the second most important funder of R&D, providing nearly 19% of all R&D funding, while the provincial and municipal governments provide about 6% of all R&D funding. The higher education sector is the third main funder with nearly 16% of all domestic spending on research and development.[5] To a large extent, the share of each sector in R&D funding is stable

[5] Statistics Canada, Canada, Domestic spending on research and development (GERD), available online: http://www40.statcan.gc.ca (consulted November 2010)

since 2003, whereas the share of the federal government had each year slightly increased between 2000 and 2003.

Figure 3 presents the main federal departments and agencies involved in R&D funding and their share of federal expenditures on R&D over the past decade.

Figure 3 Main sciences and technology expenditures in Canadian federal departments and agencies over years (1999-2010)

Government's Department	1999/2000 Federal estimated expenditures		2009/2010 Federal estimated expenditures (intentions)	
	Million CAD	% of total federal estimated expenditures	Million CAD	% of total federal estimated expenditures
Industry Canada	411	7%	445	4%
Health Canada	225	4%	536	5%
Natural resources Canada	359	6%	548	5%
Fisheries and Oceans Canada	205	3%	286	3%
National Defence	305	5%	534	5%
Agriculture and Agri-Food Canada	310	5%	367	3%
Atomic energy of Canada Limited	N/A	N/A	387	4%
Canadian space Agency	306	5%	355	3%
Environment Canada	424	7%	672	6%
National Research Council Canada	553	9%	780	7%
Statistics Canada	419	7%	641	6%
Total public Federal government expenditures on R&D	6,308	100%	10664	100%

Source: Technopolis, based on Statistics Canada, Science Statistics. Federal Government Expenditures on scientific activities, 2009/2010 and 1999/2000 (http://cansim2.statcan.gc.ca)

The four leading federal departments are therefore NRC Canada, Environment Canada, Statistics Canada, and Natural resources Canada. Federal spending for research encompasses both intramural spending led by federal department and agencies and the funding of S&T activities by non-federal organisations, i.e. extramural spending. Federal departments and agencies provide targeted grants, projects and programmes funding to research institutes, universities and firms, according to their sectoral priorities. The comparison of figures between 1999/2000 and 2009/2010 shows that, if the share of Health Canada in total federal research expenditures has slighty increased from 4 to 5%, the share of Industry Canada and the NRC has however decreased from 7 to 4% and from 9 to 7% respectively.

The main providers of S&T funding however are the three granting councils, which fund basic research mainly, and the Canadian Foundation for Innovation, which fund infrastructures for research. Together, they account for 31% of total federal expenditures on S&T in 2009/2010, compared to 25% in 1999/2000 (Figure 4).

Figure 4 Main sciences and technology expenditures in Canadian granting councils and CFI (1999-2010)

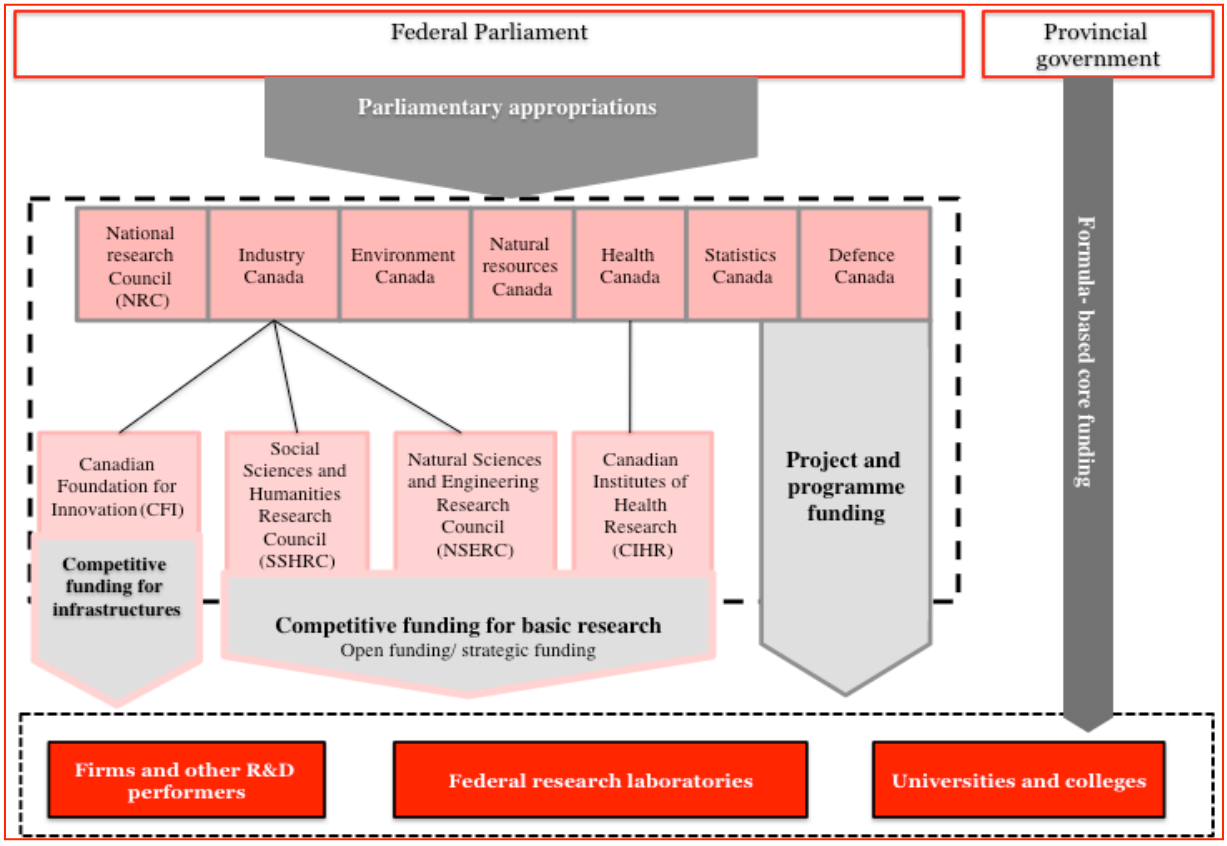
Granting Councils and CFI	1999/2000 Federal estimated expenditures		2009/2010 Federal estimated expenditures (intentions)	
	Million CAD	% of total federal estimated expenditures	Million CAD	% of total federal estimated expenditures
Natural Sciences and Engineering research Councils (NSERC)	540	9%	1,100	10%
Canadian Institute of Health Research (CIHR)	289	5%	966	9%
Social Sciences and Humanities Research Council (SSHRC)	121	2%	689	6%
Canadian Foundation for Innovation (CFI)	605	10%	580	5%
% of total Federal expenditures on R&D - granting councils and CFI	1555	25%	3,335	31%
Total Federal government expenditures on R&D	6,308	100%	10664	100%

Source: Technopolis, based on Statistics Canada, Science Statistics. Federal Government Expenditures on scientific activities, 2009/2010 and 1999/2000 (http://cansim2.statcan.gc.ca)

The share of the CIHR and the SSHRC in federal S&T expenditures over the past decade has grown consequently, while the share of the NSERC has only slightly increased. On the contrary, the share of the Canadian Foundation for Innovation, launched in 1997 and whose budget had subsequently increased during the first two years of its existence, has decreased from 10 to 5% of all federal expenditure on S&T in 2009/2010.

Figure 5 summarizes the main mechanisms for the allocation of R&D funding to Canadian research performers.

Figure 5 Main funding mechanisms in the Canadian R&D system



Source: Technopolis

1.1.1.4 Distribution of federal and provincial expenditures by research performers

An overview of the distribution of funding is given in Figure 6. Of the seven countries of the sample Canada comes as a close second for the country with the highest percentage of gross expenditure on research and development (GERD) performed by higher education at 35% (Netherlands is first at 37%). Although Business represents the largest share of R&D in terms of funding, its share has been decreasing over time, while the share of funding provided by the government has been increasing.

Figure 6 Share of GERD performed by performance (1998-2008)

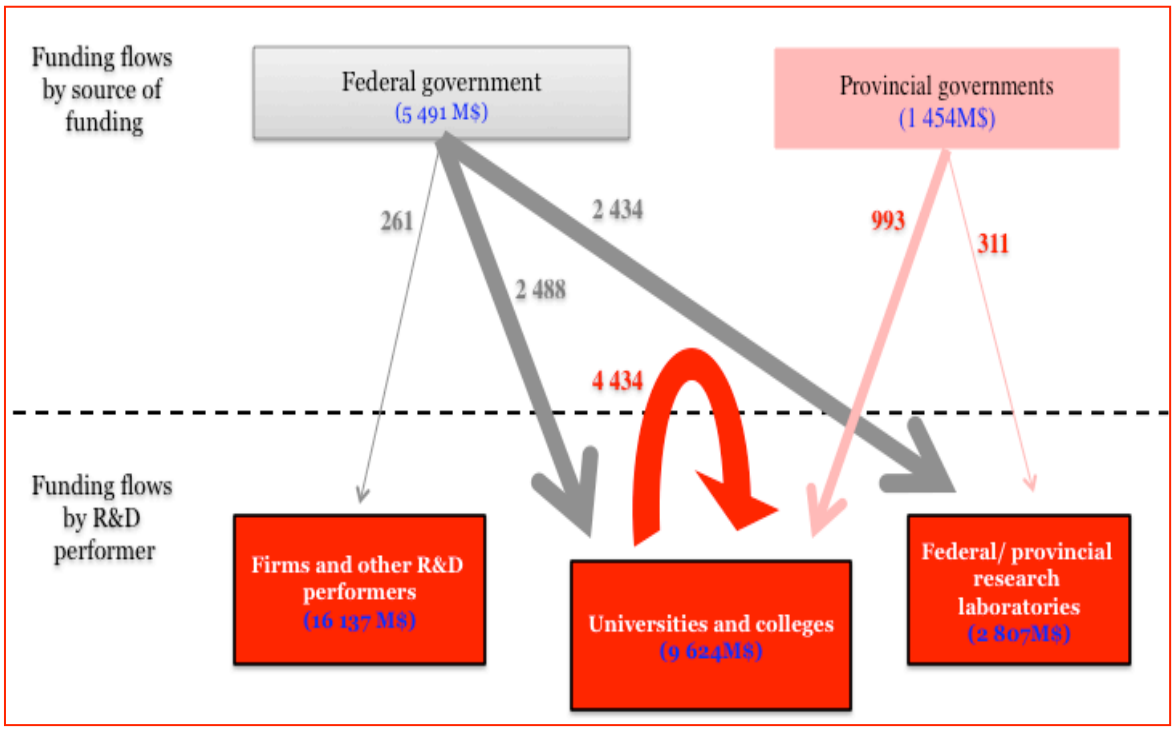
Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Business	60%	59%	60%	62%	58%	57%	57%	56%	56%	54%	54%
Higher Education	27%	29%	28%	28%	32%	33%	34%	34%	34%	35%	35%
Government	12%	12%	11%	10%	11%	10%	9%	10%	10%	10%	10%

Source: OECD Main Science and Technology Indicators

Figure 7 shows an overview of the main detailed public funding flows for science and technology in Canada in 2006, including the federal and the provincial levels.[6]

[6] Last year available.

Figure 7 Major flows of R&D funding in Canada (2006)



Source: Technopolis, based on STIC, State of the Nation 2008. Canada's science, Technology and Innovation System.

The federal government is the main provider of R&D funding to research laboratories - 86% of their budget in 2006 indeed came from federal government. The federal government is also a main funder of HEIs research and it provides 25% of R&D flows to HEIs mainly under the form of competitive funding. 46% of HEIs R&D funding came from their own budget. However the federal government accounts only for 2% of the funding flows dedicated to business enterprises. Enterprises indeed broadly finance their own research by 82%. Technology Partnerships Canada, a special operating agency of Industry Canada provides repayable R&D contributions, but the three granting councils and CFI target directly the public research sector, though fostering incentives to public private research. For instance, CFI projects can involve industry but eligible institutions are university, hospital, or post-secondary college or educational institution situated in Canada. It normally funds up to 40 percent of a project's infrastructure costs, which are invested in partnership with funding partners from the public, private, and voluntary sectors who provide the remainder. Also, specific research programmes in research agencies (e.g. Technology clusters initiative from the NRC) support business activities.

Provincial governments provide most of the basic physical infrastructure and operating costs for education and for research in Canada's universities and teaching hospitals, since institutions of higher education fall under provincial jurisdiction. Province accounted therefore for about 10% of the R&D funding flows dedicated to HEIs in 2006. Some provinces also perform and fund research in ways similar to the federal government, often in partnership with it, for instance through provincial research laboratories.

1.1.2 Priority setting at national level (Level 1)

Research objectives are regularly reviewed and reasserted at the different levels, according to prioritisation exercises.

Priority setting is decentralised — science-based departments and agencies set their own priorities, operate separately but come together through horizontal agenda of the

government. Horizontally, priorities are asserted in strategic documents. The current allocation of public funds is decided through the S&T strategy (Mobilizing Science and Technology to Canada's Advantage, May 2007), which is directed at fostering S&T-based advantages through investments and activities in three key areas:

- Entrepreneurial Advantage: to foster a competitiveness, business environment, commercialization and public-private partnerships;
- Knowledge Advantage to foster research in the national interest from a social and economic perspective and to enhance the responsiveness" of the three councils, and explore new approaches to federally performed S&T;
- People Advantage: to help to keep the most talented Canadian researchers and to attract talent from around the world, in order to enhance the quality of R&D existing workforce.

These goals deepen the innovation policy goals set by the previous government in 2002 in its innovation policy statement 'Achieving Excellence Knowledge Matters'. The document emphasized benchmarks and spending targets and Canada set itself the challenge to have its R&D efforts rank among the top five OECD member nations by 2010 in terms of GERD/GDP ratio. This was an ambitious goal that subsequently has proven difficult to meet, considering that Canada ranked only 15th among OECD member countries in R&D efforts in 2001. At the time, Canada's GERD/GDP ratio was approximately 1.9%. Just before the design of the 2007 S&T strategy it stood at approximately 2%. As a result, the 2007 S&T strategy paper does not make any reference to these R&D spending targets.[7]

Broadly speaking, Canadian S&T policy is strongly committed to competitiveness and performance goals in the business sector. In that sense, policy seeks to be sectoral – i.e. oriented towards defined business sectors - rather than cross-sectoral and horizontal. For instance the priority given to genomics research has led to the creation of the agency Genome Canada. Still, policy is relatively generic across business sectors in the sense that it does not favour one group of technologies or sciences over another. The 2007 S&T Strategy identified four priority areas for enhanced investment and activity:

- Environmental science and technologies
- Natural resources and energy
- Health and related life sciences and technologies

It also announces a new sectoral programme, the Strategic Aerospace and Defence Initiative.

Beyond the issued strategies, priorities at federal level are set through annual federal budget appropriations. To cope with the 2007 S&T Strategy's objectives, the 2008 budget contains specific investment measures for automotive and genomics R&D. The 2009 budget provides increased spending on higher education infrastructure and graduate education, but reduces funding for peer-reviewed funding from the granting councils. This was however increased in the 2010 budget.

Priorities at provincial level are set through ministries in charge of research and innovation activities. Ontario is a good example of a Province that has put in place a dedicated research and innovation strategy, through its Ministry of Research and Innovation (MRI). The plan emphasizes partnerships and research driven by industrial needs, as follows:

- Support for research with strategic value, with an emphasis on partnerships;
- Stimulation of university-industry partnerships and access to capital;

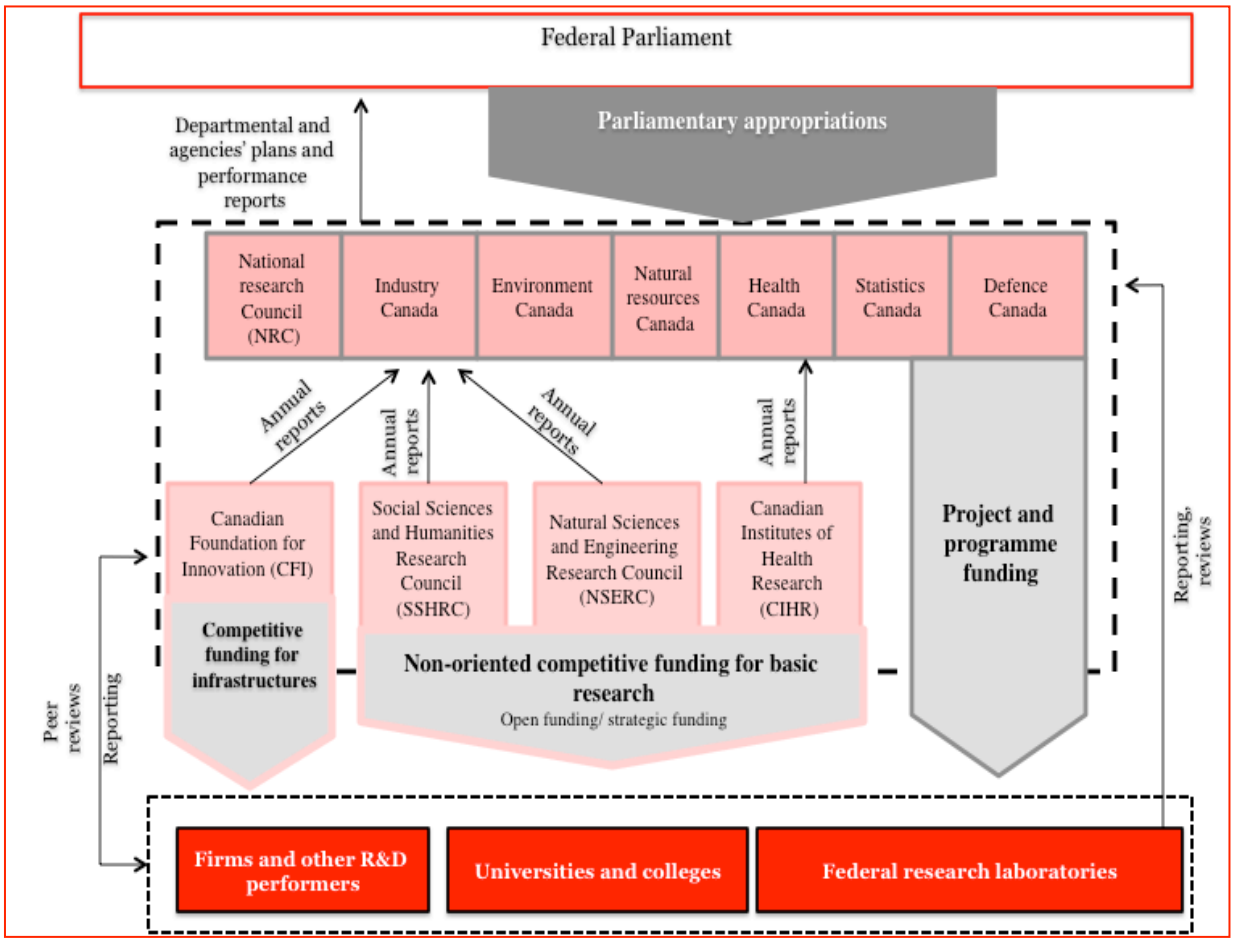
[7] Erawatch Research inventory, Canada (2009)

- Internal coordination and integration to focus efforts, and partnerships with other governments;
- Investment in people and promotion of an innovation culture;
- Development of indicators to measure progress;
- Development of a strategy to support investments in priority areas.[8]

1.1.3 Steering, governance and administration at the ministries level (Level 2)

Broadly speaking, steering mechanisms are rather well developed in all policy sectors at the federal level. Figure 8 presents an overview of the main steering mechanisms used by federal research funders and performers.

Figure 8 Main mechanisms for the steering of Canadian R&D departments, agencies, granting councils and research performers



Source: Technopolis, based on various sources

Each federal department and agency administering public money (not only those involved in research policy) reports its plans annually to Parliament in a Reports on Plans and Priorities (RPP) based on an MRRS (Management Resources and Results Structure) approved by the Treasury Board. A given MRRS consists of strategic outcomes; a programme activity architecture (PAA), and a performance measurement framework. After the end of every fiscal year, each department and agency reports back to Parliament through a departmental performance report (DPR) on its performance in delivering on plans, addressing priorities, and achieving expected

[8] Erawatch Research inventory, Canada (2009)

results.[9] MRSS and DPR also contain reviews of research projects, although with various coverage according to the department or Agency.

Moreover, since 2007 all federal direct program spending are reviewed by federal department and agencies on a four-year cycle. Strategic review results are announced through the annual federal budget. Once they have completed a comprehensive review of all of their programmes, organisations are required to identify a total of five percent of their programmes spending from the lower performing and/or lower priority level. These funds are proposed for reallocation to higher priorities and they are redirected to budget priorities to better meet the needs of Canadians.[10] Doing bad or well in relation to the strategic reviews therefore affects directly future budget and the allocation of funds.

NRC Canada's and Industry Canada's departmental performance reports (DPR) provide good examples of the main performance indicators used in the assessment of department and agencies involved in R&D activities for each strategic outcomes identified in the **Reports on Plans and Priorities** (RPPs) (Figure 9 and Figure 10).

Figure 9 Indicators used for the performance analysis of NRC Canada R&D activities and examples of performance results for 2009/2010

Expected Results	Performance Indicators	Targets	Performance Status	Performance Summary
Excellence and leadership in research that benefits Canadians	Publications in refereed journals / proceedings and technical reports	3,500 publications by March 2010	Exceeded	NRC researchers produced a total of 8174 articles: 1344 in refereed journals, 799 in conference proceedings, and 6031 technical reports.
	Technology licences issued	85 licences in high impact and emerging industry sectors by March 2011	Exceeded	Issued licenses increased by 22% to 135. In addition, NRC introduced 85 unique product and process innovations to industry.

Source: NRC Performance report 2009/2010

Figure 10 Indicators used for the performance analysis of Industry Canada's S&T activities and examples of performance results for 2009/2010

Performance indicator	**Target**	**Results and performance summary**	**Trend**
General performance indicators for the strategic outcomes			
Innovation Index (measure of the adoption of new technology, and the interaction between the business and science sectors)	Maintain or improve 12th-place ranking Status: met	Canada has maintained its 12th-place ranking in innovation out of 133 countries.The Innovation Index includes capacity for innovation; quality of scientific research institutions; company spending on R&D; university–industry collaboration in R&D; government procurement of advanced technology products; availability of scientists and engineers; and utility patents.	No change
International ranking of Canada in university–industry collaboration in R&D	Maintain 2nd-place ranking **Status**: Mostly met	Canada ranks 3rd out of 10 comparator countries in university–industry collaboration in R&D	No change (Canada ranked 2nd from 2003 to 2006. Since 2007 Canada has ranked 3rd.)

[9] Initiative Improving the Measurement, Reporting and Assessment of Federally Performed Science and Technology, Demonstrating Results for Canadians, Final Report, Part of the Policy Research Initiative

[10] NRC website: http://www.tbs-sct.gc.ca (consulted November 2010)

Performance indicator	Target	Results and performance summary	Trend
Number of people working in R&D of total employment numbers	8 per 1,000 Status: Exceeded	The latest results show that in 2005, Canada had 8.3 researchers per 1,000 of the population. This is up from 8.1/1,000 in 2004	Improving
Programme - Communications Research Centre Canada			
Client satisfaction survey (on content, timeliness and usefulness) related to Communication technical inputs and advice used to develop telecommunications policies, regulations, programs and standards	80% or higher **Status**: Not applicable	No formal client satisfaction survey was undertaken during the year. The CRC provided over 40 contributions to Industry Canada and international standards organizations (such as the Institute of Electrical and Electronics Engineers and the ITU) in the form of technical briefs and work group participation.	Not applicable
Increase in total sales revenues every 5 years of Canadian communications companies with a link to CRC, compared to market averages	20% **Status:** Not applicable	A study of CRC's economic impact is undertaken every 5 years, with the next study due in 2010–11. The last study, by an external consultant (2005–06), pointed to $1.6 million in annual sales revenues from CRC spinoff companies, and cumulative industry sales of $520 million resulting from CRC IP licences.	Not applicable
Programme - Knowledge Advantage in Targeted Canadian Industries			
Percentage of completed initiatives designed to increase knowledge and innovation in targeted Canadian industries, as a proportion of initiatives identified in the sector's business plan	80% **Status**: Exceeded	100% All initiatives designed to increase knowledge and innovation in targeted Canadian industries were completed as planned.	New indicator
Programme - Industrial Technologies Office / Special Operating Agency			
Dollar of private sector investment leveraged per dollar of agency investment in ITO projects	$2.00 Status: Mostly met	100% ITO leveraged $1.95 during 2009–10.	Declining (from last year's result, which was $2.00)

Source: Industry Canada Performance report 2009/2010

From this overview, one can conclude that performance indicators are mainly based on volume indicators and international ranking. Some indicators still deal with qualitative criteria (e.g. clients satisfaction).

The administrative efficiency is an issue in performance reports. Indeed, for instance the NRC Canada performance report contains performance indicators on the efficiency of programme management:

- HR turnover rates
- Percentage of operating budget allocated to training
- Capital investment in infrastructure
- Progress on strategy implementation
- Net cash flow

- Diversity of statistics

Last but not least, at the level of provinces, agreements are typically signed between universities and provincial governments, which are responsible for the distribution of core funding to universities. For instance, in Ontario, the provincial government allocate core funding and institutions report on outcomes achieved with the funding on an annual basis. This practice was strengthened in 2005-06 when the government introduced the Interim Accountability Agreement, and then the Multi-Year Agreement (MYA), that articulates the government's goals for the system, and its roles and responsibilities in meeting those goals. This agreement confirms the commitments expected from each institution and the sector-wide indicators that will be used to report on results achieved. Québec universities were also committed in 2000 to sign performance contracts with the Québec Minister of Education. The contract stipulates the commitment made by the institution with respect to various aspects of its activities and states that the institution must not use the amounts reinvested to eliminate its general fund operating deficit. All performance contracts are made public. Universities report to the Minister on their progress in fulfilling the commitments they made in their respective performance contracts so that the Minister may, in turn, report to the Government.

1.1.4 Setting and monitoring priorities at the agency level (Level 3)

As abovementioned, priority setting in Canada is decentralised —departments and agencies involved in S&T funding set their own priorities and come together through horizontal agenda of the government. Each agency therefore identifies its priorities in the yearly RPPs. These reports provide increased levels of detail over a three-year period on an organization's main priorities by strategic outcome, program activities and planned/expected results, including links to related resource requirements. The RPPs also provide details on human resource requirements, major capital projects, grants and contributions, and net program costs. These priorities are linked with the federal budget and the federal strategy.

Moreover, the three granting councils – SSHRC, NSERC and CIHR –all draft strategic plans determining their priorities, objectives and actions. Grants from the granting councils are provided after peer-review assessment mainly.

Reporting from research performers to departments, agencies and granting councils is well established and ensured through various mechanisms – reporting, evaluation, review of programmes and funding instruments, etc (see Figure 8, section 1.1.3 above).

Figure 11 shows that at the level of federal government basic research and funding for research education and fellowships (called 'non-oriented research') represent 6% of S&T federal expenditures for funding to intramural research and 13% for extramural research in the 2007/2008 budget. Funding for such research is mainly provided by the three granting councils and directed towards universities and university-affiliated research hospitals. Over the past decade, the share of basic funding has slightly increased for intramural research activities.

Figure 11 Estimates of basic research in the federal expenditures for S&T (1997-2008)

	1997/ 1998		**2007/2008**	
	Research carried out by federal government (intramural)	Research carried out outside the federal government (extramural)	Research carried out by federal government (intramural)	Research carried out outside the federal government (extramural)
Total federal S&T expenditures (Million CAD)	3,032	2,158	4,885	4,980
% of 'non-oriented' funding (%)	2%	14%	6%	13%

Source: Technopolis, based on Statistics Canada, Science Statistics. Federal Government Expenditures on scientific activities, 2009/2010 and 1999/2000 (http://cansim2.statcan.gc.ca)

'Oriented' funding is mainly provided by federal departments and agencies. It targets specific fields of research (e.g. exploration and exploitation of the Earth, infrastructure and general planning of land use, environment, human health, energy, agriculture, industrial production and technology, social structures and relationships, exploration and exploitation of space).

Grants for basic research and research education/ training from the three granting councils are either open - when investigator-driven - or strategic – when linked to strategic initiatives targeted to address major challenges. In the granting councils, strategic research grants and strategic joint initiatives between granting councils or other federal agencies support targeted research on pressing social, economic and cultural issues. Some examples of strategic funding provided by the SSHRC are as follows:

- Aboriginal Research (strategic research grant): Development Grants: to help teams of Aboriginal community organizations and university-based researchers develop research partnerships and proposals to investigate issues of concern to Aboriginal peoples
- Community-University Research Alliances (strategic research grant): to support research projects jointly developed and undertaken by postsecondary institution-based researchers and organizations from the community
- International Opportunities Fund Development Grants (strategic research grant): To support developmental activities that lead to significant international research collaboration
- Automotive Partnership Canada (joint strategic initiative): to support significant, collaborative research and development activities that will benefit the entire Canadian automotive industry. This initiative is a partnership between five federal research and granting agencies, including SSHRC. Interested applicants and companies should start by contacting APC's Project Office in Mississauga, Ontario.

Figure 12 present an estimate of the SSHRC expenses in terms of strategic and open funding over the past few years. According to these data, open funding (research grants and research training) accounted for about 57% of total expenditures in 2009.

Figure 12 Estimates of open and strategic funding allocation in the SSHRC over years (2003/2009)

	2003			2009		
	Open funding	Strategic funding	Other	Open project funding	Strategic funding	Other
Social Sciences and Humanities Research Council (SSHRC)	60%	16%	Canada research chair programme: 13%	57%	8%	Canada research chair programme: 17%

Source: Technopolis, based on SSHRC website (http://www.sshrc-crsh.gc.ca)

1.1.5 Research performers (Level 4)

1.1.5.1 Overall

Figure 13 shows the major flows of federal governmental funding by type of R&D performer and funder.

Figure 13 Distribution of federal government funding by performing sector in Canada (1999-2010)

S&T performer	1999/2000 Federal estimated expenditures		2009/2010 Federal estimated expenditures (intentions)	
	Million CAD	% of total federal estimated expenditures	Million CAD	% of total federal estimated expenditures
Total Federal R&D expenditures	6,308	100%	10,664	100%
Federal government	3,304	52%	5,437	51%
Provincial and municipal governments	33	1%	47	0,4%
HEIs	1,625	26%	3,275	31%
Canadian Business enterprises	1,008	16%	987	9%
Foreign	240	4%	465	4%
Other Canadian performers	With provincial and municipal governments		41	0%

Source: Science, technology and Innovation Council (STIC), State of the Nation 2008, Canada's science, technology and innovation system, 2009

The federal government therefore mainly funds its own research laboratories and agencies (51% of its whole expenditures in 2009/2010) and universities (31%). The share of universities' funding has slightly increased over the past decade, but the most important change is the share of business enterprises that has decreased from 16% to 9%. This could be explained to some extent by the fact that the federal government's role in research policy has evolved from funder to facilitator (e.g. providing loans and incentives to business enterprises to foster their R&D activities).[11]

Reports on funding flows as well as the repartition of research staff both highlight that the private sector is the foremost research performer in Canada, followed by universities and the public sector (See Figure 14).[12]

Figure 14 Principal research performing sectors

	Number	Research-active staff (% of total research FTEs, 2007)	Share of R&D funding flows (percentage of total funding flows in Canada, 2006)
Higher Education sector	400 universities and colleges	33%	34%
Government	200 federal laboratories	12%	9%
Business	8900 (2004)	60%	56%

Source: Technopolis, based on various sources

The business sector represents more than the half of total Canadian R&D expenditures in 2006. Canadian top 10 R&D business spenders are mainly active within the field of

[11] Erawatch Research inventory, Canada (2009)

[12] Additional information on research activities for each types of organisation is provided in : Association of Universities and Colleges in Canada (AUCC), Momentum, the 2008 report on university research and knowledge mobilization, 2008

telecommunications/communication equipment and services y. In 2009 they were as follows[13]:

- Research In Motion Limited
- Nortel Networks Corporation
- BCE Inc. 4
- TELUS Corporation
- IBM Canada Ltd.
- Magna International Inc.
- Pratt & Whitney Canada Corp.
- Atomic Energy of Canada Limited
- Alcatel-Lucent
- Ericsson Canada Inc.

The government sector is the third performer of research in Canada after business enterprises. Alongside extramural funding, it funds its own projects performed by its 120 research institutes and conducts research for the purposes of regulation.

The higher education sector is the third research performer. It is comprised of institutions such as universities and affiliated research hospitals, experimental stations and clinics. They are the main providers for basic research in Canada, although their role is evolving to applied research. Many universities have developed their own research strategy (e.g. university of Toronto Annual Research Report).

1.1.5.2 Mechanisms for the allocation of research funding to universities

Canadian universities are primarily public. All receive competitive funding from the three granting councils. In addition, they receive core funding and strategic funding for teaching and research from the provincial level. Overall 66% of funding to Canadian universities is provided by government for teaching and research, 24% is received through student tuition fees and the remaining 10% through investments and donations.

Mechanisms for the allocation of core funding highly varied from one Province to the other but each university receive funding through at least one of four different funding mechanisms according to the provincial or territorial location of the university[14]:

- Incremental funding: where indexation is applied to an historical funding position and rolled forward annually. This is the dominant form of funding, with some universities receiving 75% of their funding in this form.
- Formula funding: where funding is determined by the number of full-time equivalent students, type of discipline and level of study (or combination thereof).
- Strategic funding: provided on the basis of provincial or federal government priorities; for example, relating to innovation or skill shortages such as teaching or nursing. This funding is occasional, and by virtue of its nature highly discretionary.
- Performance funding: is restricted to some provinces and comprises less than 5% of overall funding.

[13]Research infosource Inc., Canada's Corporate Innovation Leaders, 2010, online:http://www.researchinfosource.com/top100.shtml, (consulted November 2010)

[14] Access Economics, Study of relative funding levels for university teaching and research activities, report for Universities Australia, june 2010

In Canada, Alberta was the first Province to allocate performance envelope. For instance, the following performance criteria were used in the allocations of core funding to universities and colleges in the Alberta province in the 2005 allocation of funding:

- Enrolment growth;
- Satisfaction of recent graduates;
- Employment of recent graduates;
- Administration expenditure efficiency;
- Revenue generation through entrepreneurial activities;
- Sponsored research awards;
- Citation impact of research papers;
- Community and industry support of research activity;
- Revenue generation through research activity.

These criteria relate both to teaching and research activities and they are mainly based on volume indicators and quantitative indicators on research quality. Performance envelopes were adopted in some provinces by the end of the 1990's, beginning of the 2000's. At the time, concerns have raised among research performers and decision-makers on the relevance of this type of funding, related to the articulation of public policy objectives and the perceived difficulty of their translation into performance measures; whether institutional achievement itself or the enhancement of achievement is to be the focus of reward; the need to recognize in the performance measures selected the legitimate variability in institutional purpose; and the means which exist to capture the relevant data, with due concern about their accuracy on the one hand and data acquisition costs on the other. For instance, the Saskatchewan province reported in 1998 little support for the establishment of a performance envelope in.[15]

1.2 Administrative efficiency of research performers

1.2.1 General overview of R&D staff

There were 224,106 full-time equivalent (FTEs) workers involved in R&D during the 2006 reference year. Comparisons for government, business and higher education respectively are as follows. Researchers were 46%, 59%, and 76%. The highest percentage of researchers was in higher education. Technicians were 29% in government, 29% in business, and 12% in higher education. Finally, support staff comprised of 26% in government, 12% in business, and 12% in higher education. Government had the largest percentage of support staff (Figure 15).

[15] Saskatchewan University Funding Review 5th Interim Report: The Development Phase, performed by Edward DesRosiers and Associates, 14 April 1998

Figure 15 Distribution of R&D personnel by occupation and sector of activity (2006)

Country	Canada									
Year	**2006**									
Sector of employment	**TIM: Total intramural**		**BE: Business enterprise**		**GV: Government**		**HE: Higher education**		**PNP: Private non-profit**	
	%	FTE	%	FTE	%	FTE	%	FTE	%	FTE
Total R&D personnel	100	224106	100	146666	100	17960	100	57270	100	2210
RSE: Researchers	62	139011	59	86581	46	8180	76	43530	33	720
TECH: Technicians	27	55146	29	42206	29	5140	12	6770	47	1030
OSS: Other support staff	13	29949	12	17879	26	4640	12	6970	21	460

Source: Technopolis, based on OECD Science, Technology and R&D statistics

The percentage of FTE support staff over the 1981-2006 reference years decreased. There was a steady increase in researchers in the 1990's, followed by a decrease in the 2000's. Support decreased significantly in the 1990's and then remained steady at about 15%. Specific patterns over time for the research sectors are given subsequently. For further information refer to Figure 16.

Figure 16 Distribution of R&D personnel by occupation (Canada, 1981-2006)

Country		Canada							
Sector of employment		**TIM: Total intramural**							
Year		1981	1985	1989	1992	1995	1999	2003	2006
Total R&D personnel (FTE)		89340	102070	115690	122370	144970	153341	196505	224106
% of Total R&D personnel	Researchers	45	51	55	59	60	64	53	53
	Technicians	30	28	27	24	25	22	31	31
	Other support staff	25	21	18	17	15	14	16	16

Source: Technopolis, based on OECD Science, Technology and R&D statistics

In the government sector there has been a steady decline in the percentage of FTE support staff amounting to a 26% decrease over twenty-five years. In 1981 support staff consisted of 35% of the total number of personnel, in 2006 they represented 26%. This has been coupled with an increase in researchers.

The business sector has had a decrease of 40% in the percentage of support staff from 1981 to 2008. In 1981 the support staff accounted for 20% of all personnel involved with business research and development, whereas in 2006 support staff accounted for 12% of total personnel involved with research and development. As in the government sector, the number of researchers has increased.

Finally, in higher education there has been a decrease of 53% in the percentage of support staff from 1981 to 2006. In 1981 the support staff accounted for 26% of all personnel involved with research and development, whereas in 2006 support staff accounted for 12% of total personnel involved with research and development. The percentage of researchers increased 52%.

1.2.2 Research administration budget in the CIHR and NRC Canada

The federal government S&T expenditures dedicated to information services, special services and studies (operations and policy studies), and the administration of extramural programmes give an estimate of the cost of the administration of research at federal level. These are shown in Figure 17.

Figure 17 The Administrative cost of research in the federal government expenditures related to S&T (1990-2010)

	1990/ 1991	1994/ 1995	1999/ 2000	2005/ 2006	2009/ 2010
% of administrative activities in the whole S&T federal expenditures	11%	10%	9%	14%	14%

Source: Technopolis, based on Statistics Canada, Science Statistics. Federal Government Expenditures on scientific activities, 2009/2010 and 1999/2000 (http://cansim2.statcan.gc.ca)

Over the last two decades, the cost of the administration of federal S&T activities has therefore slightly increased from 11% in 1990/2000 to 14% in 2009/2010. However, there is a clear shift before and after the mid 2000s. While the administrative costs have indeed steadily but gradually decreased during the 1990s, they have experienced a growth from 9% to 14% between the 1999/2000 budgetb and 2009/2010.

A look into the granting councils, the NRC and two universities budget give an overview of the main trends related to the efficiency of research administration in some research organisations (Figure 18). However, these data are hardly comparable, since they do not cover the same expenditures. That being said, Figure 18 shows that the budget dedicated to research administration in research granting councils reachs about 5% over recent years.

Figure 18 Administrative costs for research over time in some of the main Canadian research organisations

Research organisation	Share of administration costs in total budget – first year available		Share of administration costs in total budget – last year available		Definition and methodology used to calculate administrative costs
Social Sciences and Humanities Research Council (SSHRC)	1999/ 2000	9%	2010/ 2011	5%	Administration
Canadian institutes of Health Research (CIHR)	1999/ 2000	5%	2009/ 2010	6%	Operating expenditures
National Science and Engineering Research Council (NSERC)	1999/ 2000	4%	2008/ 2009	5%	Administration
National Research Council Canada	2005/ 2006	37%	2009/ 2010	57%	Operating expenditures: Utilities, materials and supplies; Amortization; Professional and special services; Transportation and communication; Repairs and maintenance; Payment in lieu of taxes; Bad debts; Information Rentals; Awards; Cost of goods sold; Net loss on disposal of capital assets
University of Quebec at Montreal	2008	16%	2008	15%	Administration costs related to teaching and research activities as percentage of total expenditures
University of Toronto	1998-1999	5%	2007-2008	4%	Operating costs related to teaching and research activities as a percentage of total expenditures

Source: Technopolis, based on various sources

1.3 Research education

1.3.1 Organisation of postgraduate researcher training

Doctoral programmes are delivered in universities and managed at University's level Prospective doctoral candidates apply directly to the University - often through the University's website.

Doctoral programmes are offered in graduate schools, together with master graduate research programmes. Admission is typically conditional on the prospective student having successfully completed a degree. Minimum average or demonstrated comparable research competences are often requested. However, some Universities and departments admit directly to the doctoral programme from a bachelor's degree for highly qualified candidates (minimum average A- required)

A minimum of three years of study and research, including the completion of a dissertation and some coursework, are the normal requirements for a doctorate. Doctoral-stream programme are often based on a research graduate programme followed by a doctoral programme. The degree is generally known as a PhD; however, doctoral degrees may also be granted in particular fields of study such as music (DMus) or law (LLD). To become a PhD, both an external examiner and an oral defence of the thesis are standard practice.

Research education is a great concern of Canada research strategy. The 2007 S&T strategy pointed out that "too few of our students, however, choose to pursue advanced S&T degrees. Compared to the OECD average, we have (…) fewer PhD-holders among young Canadians."[16]

After stagnating in the mid-1990s as the budgets of the three granting councils faced major cuts, full-time master's and PhD enrolment has risen rapidly from 65,000 students in 1996 to 102,000 students in 2006, with the introduction of new studentship mechanisms. This is a 57 percent increase over the decade, with most of that growth having taken place since 2000.[17] Figure 19 below shows evolution over recent years.

Figure 19 Number of doctoral qualifications awarded by year (2005-2008)

	2005	2006	2007	2008
Number of doctoral qualifications awarded	4,191	4,446	5,010	5,421
Percentage of doctoral degrees in total University's qualifications awarded	1,9%	2%	2,1%	2,2%

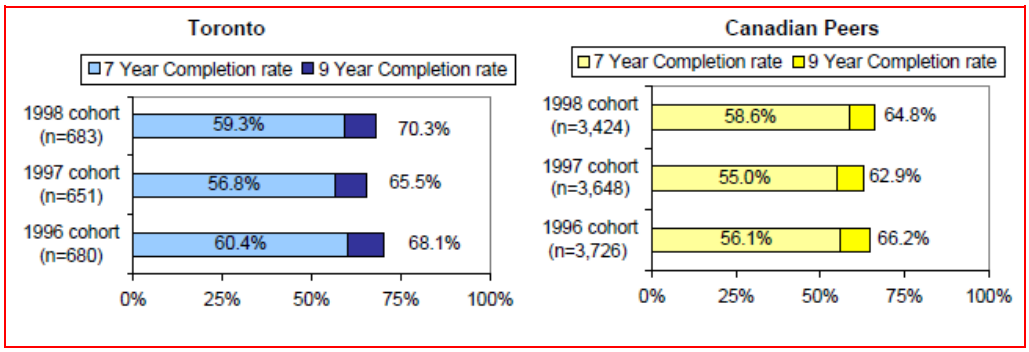
Source: Statistics Canada, University qualifications awarded by program level and gender (www.statcan.gc.ca)

According to a comparison including the University of Toronto and other peer Canadian universities, the seven-year and nine-year Completion Rate 1996, 1997 and 1998 Doctoral Cohorts is as follows:

[16] Canada's Government, Mobilizing Science and Technology to Canada's Advantage, 2007

[17] Garth Williams, Doctoral Education in Canada 1990-2005, Canadian Association for Graduate Studies, September 2005

Figure 20 Completion of doctoral students in the University of Toronto and in peer Canadian universities (1996, 1997 and 1998 cohorts)



Source: University of Ontario, performance indicators for governance 2009, Graduate Time-to-Completion and Graduation, http://www.utoronto.ca

A study from Elgar suggests that completion rate are more or less stable over time, since it reports between 45% and 70% of completion rates in doctoral programs in Canada for the 1985-88 cohort. (Franck Elgar, PhD degree completion in Canadian Universities, 2003). As for other countries, the completion rate of Canada's doctoral students in the Canadian university is far higher in Life, physical and applied sciences (between 73 and 78% of the 1996 Doctoral cohort have completed their PhD within nine years) than in social sciences and Humanities (between 47% and 59%).

1.3.2 Funding of postgraduate researcher training

In Canada, there is no overarching policy or singular strategy governing the organisation or funding of postgraduate researcher training. Doctoral programmes are funded through universities budget and tuition fees. The most common source of funding for doctoral candidates is the University. Fully 64% of graduates in the early 2000's reported income from university teaching assistantships, 58% from University scholarships and 30% from university research assistantships. In comparison, federal fellowships were reported by 35.2% of all students and federal research assistantships by 18%.[18]

Figure 21 summarizes the main mechanisms used for the allocation of research education funding in Canada at universities, provincial and federal level. It is not exhaustive, since funding systems in provinces are numerous and vary from one province to the other.

[18] Garth Williams, Doctoral Education in Canada 1990-2005, Canadian Association for Graduate Studies, September 2005

Figure 21 Main mechanisms used in Canada for the allocation of funding for research education

Type of funding	Organisation responsible for funding	Definition
Application personal stipends	Universities	Many Universities provide students with a funding package that include a minimum basic stipend to counterbalance the cost of studies (scholarship, fee waiver, bursary, etc). most of the time, admission personal stipends are awarded yearly (at application time) and they are renewable under conditions. Some research scholarships are also delivered by universities during the course of studies for purpose of travel for research conference or events.
Competitive personal stipends	Universities Provinces	Competitive stipends are delivered towards awards in various disciplines. They are publicised in calls for participation.
Research grants to individuals and institutions	The three granting councils (NSERC, SSHRC, CIHR) Provinces Other federal agencies Provinces	Competitive grants are delivered to doctoral candidates through calls for participation. Some grants also supports international mobility (e.g. Canada Graduate Scholarships—Michael Smith Foreign Study Supplements) or aims at attracting talented researchers from abroad (e.g. Georges Philias Vanier Canada Graduate Scholarships programme)

Source: Technopolis

Universities assistance is awarded in many forms, from tuition waivers, various types of assistantships, to fellowships, bursaries and loans. While some are entrance/application scholarships, other are delivered during the course of doctoral studies. The Universities provide some of the assistance schemes through doctorate applications: students are nominated by their departments (University of Waterloo) or their qualification to the University acts as application for some financial supports (e.g. Quebec university of Montreal, FARE programme). In the University of Toronto, doctoral programmes commit to a minimum level of funding at the beginning of each year. Additionally, most of the universities provide competitive personal stipends. In the University of Toronto for instance, competitive awards are delivered in various disciplines through annual calls for participation. Students submit their application to the Awards Officer.

In 2007-2008, stipends paid from grants from the three granting council to doctoral students vary between CAN$ 15,000 and CAN$ 19,000 (€ 11.064- 14.000). Usually, universities complete this up to CAN$ 23,000-26,000 (€17.000-19,000), depending on faculties and doctoral programmes. In many cases, a student who receives CAN$15,000 or more, as a major, competitive, and external award, will be provided with an additional bonus (equivalent for instance to CAN $3,000 (€2,216) in the Faculty of Physiology of the University of Toronto).

The value of PhD compared to a master degree in Canada is questioned. Statistics Canada's 2007 National Graduates Survey found that, two years after leaving university, those with a doctorate earned on average C$65,000 (€48,000) a year, only $5,000 more than the $60,000 (€44,000) earned by those with a master's degree.[19]

The federal government support research education through grants to individuals or institutions. Figure 22 shows the percentage of federal expenditures dedicated to education support over years. This includes R&D grants or research fellowships for

[19] Philip Fine , **Canada: PhD offers little salary différence**, article published on the 24th, May 2009, online : University World News (http://www.universityworldnews.com)

individuals at universities, and grants to institutions in support of the post-secondary education of students in technology and social sciences.

Figure 22 The Administrative cost of research in the federal government expenditures related to S&T (1990-2010)

	1990/ 1991	1994/ 1995	1999/ 2000	2005/ 2006	2009/ 2010
% of education support activities in the whole S&T federal expenditures	3,5%	3,2%	3,1%	2,7%	3%

Source: Technopolis, based on Statistics Canada, Science Statistics. Federal Government Expenditures on scientific activities, 2009/2010 and 1999/2000 (http://cansim2.statcan.gc.ca)

Figure 22 shows that the percentage of federal S&T expenditures dedicated to education support has decreased from 3,5% to 3% during the past two decades. However, one can observe a slight growth in the second part of the 2000s. At federal level, the three federal granting councils are the main providers of research education funding. They provide grants for research dedicated to doctoral and graduate students. In some cases, students apply directly to the responsible granting councils (e.g. the Doctoral awards provided by the CIHR); in others, Universities (mainly through the offices for graduate studies) are assigned a quota, and departments within Universities rank the applications, and recommended applications to the appropriate council (e.g. tri-council Canada Graduate Scholarships programme). The most important doctoral support programme is the tri-council Canada Graduate Scholarships Programme (CGSP) established in 2003 as the first government direct support for research education. It provides scholarships to Canadian students enrolled in master and PhD programmes. The initial programme provided 2 000 scholarships at the PhD level annually. The programme has been expanded further and represents CAN $ 116 million in 2007.

More recently, the government action has focused on excellence of postgraduate researchers and international students. It has launched in 2008 a new programme to provide an elite tranche of awards for world-leading faculty and graduate students. The Georges Philias Vanier Canada Graduate Scholarships programme is to support 500 top Canadian and international doctoral students per year, with the intention of attracting the world's best doctoral students to Canadian universities. Universities who perform their internal candidate-selection process submit applications. Granting agencies then perform their own peer review process and forward their nominations to a selection board in charge of the Vanier programme.[20] The scholarship is worth $50,000 per year for up to three years, a sum comparable to the scholarships offered through the internationally renowned Fulbright Program in the USA. In addition, the Research Affiliate Program (RAP) implemented since 2005 across federal departments and agencies is designed to give postsecondary students (graduate and PhD) experience in research (design, execution, evaluation) through salarysupport, stipends or bursaries. Candidates apply online and the hiring departments organize a recruitment process. Interesting is also the NSERC's Industrial Postgraduate Scholarships and Industrial Research Fellowships programmes, which delivers $15,000 per year for up to three years plus a minimum contribution from the sponsoring organization of $6,000 per year to promote research-industry collaboration. It enables students from the graduate, doctoral and postdoctoral levels to gain research experience in industry. Universities are in charge of selecting the awarded students.

Some provinces (Ontario, Quebec, Alberta) have sought in the 1960s to complement federal research funding and encourage the application of research results. As a result, doctoral students historically increasingly chose to study in those Provinces. The Ontario Graduate Scholarship Programme for instance encourages excellence in

[20] Vanier Canada Graduate scholarships Programme's website: http://www.vanier.gc.ca (consulted October 2010)

graduate studies at the master and doctoral levels. It is a merit-based scholarship and awards are available to students in all disciplines of academic study. Students may apply through their University or directly to the Programme, depending on their situation. Two Academic Assessment Reports completed by professors familiar with the field of studies are required for application.

1.3.3 Criteria for postgraduate researcher training

Figure 23 presents the major type of research education funding and the related criteria for funding. Although it offers a broad overview of the main mechanisms at stake, it is not exhaustive. Research education funding is indeed hard to assess, since it is often embedded in graduate, research projects or other type of funding.

Figure 23 Main type of funding and criteria for research education funding

Type of funding	Organisation responsible for funding	Criteria used in the allocation of funding and examples of indicators in institutions involved in doctoral training
Admission personal stipends	Universities	Most of the time these stipends are based on the assessment of the **quality of candidates**. This includes **academic merit** but not only. Examples of indicators used to assess the quality of candidates are as follows: • University of Ottawa: admission scholarship is given automatically to any student whose admission average is 8.0 / 10 or more and who registers full-time without interruption for the duration of the scholarship • FARE programme of the Quebec University of Montreal, recruitment excellence award: Entrance awards for doctoral candidates who have received a fellowship/scholarship offer from the provincial or federal governments
Competitive personal stipends	Universities Provinces	The **quality of candidates** is the main criteria used, based on **individual academic merit**. For instance in the University of Toronto, personal stipends are delivered according to academic performance: • University of Toronto fellowships awards: new students must have at least an A- average in the final years of their previous programme at the University of Toronto, or its equivalent from an approved university. Current University of Toronto Fellowship holders must maintain a minimum annual standing of A- or be deemed to be making satisfactory progress towards the degree for which they are registered. The renewability of an award is dependent on the maintenance of the minimum annual standing or an assessment of satisfactory progress in the programme as well as on the graduate student financial support budget available to the Department in a given year. Many competitive grants available in universities are also focus on **specific fields of research**.
Research grants to individuals ad institutions	The three granting councils (NSERC, SSHRC, CIHR) Other federal agencies Provinces	The **quality of candidates** is the main criteria used, based on **individual academic merit** calculated thanks to grads transcripts and references. Several competitive grants available in universities are also focus on **specific fields of research**, for instance: • 2010/2011 CIHR Doctoral research award focused on stroke • IDRC Doctoral Research Awards: in the field of international development. Relevance to sustainable and equitable development and to IDRC priorities, quality of the research proposal, and suitability of the candidate are evaluated • Vanier Canada Graduate Scholarship (CGS) Program: SSH focused

Some awards are directed to Canadian permanent resident only, other are designed to attract talented doctoral candidates from abroad. Several only target full-time

students. All in all, the major part of the assistance programmes are based on the quality of the students calculated through the academic standing of the candidate.

In universities, the selection process for grants is organised at the department level and often involve an administrative antenna within the universities dedicated to grants and awards, or a graduate office. Those are in charge of administering grants but also of helping candidates to find an appropriate grant. Lists of available funding support for research doctoral candidates are available online in most of the universities and in some cases could be sorted by type of support, responsible organism, disciplines, status of the candidate (Canadian resident/ international), value, etc.[21]

In the granting councils - Canadian Institutes of Health Research (CIHR), Natural Sciences and Engineering Research Council (NSERC), Social Sciences and Humanities Research Council (SSHRC) - recruitment is made through awards programmes and is based on a competitive process and a peer-review assessment. Some awards target specific fields of research or disciplines (IDRC Award, Vanier Canada), while other are generic competition.

For instance, the CIHR Doctoral research awards 2010-2011 involve a review committee in charge of evaluating the full applications. The committee may be drawn from one of CIHR's pre-existing committees or may be created specifically for this funding opportunity. Committee members are selected based on suggestions from many sources including the instituted / branches and partners. The following general criteria for evaluating training award applications are used:

- Achievements and Activities of the Candidate
- Characteristics and Abilities of the Candidate
- Research Training Environment

Applications are peer-reviewed in a single CIHR Doctoral Awards competition. A ranking list is generated and CIHR funds applications from top down in order of ranking, to the limit of the pool's funds. Applications that receive a rating below 3.5 are not funded.[22]

Another example is the SSHRC Doctoral award. It is based on a two-stage process involving multidisciplinary selection committees in charge of evaluating applicants on academic merit, measured as follows by:

- Past academic results, as demonstrated by transcripts, awards and distinctions;
- The program of study and its potential contribution to the advancement of knowledge;
- Relevant professional and academic experience, including research training, as demonstrated by conference presentations and scholarly publications;
- Two written evaluations from referees;
- The departmental appraisal (for those registered at Canadian universities).

Multidisciplinary selection committees divide applications into two categories: A-list applications, which are recommended; and B-list applications, which are not. All A-list applications are entered into the national competition, where they are evaluated by one of five multidisciplinary selection committees.[23]

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[21] A good example is the University of Waterloo Scholarships database search engine: http://www.grad.uwaterloo.ca/scholarships/index.asp (consulted November 2010)

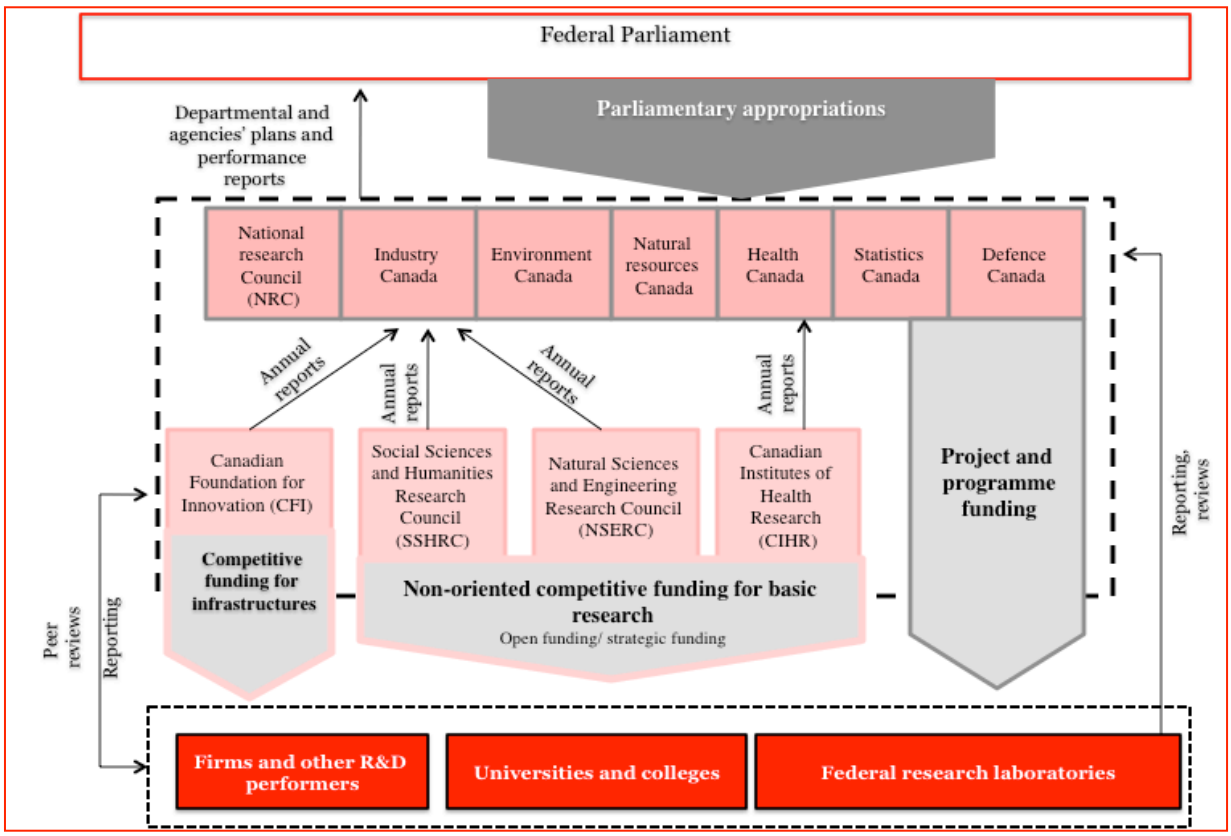
[22] CIHR website: http://www.researchnet-recherchenet.ca (consulted October 2010)

[23] SSHRC website: http://www.sshrc-crsh.gc.ca (consulted October 2010)

1.4 Research funding criteria and mechanisms

Some of the issues related to the funding criteria and mechanisms have already been reported in the first section of this report (see sections 1.1.3 and 1.1.4) and are shortly summarized here. Figure 24 sums up the main funding mechanisms used in the allocation of public money for research in Canada.

Figure 24 Main mechanisms for the steering of Canadian R&D departments, agencies, granting councils and research performers (reminder)



Source: Technopolis, based on various sources

1.4.1 Core funding to universities from the provincial governments

Although Canadian provinces are not represented on the above scheme, they are responsible for core funding delivered to the higher education sector. As aforementioned (see section 1.1.5.2), the basis for the allocation of core funding varies strongly from one province to the other, although it is based on at least one of four different funding mechanisms according to the provincial or territorial location of the university[24]:

- Incremental funding: where indexation is applied to an historical funding position and rolled forward annually. This is the dominant form of funding, with some universities receiving 75% of their funding in this form.
- Formula funding: where funding is determined by the number of full-time equivalent students, type of discipline and level of study (or combination thereof).
- Strategic funding: provided on the basis of provincial or federal government priorities; for example, relating to innovation or skill shortages such as teaching or

[24] Access Economics, Study of relative funding levels for university teaching and research activities, report for Universities Australia, june 2010

nursing. This funding is occasional, and by virtue of its nature highly discretionary.

- Performance funding: is restricted to some provinces and comprises less than 5% of overall funding.

In the Ontario Province, performance indicators used as basis for the allocation of formula based funding are mainly related to teaching and not to research (e.g. students access to universities, quality of the learning environment, students retention rate).

There is no available data at the national level on the share of core funding over competitive funding in Canadian universities. However, let us take the case of the Toronto University (Ontario Province) in point.

Figure 25 Revenues of the University of Toronto by posts over years (2000-2010)

Revenues	2000	2005	2010
Ontario government grants for general operations	26,4%	33%	31%
Student fees	20,3%	29%	32%
Ontario government and other grants for restricted purposes	18%	17%	17%
Sales, services and sundry income	9,7%	12%	11%
Investment income	2,2%	5%	6%
Donations	7,6%	3%	3%
Contract research/ other grants	2,3%	1%	1%
Total revenues	100%	100%	100%

Source: Technopolis, based on the University of Toronto Financial Reports 2000, 2005 and 2010 (http://www.finance.utoronto.ca/Page799.aspx)

Figure 25 shows that the core funding provided by the Ontario government ('government grants for general operations') has increased over the past decade, from 26% to 31%. In comparison, grants for restricted purposes provided by the Ontario government and the federal government have remained stable over the period (18% to 17%).

1.4.2 Targeted projects and programme funding from the federal departments and agencies

Targeted projects and programmes funding from the federal government to universities, research institutes and firms are mainly provided through federal departments and agencies in their sector of relevance. Project funding through grants are most of the time open to proposals from the research community and provided on a competitive basis. Targeted programme funding entails mission-oriented funding, among them:

- The Knowledge Infrastructure Programme is a two-year $2-billion economic stimulus measure to enhance infrastructure at post-secondary institutions while generating economic activity and creating jobs in communities across Canada;
- The Canada Excellence Research Chairs (CERC) programme offers eligible Canadian degree-granting institutions the opportunity to establish highly remunerated research Chairs at their institutions in research areas that are of strategic importance to Canada;
- CANARIE Inc. is a not-for-profit corporation that develops and operates Canada's advanced research network, CAnet 4, linking researchers and educational communities across Canada and around the world. CANARIE facilitates the

development and use of next-generation research networks, and the applications and services that run on them;

- Industrial Research Assistance Programme (IRAP) provides a range of both technical and business-oriented advisory services along with potential financial support to growth-oriented Canadian small and medium-sized enterprises;
- Networks of Centres of Excellence (NCE) - with the Centres of Excellence for Commercialization and Research and the Business-Led - support for the growth of innovation in Canada by fostering cross-jurisdictional partnerships.

Some funds to NRC Canada's programmes are provided on a sunsetting basis. This means that rather than providing a permanent increase in the NRC allotment, the government allocates funding for strategic purposes for a limited period of time with the option for renewal. Renewal is conditional on various factors, including:

- Performance criteria;
- Effectiveness criteria (i.e. achieving desired objectives);
- Relevance criteria (i.e. linkages to priorities);
- Efficiency criteria (i.e. the availability of funds).

The funding is therefore both thematic/strategic and linked to performance achievements. Currently, NRC has numerous initiatives and projects funded on a sunsetting basis, several of which received renewed intentions of support from the Government in the 2010 Federal Budget, including[25]:

- Technology Cluster Initiatives that nurture the growth of local scientific and innovative capability at local level to encourage industrial competitiveness. An evaluation of the clusters initiative was undertaken to provide information in support of the renewal process for the initiatives in 2009-2010;
- Contribution agreement with TRIUMF (Canada's National Laboratory for Particle and Nuclear Physics)
- Genomics R&D Initiatives that coordinates genomics R&D in 6 federal departments and agencies to support their mandates, public policy objectives and key national interest in human health, agriculture and food safety, environment and natural resources management.

Within the framework of their research projects and programmes, federal departments and agencies also contract out to universities to do research on specific topics. In 2006, universities performed more than 1,700 research contracts worth $155 million for the federal government.[26] For instance, *Agriculture and Agri-Food Canada (AAFC)* funded 59 new agricultural research projects across Canada in 2008-2009 and a panel of external scientific experts systematically evaluates research proposals.

Agriculture and Agri-Food Canada (AAFC): the proposals are evaluated by panel members composed of independent experts from national and international institutions such as universities, other government organisations and industry. Agriculture and Agri-Food Canada (AAFC) 2009-2010 research proposals were evaluated by Research Branch management for alignment to government priorities and by external experts from the scientific community for scientific quality.

Research Branch established five external review panels comprised of 39 recognized science experts from outside AAFC to effectively evaluate the 2009-2010 research proposals. The five panels were:

- Plant Science

[25] NRC, 2010 annual report.

[26] Association of Universities and Colleges in Canada (AUCC), Momentum, the 2008 report on university research and knowledge mobilization, 2008

- Animal Science
- Environment and Ecology
- Food Science
- Crops Genomics

The panel members assess research proposals on:

- Scientific excellence of the research scientists
- Scientific merit and originality of the proposal
- Contribution to innovation and to AAFC National Priorities
- Feasibility and potential to achieve objectives and deliver outputs

AAFC also assessed whether the research proposals aligned with federal government and departmental mandates by determining if the proposed science.

Source: Agriculture and Agri-food Canada, http://www4.agr.gc.ca

1.4.3 Competitive funding from the three granting councils and CFI

The three granting councils – Canadian Institutes of Health Research (CIHR), Natural Sciences and Engineering Research Council (NSERC), Social Sciences and Humanities Research Council (SSHRC), and the Canada Foundation for Innovation (CFI) - display the main federal non-oriented funding mechanisms for research, mainly to universities. In all cases, funding is awarded on a competitive basis through peer review processes[27]:

[27] Erawatch Research inventory, Canada (2009)

Figure 26 Main criteria used in the allocation of research grants in the three Canadian granting councils

Granting council and assessment procedure	Main criteria used in the assessment and related indicators (if available)
Social Sciences and Humanities Research Council (SSHRC) Peer-review committees made of volunteers Canadian or foreign scholars and experts The peer review committee first chooses 2 or 3 benchmark applications files to be reviewed by all reviewers and agree on the score of these files. Reviewers then review other applications files (2 reviewers per file). Before the committee meets, readers send their preliminary scores, evaluating according to the various criteria and discussions on the final scoring during the meetings through consensus seeking.	60 per cent of the assessment grad ought to be attributed to the track record and 40 per cent to the description of program of research • Academic excellence, based on the researcher's track record (60% of the final note) • Quality of the research proposal, originality, potential significance (40% of the final note)
Canadian institutes of Health Research (CIHR) Independent peer review committees composed of a number of volunteer reviewers (national and foreign) who write detailed reports on the proposal's strengths and weaknesses Numerical rating for each proposal and a portion of the total competition budget amount is allocated to each successful application starting from the top of the ranking list until the total competition budget is expended	• Criterion 1: Research Approach – Clarity of the research question. – Completeness of the literature review and relevance to study design/research plan. – Clarity of rationale for the research approach and methodology. – Appropriateness of the research design. – Appropriateness of the research methods. – Feasibility of the research approach (including recruitment of subjects, project timeline, preliminary data where appropriate, etc.). – Anticipation of difficulties that may be encountered in the research and plans for management. • Criterion 2: Originality of the Proposal – Potential for the creation of new knowledge. – Originality of the proposed research, in terms of the hypotheses/research questions addressed, novel technology/methodology, and/or novel applications of current technology/methodology. • Criterion 3: Applicant(s) – Qualifications of the applicant(s), including training, experience and independence (relative to career stage). – Experience of the applicant(s) in the proposed area of research and with the proposed methodology. – Expertise of the applicant(s), as demonstrated by scientific productivity over the past five years (publications, books, grants held, etc.). Productivity should be considered in the context of the norms for the research area, applicant experience and total research funding of the applicant. – Ability to successfully and appropriately disseminate research findings, as demonstrated by knowledge translation activities (publications, conference presentations, briefings, media engagements, etc.). – Appropriateness of the team of applicants (if more than one applicant) to carry out the proposed research, in terms of complementarity of expertise and synergistic potential. • Criterion 4: Environment for the Research – Availability and accessibility of personnel, facilities and infrastructure required to conduct the research. – Suitability of the environment to conduct the proposed research. – Suitability of the environment (milieu, project and mentors) for the training of personnel (if applicable). • Criterion 5: Impact of the Research – Research proposal addresses a significant need or gap in health research and/or the health care system. – Potential for a significant contribution to the improvement of people's health in Canada and the world and/or to the development of more effective health services and products. – Appropriateness and adequacy of the proposed plan for knowledge dissemination and exchange.

Granting council and assessment procedure	Main criteria used in the assessment and related indicators (if available)
National Science and Engineering Research Council (NSERC) Independent peer Review committees ('Evaluation Groups') whom most of the members are appointed for three years from the Canadian academic community but might come from abroad or from the private and public sectors as well Reviewers are asked to rate each application with respect to each criterion, and the consensus vote will be determined for these criteria. Proposals are evaluated for each criterion according to the following scale: 1. Exceptional 2. Outstanding 3. Very Strong 4. Strong 5. Moderate 6. Insufficient	• Criterion 1: Scientific or engineering excellence of the researcher – Knowledge, expertise and experience – Past or potential contributions to, and impact on, the proposed and other areas of research – Importance of contributions – Complementarity of expertise between members and synergy (For group applications) • Criterion 2: Merit of the proposal – Originality and innovation – Anticipated significance – Clarity and scope of objectives – Methodology and feasibility – Discussion of relevant issues – Appropriateness / Justification of budget – Relationship to other sources of funds • Criterion 3: Contribution to the training of highly qualified personnel – Quality and extent of past contributions – Appropriateness of the proposal for the training of HQP – Training in collaborative and interdisciplinary environment (if applicable) • Criterion 4: Cost of research (high/ normal/ low)

Source: Technopolis, based on the granting councils' manuals for peer reviews and websites

Typically, the three granting councils are run as innovation agency, where peer reviews make recommendations for funding to the granting councils' officers. In the three granting councils, criteria used during the peer review process target both the quality of the applicant and the quality of the research project. However, in the SSHRC the quality of the applicants (based on the assessment of his track records) contribute to 60% of the final scoring, whereas in the two other councils it is only a criterion among the others. The NSERC also evaluate the proposals potential in contributing to the training of highly qualified personnel. For specific funding opportunities linked to strategic programmes, the CIHR has tailored the peer review process to ensure that funded applications meet strategic programmes' objectives: Merit Review – with specific scoring for scientific merit - and Relevance Review - used to ensure that the objectives of the applications align with the objectives of the funding opportunity.

Interesting is that in 2008, as part of its commitment to continuous improvement, SSHRC commissioned a panel of international experts in peer review to assess the quality of the organization's peer review practices in the council.[28] The panel's final report concluded that SSHRC's peer review system is "*up to the best practices and highest international standards*." However it notices some limits in the process and make recommendations in that sense, among them:

- The use of electronic files: committee members handle boxes of huge binders that they receive at home or at their office, and then eventually carry or send back to Ottawa for their own use during the adjudication meeting week, whereas, in other countries and also in Canada (e.g. NSERC), some agencies have entirely moved to electronic applications since a while and use exclusively digital documents.
- Do away with the 60/40 percentage rules: track record should, on its own, entitle no one to receive another research grant, and the quality of the research proposal, its originality and potential significance should always be the primary focus of attention in decision making.

A number of provinces also fund research through their own granting agencies, and many provide support for such activities as targeted research initiatives (for example, in health or agriculture) or promotion of university-industry collaboration and

[28] Promoting Excellence in Research—An International Blue Ribbon Panel Assessment of Peer Review Practices at the Social Sciences and Humanities Research Council of Canada, 2008

technology transfer. Several provinces also provide funds to cover a portion or all of the institutional costs associated with provincially sponsored research, or research sponsored by other external sponsors.[29] As federal funding, provincial funding is mainly provided on a competitive basis through peer reviews. One example is the Ontario Early Researcher Awards Programme, which targets research education as well as research capacity strengthening.

The **Ontario Early Researcher Awards Program Guidelines** (Ontario Ministry of Research and Innovation) helps promising, recently appointed Ontario researchers build their research teams of undergraduates, graduate students, post-doctoral fellows, research assistants, associates, and technicians. The goal of the program is to improve Ontario's ability to attract and retain the best and brightest research talent. Eligible applications are forwarded to peer review panels for an expert review, which makes recommendations to the Ontario Research Fund (ORF) Advisory Board

- Excellence of the Researcher (40%): academic and employment record, research grants and awards received, etc.
- Quality of Research (30%): originality, excellence of research proposed, etc
- Development of Research Talent (20%): skills development of the team, training
- **Strategic Value for Ontario (10%): economic benefits, knowledge transfer, etc.**

The research institution on behalf of the researcher administers the grant.

Source: Ontario Ministry of Research and Innovation, online: http://www.mri.gov.on.ca

1.5 Monitoring of research grants

1.5.1 Monitoring at federal level

As aforementioned (see section 1.1.3), each federal department and agency administering public money (not only those involved in research policy) reports its plans (i.e. Report on Plans and Priorities, RPP) and performance (i.e. Departmental Performance Report, DPR) annually to Parliament These contain reviews of research projects, although with various coverage according to the department or Agency.

Indicators used in NRC Canada's and Industry Canada's performance reports are mainly based on volume indicators and international ranking. Some indicators are however based on qualitative criteria (e.g. clients satisfaction). Performance reports are published in the federal budget and are used in the following year funding allocation. A list of indicators and related criteria used in the assessment of S&T performance for the two agencies is provided in section 1.1.3. Some of them are listed below:

- IP portfolio (patents issued, patent applications, licences)
- Publications in refereed journals / proceedings and technical reports
- Leadership and contribution to federal horizontal initiatives
- Number and value of national and international collaborative agreements

Moreover, since 2007 all federal direct program spending are reviewed by federal department and agencies on a four-year cycle. Once they have completed a comprehensive review of all of their programs, organizations are required to identify a total of five percent of their program spending from their lower performing, lower priority programs. These funds are proposed for reallocation to higher priorities and they are redirected to Budget priorities to better meet the needs of Canadians.

More specifically, research programmes conducted and managed by federal agencies and departments are submitted to a rather strong monitoring and review process,

[29] Association of Universities and Colleges in Canada (AUCC), Momentum, the 2008 report on university research and knowledge mobilization, 2008

although for many bodies few information is available on the monitoring process once the funding has been elected and delivered. In this respect, Genome Canada and its six Genome Centres, which fund and manages large-scale research projects in key selected areas such as agriculture, environment, fisheries, forestry, health and new technology development, undertakes interesting practices under the form of an interim review of projects.

Genome Canada undertakes an interim review of each approved project and science and technology platform, within approximately eighteen months from the start date.

- The progress of the research;
- The research team's ability to achieve the approved objectives;
- The changes in research direction (made or proposed);
- The progress towards ensuring the benefits to Canada are realized;
- The financial and management aspects of the project including an assessment of financial expenditures in relation to achieved outcomes. In the case of science and technology platforms the review comprises a technical evaluation of all services offered by the platform; a performance review of services delivered by the platform to Genome Canada-funded researchers and others; a review of efforts by the platform to reduce the cost of services; and other financial and management issues related to a service organization.

The results of interim review are used to determine whether funding should be continued, reduced or cancelled. The review will take into consideration the timeframe during which the project research has been ongoing and will also be used to provide advice regarding alternative approaches and avenues to strengthen the project.

Source: Genome Canada, http://www.genomecanada.ca

1.5.2 Monitoring of research grants in the different granting councils

Grants are delivered by granting councils to institutions who are in charge of their use. According to the 2010 Tri-Agency Financial Administration Guide (CIHR, NSERC, SSHRC), which delivers regulations for the administration of funding provided by the tree agencies[30], the monitoring of grants is mainly related to regular and/or final reports on the projects funded. Depending on the type of grants, following reviews are requested:

- Annual Statement of Account, and if requested other financial reports;
- Research activity reports, both progress or final (if requested in the grants description);
- Acknowledgment of the funding agency in research outputs (publications, etc) is also seen a duty for grantees.

CIHR seeks to demonstrate a return on investment for taxpayers through the promotion of key research developments and results. The research process is not complete until the results are validated and openly transmitted to the appropriate audience, especially through the publication of research results. Researchers are expected to maximize the impact and utility of their work and to ensure maximum impact on the field for the following reasons.[31]

SSHRC is committed to the principle that research data collected with grant funds belong in the public domain. Accordingly, SSHRC has adopted a policy to facilitate

[30] NSERC website: http://www.nserc-crsng.gc.ca/Professors-Professeurs/FinancialAdminGuide-GuideAdminFinancier/index_eng.asp (consulted october 2010)

[31] CIHR website: http://www.researchnet-recherchenet.ca (consulted October 2010)

making such data available to other researchers. All recipients of SSHRC funding are required to comply with the SSHRC Research Data Archiving Policy.[32]

Sometimes, additional resources such as Canada Research Chairs are also distributed among institutions on the basis of past performance in scholarly granting council competitions.

1.6 Cataloguing research outputs

1.6.1 Gathering and providing information on research outputs

Although practices in terms of cataloguing research projects and funding are well developed, both at the government and universities level, so far no national central system exists for reporting research outputs. A review of the granting councils operated in 2006 noted moreover that progress could be made in the systematic collection of key data required for meaningful performance measurement by the councils, the universities or Statistics Canada.[33] Canada therefore is behind countries like Norway, Australia or the United Kingdom, which have further developed national methodology and systems for collecting and analysing data on research performance. However, this could be explained by the fact that Canada is a federal State, wherein responsibility for S&T policy rests at different level (federal government and provincial governments) and is fragmented among several departments, agencies and granting councils at federal level. The Science and Technology Strategy announced in May 2007[34] however pave the way for further development in the centralization of data on research outputs. Especially, the Policy Initiative Research[35] that is a part of the implementation plan for the Strategy questions how the impact of S&T performed by the federal government can be better measured and reported, and thereby potentially enhanced over time. The project explored what information is and could be collected about federally performed S&T, and how that information is and could be made available.

More specifically, the federal granting councils - Canadian Institutes of Health Research (CIHR), Natural Sciences and Engineering Research Council (NSERC), Social Sciences and Humanities Research Council (SSHRC), and the Canada Foundation for Innovation (CFI) - maintain, on their Web sites, searchable databases of their investments. These databases include information on each grant and scholarship/fellowship awarded by the agency, such as the name of the recipient, institution, the program under which the award was made, and the title and annual amount awarded.[36] It is planned that the CIHR database will be improved with information about the outputs and outcomes of funded research. [37]

At University level, the University of Toronto for instance provides performance indicators every year to its governing council comprising number of publications, teaching awards, licenses, spin-off, etc.[38]

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[32] SSHRC website: http://www.sshrc-crsh.gc.ca (consulted October 2010)

[33] James R. Mitchell, A Review of NSERC and SSHRC, 2006.

[34] Government of Canada, Mobilizing Science and Technology to Canada's Advantage, May 2007

[35] The policy research initiative is a federal initiative designed to enhance the impact of social sciences and humanities research on the development of public policies (http://www.policyresearch.gc.ca/homepage.asp?pagenm=root)

[36] The databases are as follows: CIHR Funded Research Database, Canadian Research Information System (covers several health research organizations), NSERC Awards Search Engine, NSERC Chairholders Database, SSHRC Awards Search Engine, Canada Research Chairs Database

[37] Initiative Improving the Measurement, Reporting and Assessment of Federally Performed Science and Technology, Demonstrating Results for Canadians, Final Report , Part of the Policy Research Initiative

[38] University of Toronto, performance indicators page, online: http://www.utoronto.ca/about-uoft/measuring-our-performance/performance-indicators-main/performance_indicators_2009/PI2009_complete.htm (consulted October 2010)

Specific methods to assess the effects of their S&T activities have also been developed by some departments and agencies. The NRC has for instance implemented an overall impact measurement framework to quantify the socio-economic impacts of its programmes, national initiatives, and R&D activities. The Natural Resources Canada's Annual Science and Technology Report is another interesting initiatives in the monitoring of federal research activities and funding.

The **Natural Resources Canada's Annual Science and Technology Report** is composed of separate inputs provided by the four S&T sectors and integrated into a single report by Science Policy Integration (SPI).

In 2005, the Department created the online S&T Information Management System (STIMS) that has since been used to collect and process data automatically and generate the NRCan S&T annual report. Now a multi-year enterprise-wide information repository, STIMS permits year-to- year comparisons and trend analysis.

The original STIMS software has been progressively upgraded to include additional functions, one of which is a mechanism to upload financial information from the Department's financial system (GFS), thereby providing more granularity for some performance indicators. The current version of the system also allows input of information at the regional and branch levels. This information can be rolled up to the sector/Department level.

Source: Initiative Improving the Measurement, Reporting and Assessment of Federally Performed Science and Technology, Demonstrating Results for Canadians, Final Report, September 2010

1.6.2 Cataloguing research publications

In Canada, initiatives for cataloguing research publications come under the responsibility of each research organisations. No federal-wide initiative seems to be in place. For instance, the International Development Research Centre (IDRC) has recently launched an institutional repository: the IDRC Digital Library (IDL). The digital library has been developed to enhance the dissemination of research outputs created as a result of Centre-funded research. The content is retrospective, dating back to the early 1970s.[39]

Interesting is the Canadian Institutes of Health Research (CIHR) initiative to put in place a dedicated policy related to the access to research outputs. It takes stock of initiatives of 20 health research funding agencies worldwide, that call for funded researchers to provide free online access to supported research publications.

Following the **CIHR Policy on Access to Research Outputs (2008)**, researchers awarded new or renewed funding from CIHR are reminded to adhere with the following new responsibilities:

- Ensure that all research papers generated from CIHR funded projects are freely accessible through the Publisher's website or an online repository within six months of publication;
- Deposit bioinformatics, atomic, and molecular coordinate data into the appropriate public database (e.g. gene sequences deposited in GenBank) immediately upon publication of research results;
- Retain original data sets for a minimum of five years (or longer if other policies apply);
- And acknowledge CIHR support by quoting the funding reference number in journal publications.

[39] *Barbara Porrett*, The IDRC Digital Library: an open access institutional repository disseminating the research results of developing world researchers, online: http://www.idrc.ca/ (consulted October 2010)

Greater access to research publications and data will promote the ability of researchers in Canada and abroad to use and build on the knowledge needed to address significant health challenges.

For journal publications, there are two ways to adhere with the policy:

- Submit your manuscript to a journal that offers immediate open access (e.g. CMAJ, PLoS) or offers open access to the paper on its website within six months (e.g. NEJM).
- Submit your manuscript to a journal that does not offer open access, but will permit you to archive the peer-reviewed manuscript in a central or institutional repository within 6 months of publication.

A database (SHERPA/RoMEO database) contains a searchable listing of journal publisher's copyright and self-archiving policies which will help researchers to determine journal's that adhere with CIHR policy.

Source: CIHR website, http://www.cihr-irsc.gc.ca/e/32005.html (consulted October 2010)

1.7 Example of successful goal orientated public governance of research policy

Goal-oriented public governance is part of the performance management tradition introduced with the New Public Management in the 1980s. Armstrong and Baron define performance management as 'a process which contributes to the effective management of individuals and teams in order to achieve high levels of organisational performance. As such, it establishes shared understanding about what is to be achieved and an approach to leading and developing people which will ensure that it is achieved'.[40] Goal oriented public governance refers therefore in our sense to:

- A policy whom launching follows clear objectives and priorities;
- A policy whom implementation strategy is oriented towards target achievements;
- A policy monitored with assessment systems and regular performance reviews.

1.7.1 Overall: governance attached to the 2007 Strategy and main trends in the renewed policy-mix

As we have seen in the remainder of this report, management by performance and by objectives, reporting systems, evaluation of research impacts, etc. - are standard practice in the implementation of Canadian S&T policies. The implementation of the 2007 S&T strategy 'Mobilizing Science and Technology to Canada's advantage' is a good example. It indeed identifies clear challenges, objectives and related actions to be implemented by the various departments, agencies and granting councils active in the S&T field. Moreover, progresses in the implementation of the strategy are reported in progress reports. The first one was produced in 2009 and highlighted the actions carried out so far by federal actors.

As aforementioned, research and innovation are tightly linked in Canada. This is illustrated by the 2007 S&T strategy, which put the focus on the commercialization of research through public-private partnerships (through the Networks of Centres of Excellence mainly) and on the creation of competitive and dynamic business environment (e.g. tax incentives, new regulations, etc). Likewise, the government commit itself in the 2007 strategy to grow Canada's base of knowledge workers through the improvement of research education and through regulations and grants to attract talented researchers from around the globe (immigration regulations, Vanier Canada Graduate Scholarships Programme, Canada Excellence Research chairs to support research teams in the establishment of ambitious research programmes in Universities, etc).

[40] ARMSTRONG, M. and BARON, A. (2004) *Managing performance: performance management in action*. London: Chartered Institute of Personnel and Development.

Interesting is to note that universities, that are the main providers of basic research (mainly funded through the three granting councils non-oriented grants), are moving to some extent towards more applied research, as they take part more and more in joint research with business enterprises.

On top of that, the federal government is examining changes in the status of non-regulatory federal research institutes. Within the framework of the 2007 Strategy, it has appointed an independent panel of experts to consult with stakeholders and provide advice on transferring federal non-regulatory laboratories to Canadian universities or the private sector. Reporting back in June 2008, the panel identified five early candidates for alternative management arrangements.

1.7.2 Towards more coordination in S&T policy at federal level – Tri-Council enhanced cooperation in the management of grants for research

As observed in section 1.1, the S&T policy in Canada is fragmented towards several ministers, departments, agencies and granting councils. S&T policy is therefore highly decentralised and ruled by a sectoral work repartition.

In this respect, coordination and cooperation have always been burning issues in the administration of federal S&T funding. A 2003 report showed that the federal S&T community was not well positioned to take advantage of the benefits of technology that require horizontal approach. Today there continue to be competing culture among the science-based departments. The Framework for Federal Science and Technology renewed in 2005 the goal of fostering interdepartmental, horizontal linkages among science-based departments on crosscutting challenges. Additionally, a 2006 Review of NSERC and SSHRC[41] noted that there was a strong need on both sides for more effective funding collaboration across the disciplines, as well as more effective working relationships across the three Councils. This was reasserted in the 2007 Strategy.

It should be noted that the two councils already collaborate (in many cases with CIHR as well) on a wide range of issues and activities, including in 2006:

- Regional meetings with scholarship liaison officers;
- Financial data submission and reconciliation;
- The Networks of Centres of Excellence program (administered by NSERC);
- The Canada Research Chairs Program (administered by SSHRC);
- Tri-council grants (e.g. tri-council Canada Graduate Scholarships Programme);
- Indirect costs (administered by SSHRC);
- Tri-council cooperation on risk;
- The Interagency Advisory Panel on Research Ethics;
- SSHRC and NSERC also share support from a common Administrative Services Directorate.

The 2006 review however highlighted that more should be done in the governance of research grants among the three-councils (e.g. annual planning and priority-setting; harmonization of application requirements and decision-making; dealing with the research communities in a more integrated way, etc).

As a result for instance, Canada is currently developing an overarching web tool to provide research organisations with a single point of contact with granting councils and other funding organisations. ResearchNet (http://www.researchnet-recherchenet.ca) is a secure web portal, which provides an electronic workflow for the submission of grant and award applications, and the submission of peer reviews. It

[41] James R. Mitchell, A Review of NSERC and SSHRC, 2006.

aims at streamlining and simplifying the administration of research grants. The website is currently in a pilot phase and is intended to provide a virtual meeting place for the research community by providing a single point of contact to share information, collaborate, and conduct business with funding organizations.

1.7.3 Data collection on R&D performance and the centralisation of data at federal level – 2010 Report of the Policy Initiative Research

Management by performance indicators is a main feature of Canadian research governance. However, except the reporting system from departments and agencies to the Parliament through Departmental Performance Report, there is a clear lack of methodology and systems at the national level for collecting and analysing data on research performance.

As aforementioned, the Science and Technology Strategy announced in May 2007[42] pave the way for further development in the centralisation of data on research outputs. The final report of the Policy Initiative Research[43] project that is a part of the implementation plan for the Strategy has been issued in September 2010. The project drew implications from recent research, the experience of practitioners, and original analysis to suggest how the impact of S&T performed by the federal government can be better measured and reported, and thereby potentially enhanced over time.

The project explored what information is and could be collected about federally performed S&T, and how that information is and could be made available. The final report also points out that "planning, measuring, reporting and assessing S&T activities (…) would require additional investment by the federal government".[44] This illustrates evidence that assessment and measurement practices reviewed in the report cause additional cost in terms of management and monitoring of public funding.

1.7.4 Data collection on R&D performance at University level – best practice in the University of Toronto's annual Performance Indicators Reports

That being said, although no national system is in place, individual granting councils, agencies and universities have well-established performance reporting management system. One of the best examples is the Performance Indicators Report provided each year by the University of Toronto to its governing council since 1998. The indicators have changed over the years as the University has expanded the scope of areas measured, enhanced the data collection, and created partnerships with other institutions and agencies for external benchmarking. Reports are available online on the University's web portal: http://www.utoronto.ca/about-uoft/measuring-our-performance/performance-indicators-main.htm. The main research related criteria presented in the 2009 report are presented in Figure 27.

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[42] Government of Canada, Mobilizing Science and Technology to Canada's Advantage, May 2007

[43] The policy research initiative is a federal initiative designed to enhance the impact of social sciences and humanities research on the development of public policies (http://www.policyresearch.gc.ca/homepage.asp?pagenm=root)

[44] Initiative Improving the Measurement, Reporting and Assessment of Federally Performed Science and Technology, Demonstrating Results for Canadians, Final Report , Part of the Policy Research Initiative, page 42.

Figure 27 Lists of research related performance indicators used by the University of Toronto (2009)

Main criteria related to research	Related performance indicators
Faculty Honours and Research Output	Faculty Honours Canada Research Chairs Faculty Honours in the Humanities Research Rankings Research Publications and Citations Research Publications and Impact in the Humanities Doctoral Student Placement in the Humanities Faculty Teaching Awards
Research Funding and Yields	Tri-Council Funding - SSHRC, NSERC, CIHR Canada Foundation for Innovation Research Funding from Industrial Sources
Commercialization and Knowledge Transfer	New Invention Disclosures, New Licenses, New Spin-off Companies
Student recruitment	Applications, Offers, Registrations and Yield Rates (including doctoral programmes)
Graduate Student Awards	Doctoral Scholarships from Federal Granting Councils
Student Access and Support	Doctoral Financial Support
Student Retention and Graduation (time to degree)	Doctoral Completion Rate by SGS Grouping – 7 & 9 years Doctoral Median Number of Terms Registered to Degree
International Experience	Number of Participants in Study Abroad & Exchange Programs Graduate Interdisciplinary Opportunities (Canadian Graduate and Professional Survey) Graduate Publications and Presentations Graduate Publications and Presentations (Canadian Graduate and Professional Survey)
Annual Fundraising Achievement and Alumni Donors	Annual Fundraising Achievement time series Annual Fundraising Achievement by Sector
University Central Administrative Costs	University Central Administrative Costs

Source: Website of the University of Toronto, Performance Indicators 2009 Comprehensive Inventory (http://www.utoronto.ca)

2. Denmark

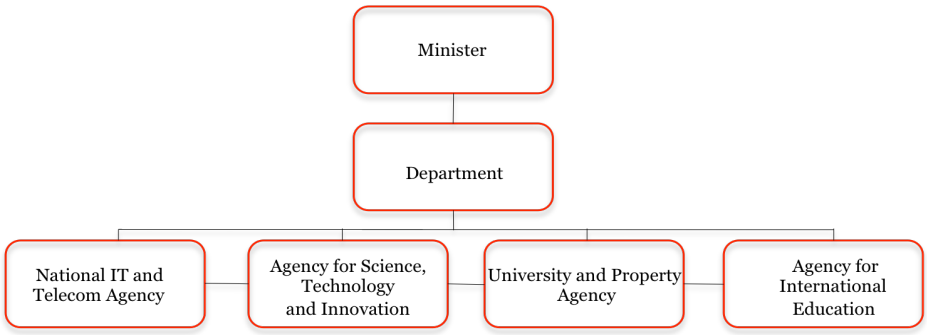
2.1 Overview of Danish research system

2.1.1 Overview

In the last decade, Denmark has undergone a comprehensive restructuring of its research and innovation infrastructure, including its governance and university system, mainly as a result of declining investment and defragmentation of the research system in the early 2000s. Danish R&D policy mix has been described as being "the result of a series of more or less independent decisions"[45]. Denmark has reallocated (from numerous ministries) the bulk of research responsibility – including innovation and correlated activities of small firms – to the Ministry for Science, Technology and Innovation (formerly the Ministry for IT and Research), which has subsequently become a more central actor in the Danish research and innovation system.

A number of characteristics can be drawn out from the Ministry: i) it is a slim organisation that has a central policy unit with strong connections to the Ministry's international activities, ii) it aims to strengthen integration between research and innovation, ii) it constitutes a strengthened administrative platform for the Danish university system[46].

As is common in some Nordic countries, policy is executed by an agency – the Agency for Science, Technology and Innovation (*Forsknings- og Innovationsstyrelsen*, FI), whose task is to execute – through ministerial orders – the Ministry's political priorities, while the Ministry is focused on coordination, control and quality assurance. FI, which is still part of the actual Ministry, is the actor directly interacting with the research councils, universities, research institutes and the private sector.



There is a separate agency – Danish University and Property Agency – responsible for the university sector. This agency is also part of the Ministry for Science, Technology and Innovation.

2.1.1.1 Globalisation strategy

The main policy drive is the so-called Globalisation strategy, which was introduced by the Danish government in 2006. This is a cross-policy strategy, although much of it stems from the Ministry of Science Technology and Innovation, with the main objectives relevant to R&D and research policy being (summarised – the full list of higher-level R&D policy objectives can be found in the last section of this chapter):

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[45] Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments: the policy mix project, Country Review: Denmark, K Siune, and K Aagaard, the Danish Centre for Studies in Research and Research Policy, University of Aarhus, December 2007

[46] cordis.europa.eu/erawatch/index.cfm?fuseaction=org.document&uuid=7D87C6AA-EA39-786A-70CB684572C1FAA1

- Research and development should be strengthened: the objective is that public and private companies and institutions spend a total of at least 3 per cent of GDP on research and development by 2010. Publicly financed expenditure on research and development should reach 1 per cent of GDP by 2010, while private R&D should be spurred by improved framework conditions.
- Reform of the public research system in order to improve the quality and efficiency of research spending. To ensure that public funds are allocated to the best researchers and the best research environments, at least 50 per cent of the funds should be subject to open competition based on quality criteria. A larger share of the funds should be targeted at large, long-term research projects and at strategic research projects. In order to provide enough researchers, the number of PhD students should be doubled.
- Danish companies should be amongst the most innovative. Close relations between companies and universities should contribute to a more rapid dissemination of public sector research results to the business community[47].

2.1.2 Data overview

The OECD provides a good number of national indicators relevant to Danish R&D.

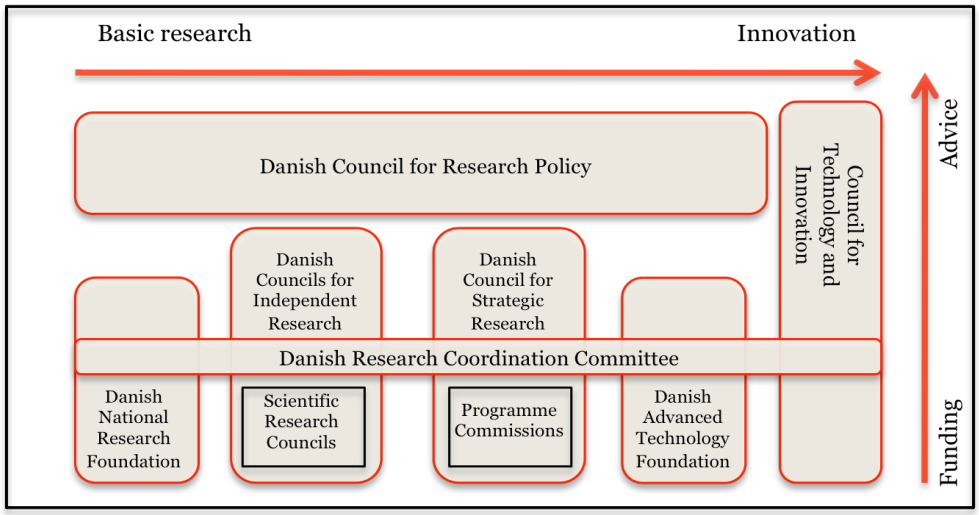
Indicator	2004	2005	2006	2007	2008
GERD $	4 335.914	4 418.877	4 739.259	5 066.188	5 498.247
GERD as percentage of GDP	2.485	2.456	2.478	2.55	2.72
Government financed GERD as percentage of GDP	-	0.678	-	0.663	0.689
Percentage of GERD performed by HEIs	24.408	24.626	25.909	26.739	26.249
Percentage of GERD performed by the government sector	6.864	6.451	6.561	3.277	3.151
Percentage of GERD performed by the business sector	8.039	68.254	66.935	69.5	70.129
Percentage of GERD performed by private non-profit sector	0.689	0.669	0.595	0.484	0.471
Denmark BERD as percentage of GDP	1.691	1.677	1.658	1.775	1.907
Denmark HERD	1 058.32	1 088.214	1 227.904	1 354.628	1 443.227
HERD % GDP	0.607	0.605	0.642	0.683	0.71
GOVERD $	297.6	285.057	310.922	166.041	173.261
GOVERD as % of GDP	0.171	0.158	0.163	0.084	0.086

Source: OECD Main Science and Technology Indicators

[47] www.globalisering.dk

2.1.3 Principal research policy making organisations

The main players – for policy and funding – can be found illustrated below:



Source: FI website

2.1.4 Principal policy advisory organisations

The players pictured constitute the centre of the system, with the **Danish Council for Research Policy** acting as the link to the Danish government, parliament and also other more peripheral ministries that participate on a more ad-hoc basis, in principle, the Ministry of Food, Agriculture and Fisheries and the Ministry of Economic and Business Affairs. It further has an advisory role towards the **Ministry for Science, Technology and Innovation**, in matters such as training and supply of researchers, research framework conditions, strategy and international cooperation, and research funding, including national and international research infrastructures.

The **Council for Technology and Innovation** also has an advisory function towards the Ministry, and is in addition tasked with administering initiatives stemming from the Ministry. Although its areas of interests includes research, the council is also concerned with wider issues, namely, (R&D&I) cooperation and interaction, entrepreneurship and commercialisation, initiatives at regional level, and international cooperation, including pre-projects for the 7th Framework Programme.

Although not pictured in the above figure, the **Globalisation Council** should also be mentioned in the context of policy formation and advice. It was set up in 2005 with the task of advising the government on a strategy for Denmark in the global economy. Several of the representative groups here have strong links to the research and innovation system, including Danish industry and academic groups.

The rationale behind the Danish public research system

In Denmark, the more recent (5-10 year) strategy has been to strengthen and defragment the national research system, much centred on the universities. Policy measures are put in place to boost competiveness and entrepreneurship within the system. Collaboration with, and responsiveness towards, industry is also a priority.

The public research system in Denmark is a reflection of the national Globalisation strategy, emphasising improved coordination and internationalisation. There is a clear demarcation between bottom-up research on the one hand and strategic research on the other, which is a conscious policy strategy to support both the needs of the researcher as well as curiosity-driven research, while simultaneously encouraging targeted research of social and economic importance.

In the last decade (when the current Liberal-Conservative Government was elected for the first time) R&D policy objectives have been put forward as a distinct theme in a number of key policy documents. It is for example clear that the overall objectives of the Lisbon Strategy also to a great degree fit with the overall objectives of the current Danish Government[48].

The objectives and priorities of the Danish R&D policy have not changed substantially in the last five years. They have, however, been given higher priority and increased efforts have been put into operationalising the objectives.

Coordination between the funding and policy institutions are generally considered to be good, both on a strategic level (through for example the work of the Danish Research Coordination Committee) as well as on an administrative level. No indications of a restructuring of the system have been found.

2.1.5 Principal research funding organisations

There are four main funding agencies, whose work is coordinated by the **Danish Research Coordination Committee**. The Committee's main responsibility is to ensure optimal coherence between government research funding, whether it allocated at institutions or under the auspices of the foundations. The committee, represented by major actors in the Danish research system, operates based on a consensus, but has no commanding role in the research and innovation system as such.

The principal funding agencies are:

- The **Danish Councils for Independent Research**. These councils (Medical Sciences, Natural Sciences, Humanities, Technology and Production Sciences, and Social Sciences) finance research that is based on researchers' own initiatives, and aims to "improve the quality and internationalisation of Danish research"[49].
- The **Danish Council for Strategic Research**. This council constitutes a number (currently six) of Programme Commissions, who have the authority to allocate research funding within their remit. The Commissions are made up of expert researchers from Denmark and possibly neighbouring Nordic countries. When individual Commission's tasks are understood to have been accomplished, they are dissolved, that is to say, the Commissions reflect present policy priorities. The current priorities translate into the following:
  - Programme Commission on Health, Food and Welfare
  - Programme Commission on Sustainable Energy and Environment
  - Programme Commission on Strategic Growth Technologies
  - Programme Commission on Individuals, Disease and Society
  - Programme Commission on Transport and Infrastructure
  - Programme Commission on Education and Creativity[50]

[48] Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments: the Policy Mix project, Country Review: Denmark, submitted by Karen Siune and Kaare Aagaard, Danish Centre for Studies in Research and Research Policy, University of Aarhus, October 2006

[49] http://en.fi.dk/councils-commissions/the-danish-council-for-independent-research

[50] Our translation

- The **Danish National Research Foundation**. This foundation was set up in 1991 and funds a smaller number of long-term large-scale research centres – Centres of Excellence. It funds basic, elite research in all scientific fields: basic sciences, life sciences, technical sciences, social sciences and the humanities. Support can be given for up to 10 years. Currently about 25 centres are supported.

  The **Danish Advanced Technology Foundation**. This foundation co-funds high-technology R&I projects, which i) have clear commercial potential, ii) involve technology transfer, and iii) involve collaboration between public-sector research institutions and private-sector companies. Centres for Higher Education or public sector companies may also participate. The foundation's capital stems from the Danish state, and should support growth and strengthen employment by supporting strategic and advanced technological – but also political – priorities within the fields of research and innovation, such as nano- and biotechnology, and ICT. SMEs are an articulated target group. The foundation has so far invested in 114 advanced technology projects and platforms with a total budget on DKK3m. This includes (50 per cent) funding from companies and research institutions[51].

Organisation	Thematic focus	Type of agency	Estimated percentage of bottom up funding
Danish Councils for Independent Research	• Medical Sciences • Natural Sciences • Humanities • Technology and Production Sciences • Social Sciences	Research Council: the Danish Council for Independent Research is comprised of a Board of Directors and five scientific research councils	100%
Danish Council for Strategic Research	• Health, Food and Welfare[52] Sustainable Energy • Strategic Growth Technologies and Environment • Individuals, Disease and Society • Transport and Infrastructure • Education and Creativity	Research Council: the Danish Council for Strategic Research consists of a board and a number of programme commissions. The board performs a number of advisory tasks and is vested with decision-making authority concerning the administration of strategic research. The board determines the number of programme commissions in existence at any time and the areas for which they are responsible	0%
Danish National Research Foundation	Basic, elite research in all scientific fields	Research Council: the board of trustees consists of nine members, whom must possess insight into research at an international level	0%*
Danish Advanced Technology Foundation	High-technology R&I	Innovation foundation: the board consists of nine members, whom have insight into research *and* innovation. Applications are also evaluated by two independent scientific reviewers	100% *

[51] http://hoejteknologifonden.dk

[52] Current focus of the organisation

* Both funding agencies have elements of top-down strategic criteria. Funding is relatively either bottom up or top-down.

2.1.6 Industry

In 2008, Business Enterprise R&D contributed to just over 2 per cent to Danish GDP[53]. The most active industry sectors, which funded 55 per cent of intramural R&D (€4.8m) in 2008, were i) services (€1.3m), ii) pharmaceutical industry (€0.8m), and ICT (€0.6m).

As for extramural R&D, the i) pharmaceutical industry (€0.7m), ii) services (€0.2m) and iii) trade (€0.09m) sectors funded 69 per cent of total investments in Denmark[54].

On an aggregate level, the Danish business sector contributes relatively little funding to national public research institutions. Structurally, the Danish GTS system is perhaps a more prominent player in the Danish R&D landscape. The GTS institutes are further described below.

2.1.7 Framework Programme participation

According to a 2009 Technopolis / Danish Agency for Science, Technology and Innovation report, Danish participation in FP7 has so far generated a total of €136m. The below figure is taken from the abovementioned report[55].

Figure 4 – Denmark's EU funding allocations under FPs 4, 5, 6 and 7 (€ million)

Indicator	FP4	FP5	FP6	FP7 (to date)	Total
Danish FP funding allocation	410	399 (-3%)	396 (-1%)	136 (-66%)	1,341
Total FP funding allocations (all countries)	13,215	14,960 (+13%)	16,669 (+11%)	6,652 (-60%)	51,496
Danish share of FP project funding	3.10%	2.67%	2.38%	2.05%	2.60%

Sources: FP4 and FP5 data - 'Figures on Danish participation in FP6' (Forsknings-og Innovationsstyrelsen, August 2008), FP6 and FP7 data – FP6/7 participation data (E-CORDA, September 2009)

2.1.8 Budget

The total budget for the Ministry for Science, Technology and Innovation was around DKK18bn in 2009 and just under DKK20bn for 2010.

It is the Danish Agency for Science, Technology and Innovation that administers research and funding for the Danish Councils for Independent Research, the Danish Council for Strategic Research, the Danish Council for Technology and Innovation and the Danish Research Training Committee (under the auspices of the Danish Research Coordination Committee).

The Agency also administers allocation of funding for the particular initiatives, including the Industrial PhD Scheme, and the Young Researcher Initiative.

Alongside the Globalisation strategy in Denmark there is also a fund dedicated to facilitating the objectives of the strategy. For R&D purposes the following finance is available 2009-2012:

2009 – DKK1,079m 2011 – DKK4,225m

2010 – DKK3,935m 2012 – DKK4,397m

This funding (known as *Globaliseringsmidler*), and its allocation within the public R&D system is negotiated and agreed upon on a party political level. Key areas that

[53] Statistics Denmark

[54] cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=60&parentID=50&countryCode=DK

[55] Evaluation of Danish Participation in the 6th and 7th Framework Programme, Danish Agency for Science, Technology and Innovation, Technopolis, 2009 (Printed in 2010)

receive funding boosts include basis research, strategic research (e.g. into energy related issues), research infrastructure and 'internationalisation'[56].

Overall budget for the Ministry for Science, Technology and Development 2009 and 2010 in DKK millions

Budget posts[57]	**2009**	**2010**
RESEARCH AND UNIVERSITY EDUCATION	13,582.3	14,319.5
Universities	13,303	14,003.4
Specific grants	238	268.2
Specific institutions	41.3	47.9
RESEARCH COUNCILS AND RESEARCH EDUCATION	2,881.1	2,707.6
Research Councils	2,468.3	2,601.7
Research education	125	105.9
Specific research 'appropriations' for universities	287.8	-
OTHER	N/a	N/a
International research cooperation	299.5	318.6
New research programmes	272.3	203.3

Source: Finanslov for finansåret 2009 & 2010

The Danish National Research Foundation was established by the Danish Parliament in the 1990s when it received a capital of DKK2 billion (plus an additional sum of DKK3bn in 2008). Funds allocated by the foundation make up roughly two per cent of total public research grants, which is about DKK400 million.

The capital of the Danish Advanced Technology Foundation is gradually increased via the annual national budget. By 2012, the foundation should have a base capital of DKK16bn.

2.1.9 Principal research organisations

The principal group of public research organisations is the Danish universities, who in 2005 performed 25 per cent of total R&D[58]. However, a reform of the entire research system in 2007 saw a number of research institutes merged with the universities – 12 universities and 13 research institutes were merged into eight universities and three research institutes. Subsequently 97 per cent of all public research activities now take place in Danish universities, who house many former government research institutes within their departments[59].

The universities have entered into development contracts (*Udviklingskontrakter*) with the Danish University and Property Agency (or predecessors) since the 1990s. The current agreement spans 2008-2010 and includes indicators/activities in the areas of:

- Research (research production, internationalisation of research, attraction of external non-governmental funds, PhD activity)
- Education (new enrolments, drop-outs, completion time, degree programme relevance to society, entrepreneurship, internationalisation and quality assurance of degree programmes)

[56] Avtale om fordelning af globaliseringsmidlerne til forskning og udvikling www.fm.dk/Publikationer/2008/1678aftaler%20om%20Finansloven%20for%202009/Fordeling%20af%20globaliseringsmidlerne%20til%20forskning%20og%20udvikling.aspx

[57] Our translation

[58] ERAWATCH Country Report 2009: analysis of policy mixes to foster R&D investment and to contribute to the ERA – Denmark, 2009

[59] www.denmark.dk/en/menu/Business-Lounge/Science-Research/Research-Institutions/GuideTheBackboneOfDanishResearch/TheGovernmentResearchInstitutions/

- Dissemination of knowledge (collaboration with the business community)
- Research-based public sector services.

Thus, the agreements cover the main strategic goals and activities of the universities. It appears the universities produce the first draft of the contract, which is subsequently submitted to the Danish University and Property Agency for negotiation. Once agreed upon and signed, progress reports on the development contracts are submitted back to the Agency as part of the annual reports.

2.1.9.1 Universities

As of 2007, the eight Danish universities are

- Aalborg University (1974): the Aalborg University also consists of Esbjerg Institute of Technology and Copenhagen Institute of Technology
- University of Århus (1928)
- University of Southern Denmark (1966-1974): as of 1998 the university comprises the University of Odense, Engineering College South, Southern Denmark Business School and Southern Denmark University Centre
- Technical University of Denmark (gained university status in 1994)
- IT University of Copenhagen (gained university status in 2003)
- Copenhagen Business School (gradually integrated as an institution of higher education in 1965)
- Roskilde University (1972)

In terms of research, there are three larger HE institutions: University of Århus, University of Copenhagen, and the Technical University of Denmark. The IT University of Copenhagen is the smallest institution.

2.1.9.2 GTS institutes

The GTS-institute network (*Godkjente Teknologiske Serviceinstitutter*) is an independent group of nine (not-for-profit) research and technology organisations. They perform R&D to an approximate value of €73m a year (total turnover €379m)[60], which equates to one third of GTS' work (this includes R&D and 'services with high knowledge content)[61]. The GTS institutes develop and facilitate technological services within their specific specialist fields. Their clients are both private and public businesses and organisations, in Denmark and internationally. A 2009 evaluation of the network concluded that "[t]he division of labour between institutes and universities is becoming less clear and the need for them to work together is growing. GTS' declining R&D-intensity and falling production of research outputs like scientific publications is therefore a problem"[62].

[60] http://cordis.europa.eu/erawatch/index.cfm?fuseaction=org.document&uuid=955AB01C-A6D9-985E-7DB9E00DB3D2F6E3

[61] A Step Beyond: International Evaluation of the GTS Institute System in Denmark, published by Forsknings- og Innovationsstyrelsen, 2009

[62] Ibid.

GTS institute	Main area of interest
Bioneer	Biotechnology
Danish Fundamental Metrology	Metrology
Danish Institute of Fire and Security Technology	Fire safety and prevention
Danish Technological Institute	Broader technology fields
DELTA Danish Electronics, Light & Acoustics	Electronics, microelectronics, light, optics, acoustics, vibration and sensors
DHI Water and Environment	Water, environment and health
FORCE Technology	Optimisation and automation of production and processes, material use, protection and analyses, maritime technology, utilisation and development of sensor technologies, optimisation and development of management systems, and energy, climate and environment
AgroTech	Agriculture and food
Alexandra Institute	IT

Source: GTS Performanceregnskab 2008

Core funding is provided by the Ministry for Science, Technology and Innovation, through specifically drafted performance contracts, renewed every three years. In 2007, the GTS network turnover was DKK2.46bn. Less than 10 per cent constituted core funding from the state.

Three of the institutes dominate the network in terms of size, although some newer institutes are expected to grow. The proportion of R&D varies between the institutes, as does their proportion of public of core funding received.

2.1.9.3 University hospitals

There are three university hospitals: Københavns Universitetshospital, Odense Universitetshospital, and Århus Universitetshospital. They appear to be under the auspices of the Ministry of Interior and Health, although are often listed as part of the university in statistical data. University hospitals received DKK149m in public R&D support in 2008, which in proportionate terms appears to represent about one per cent of total public spending[63].

2.1.9.4 Government sector

The government R&D sector is small, even before the university-research institute mergers. In 2005 it performed six per cent of R&D, a decrease with earlier years (with public research support valued at roughly DKK764m[64]). The integration of the public sector research institutes into the Danish university system was another part of the Globalisation strategy of 2006.

Currently there are six government research institutes in operation, all within very expert areas. The purpose is typically to deliver research based expert advice or services. Thus the institutes are primarily engaged in problem oriented applied R&D, but with clear and direct benefits for society.

Only one is under the auspices of the Ministry of Science, Technology and Innovation:

- The Kennedy Center (performance contract with the Danish Ministry of Social Affairs)

[63] Forskning og udvikling in den offentlige sector 2008, Danmarks Statistik, Nr.103, 2010

[64] ERAWATCH Country Report 2009: analysis of policy mixes to foster R&D investment and to contribute to the ERA – Denmark, 2009

- National Research Centre for the Working Environment (Danish Ministry of Employment)
- **Danish National Centre for Social Research** (Danish Ministry of Social Affairs)
- Statens Serum Institute (Danish Ministry of Health and Prevention)
- Danish Meteorological Institute (Danish Ministry of Climate and Energy)
- **Danish Center for Scientific Computing (**Danish Ministry of Science, Technology and Innovation).

2.1.10 Distribution of funding

The below table illustrates total research income and, within this income, the proportion of public support for the eight Danish universities. For the GTS network system, the table provides the funding received by the Danish government in 2008 (the core grants).

	2007	**2008**	**2009**
Universities	*Total research income in DKK millions/of which public (basic) grant, including funding for PhDs*		
Aalborg University	776/237	830/251	957/316
University of Århus	2,951/1,277	3,160/1,352	3,38/1,387
University of Southern Denmark	994/373	1,079/429	1,170/448
University of Copenhagen	3,457/1,136	3,765/1,366	3,972/1,425
Technical University of Denmark	2,460/964	2,488/973	2,673/1,010
IT University of Copenhagen	86/12	93/16	109/17
Copenhagen Business School	291/82	317/98	336/97
Roskilde University	310/88	320/101	308/72
GTS Institutes	*Core grant as awarded by the government (DKK millions)*		
Bioneer	-	15	-
Danish Fundamental Metrology	-	13	-
Danish Institute of Fire and Security Technology	-	6.8	-
Danish Technological Institute	-	96.4	-
DELTA Danish Electronics, Light & Acoustics	-	37.4	-
DHI Water and Environment	-	35.8	-
FORCE Technology	-	51	-
AgroTech	-	17	-
Alexandra Institute	-	9	-

Source: www.ubst.dk/en/universities-in-denmark and GTS Performanceregnskab 2008

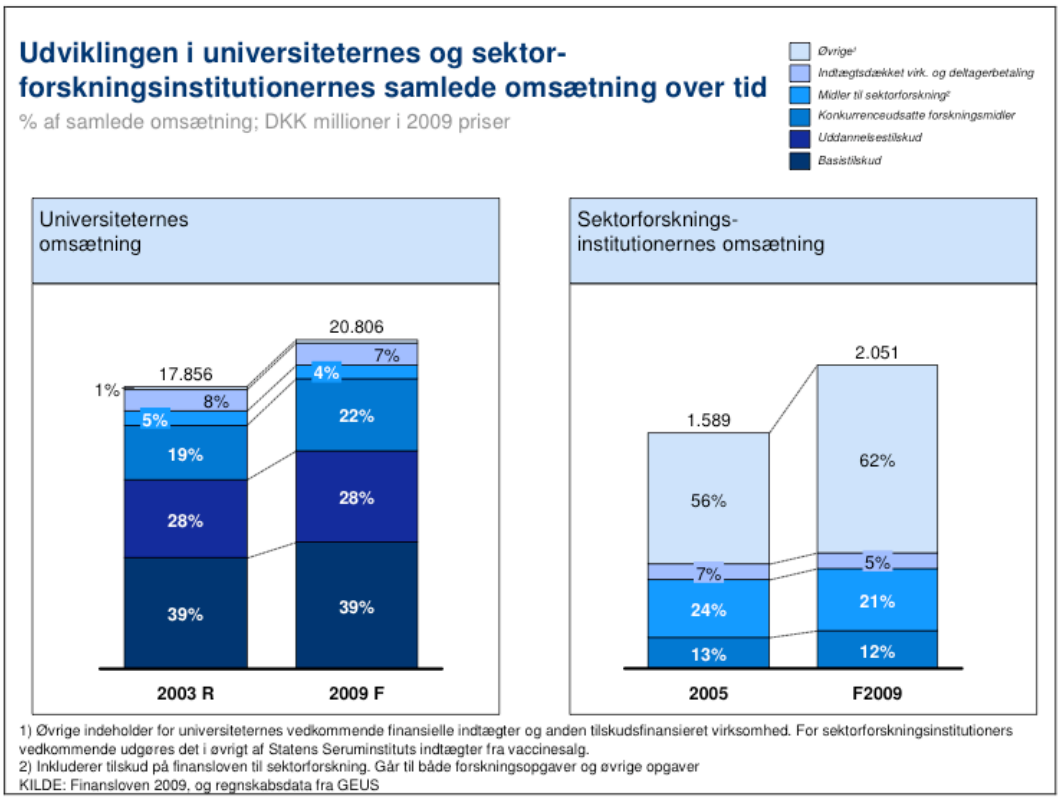
The below figure is taken from a 2009 McKinsey report which (with some limitations) looked at the financing and organisation of Danish universities and sectors research institutes in the light of the financial injection stemming from *Globaliseringsmidler*.

The report highlighted among other things that in real terms turnovers have increased (2003-2009) for both universities and for sectoral research institutes. Together they generated almost DKK23bn in 2009, with the university sector responsible for almost DKK21bn. Further, the university sector has seen an increase in research funding – spread roughly 50-50 between non-competitive and competitive funding. However,

Danish universities dispose freely of 60 per cent of their turnover. Thus, income theoretically earmarked for research activities could in practice be used for educational activities.

From light blue to dark blue, the image breaks down the total turnover in the following activities/fields: Other, Income from commercial activities or tuition fees, Funds for sector research, Competitive research funding, Educational subsidies, Core funding.

Development in universities and sector research institutes total turnover over time (percentage of total turnover; DKK millions in 2009 prices)



Source: Image taken from the report Analyse af universiteternes og sektorforsknings-institutionernes finansiering og organisering, McKinsey & Co. on behalf of Videnskabs-ministeriet og Finansministeriet, June 2009

2.1.10.1 Basic grants (core funding) allocated to Danish universities

The eight Danish universities benefit from basic grants from the government, which is allocated according to two different principles – core funding based on historical indicators, which vary little over time, and additional competitive funding, allocated using four indicators.

Every year 2 per cent of the non-competitive funding is allocated to a restructuring fund (the last entry in the below table) which is then redistributed to the universities according to the competitive 45-20-25-10-model.

Basic funding (first principle) for Danish universities 2009-2013, DKK millions

University basic funding	2009	2010	2011	2012	2013
Education (including funds granted on the basis of the number of international exchange students as well as a development grant for education allocated under the Globalisation Agreement in 2006)	5,391	5,657	5,767	5,757	5,470
Research	7,043	7,259	7,290	7,242	6,917
Other purposes	1,163	1,188	1,063	1,065	1,045
Total basic funding (Basic funds earmarked for the universities in the annual Appropriations Act)	13,579	14,004	14,120	14,064	13,432
Restructuring fund	22	-	16	117	359

Source: Danish University and Property Agency

As illustrated in the above table, allocation of university core funding is relatively steady up until 2012. Notably for 2012-2013, funding allocated for research is decreasing, seemingly at the expense of increases in the allocation of funds under the Restructuring fund, indicating that competitive funding is small but increasing.

On a competitive basis, additional university funding is allocated through the 45-20-25-10 model (based on data submitted from the universities to the Danish University and Property Agency):

- 45% of research allocation is based on the university's education funding
- 20% is distributed in accordance with the universities' external research funding, including any European funding
- 25% is distributed in accordance with the universities' research publishing
- 10% distributed in accordance with the number of students having completed their PhD thesis[65].

This research funding model is newly implemented (2010) and succeeds an older 50-40-10 model, which did not take into account output – research publishing. Instead the allocation was based on: 50% – education funding, 40% – external research funding, 10% – PhDs.

2.1.10.2 Allocation and development over time

In Denmark, the more recent (5-10 year) strategy has been to strengthen and defragment the national research system, much centred on the universities. Policy measures are put in place to boost competiveness and entrepreneurship within the system. Collaboration with, and responsiveness towards, industry is also a priority.

Research and innovation investments did receive a significant (priority) boost, in the political adoption of the Globalisation strategy in 2006, which was much the result of the change of government following the 2005 general election.

Although often labelled 'a SME-country', historically the Danish public system has not prioritised direct support for businesses. There are a smaller number of schemes aimed at boosting R&D and collaboration with universities, such as Knowledge Vouchers and Research Vouchers for SMEs. Some support is allocated via the core funding of the GTS institute network. SMEs constitute an important part of the GTS network's client base.

Funding is allocated partly in a top-down approach, through the Research Council for Strategic Research, and bottom-up, through the Research Councils for Independent Research.

[65] www.ubst.dk/en/universities-in-denmark/economics-of-university-sector/funding-for-research

The Globalisation strategy also advocates, and has led to, more public research funding being allocated competitively. A share of the public funding to universities (the abovementioned 45-20-25-10 model) is measured and subsequently allocated through a number of bibliometric indicators, thus focusing on improving research *quality*.

The emphasis on quality is, along with competitiveness and internationalisation, a reoccurring theme in Danish research policy. Again, the Globalisation strategy would like to see increased (business) participation in the Framework Programme for example, and both the 2009 and 2010 budgets for the Science Ministry saw more funds allocated to international research cooperation than to new research programmes.

Views (in Denmark) on the degree of success Danish researchers have in participating in the FP appear to vary somewhat depending on the type of report and source. The ERAWATCH Denmark country report – utilising data from FI – suggests the Danish share of EU funding decreased 2003-06. In 2006, "the share of EU funding of R&D expenditure in the Business Enterprise sector (BERD) was 0.7%, and 3.5% of R&D expenditure in the Higher Education Sector (HERD). The share of funding of the Government Intramural Expenditure on R&D (GOVERD) was 5.2%"[66].

2.1.11 Competitive funding

In Denmark competitive research funds are allocated as 'independent' research funds, and as strategic research funds, that is to say funds are allocated the Independent and Strategic Research Councils.

2.1.11.1 Strategic research funding budget

Area of research[67]	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Strategic growth technologies	245.2	100.2	146.2	127.8	124.3	90	88
Sustainable energy & environment	159.3	294	369	135.4	134.1	102	100
Food, health and welfare	283.4	301.6	279.8	155.9	169.4	102	100
Health & wellbeing	41.4	87.9	172.3	116	125.1	65.5	63.9
Sustainable transport & infrastructure	29	49	29.6	30.1	30.1	-	-
Education	42.3	32	62.8	-	30.1	-	-
Creativity & innovation	69	66.8	15	-	-	-	-
International research collaboration		7.8	26.7	20	15	-	-
Total	869.6	934.4	1,101.5	585.2	628.1	359.5	351.9

Source: Universiteternes forskning

Within this budget, universities are awarded the most amount of funding, in 2008 84%, or DKK599m. Hospitals stand for 10%, while Sector research 5% and 'Other' 1% of funds. The universities' share of the competitive funding must, to an (unknown) extent, benefit PhD students[68]. Notable from the above table is the somewhat drastic decrease (and seeming inconsistency) in funds from 2011 onwards.

2.1.11.2 Independent research funding budget

Independent research funds can be sought within (or across) all disciplines, but must aim to strengthen the quality and internationalisation of Danish research. The funds

66 ERAWATCH Country Report 2009: analysis of policy mixes to foster R&D investment and to contribute to the ERA – Denmark, 2009

67 Our translation

68 Universiteternes forskning, Forsknings- og Innovationsstyrelsen

are not tied to any political (scientific) priorities but are allocated on the basis of the quality of the proposals received by the Danish Council for Independent Research, whose budget for 2010 is DKK1,226m.

Although no data was found for 2010, as a comparison, in 2008, the council's funding was allocated (to its 'sub-council') in the following way:

- Research Council for Culture and Communication (DKK152m)
- Research Council for Nature and the Universe (DKK269m)
- Research Council for Society and Trade (DKK114m)
- Research Council for Health and Illness (DKK262m)
- Research Council for Technology and Production (DKK322m)[69]

2.2 Administrative efficiency of research performers

There does not appear to be policy documents or government commissioned studies that directly discuss issues around administrative efficiency. Historically, research administration in Danish universities has been relatively small, and should in theory have been made further efficient through the recent merger of universities and institutes. Notably, the annual statistics[70] published by the Danish government only distinguishes between 'research' and 'non-research' activities performed by academics, where administration has fallen into the former category along with, for example, PhD supervision and participation in seminars, while e.g. teaching has been categorised as non-research[71]. The *Tal om Forskning* publications do not cover the administrative costs of running central research offices.

One objective of the Globalisation goal is that rules for research grants allocated on a competitive basis should be revised, in order for funding to cover the full costs of the institutions, indicating that an acceptable level of administrative efficiency is believed to exist already.

Nevertheless, other discussions within university organisations, such as the **Danish Association of Masters and PhDs[72], suggest a large increase in administrative costs post the mergers. A study across the eight universities carried out by the association, using government figures, suggested that in the period 2005-2009:**

- Publicly financed funding has increased by 40 per cent, and much of this have been competitive funds
- Expenditure (for universities) has increased by 32 per cent
- Administration related costs have increased by over 75 per cent, which is the equivalent of 2.4 per cent of total expenditure of the **universities**
- **Expenditure for central university administration has increased by 89 per cent[73].**

Crucially, the study does not make clear how the increased costs relate to the mergers of research institutes, which makes further overall conclusions difficult to draw.

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69 http://cordis.europa.eu/erawatch/index.cfm?fuseaction=org.document&UUID=8604BDB6-B9DF-2588-DED7E23F66C977AB&hwd=

70 Tal om Forskning

71 Tal om Forskning, Forskningsstyrelsen, August 2004, pp.4-5

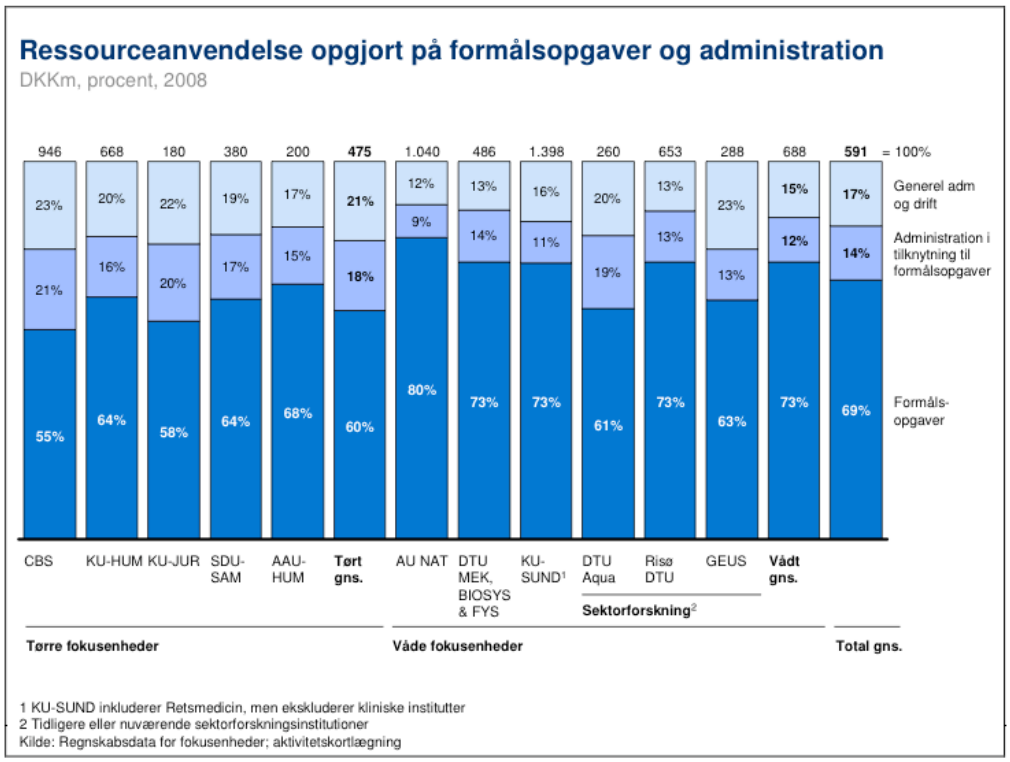
72 www.dm.dk

73 Fodboldlønninger og tung administration dræner universiteterne, Liv Alfast Kretzschmer, Magisterbladet 17, October 2010

From a different perspective, the 2009 McKinsey analysis of university and sector research institute financing and organisation also looked into administrative efficiency in the Danish HE and R&D sectors, although the study was limited in scope (did not cover all universities in all areas), but did include some research institutes.

Looking across the study samples – here encompassing both universities and a few sector research institutes – this analysis suggests a spend of between nine and 21 per cent on administration related to specific 'objectives' (*förmålsopgaver*) while general administration and operational costs varies between 13 and 23 per cent.

The equivalent monetary numbers of these percentages are DKK14-16bn and DKK6-8bn respectively.



Source: Image taken from the report Analyse af universiteternes og sektorforskningsinstitutionernes finansiering og organisering, McKinsey & Co. on behalf of Videnskabsministeriet og Finansministeriet, June 2009

2.3 Research education

In 2007, the Danish university sector was made up of

- 11,850 scientific personnel year equivalents
- 120,000 enrolled students (largest to smallest scientific field: humanities, social sciences, science and technology and health sciences)
- 5,800 PhD students[74]

2.3.1 Organisation of postgraduate researcher training

All eight universities offer PhD programmes within their specific disciplines. Universities or schools may also collaboratively set up research training programmes. It is the universities' responsibility to organise their programmes, which must comply

[74] The Danish University System (presentation), Jens Peter Jacobsen, Ministry of Science, Technology and Innovation

with the framework of the PhD Order, a ministerial order from 2007 which encompasses regulation pertaining to: purpose and structure, admission, content, completion, and the PhD thesis[75].

Trends in access to PhD students in Denmark in the last decade look like this

Discipline[76]	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Humanities	181	194	199	144	177	165	170	175	139	196	213
Natural sciences	340	355	293	317	281	334	338	321	384	501	495
Social sciences	138	160	172	183	172	197	180	167	213	230	225
Health sciences	274	263	304	294	261	286	371	425	436	443	547
Technical sciences	258	247	253	224	195	267	301	283	288	430	457
Total	1,191	1,219	1,221	1,162	1,086	1,249	1,360	1,371	1,460	1,800	1,937

Source: Ph.d.-uddannelsen, University and Property Agency

Overall, access to PhDs has increased in this time, on average with 10 per cent every year. Although all disciplines have experienced growth, relatively speaking, the highest increase can be found within the technical sciences.

Denmark also has a long-standing programme for industrial PhDs, where doctoral are employed by a private business, while also being enrolled in university. In 2010 and 2011, a smaller number of industrial PhD projects (10) will also be available to the public sector.

Vis-à-vis 2009, the 2010 budget for the industrial PhD programme has increased (DKK135m as compared with DKK104m in 2009).

In the last decade, access has increased here too:

Year	**Approved applications**	**Rejected applications**	**Total number of applicants**
2002	50	38	88
2003	64	24	88
2004	70	19	89
2005	83	32	115
2006	85	44	130
2007	109	65	174
2008	119	73	192

Source: Ph.d.-uddannelsen, University and Property Agency

2.3.2 Criteria and funding for postgraduate researcher training

Responsibility for both funding and overall criteria falls to the Danish Research Training Committee (under the Danish Research Coordination Committee – DRCC). The Research Training Committee was formed in 2003 and provides advice to the DRCC on research training in general, and the utilisation of funding to be allocated on researcher training, as laid out in the national budget. It is however the Danish Agency for Science, Technology and Innovation who has ultimate competency to decide on PhD funding.

[75] Ministerial Order on the PhD Programme at the Universities (PhD order)

[76] Our translation

2.3.3 PhD stipend rates

PhD students in Denmark are paid a salary by the institute they are enrolled in, normally around DKK26,500 (pre-tax) including a pension[77] and with the possibility of additional external financing. Additional funding can also be sought from funds and private foundations to help cover project and tuition fee costs.

Industrial PhD students' salaries depend on the company that are based in, and includes a 30-40 per cent public contribution.

2.3.4 Drop out rates

Although somewhat out of date, a 2006 report by the Ministry of Science, Technology and Innovation[78] implied that science and agricultural PhD students have the lowest drop out rates, while social science and humanities students the highest. The complete data from this report can be seen in the following three tables.

General overview of Danish PhD students. 1998. No. of individuals.
Altogether, 258 PhD students initiated studies in Medicine in 1998

Medicine	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	257	251	243	184	66	31	30
Finished without PhD degree	1	6	9	17	19	19	19
Finished with PhD degree	0	1	6	57	173	208	209
National total	258	258	258	258	258	258	258

Medicine	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	100%	97%	94%	71%	26%	12%	12%
Finished without PhD degree	0%	2%	3%	7%	7%	7%	7%
Finished with PhD degree	0%	0%	2%	22%	67%	81%	81%
National total	258	258	258	258	258	258	258

General overview of Danish PhD students. 1998. No. of individuals.
Altogether, 101 PhD students initiated studies in Agricultural and Veterinary Sciences in 1998

Agricultural and Veterinary Sciences	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	101	98	94	59	27	13	13
Finished without PhD degree	0	2	2	5	5	6	6
Finished with PhD degree	0	1	5	37	69	82	82
National total	101	101	101	101	101	101	101

Agricultural and Veterinary Sciences	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	100%	97%	93%	58%	27%	13%	13%
Finished without PhD degree	0%	2%	2%	5%	5%	6%	6%
Finished with PhD degree	0%	1%	5%	37%	68%	81%	81%
National total	101	101	101	101	101	101	101

[77] www.ug.dk/uddannelser/universitetsuddannelser/forskeruddannelse_phd.aspx

[78] A Public Good PhD Education in Denmark Report from an International Evaluation Panel, Ministry of Science, Technology and Innovation, April 2006

General overview of Danish PhD students. 1998. No. of individuals.
Altogether, 137 PhD students initiated studies in Social Sciences in 1998

Social Sciences	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	137	126	125	98	56	36	36
Finished without PhD degree	0	10	10	17	23	26	26
Finished with PhD degree	0	1	2	22	58	75	75
National total	137	137	137	137	137	137	137

Social Sciences	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	100 %	92%	91%	72%	41%	26%	26%
Finished without PhD degree	0%	7%	7%	12%	17%	19%	19%
Finished with PhD degree	0%	1%	1%	16%	42%	55%	55%
National total	137	137	137	137	137	137	137

General overview of Danish PhD students. 1998. No. of individuals.
Altogether, 185 PhD students initiated studies in Humanities in 1998

Humanities	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	182	176	172	135	81	51	49
Finished without PhD degree	1	6	10	32	45	55	56
Finished with PhD degree	2	3	3	18	59	79	80
National total	185	185	185	185	185	185	185

Humanities	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	98%	95%	93%	73%	44%	28%	26%
Finished without PhD degree	1%	3%	5%	17%	24%	30%	30%
Finished with PhD degree	1%	2%	2%	10%	32%	43%	43%
National total	185	185	185	185	185	185	185

General overview of Danish PhD students. 1998. No. of individuals.
Altogether, 226 PhD students initiated studies in Natural Sciences in 1998

Natural Sciences	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	221	217	210	158	80	28	28
Finished without PhD degree	2	4	5	5	7	7	7
Finished with PhD degree	3	5	11	63	139	191	191
National total	226	226	226	226	226	226	226

Natural Sciences	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	98%	96%	93%	70%	35%	12%	12%
Finished without PhD degree	1%	2%	2%	2%	3%	3%	3%
Finished with PhD degree	1%	2%	5%	28%	62%	85%	85%
National total	226	226	226	226	226	226	226

General overview of Danish PhD students. 1998. No. of individuals.
Altogether, 231 PhD students initiated studies in Technology in 1998

Technology	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	219	215	206	154	65	37	37
Finished without PhD degree	12	15	21	22	23	23	23
Finished with PhD degree	0	1	4	55	143	171	171
National total	231	231	231	231	231	231	231

Technology	1998	1999	2000	2001	2002	2003	2004
Years of study	0	1	2	3	4	5	6
Ongoing	95%	93%	89%	67%	28%	16%	16%
Finished without PhD degree	5%	6%	9%	10%	10%	10%	10%
Finished with PhD degree	0%	0%	2%	24%	62%	74%	74%
National total	231	231	231	231	231	231	231

2.4 Research funding criteria and mechanisms

There are several factors influencing research funding, including the policy areas found under the Research Council for Strategic Research – responding to the Programme Commission areas (Health, Food and Welfare, Sustainable Energy and Environment, Strategic Growth Strategies, Individuals, Disease and Society, Transport and Infrastructure, and Education and Creativity). Equally the quality and internationalisation aspects as promoted by the Research Councils for Independent Research play important parts in when allocating research funding.

These two councils' guidelines for the performance of the funding function have been drawn up by the Danish Research Coordination Committee. This is officially the body that advises on public funding allocation.

For the two foundations, funding is possibly less dependent on policy objectives. The Danish National Research Foundation uses peer review in its funding criteria. Similarly, the Danish Advanced Technology Foundation's board makes the assessment based on criteria that are part of the foundation's overall objectives. However, considering the foundation's general objective is to "enhance growth and strengthen employment by supporting strategic and advanced technological priorities within the fields of research and innovation[79]", the foundation is rather influenced by current policy priorities and the Globalisation strategy.

2.4.1 Danish Research Coordination Committee

The main role of the DRCC is to "ensure the best possible coherence between all government research funding, whether it is allocated at institutions or under the auspices of foundations"[80]. The Committee's remit include not just the Research Councils for Independent Research and Strategic Research, but also the

- Danish National Research Foundation
- Danish Advanced Technology Foundation
- Danish Rectors' Conference (the umbrella organisation for the universities)
- Danish Government Research Laboratories' Steering Committee
- Danish Council for Technology and Innovation

In addition, the DRCC promotes Danish international research activities and collaboration with the Faroe Islands and Greenland.

2.4.2 Research evaluations

Since 2006 (and the increased investments stemming from the Globalisation strategy and *Globaliseringsmidler*) research evaluations play a more significant part of strategy and future directions of the funding streams. The objective of research evaluations is to "document the quality of Danish research, to create a basis for qualifying future prioritisations and to assess the results of Danish research investments"[81].

Specific evaluations are selected by a group of stakeholders, and further developed in three-year Action Plans, which are approved by the Ministry. Evaluations appear to generally be led by Expert Panels. The types of activity that are evaluated vary, but overall appear to be on a programme level, specifically programmes which have received additional financial support through *Globaliseringsmidler*. Evaluations and themes of evaluation are thus linked to policy priorities, the commercialisation of research results for example. Contrasting to countries like the UK, the Netherlands

[79] http://hoejteknologifonden.dk/en/about_the_foundation/

[80] http://en.fi.dk/councils-commissions/the-danish-research-coordination-committee

[81] Forsknings- og Innovationsstyrelsen

and Norway, there is no tradition in Denmark in the systematic evaluation of research quality, although this is an aspect which is growing in importance. Further, as policy relevant evaluation is a relatively new development, studies still appear to have limited impact on research funding criteria and allocations, however this may well change in the future.

2.5 Monitoring of research grants

2.5.1 Project or programme level

Although there are a number of Danish Committees on Scientific Dishonesty, monitoring related to the management of public research funding appears to be done through reporting (on grant or programme level) back to the financier.

Danish grant holder are required to submit a scientific report not later than three months after the expiry of the funding period, which should cover the entire funding period. The funding body may also request information regarding the progress of the project at any time during funding.

2.5.2 Block grants

The block grants to the Danish universities are tied to the agreements (*Udviklingskontrakterne*) made between the ministries (education and research) and the institutions; that is to say, they are developed in a negotiating process, which takes into consideration longer-term socioeconomic developments, for example, expected future need of PhDs in different industries and fields. Thus, the overall activities and subsequent performances, including education, research and knowledge transfer, of the HE sector is in practice monitored through the annual reports submitted by each university to the Ministries.

However, with the implementation of the 45-20-25-10 model, there is also the political will to partly apportion basic funding to universities on the basis of the universities' peer-reviewed research publications, as these appear in the Ministry's Bibliometric Research Indicator[82].

2.6 Cataloguing research outputs

2.6.1 Cataloguing research funding and performance

2.6.1.1 Danish National Research Database

The Danish National Research Database[83] is part of the Danish Electronic Research Library, which is jointly run by the Danish Ministry of Science, Technology and Innovation, Ministry of Education and the Ministry of Culture.

The database is a central portal for published Danish research, covers scientific articles, PhD theses, conference presentations and lecture notes, as well as other published information. Data mainly stems from the Danish universities, but all institutions of higher education, government research institutes, research councils and other public institutions carrying out research can become data providers. The data providers participate on a voluntary basis.

Beyond the voluntary national database, the cataloguing of research performance has generally been done through international or chronological comparison of number of publications, citations etc. Denmark has also developed two new instruments, which are both related to research performance vis-à-vis policy targets (Globalisation strategy).

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[82] http://www.fi.dk/forskning/den-bibliometriske-forskningsindikator

[83] www.forskningsdatabasen.dk

2.6.1.2 Cataloguing 'future research funding': the RESEARCH2015 system

Although not a traditional system, it might still be relevant to mention the recently implemented RESEARCH2015 system. This is a system that catalogues all proposals on especially promising themes for future strategic research, with the aim of inspiring and informing future funding streams and priorities. The idea behind the system dates back to a political agreement to implement the Globalisation strategy and funding increase in the Danish research system. The main purpose of RESEARCH2015 is to improve the political prioritisation of funds for strategic research.

Proposals for strategic research themes are focused on the long-term challenges, that is, "areas in which Danish research and new knowledge may be the driving force in the economic development or contribute to implementation of significant policies of Danish society"[84].

The design of the system is three-fold:

1. "A broad-based mapping of the of the strategic research needs created by societal and business development
2. Identification of a number of defined and coherent research themes, which may form the basis of goal-oriented strategic research investments
3. The preparation of the final proposal through dialogue with interested parties from society at large"[85].

A recent evaluation of the RESEARCH2015 system by the Danish Technological Institute concluded "the RESEARCH2015-catalogue has given the politicians an improved basis for the prioritisation of the strategic research. Further the evaluation shows a positive perception concerning involvement and influence in the process. However, the evaluation also shows, that several of the respondents have doubt whether the RESERCH2015 will be used to prioritise strategic research in the future. The concern is that the time and effort laid in the process cannot be justified, if the RESEARCH2015-catalogue is not used in future Budget negotiations"[86].

2.6.2 Cataloguing research outputs

The Ministry for Science, Technology and Innovation has developed a new Bibliometric Research Indicator (implemented in 2010) that will not only have influence on basic funding allocation for the universities, but also aim to more generally improve the inventory of university scientific research production in Denmark.

The background to the development of the indicator is again the Globalisation strategy, and the goal of increasing quality and competitiveness in the Danish research community.

The Research Indicator distinguishes between five categories of scientific publications, including both scholarly articles in journals and four other peer-reviewed publications.

The Bibliometric Research Indicator aims to improve the analysis of the performance of the Danish scientific society, by including a broader set of articles and journals and not focus exclusively on the English language. Currently, around 20,000 journals and publications are included in the indicator, which will be updated continuously. The ministry is expected that research, particularly in the humanities and social sciences, will to a greater degree than before be more visible in the submissions made by the Bibliometric Research Indicator. The information pertaining to the inventory of

[84] http://en.fi.dk/research/research2015/about-research2015

[85] Ibid.

[86] http://en.fi.dk/research/research2015/the-final-proposal/evaluation-of-reseach2015

Danish research output will only be available for Denmark, thus not be internationally comparable.

Five types of publication are included in the indicator:

- Scientific monographs, that is, monographs with a scientific aim and that have an ISBN number and are published by scientific publishers that meet the requirement of peer review
- Scientific articles in journals (periodicals or series), that is, articles with a scientific aim, published by a scientific publisher that has procedures for peer review, and have an ISSN number
- Scientific articles in anthologies, that is, articles that form part of a larger scientific work that have an ISBN and are published by a publishing channel that meets the requirement of peer review
- Patents, that is publications on patented inventions, that are issued and registered on recognised patent databases
- PhDs and doctoral dissertations, based on individual university rules for defence of theses[87].

2.7 Example of successful research policy

2.7.1 Overview – general experience

The Danish public research system has in last five years clearly been 're-jigged' to align with specific R&D aspects, and broader objectives of the Globalisation strategy. Emphasis has been put on competitiveness (including for the allocation of funding), quality and internationalisation, and also on the development of PhDs. Funding has been increased, and the ERAWATCH report estimated that the public sector in Denmark will reach the one per cent funding target in 2010. At the same time, and despite containing specific objectives, the Globalisation strategy is a long-term stratagem and very comprehensive:

- Research and development should be strengthened. The objective is that public and private companies and institutions spend a total of at least 3% of gross domestic product (GDP) on research and development by 2010. Publicly financed expenditure on R&D should reach 1% of GDP in 2010, while private R&D should be spurred by improved framework conditions
- At least 50% of the research funds should be subject to open competition. Increased competition will ensure that the funds go to the best researchers and the best research environments
- A new model for competition between universities should be designed, so that funds will be targeted at large, long-term research projects
- The rules for research grants allocated on a competitive basis should be revised, so that the grants cover the full costs of the institutions
- The grant award procedures of the Danish Council for Strategic Research and the Danish Councils for Independent Research should be revised, with the aim of increasing the proportion of large, long-term research grants
- A long-term Danish strategy for investments and priorities of major research infrastructures should be formulated
- A larger proportion of the public sector research funds should be targeted at strategic research conducted within areas that can act as a driving force for increasing prosperity or remedy important social problems

[87] Research Barometer 2009, Ministry of Science, Technology and Innovation

- The basis for the political prioritisation of strategic research should be strengthened. Once every four years, a catalogue should be compiled of themes for strategic research
- The quality of Danish research should be measured and evaluated in a systematic way. A "quality barometer" should be established that gives a picture of how the quality of Danish research is developing
- The rules should be amended so the research councils can allocate funding support towards international research cooperation[88]

As an example of policy-led change, perhaps the recent mergers of universities and research institutes is a better, more concrete, example.

2.7.2 Example – Merger of the university and research institute sectors

The 2007 merger between Danish universities and research institutes is likely to one of the most comprehensive changes seen in the national research and innovation system in the last decade. And it was a policy-driven change led by a new government.

2.7.3 Rationale

The rationale for the merger was multilevel. Partly the rationale was global – a strategy to keep up with other countries' reforms – and on a European level to gain increased influence and attract further EU funds by improved gravitas. There were also thoughts about improving Nordic HE cooperation behind the strategy.

On a national level, the government wished to take into account newer socioeconomic structure and political directions, in particular the Globalisation strategy. There was a explicit need for universities to form and execute their own strategic priorities in education, research and innovation. In addition, the light-weight public research institute sector were to become part of a larger research structure.

The who re-organisation was however a voluntary process – to force it through would have required a majority in Parliament the Danish government did not have.

2.7.4 Description of themes/ entity and objectives

An expert panel evaluating the merger in 2009 explained that "The university merger processes consisted of an integration of GRIs into the university sector, which was a target of the globalisation strategy; and mergers between universities, which was initiated by the Government. The integration of GRIs had as its main aims to stimulate research synergies between until now institutionally separated sectors; to fertilise the university sector with practice oriented research leading to close contacts with societal, i.e. private and public sector agencies; and: to make additional research resources available for educational processes, leading to a strengthening of the link between higher education and research"[89].

The university-research institute mergers were preceded by a new University Act (2003) which gave university increased autonomy. The new Act was an important accompaniment to the mergers, which were seen to have been inefficient on their own.

2.7.5 Outcomes

The abovementioned 2009 evaluation looked at both the implementation and results of the new University Act 2003 and of the mergers. In relation to the mergers, there were a number of expected outcomes – particularly with regards to research.

The mergers were overall expected to stimulate:

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[88] www.globalisering.dk

[89] The University Evaluation 2009, Evaluation report, Ministry of Science, Technology and Innovation

- More interdisciplinary cooperation in education
- More flexible and relevant offerings of degree programmes for the Danish students
- Greater success for Danish universities in their applications for EU research funding
- Higher quality (in the sense of impact) of the Danish university research output
- Better cooperation between the universities and the private sector with respect to innovation
- More effective knowledge relationship between the public research sector and the sector ministries.

According to the panel, actual outcomes largely corresponded with predicted ones, although some specific targets – in particular vis-à-vis the international plane had no fixed indicators to look at, and, in addition Danish universities had been in a strong starting position, hence any concluding thoughts were difficult to draw out. Other continued obstacles was the low degree of private funding going towards universities.

However, particular positive points included:

- The development of university-specific strategies somewhat patchy, but good concentration of academic resources
- Satisfactory results in FP7 – although low in some places, Denmark receives more funding from FP7 than it invests, although Danish universities rather participate than coordinate
- In terms of educational offerings, university mergers have helped towards a smooth transformation to Bologna study structures
- Positive effects on internationalisation of higher education and exchange students – both to and from Denmark has increased. As for foreign PhD students, this group has grown by almost 150 per cent 2000-20008 – which granted includes a fairly long period before the re-organisation
- New two-year Masters programmes function well and without major growing pains
- Consulted students were overall positive to the changes.

Although there were few comments from the panel on the non-merged universities, they recommended the remaining research institutes be integrated in the university system.

Further, the panel also underlined that future strategies on the university sector needed to start to take shape[90].

[90] Ibid.

3. Finland

3.1 Overview of the Finnish research system

3.1.1 Overview of public funding flows for research

Despite its small size, Finland is one of the OECD most dynamic economic countries. In 2008, Finland's GERD as a percentage of GDP was 3.7%, which was significantly higher than the EU 27 average of 1.83%. Over the last decade, GERD as a percentage of GDP has increased gradually and was up to 4% in 2009.

Figure 28 Percentage of Finnish GDP dedicated to GERD (1997-2009)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
% of GDP dedicated to GERD	2.7%	2.9%	3.1%	3.3%	3.3%	3.4%	3.4%	3.4%	3.5%	3.5%	3.5%	3.7%	4%

Source: OECD Science, Technology and R&D Statistics

3.1.1.1 Policy advice for R&D

The highest-level governance for research policy takes place at the Parliament and at the national government level. Finnish R&D policy is centralised and prioritised in the Research and Innovation Council (RIC) (former Science and technology Policy Council, up until 2009). The Council members include representatives from Minister of Education, the Minister of Employment and the Economy, the Minister of Finance, and up to four other ministers appointed by the Council of State. RIC is the key advisory body in matters of research, education and innovation policies. It is active in the formulation of guidelines for the government as well as in the coordination of the different actors involved in research policy. Apart from RIC, the development of scientific research at the general policy level is based on the Development Plan for Education and Research and the Government Programme. The strategies outlined by the RIC have an impact not only on general research policy but also the operations of various organisations such as the Academy of Finland, which is one of the two R&D agencies (together with Tekes, the Finnish Funding Agency for Technology Innovation).

That being said, scientific advice is however highly decentralised to the different levels and operators of the research system. The Academy of Finland is the most important expert organisation that provides advice in research policy:

- It conducts research policy reviews, i.e. a review of the state and quality of science and research, which provides a comprehensive package of impact reports and assessments, including separate publications by the Academy's four Research Councils.
- It implements evaluations and assessments foresights in different fields of research.

Likewise, Tekes independently sets priorities related to technological research.

In this respect, scientific advice does not only involve administration, but also the steering groups of the different national research and development programmes launched by the Academy of Finland and Tekes, which consist of experts from research organisations and from the leading business enterprises.

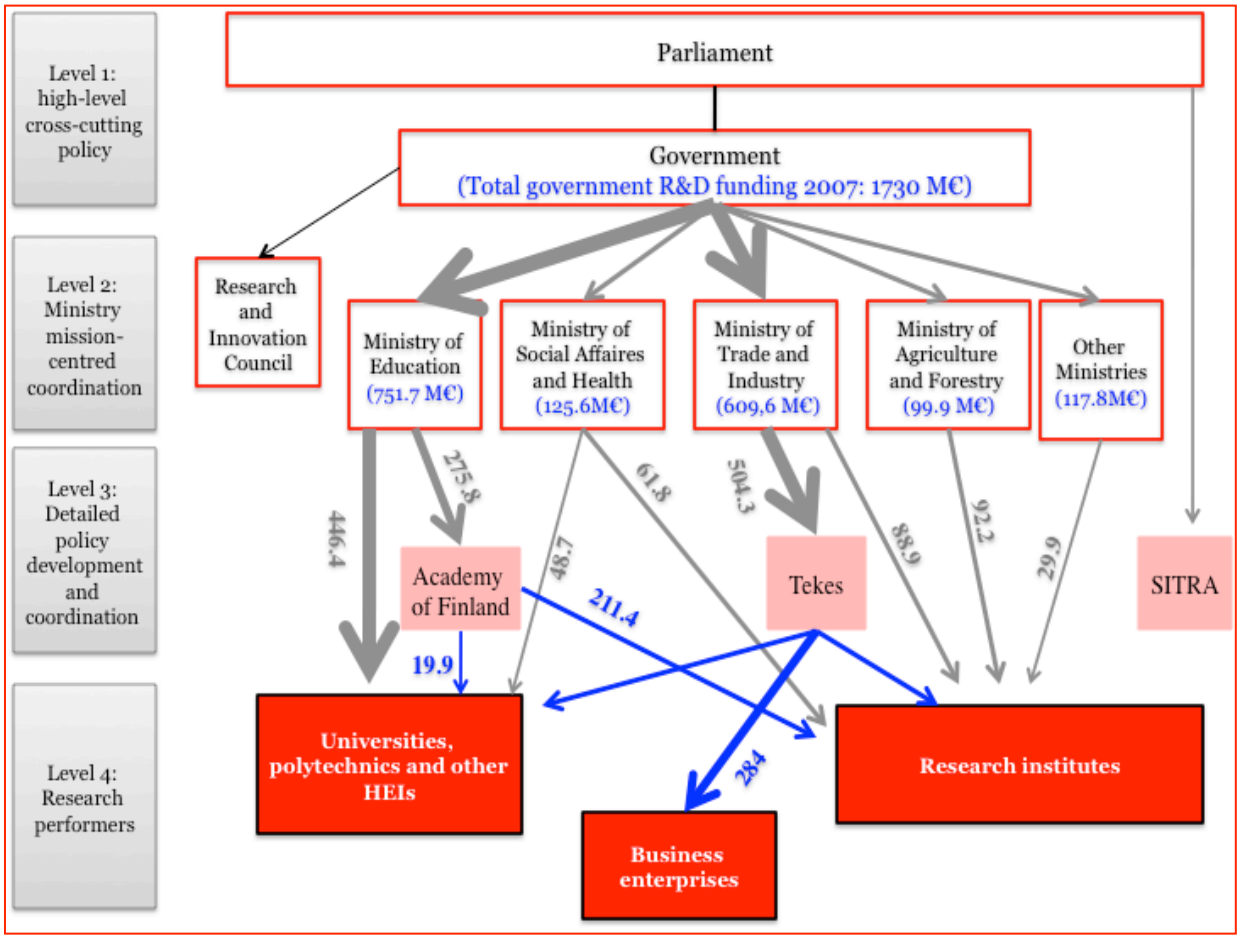
Although Finland counts 19 regions plus the autonomous province of Åland, their institutional role is minor. Regional concerns have however had an important effect on the national policy in many respects. For instance, Tekes formed a regional strategy in

2000 and the Ministry of Education followed in 2003. As of 2002, universities are also obliged to prepare regional strategies.

3.1.1.2 Key players involved in Research policy

A stylised overview of the organisational structure and the funding flows for research and innovation is shown in Figure 29. The four-level structure presents all the actors involved in research policy from central decision-making bodies to research performers. The four levels and the relations between them are explained further in the following subsections.

Figure 29 Organisational structure for research policy in Finland and main government R&D funding appropriations in M€ in the state budget (2007)[91]



Source: Technopolis, based mainly on the Erawatch research inventory report 2009 (online: http://cordis.europa.eu/erawatch/index.cfm); and Statistics Finland (Government R&D funding in the state budget 2007, online: http://www.stat.fi)

The following ministries are key players within the Finnish research policy. Although historically research policy tended to be divided into sectoral areas of competences, many have increased their cooperation over the past few years:

- The Ministry of Education and Culture (Minedu): accounts for 43% of the government R&D appropriations in 2007;

[91] 2007 is the last year for which all data are available and offer a good overview of the major flows.

- The Ministry of Employment and the Economy (MEE, former Ministry of Trade and Industry, as shown in Figure 29): is in charge of technology policy and accounts for 35% of the government R&D appropriations in 2007.

The Ministry of Social Affairs and Health and the Ministry of Agriculture and Forestry are also important providers of R&D funding, with respectively 7% and 6% of the total government budget dedicated to R&D funding in 2007.

As shown in Figure 29, the two R&D agencies – the Academy of Finland and Tekes - together represent 45% of the total government R&D appropriations in 2007 (respectively 16% and 29%). Within the remainder, 26% is dedicated to Universities funding, 3% to university central hospitals and 16% to government research institutes.

The Academy of Finland and Tekes provide competitive funding to research performers:

- The Academy of Finland funds basic research of individual researchers and research units of universities and research centres. It also launches and runs research programmes, whose objectives are defined by the Academy, but may also include Tekes, ministries or foundations, for example in cases of jointly funding programmes. The practical operations of the Academy are structured into four Research Councils, which are nominated for four-year terms. These are Research Councils for Biosciences and Environment, for Culture and Society, for Health and for Natural Sciences and Engineering.
- Tekes provide selective funding for applied research as well as expert services to business entreprises, research institutes, and universities. In Figure 29, Tekes R&D funding flows are not split between research institutes and universities since detailed data are not available. However, all in all they represent 185 M€, compared to 284 M€ for the private sector.[92]

SITRA (the Finnish Innovation Fund) is directly under supervision of the Parliament.

European funding for universities, research institutes and the private sector amounts to about 127.5 M€ in 2007. The same year, about 5% of the total R&D funding to research institutes and 12,3% of universities external funding came from the Union. As far as R&D funding only is concerned, almost two thirds of the European funding was received by VTT.

3.1.1.3 Trends in funding flows to research performers

Finland implements a binary system for the allocation of public funding for research. Public funding is namely divided between core funding and competitive funding, as follows.

Figure 30 Overview of the main public funding by research performers in Finland (2009)

	Core funding (appropriations in State budget, M€)	Competitive funding provided by the two R&D agencies (M€)
Universities, polytechnics and university central hospital	546.3	348
Research institutes	295.7	95.9
Business enterprises	0	343

Source: Technopolis, based on various sources

These data do not allow giving shares of R&D budget provided by core funding and by project funding, since we have found any comparative data on the R&D total budget of

[92] Tekes, Annual review 2007, online: www.**tekes**.fi/en/document/42734/**annual_review_2007**_pdf *(consulted November 2010).*

universities and research institutes. However these show clear trends in the basis allocation for funding to research performers:

- Core funding to universities is split towards negotiated funding based on education and research volume, and on performance based funding related to quality and impact criteria. They also receive competitive funding from the Academy of Finland and to some extent from Tekes.
- Likewise, most of the public research institutes receive core funding, based on various criteria stated in the yearly performance agreement with their affiliated ministries. Competitive funding is provided by the Academy of Finland and to some extent by Tekes.
- Public R&D funding to business enterprises is provided mainly through Tekes' competitive projects and loans.

As far as public research performers are concerned, the amount of core funding from the state budget has steadily decreased over recent years as the share of competitive funding become more important. While public R&D funding in general has grown 30% between 2005 and 2009, Tekes' and the Academy of Finland's competitive funding have grown by 36% and 72% respectively over the period (Statistics Finland 2005 and 2010). Over time, core funding therefore become less important in the share of government appropriations for research (Figure 31).

Figure 31 Main government budget appropriations for core funding to research performers in Finland (1999-2010)

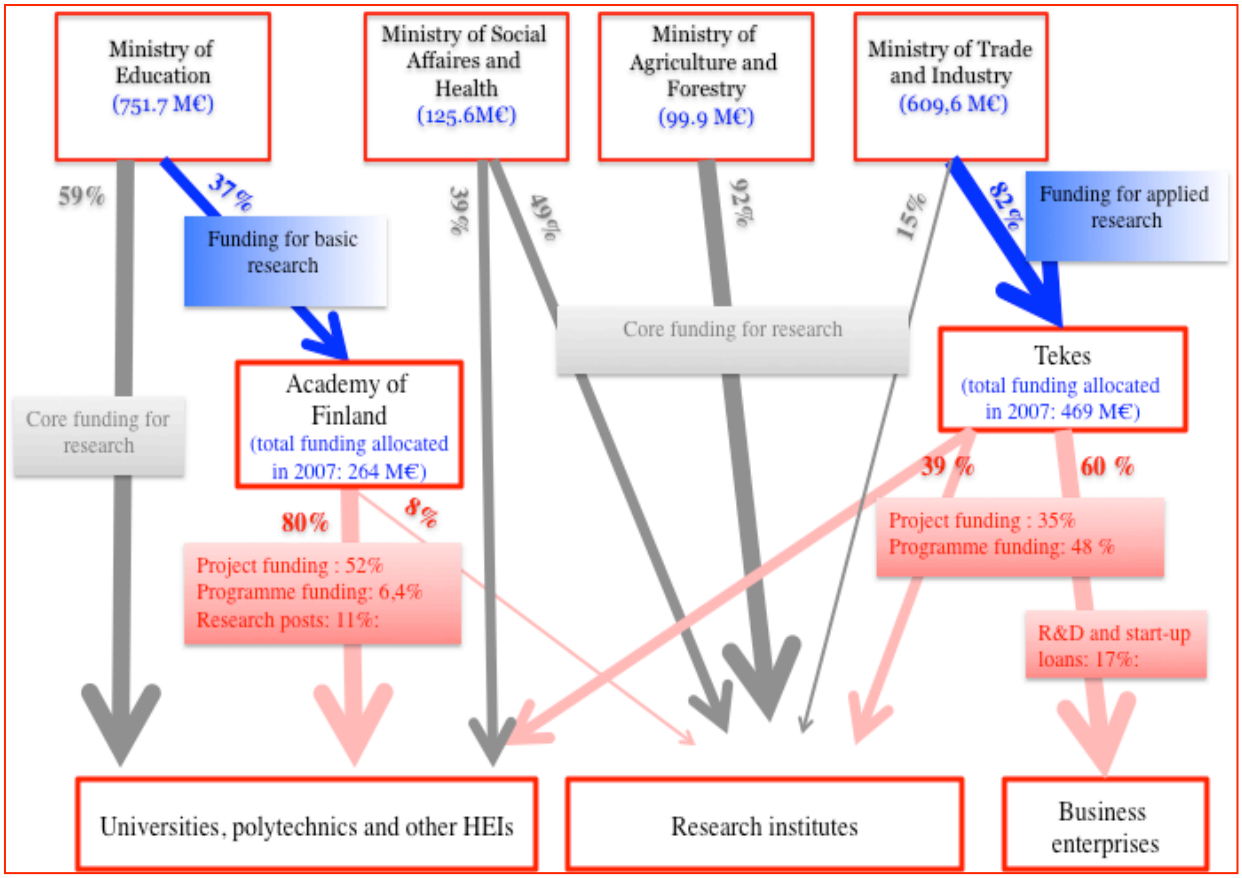
R&D Agencies	1999		2005		2010	
	M€	% of total gov. R&D funding	M€	% of total gov. R&D funding	M€	% of total gov. R&D funding
Universities and university central hospital	323.3	25%	457.4	29%	546.3	26.5%
Government research institutes	209.8	16,4%	259.4	16%	295.7	14.4%
Academy of Finland	155.5	12%	223.5	13,9%	384,4	18,7%
Tekes	411.2	32%	448.4	28%	610.8	29,7%

Source: Technopolis, based on Statistics Finland (Government R&D funding in the state budget 2005 and 2010, online: http://www.stat.fi) and the Academy of Finland publication, Scientific research in Finland, 2003.

Alongside, Figure 31 shows that the competitive funding dedicated to basic research through the Academy of Finland has consequently grown both in nominal and in relative terms. This goes hand in hand with the implementation by the Academy of new research programmes. On the contrary, funding dedicated to Tekes applied research has slighty decreased its share in the total government R&D funding since 1999.

Figure 32 details the main types of funding (core funding, competitive project and programme funding) and their share in the R&D budget of public funders. In grey are the funds from the ministries to research performers, in blue funds from the ministries to research agencies and in red funds from agencies to research performers. For instance, 37% of the 751.1 M€ funding of the Ministry of Education dedicated to research went to the academy of Finland in 2007 and 59% to universities. The same year, of the 264 M€ allocated to research funding in the Academy of Finland, 80% went to universities and 8% to research institutes.

Figure 32 Share of the main government R&D funding flowing to Finnish R&D agencies and R&D performers in M€ (2007)



Source: Technopolis, based on Statistics Finland (Government R&D funding in the state budget 2007, online: http://www.stat.fi) and various other sources

3.1.2 Priority-setting at the national level (Level 1)

Broadly speaking, the Finnish government increasingly targets new funding through prioritisation exercises, in a way that it promotes the application of results of research.[93] What is more, Finland also conducts regularly prioritisation exercises and use studies of leading foreign countries to improve its research policies. Research strategy and roadmaps are traditionally issued through consensus, i.e. by large working committees and long processing times. The consensus culture is however shifting and is being replaced by committees of the wise (a few prominent individuals) who hire consultants for analysis of operating and upcoming research policies.[94]

More specifically, priorities for research policy are mainly set out through strategic documents issued by the Research and Innovation Council (RIC) (former Science and technology Policy Council Recently) and by certain branches of the government. Policy reviews as well as evaluations and foresights carried out by the Academy of Finland also play a key role in the priority-setting process by informing policy-makers.

Core recent strategic documents include:

[93] Erawatch country report Finland, 2009, online: http://cordis.europa.eu/erawatch/index.cfm (consulted November 2010)

[94] Royal Swedish Academy of Engineering Sciences (IVA), "Prioritisation of Research and Innovation", 2009

- The National Innovation Strategy (2008)[95];
- The second National Reform programme 2008-2010 (2008)[96];
- The Science and Technology Policy Council Review (2008)[97].

These strategic documents have asserted the following targets for public research inputs, of which as follows:

- Public GERD as a proportion of GDP to be 4% in 2011;
- Public funding to remain stable at 30% of all GERD;
- Public funding of R&D and innovation activities to be increased at a pace exceeding that of general economic growth in Finland by about 5% annually.

When it comes to sectoral priorities, an Advisory Board for Sectoral Research was established in 2007 in the Ministry of Education and Culture to coordinate the overall steering of state sectoral research. Its action is geared to support and strengthen performance management of sectoral research in each field of administration. It was appointed for six years. The aim is to improve ministries' commissioning know-how, enhance the targeting of sectoral research and step up the utilisation of research over administrative boundaries. It also issues publications dealing with the state of research in Finland. The most recent one was issued in March 2010 and deals with the internationalisation of Finnish research. The domain of state sectoral research is divided into four themes, corresponding to the four subcommittees of the Advisory Board:

- Regional and community structures and infrastructures;
- Knowhow, work and well-being;
- Sustainable development;
- Security.

Plans, i.e. agendas, for each thematic area are issued by the Advisory Board for their inclusion in the yearly Government's Strategy Document, which serves the implementation and monitoring of the Government Programme and consists of policy programmes, other intersectoral Government policies plus annual plans and measures for the implementation of the Government Programme. Each sectoral agenda comprises research themes of interest to several administrative sectors and involve several ministries. Research agendas are implemented under the form of programmes for the period 2009–2012.

That being said, thematic priorities are rather set up at agency level through the programmes run by the Academy and Tekes. Typically, both agencies' programmes are however generated bottom-up by initiatives from research performers, rather than centralised strategic planning mechanisms.[98] Here one can point to the sprinkling of public strategic funding in Tekes for instance, since the agency runs currently 29 research programmes, many of them being minor in terms of funding. In this respect, the implementation of steering mechanisms such as the Advisory Board in the Ministry of education may have effects in increasing the steering up and planning through governmental priorities in the longer run.

In practical terms, the Academy of Finland targets basic research in the following fields – which corresponds to its Research Councils competencies - i.e. Biosciences and Environment, Culture and Society, Health and Natural Sciences and Engineering.

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[95] Ministry of Employment and Economy, Government statement on Innovation Policy, 2008

[96] Ministry of Finance, The Lisbon strategy for growth and jobs 2008-2010 – The Finnish National Reform Programme, 2008

[97] Science and Technology Policy Council, Review 2008

[98] Erawatch, research inventory report (2009)

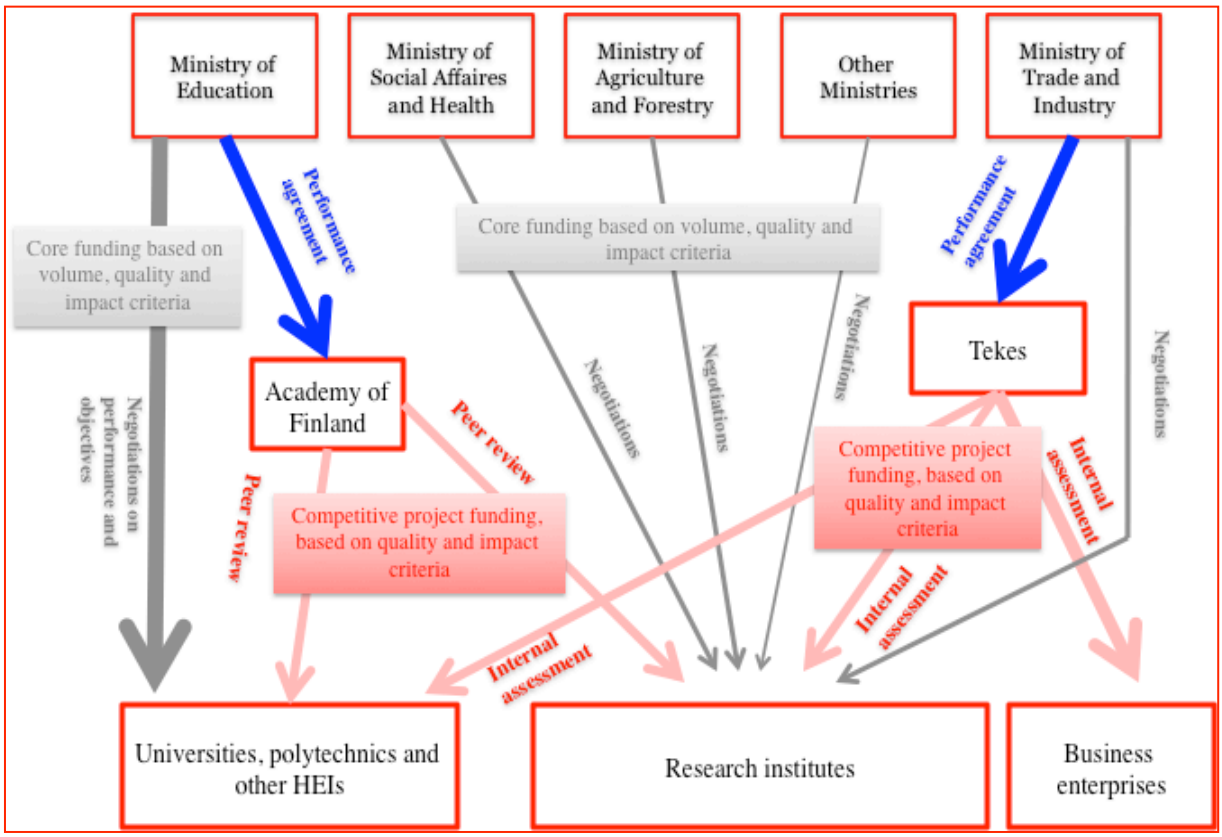
When it comes to applied research Tekes programmes offer focus on the following areas, that cover the priorities set up at governmental level[99]:

- The wellbeing and health
- Knowledge society for all
- The clean energy
- The scarce resources
- The built environment
- The intelligent systems and environments
- The service business and service innovation
- The purpose of the interactive media

3.1.3 Steering, governance and administration at the ministries level (Level 2)

Steering at the ministries level is based on a balanced approach between horizontal negotiated agreements and a vertical monitoring of research performance. The government makes a broad use of performance agreements or other negotiation tools with R&D agencies/ universities/ research institutes and their affiliated Ministry (Figure 33).

Figure 33 Mechanisms for the steering of Finnish R&D agencies and R&D performers and allocating funding



Source: Technopolis

Steering mechanisms vary from one Ministry to the other. Most of the time, negotiations agreements determined the amount of funding for the next budget year

[99] Tekes' website: http://www.tekes.fi/ (consulted November 2010)

or for a determined period of time. Objectives and performance targets are set either in performance agreements or in strategic plans and they comprise as follows:

- Objectives and targets concerning impacts and operational performance;
- Resources;
- And, sometimes, indicators used in the monitoring of objectives.

Moreover, some ministers prepare a yearly assessment of research institutes' and agencies' performance in the previous year and of its success in meeting the performance targets (e.g. Minister of Employment and Economy). Performance and budget-based management are then decided, based on the Finance Act and the related Budget Decree. Typically, research programmes and projects in research institutes are evaluated at set intervals, the latest at the end of the project. Recognised national and international experts participate in the evaluation process.

Let us take Tekes case in point. The Ministry of Employment and the Economy launches effectiveness studies on these objectives carried out by external experts every third year. Besides, the ministry discusses with the organisations all through the year: if some problems in the operation of the organisation occurs, the ministry and the organisation take immediately measures to correct the situation. Moreover, the ministry follows quarterly Tekes with some defined indicators for each one of the three Tekes objectives, among them:

- Objective 1: capabilities in innovation activities:
  - The total budget of enterprise projects funded by Tekes;
  - The level of challenge and novelty value in the projects funded;
  - Number of network contacts in Tekes and SHOK programmes;
  - Enterprise funding to public research organisations in Tekes projects;
  - The share of internationally cooperating projects of the funding;
- Objective 2: productivity and renewal of industries
  - The share of SMEs of total enterprise funding;
  - Number of customers Tekes has funded during last five years;
  - Number of newly established companies as customers;
  - Number of growth enterprises and potential growth enterprises as customers;
- Objective 3: environment and well-being
  - Funding to R&D&I activities in energy and environment sector;
  - Funding to R&D&I activities in health and wellbeing sector;
  - Number of new products, processes and services created in the projects of information and communication sector;
  - Funding to work-place development.

3.1.4 Setting and monitoring priorities at the agency level (Level 3)

Unlike Norway, research funding in Finland is organised under the model of the separation of power: one agency is in charge of basic academic research, while the other is responsible for technologic applied research. The Finnish model is remarkable for its integration and its coordination, thanks to the the Research and Innovation Council in charge of coordinating the Academy's and Tekes' work. The shift towards more coordination is a long-lasting trends. Ylä-Anttila and Palmber report indeed that the changes in the research and innovation policy thinking since 1980 include moving away from the linear innovation model towards a

more systematic approach and acknowledging the interdependencies between the various research actors.[100] This resulted in increased focus on coordination between the various innovation supporting bodies.

Tekes and the Academy of Finland both mainly provide competitive funding under the form of research projects or research programmes:

- Bottom-up project-funding accounts for 43% of the total funding allocated by the Academy of Finland (200ç) and 35% of the total funding allocated by Tekes (2009)
- Research programmes and centres of excellence account respectively for 10% and 53% of the Academy of Finland and Tekes total funding (2009).

Interesting is the shift in open projects funding (i.e. open without specific target) and strategic funding (e.g. programme funding and specific centres scheme, involving thematic and targeted funding).

Figure 34 Estimates of open and strategic funding in Finnish R&D agencies (2002-2009)

R&D Agencies	**2002**			**2009**		
	Open Project funding	Strategic funding (Programmes and Centres of excellence)	Other	Open project funding	Strategic funding (Programmes and CSTIs[101])	Other
Academy of Finland	43%	20%	Research posts and research training: 26%	45%	10%	Research posts and research training: 36%
Tekes	N/A	N/A	Loans to enterprises: 21 %	35%[102]	53% (10% for CSTIs)	Loans to enterprises: 17%

Source: Academy of Finland publication, Scientific research in Finland, 2003 and annual reports Academy of Finland and Tekes 2009

Figure 34 shows that strategic funding from Tekes has slighty increased between 2007 and 2009, but the lack of data does not enable a wider comparison with previous year. The Academy of Finland's strategic funding has on the contrary consequently decreased since 2002 and 2009 from 20% to 10%. Likewise, the Academy's allocation dedicated to research training has grown from 13% in 2002 to 21% in 2009.

In 2009, the Academy funds 13 research programmes – e.g. the Future of Work and well-being, sustainable energy, etc, it also participates in the joint European Baltic Sea research programme (2010–2016). Typically, programmes are focused on a defined subject area, scheduled to run for a set period (at least four years) and composed of several research projects. They aim at developing interaction and networking around specific fields. Likewise, 29 thematic research programme are run by Tekes in 2009 – e.g. biomass, digital technologies, nanoscience, health, fuel cell, etc.

On top of that, the Academy and Tekes fund 18 centres of excellence in research for the 2008-2013 period. The objective of these centres is to enable the emergence of research and training environments that can generate top international research with social relevance. They promote interaction between different types of research and a

[100] Pekka Ylä-Anttila – Christopher Palmberg: The Specificities of Finnish Industrial Policy - Challenges and Initiatives at the Turn of the Century; ETLA, The Research Institute of the Finnish Economy, Discussion Paper, No 973; 2005

[101] Strategic Centres for Science, Technology and Innovation

[102] 2007, no data available for 2009.

multidisciplinary approach to research, with a view of supporting all disciplines from the natural sciences to the humanities and social sciences. The two R&D Agency also support the operation of the Strategic Centres for Science, Technology and Innovation (CSTIs) run by Tekes, wherein top-quality research teams and units work together with companies that apply their research results. CSTIs account for 10% of Tekes allocation funding to research performers in 2009.

As for project funding, strategic funding is more generated bottom-up by initiatives from research performers than centralised strategic planning mechanisms.[103] In the Academy of Finland the process is led through a two-stage call for application. Applicants first submit a draft letters of intent and then projects, which retain the attention of the Academy, are requested for full applications. The Academy's Board makes decisions on launching a programme or on a possible continuation of ongoing programmes once a year. When making decisions, the Board assesses the objectives, preconditions and co-operation forms of the programme.

Progress is also monitored at global level, through regular evaluations and impact assessment by the Academy of Finland and Tekes. As far as programme funding is concerned, a steering group is appointed and in the charge of the programme follow-up. When it comes to project funding, both agencies typically request a research report upon completion of the project, and interim administrative reports.

Criteria related to scientific quality and originality, feasibility of the proposal and relevance with regards to science and research policy are used to award grants for projects and programmes in the two R&D agencies. Tekes also focus on the potential impacts in terms of commercialisation. Interesting is that both agencies have developed new criteria next to these traditionally used: both of them indeed target international and disciplinary cooperation, and the Academy of Finland target the significance of the project for the promotion of professional careers in research and for research training.

3.1.5 Research performers (Level 4)

Business enterprises are the main source of R&D funding (74% of total R&D funding in 2008, of which Nokia accounts nearly for the half), followed by higher education (17%) and government (8%) (see Figure 35).

Figure 35 Share of Finnish GERD by performed by sector (1998-2008)

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Business	67%	68%	71%	71%	70%	70%	70%	71%	71%	72%	74%
Higher Education	20%	20%	18%	18%	19%	19%	20%	19%	19%	19%	17%
Government	13%	11%	11%	10%	10%	10%	9%	10%	9%	8%	8%

Source: OECD Main Science and Technology Indicators

HEIs are the main public research performers in terms of GERd. The majority of the R&D activity in the higher education sector is carried out in the university cities of Helsinki, Turku, Tampere and Oulu.[104]

[103] Erawatch, research inventory report, 2009

[104] Erawatch country profile Finland, online: http://cordis.europa.eu/erawatch

Figure 36 Principal research performers in Finland

	Number[105]	Research-active staff (FTEs and % of total research FTEs, 2007)		R&D performance by sector (% of GERD, 2008)
Higher Education sector	20 Universities and 26 polytechnics	11,849	27%	18%
Government	18 public research institutes	7,122	17%	9%
Business	Not available	24,132	56%	73%

Source: OECD Science, Technology and R&D Statistics

By definition, business enterprises are autonomous to make their own R&D investment decisions, although they rely on the thematic focus set up by Tekes. These are however broad enough to meet the diversity of business enterprises' strategies.

Government research institutes are dependent from their ministries and negotiate their objectives within performance agreements with their affiliated ministries. Typically, they also entail a scientific Advisory Board to advise their strategy and focus area.

The 2009 Universities Act is a major shift in the autonomy granted to Finnish universities. It is intended to balance between public and private funding to universities in the coming years. In 2008, core funding allocated by the Minister of Education accounted for nearly 60% of the total Universities expenditures.[106] The Act aims at enhancing university autonomy to better supplement basic funding with donations and business activities. As a result, Finnish universities are detached from the state budget, although the Ministry of Education continue to grant core funding to the universities for the execution of their statutory public duties.[107] Universities are granted with an independent legal status, either under the form of independent corporations (public law) or under the form of foundations (private law). In upcoming years, autonomy is likely to lead to more strategic steering of universities in the field of R&D.

As a result from 2010 on, 75% of core funding addressed to Finnish universities is performance based funding awarded on the basis of a number of education and research related. Performance based funding was already used before 2010, but criteria are under review and the focus is increasingly put on research outcomes (which accounts for 45% of the 75% of performance based funding). The other 25 % of core funding are awarded on the basis of science and policy objectives.

Figure 37 University core funding formula implemented since 2010

Funding based on the quality, extent and effectiveness of the activities: 75%		**Other education and science policy objectives: 25 %**
Education: 55%	**Research and researcher training: 45%**	
Extent of activities 85%	Extent of activities 75%	Strategic development 25%
Quality and effectiveness 15%	Quality and effectiveness 25%	Education and discipline structure 75%

Source: Joint Report by the Economic Policy Committee (Quality of Public Finances) and the Directorate-General for Economic and Financial Affairs, Efficiency and effectiveness of public

[105] Erawatch country report Finland (2009)

[106] Joint Report by the Economic Policy Committee (Quality of Public Finances) and the Directorate-General for Economic and Financial Affairs, Efficiency and effectiveness of public expenditure on tertiary education in the EU, Annex: country fiche Finland, European Economy Occasional Papers No 70.

[107] Proposal for the new Universities Act in Brief, 2009

expenditure on tertiary education in the EU, Annex: country fiche Finland, European Economy Occasional Papers No 70.

3.2 Administrative efficiency of research performers

3.2.1.1 General overview of R&D staff

Available data on research staff and supports staff in Finland is largely incomplete. We were not able to find OECD data on all the sectors, personnel nor development over time. There were 56 698 full-time equivalent (FTEs) workers involved in R&D during the 2008 reference year. Researchers account for 64% of R&D personnel in the government sector, 73% in business enterprises, and 74% in the higher education sector (Figure 38).

Figure 38 Distribution of Finnish R&D personnel by occupation and sector of activity (2008)

Country		Finland									
Year		**2008**									
Sector of employment		**Total intramural**		**Total intramural**							
				Business enterprise		**Government**		**Higher education**		**Private non-profit**	
		%	FTE	%	FTE	%	FTE	%	FTE	%	FTE
Total R&D personnel		100	56698	100	33111	100	7122	100	15968	100	497
Total R&D personnel	**Researchers**	72	40878	73	24132	64	4540	74	11849	72	357
	Technicians	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Support Staff	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: Technopolis, based on OECD Science, Technology and R&D statistics

3.2.1.2 The administrative cost of research in selected research organisations

Likewise, no comprehensive data are available at national level on the share of administrative costs for research in total research expenditures. A further look into the R&D agencies, main universities and research institutes budget however gives an overview of the main trends related to the efficiency of research administration. However, these data are hardly comparable, since they do not cover the same expenditures. Figure 39 presents an estimate of the share of administrative funding over the last decade in the two R&D agencies, including the first and the last available years.

Figure 39 Administrative costs for research over time in the main Finnish research organisations

Research organisation	Share of administration costs in total budget – first year available		Share of administration costs in total budget – last year available		Definition and methodology used to calculate administrative costs	Source
Academy of Finland	2001	0,5%	2008	12%	2001: an estimate of administrative costs is given by the share of state budget that is not used in the allocation of funding for research 2008: Operation costs	2001: 2001 report of the Academy 2008: Erawatch website
Tekes	2001	3%	2008	8%	2001: an estimate of administrative costs is given by the share of State budget that is not used in the allocation of funding for research 2008: Operation costs	2001: 2001 review of Tekes 2008: Erawatch website

Source: Technopolis, based on various sources

Due to their different origin and mode of calculation, these data should be handle very carefully. However, there is a clear trend towards an increase in the administrative cost of the two R&D agencies over the last decade, even if it is hard to tell exactly to what extent.

Budget from research institutes and HEIs as they are available in annual reports do not permit to distinguish the administrative costs for research. However, the personnel structure of research institutes could indicate to some extent the evolution of human resources for research administration. Let us take the VTT case in point. VTT (Technical Research Centre of Finland) is the biggest public research institute in Finland. VTT management staff has slighty increased over the last four years, although the share of management staff was stable since the beginning of the 2000's. On the contrary, the share of administrative staff has decreased during the first mid of the 2000's, but has remained stable over recent years.[108]

Last but not least, a study provided by Statistics Finland indicated that in 2005 39% of universities staff time was spent on research (10% for polytechnics staff), while 43% (74% in polytechnics) was spent on teaching and 18% (16% in polytechnics) on "other tasks", including administrative tasks related to research or teaching activities.[109] These figures cover all research staff from professors to assistants.

Considering only researchers, working hours are divided as follows:

- In universities: 77% research, 15% teaching and 8% other tasks
- In polytechnics: 47% research, 29% teaching, and 24% other tasks

Since 1983, the time spent on administrative tasks has remained stable (was 17% in 1983). With the exception of humanities and social sciences, the proportion of research went up in all disciplines over the period. In 2004-2005, research accounted for the largest share, or almost one-half of working hours, in medical and health care sciences (49%), agriculture and forestry (48%), natural sciences (47%) and technology (46%). Least amounts of research were done in humanities and social sciences.

[108] VTT Reviews 1998 and 2008

[109] Time use survey of university and polytechnic staff in the academic year 2004-2005. Statistics Finland, online: http://www.stat.fi (consulted October 2010)

(Survey of Time Use among University and Polytechnic Staff. Statistics Finland. Science, Technology and Information Society 2006.

3.2.2 Improving the administrative efficiency of research

There are strong evidences of improvement in the administrative efficiency of research in Finland, among them the mergers of universities, the application of the full-cost model in competitive grants and the centralisation of research data at national level.

3.2.2.1 Mergers of Universities as a way to bring together administrative efforts

The Finnish government decided in 2007 to create a new merger edifice from Helsinki University of Technology, Helsinki School of Economics and the University of Art and Design. The new university was renamed Aalto University and was established as a foundation under private law. Further mergers are planned between regional Universities and strategic alliances with polytechnics. The idea behind this is to aggregate resources and means for research. The ultimate expectation is that in 2012 the Finnish education system will have no more than 15 universities and 18 polytechnics.

Mergers are seen as a way to improve the international visibility of universities, to put together funding for research, but also to lower the barriers which hamper smaller universities in participating in research competitions because of the high administrative costs. The concept behind Aalto University, namely the creation of strong large-scale universities, has however been criticized.

3.2.2.2 The application of the full-cost model in the application procedures of competitive grants for research

In 2009, the Academy of Finland and Tekes have launched the full cost model for the grants they deliver to research performers, by which applicants for grants are requested to give an overall cost estimate and a funding plan for the project. Applicants are therefore expected to give the percentage for indirect employee costs, the overheads percentage, and the coefficient for effective working hours applied by their own organisation at the time of application submission. Calculations in accordance with the full cost model rely on these coefficients. The use of the full-cost model is a progress in terms of administrative efficiency of research performers, since it offers a better overview and understanding of the direct and indirect costs of research.

3.2.2.3 The centralisation of administrative data at national level

As aforementioned, Finland implements a database (KOTA HE Database) that brings together data issued from universities' annual performance reports. The database is made of 19 indicators dealing with teaching and research activities. Data are available from 1981 on for each university and each field of education. This help to improve the centralisation of data on research activities and as such the level of information at national level.

3.3 Research education

3.3.1 Organisation of postgraduate researcher training

Researcher training is one of the priorities of the Finnish education policy. Doctoral studies are organised within universities and are considered as postgraduate studies, together with the Licentiate (medicine studies).

In Finland, the full-time studies for a Doctor's degree take four years after the completion of a Master's degree. The median duration of studies in all fields of education and for all degrees was 6 years in 2009 (compared to 6.5 years in 1999) (KOTA database). However unlike countries like Australia, the UK, Canada and New Zealand, no data are on the completion rate of PhD studies are available at the level of

the country. However, Finland, as other Nordic countries (Norway, Sweden, Denmark), drop-out rates are high and completion times tend to be long.[110]

Traditionally doctorates were based on independent research. In 1995, a graduate school system was launched in Finland, particularly with a view to reducing the amount of time required by completion of the doctorate and lowering the average age of graduating PhDs.[111] Up until 2007, 119 graduate schools (called by the Academy of Finland 'doctoral programmes') funded by the Ministry of Education have been set up in cooperation between several universities and research institutes. Nearly one third of them operate at the University of Helsinki.[112] The aim of graduate schools is to train high-level professional researchers and experts, as well as to increase international cooperation and the share of foreign doctoral students in the graduate schools to 20% on average by 2012.

The four-tier research career system, as well as the implementation of graduate schools tell us that the focus of research education policies in Finland is more on the quality of research education – i.e. research career, international cooperation, research skills development, etc - than on the quantity of research students.

As a result, while the number of doctoral degrees has increased of 31% during the 2000s, the number of doctoral students has only grown by 7% over the period. Likewise, the share of doctoral students in total the Finnish students' population has only very slightly increased from 6,7% to 7,2% (Figure 40).

Figure 40 Number of doctoral degrees and doctoral students in Finnish universities (2003-2009)

	2003	2004	2005	2006	2007	2008	2009
Doctoral degrees	1,257	1,399	1,422	1,409	1,526	1,527	1,642
Doctoral degrees as % of total degrees	7,1%	7,8%	7,6%	7,3%	6,8%	4%	6,9%
Students in doctoral degrees (FTE)	7,694.5	7,980	8,342.5	8,467.5	8,288	8,167.5	8,254
Students in doctoral degrees (FTE) as percentage of total students	6,7%	6,8%	6,9%	7%	6,9%	7,3%	7,2%

Source: Technopolis, based on: Ministry of education and culture, KOTA online: https://kotaplus.csc.fi/

Doctoral students are expected to prepare a dissertation, which they defend in public, and to attend required courses and training - in the specific field of study as well as courses related to other fields or providing general skills (e.g. research methods, etc).

Doctoral candidates apply to universities, which are responsible for the doctoral candidates selection. The final decision is made by the University's dean, on proposal of the director of the doctoral programme. The requirement for postgraduate studies is a Master's or corresponding degree.

Earning a PhD is attractive in terms of career prospects compared to lower degrees and the unemployment rate of PhD students is very low over the last decade. Most of the PhDs work in academia and employers in the private, public and non-profit sectors are still sufficiently aware of the broad training that doctorate graduates obtain. Data from Statistics Finland suggest that, when comparing the total earnings of full-time wage and salary earners in different employer sectors in 2009, completion of

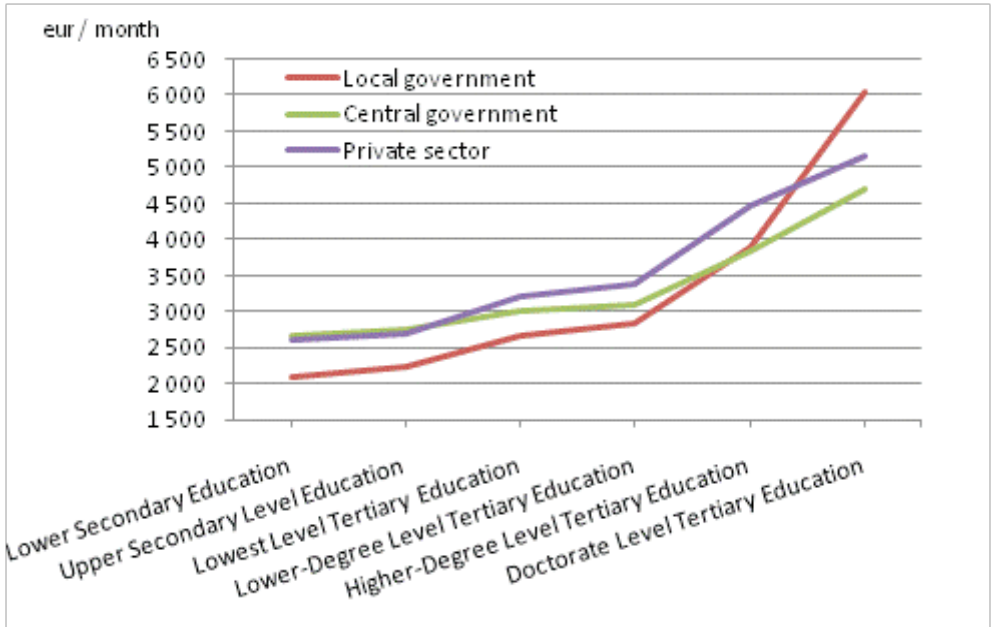
[110] Chris park, redefining the doctorate, decision paper of the UK Higher Education Academy, 2007

[111] European Commission, EACA, Organisation of the education system in Finland, 2008, online: http://eacea.ec.europa.eu/education/eurydice/eurybase

[112] University of Helsinki website: http://www.helsinki.fi (consulted October 2010)

doctorate level education had a pay rising impact in all employer sectors. The average earnings of those with doctorate level education is quite high particularly in the local government sector in relation to lower level qualifications. The large pay differentials with other levels of education in the local government sector are partly explained by that the majority of those with doctorate level education are doctors or teachers in higher level education, whose pay is high relative to other local government occupations.

Figure 41 Monthly earnings by level of education in 2009



Official Statistics of Finland (OSF): Structure of Earnings [e-publication].
ISSN=1799-0092. Helsinki: Statistics Finland [referred: 8.2.2011].
Access method: http://www.stat.fi/til/pra/tup_en.html.

3.3.2 Funding of postgraduate researcher training

The Ministry of Education contributes to the funding of graduate schools through Doctoral programmes calls (former Graduate Schools programme) arranged every second year. These are the main support to doctoral training in Finland. The doctoral programme system was established in 1995 and has been gradually expanded since. As of 2008, the Ministry of Education delegates the decision-making and responsibility for the development and monitoring of doctoral programmes to the Academy of Finland. Doctoral programme calls are arranged every second year and funding is granted for four years on purposes of establishing new doctoral programmes (e.g. scientific breakthroughs) and for continued funding and the renewal and development of existing doctoral programmes. The annual flows of funding for the Doctoral Programmes are as follows[113]:

- 36 M€ from the Minister of Education, that funds full-time doctoral candidates positions for four years;

  4 M€ from the Academy of Finland, that allocates funding to the doctoral programmes for their operating expenses (e.g. course activities, coordination and internationalisation).

[113] Finnish science and technology information service: Research.fi (consulted October 2010)

The last call of proposals, launched in 2010, will fund 2012-2015 programmes. Doctoral positions in graduate schools are paid according to levels 1 - 4 of the university salary scale for teaching and research staff, which amounts to € 19,296 – 26,316 a year pre-tax (tax-exempt up to EUR 18.702, 60 per year). In addition, the doctoral candidate is paid a salary component based on personal work performance, which will be, at most, 46 % of the job-specific component.

Otherwise, PhD related grants and funding are mainly provided by university or university's foundation through personal stipends. Some also come from private foundations. Broadly speaking, doctoral candidates are often part of the staff of universities as junior members of research teams or as assistants responsible for giving tuition besides their doctoral studies.

Apart from the funding allocated to doctoral programmes decided at governmental level within the framework of the Doctoral Programmes, grants for research education are often not identified in their own, but in relation with broader grants to researchers or for teaching. As a result, few data are available on the exact level of funding dedicated to doctoral candidates in Finland. Until recently, the Academy of Finland also funded grants to promote doctoral studies of employed persons in cooperation with **business company, research institute or an organisation within public administration, as well as grants** for doctoral training within the framework of the grants it awards for researcher training and research abroad. However in 2010, these grants have been discontinued as independent calls.

We cannot but mention that doctoral training and the development of human resources has been a main focus area of the Finnish research and higher education policy since 2002, when the Ministry of Education appointed a committee to look into the further development of researcher training. An operational programme for developing research career and researcher training for 2007-2011 followed it. This set up clear targets in terms of public funding inputs (e.g. to increase the number of graduate schools positions under the Doctoral programme to 2000 by 2012) and outputs (e.g. to internationalise the graduate school system). Within this framework, the Ministry of Education has issued a four-stage research career model. This model aims at increasing the transparency and the attractiveness of research careers in Finland. It is built around the following step[114]:

- Doctoral candidate/Researcher training;
- Postdoctoral Researcher;
- Independent research and education professionals capable of academic leadership;
- Professorship.

The Academy of Finland has also very recently published a brochure to promote doctoral degrees among the Finnish population (Academy of Finland, Get ahead in your career, get a doctorate, 2010).

3.3.3 Criteria for postgraduate researcher training

University-specific performance targets for doctoral degrees are determined in the performance negotiations between universities and the Ministry of Education and condition to some extent the amount of funding received by universities.

That being said, universities benefit from complete freedom for designing doctoral curricula and selecting doctoral students. Students are selected according to their previous grads and the prerequisite is usually the grade "good" in the major subject.

[114] Erawatch country report Finland (2009)

The university may also accept a degree taken in another field, if the person is found to have the knowledge and ability required for doctoral studies.[115]

Figure 42 shows the criteria used in the allocation of the aforementioned funding for doctoral training. Funding for doctoral programmes is provided through a review of applications according to scientific, administrative and training quality, as well as to the level of cooperation and relevance of the doctoral programmes. Likewise, most of the individual grants to doctoral training in universities are delivered on a competitive basis following academic and scientific excellence criteria, although some are non-competitive funding provided according to the financial and/or academic situation of the doctoral candidate. Several grants delivered by universities and foundations also target specific fields of research – e.g. the Finnish Savings Bank of Turku Juristic Scholarship Fund equivalent to € 1,990 for postgraduate students working on a Licentiate of Laws or a Doctor of Laws in the University of Turku.

Figure 42 Main criteria used for the allocation of funding to research education

	Type of funding	Application procedure	Eligibility costs	Main criteria for programmes' selection
Competitive allocation to institutions (Academy of Finland)	**Doctoral programmes**	Competitive call for applications Application submitted by the director of the doctoral programmes with a letter of commitment from the host university, an action plan for the doctoral programme and CV and publications of the most important supervisors Applications reviewed by the Academy of Finland's Research Councils Decision by the Academy 6 months after submission of the proposal	Positions of full-time work on a doctoral dissertation, candidates are hired to these positions for a four-year term and are selected by universities Operating costs related to systematic and high-level education and to systematic cooperation on an international, national and sectoral level	• Quality of the scientific or artistic activity of research and the research environment: business idea, research community and research infrastructures, results • Education: training and education according to discipline, field of research or art, general skills and competencies, other activity • Cooperation: international and national cooperation and networking, including contacts with society • Quality of operations: administration, good practices, supervision, operating environment
Personal stipends	**Scholarships/ grants awarded mainly at university level**	Non-competitive grants: decision by university's internal services or Announcement of open competitive grants: Individual applications comprising a work plan (often with reference); Internal and/ or external expertise of the applications	Doctoral students funding	• Thematic focus often, according to the area of interest of the foundation • Sometimes limited to Finnish citizens and/or Finnish permanent residents • Academic excellence of the candidate and other related criteria • Students could be asked to present an account of the progress of their studies or research

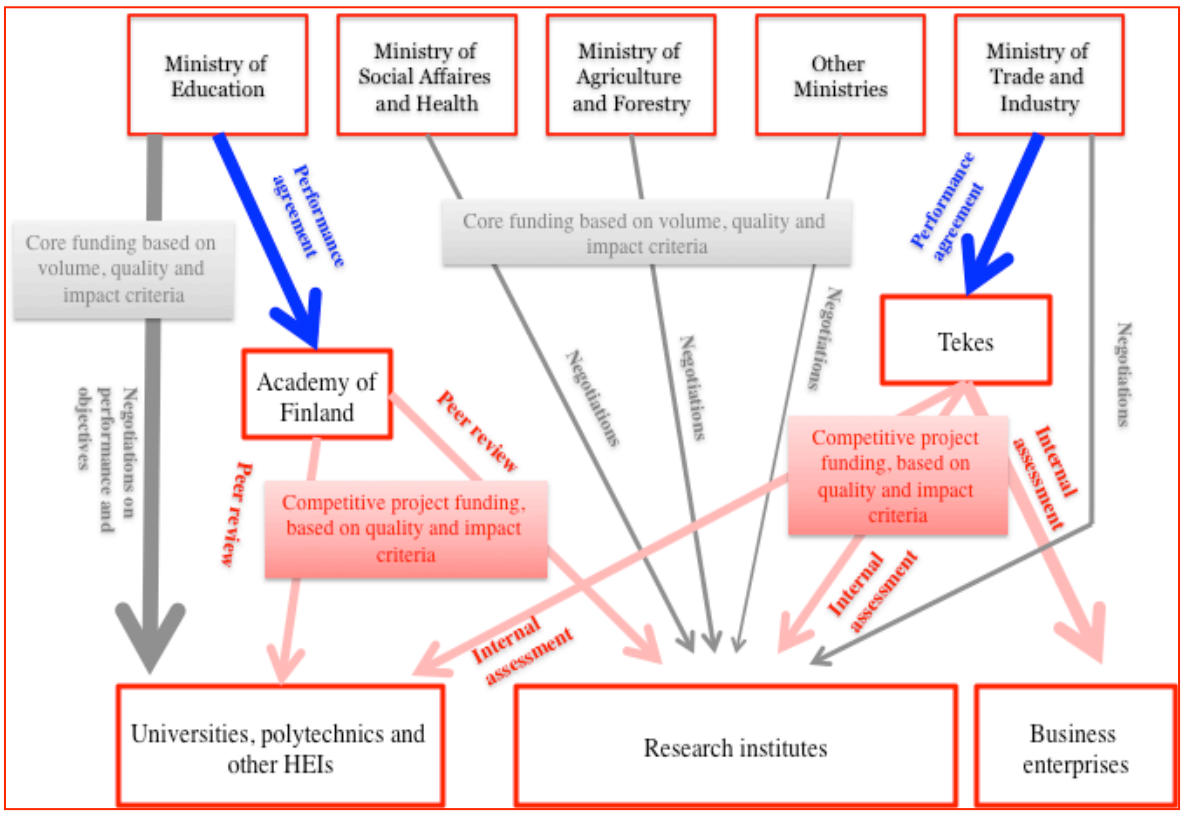
Source: Finnish universities websites, especially the Aalto University and the HSE foundation (http://www.hse.fi); Website of the Academy of Finland (http://www.aka.fi/)

[115] European Commission, EACA, Organisation of the education system in Finland, 2008, online: http://eacea.ec.europa.eu/education/eurydice/eurybase

3.4 Research funding criteria and mechanisms

Many of the issues related to the funding criteria and mechanisms have been dealt in the first section of this report (see section 3.1) and are shortly summarized here. Figure 43 below sums up the main funding mechanisms used in the allocation of public money for research.

Figure 43 Mechanisms for the steering of R&D agencies and research performers and allocating funding (reminder)



Source: Technopolis

3.4.1 Core funding from the state budget

Finnish universities are autonomous entity detached from the state budget as stated in the 2009 Universities Act. From 2010 on, the Ministry of Education grants core funding to the universities for the execution of their statutory public duties according to the extent, quality and impact of the activities and education and science policy objectives. The new elements in the funding model are geared to give incentive for the universities to develop their profiles and to attain important research and education policy aims, notably to reduce overlapping and doubling in education and to promote full-time studies. Performance based funding was already used in Finland, but criteria are under review and the focus is increasingly put on research objectives and outcomes. During the transition period 2010-2012 core funding negotiations with the Ministry of Education are to take place every year, and every four years after this period. Before 2010, negotiations were renewed every three years.

The criteria underlying university funding include objectives as well as research outcomes, as follows (Figure 44).

Figure 44 University core funding formula implemented since 2010 (reminder)

Funding based on the quality, extent and effectiveness of the activities: 75%		Other education and science policy objectives: 25 %
Education: 55%	**Research and researcher training: 45%**	
Extent of activities 85%	Extent of activities 75%	Strategic development 25%
Quality and effectiveness 15%	Quality and effectiveness 25%	Education and discipline structure 75%

Source: Joint Report by the Economic Policy Committee (Quality of Public Finances) and the Directorate-General for Economic and Financial Affairs, Efficiency and effectiveness of public expenditure on tertiary education in the EU, Annex: country fiche Finland, European Economy Occasional Papers No 70.

Specific criteria for the quality and effectiveness of research and researcher training are, as follows:

Figure 45 Impact of research quality assessment on University funding

Specific criteria	Indicators	Weight
Research funding competed for nationally	**60%**	
	Academy of Finland funding for the university	75 %
	Tekes funding for the university	25 %
Scientific publications	**20%**	
	Number of refereed international publications	60 %
	Number of other scientific publications	40%
Internationalisation of research	**20 %**	
	Amount of international research funding competed for	60 %
	The overall amount of teacher and researcher mobility	40 %

Source: Joint Report by the Economic Policy Committee (Quality of Public Finances) and the Directorate-General for Economic and Financial Affairs, Efficiency and effectiveness of public expenditure on tertiary education in the EU, Annex: country fiche Finland, European Economy Occasional Papers No 70.

As was the case before the Universities Act, the basic calculation is to be updated annually on the basis of statistical data from the KOTA system. The percentages are determined on the basis of the information available during the year in question. Three-year averages will be used as far as possible in the calculation in order to balance out annual changes. Moreover, the universities themselves arrange the funding of joint networking, education and activities through mutual agreements.

The Ministry responsible for the governance of each specific sector also deliver core funding to research institutes. The steering of research institutes and their basic funding is similarly based on management by objectives, comprising negotiations on objectives and targets between the ministry and the respective sectoral research institutes (see sections 3.1.3). The 2007 budget funds for R&D of the main government research institutes was as follows Figure 46.

Figure 46 Core funding from the State budget and European funding in the total funding of the main government research institutes (2007)

Research institute	Total funding (M€)	Budget funding (M€)	Extramural funding (M€)	% of budget fund in total funding	% of EU extramural fund in total funding
VTT Technical Research Centre of Finland	224.8	73.6	151.2	32%	8%
Finnish Forest Research Institute	44.9	40	4.9	89%	2%
Agrifood Research Finland	47	33.5	13.5	71%	0.4%
National Public Health Institute	36	26	10	72%	5%
Finnish Institute of Occupational Health	23.7	15	8.7	63%	3.3%
Finnish Environment Institute	21.2	10.4	10.8	49%	6%

Source: Technopolis, based on Statistics Finland (Government R&D funding in the state budget 2007, online: http://www.stat.fi)

Figure 46 shows that VTT (Technical research centre Finland) alone accounts for 26% of the State funding for government research institutes in 2007. It is also the one who perform best in attracting extramural funding, including European funding (8% of total funding).

3.4.2 Competitive funding from the R&D agencies

The two R&D funding agencies provide competitive funding to universities, research institutes and business enterprises.

Tekes is run as an innovation agency and funds are distributed through internal assessment of the applications submitted. In the Academy of Finland decisions are made through the research councils helped by a scientific peer review of esteemed experts. In both agencies, criteria for research funding target scientific and applicants' quality, as well as broader science-policy related factors – e.g. impacts for society and businesses, scientific breakthroughs, etc (Figure 47).

Figure 47 Main type of research funding and related mechanisms of allocation and criteria provided by the Academy of Finland and Tekes

Type of funding	Application procedure	Eligibility costs	Main criteria for projects' selection
Academy of Finland			
Projects funding Personal grants for researchers (mobility, fellowships, etc) Research Infrastructures	Two annual calls for applications (but some research programmes and international calls may be open all the time) Applications submitted online, with commitment of the site of research and research plan, CV and list of publications Scientific peer review of the research plan and the applicant by experts (international experts mainly) or for some grants an expert panel with esteemed people within the field of research is requested Final funding decisions are made by the Academy's Research Councils Academy funding is allocated to the researcher's host organisation, but grants for work abroad may also be allocated directly to the researcher	• Direct projects costs: the research team's working hours, research costs, travel, domestic and international cooperation and mobility, and the preparation of international projects. • Indirect project costs: costs of the premises, etc • Personal grants are normally awarded only for work or studies abroad and for a research visit by a foreign researcher to Finland The Academy of Finland always provide co-funding (in calls where cost calculation is based on the full cost model, the Academy's contribution to the project usually covers no more than 80% of the total costs)	• Scientific quality and innovativeness of the research plan • Competence of the applicant/research team • Feasibility of the research plan • Cooperation contacts for the research • Significance of the research project for the promotion of professional careers in research and for researcher training • Science-policy related factors: significance of the research project in terms of society, business and industry; scientific breakthroughs, renewal of science and research
Tekes			
Projects funding Grants Loans	Submission of application Decision of financing by Tekes	• Direct costs: Wages, salaries, travel, machinery and equipment, etc • Indirect costs • Researcher exchange Tekes always provide co-funding.	• Potential for commercialising the outcomes of the planned project. • Extensive international and disciplinary cooperation is rewarded with greater funding participation • Science-policy related factors: significance of the research project in terms of society, business and industry

Source: Websites of Tekes (http://www.tekes.fi) and the Academy of Finland (http://www.aka.fi/)

3.5 Monitoring of research grants

3.5.1 Monitoring of government funding

In order to review the achievements of national research strategy targets, regular evaluations and impact assessments are carried out at central level by the Academy of Finland – i.e. disciplinary evaluations and reviews of the research system, - and by Tekes – i.e. impact of technology development, evaluation of national technology

programmes.[116] Moreover, in 2008, the Academy of Finland and Tekes have developed an Impact Framework and Indicators for Science, Technology and Innovation (VINDI). It aims at creating an overall view of effectiveness of science, technology and innovation. As far as public research organisations are concerned, external performance evaluation are also conducted in the Finnish universities and a Higher Education Evaluation Council (FINHEEC)[117] assists higher education institutions in their evaluation exercises.

Specific steering methods are implemented towards universities since 1991. Following the recent universities reform and the 2009 University Act, there has been a recent shift towards an increase in monitoring at universities level. The growing independence of universities goes namely hand in hand with the demand for more accountability. A few universities have drafted their own research policy strategy - e.g. University of Helsinki Research Policy 2010-2012, which is although light. Several have taken initiatives to ensure the quality of research activities provided in each institution.

In this respect, the University of Helsinki focuses its action on the development of management and leadership skills. The recently issued programme for Leadership, Management and Support Services programme[118] does not only target research activities, however it has important consequence for the monitoring of research activities. The programme indeed introduces new action lines as follows:

- The further development of services is to be based on the needs of research;
- The support services to research will be monitored with various indicators.

Alongside, the University of Helsinki conducts research assessment exercise every six years since 1999 and delivers extra-funding targeting excellent research units. The last Research Assessment Exercise carried out in 2005 combined an external assessment by international evaluation panels with an internal self-assessment exercise. The purpose of the evaluation focused on support to the development of research in future. The main objectives was:

- To examine the quality of the research of the units during 1999-2004, and to advise how to develop the University's research in the future;
- To evaluate the quality of research with regard to the international level of research in the field;
- To develop the University's research activities;
- To offer units the opportunity to receive international feedback on their research;
- Learning and developing of own work during the evaluation process;
- Follow-up since the previous evaluation in 1999.

The results of the external evaluation of the quality of research have an effect on the funds for research distributed within the University.[119]

3.5.2 Monitoring of research grants by the R&D funding agencies

The Academy of Finland and Tekes provide a well-developed monitoring of research grants, which aims at ensuring the completion of the projects funded and the achievement of the targeted R&D results. Monitoring systems vary from one funding system to the other, however they point out that reporting practices (either interim

[116] Finnish science and technology information service: Research.fi (consulted October 2010)

[117] FINHEEC website: http://www.kka.fi

[118] University of Helsinki, Programme for Leadership, Management and Support Services 2010-2012, 2009

[119] Website of the University of Helsinki: http://www.helsinki.fi (consulted October 2010)

and/or final; either administrative and/or research related) are implemented for the full range of available funding. Likewise, when requested, steering groups are in charge of following-up research programmes (Figure 48).

Figure 48 Monitoring of the main research grants dedicated to public research performers in the Academy of Finland and Tekes

	Follow-up of the project	Administrative review	Research progress report
Academy of Finland	Research programmes: Appointed Programme Steering Group and tone Programme Coordinator is in charge of drafting a programme-specific plan for monitoring and evaluation	The site of research shall annually submit to the Academy an account of the use of the funding and data on the person-years	Research report submitted upon completion of the research project Research programmes: other reports such as annual reports can be requested
Tekes	Steering Group with one member of Tekes	Interim reporting and cost statement form	Final report to review how project objectives have been reached and how the results have been utilised and exploited Follow-up report form approximately three years after completion of the project

Source: General Terms and Conditions for Tekes Research Funding for Government Agencies and Institutes, 2008 (http://www.tekes.fi); and Academy of Finland's website (http://www.aka.fi/)

The Academy of Finland also conducts evaluation of its research programmes and Centre of Excellence programmes carried out by external experts upon their completion. These evaluations consider the achievement of the objectives set for the programmes, their success in generating new knowledge and the value added produced by the programme.

Last but not least, interesting is the Science Policy Library of the Academy of Finland. The Library was implemented with a view to supporting decision-making at the Agency and includes volumes in the following fields:

- Science and technology policy;
- Science studies, material on assessments of research and higher education policy;
- Research statistics.[120]

The Science Policy Library acts as a key support in improving the implementation and planning of the Academy's research funding.

3.6 Cataloguing research outputs

3.6.1 Gathering and providing information on research outputs

Apart from evaluations and impact assessments carried out by the Academy of Finland, Tekes and the Higher Education Evaluation Council (FINHEEC), information on the outputs of public funded research are available in the annual reports (or reviews) published by each university, research institute and funding agencies. This reports are most of the time public and available online.

Alongside, various online databases provide statistics on the outputs of public funded research:

- The Ministry of Education publishes an annual Universities publication containing data on university activities;

[120] Website of the Academy of Finland: http://www.aka.fi/ (consulted October 2010)

- Statistics Finland publishes data on patents and innovation-related statistics;[121]
- The Finnish Science and Technology information service publishes statistics on performance of research performers (e.g. scientific publications, innovation, patents, degrees, etc. although the information is sometimes outdated[122]);
- Lastly, the Academy of Finland's website hosts a database on the Academy-funded research projects and their results and impacts.[123]

While instructive in their own rights, these practices remained limited in the amount of information provided. More interesting is the KOTA database maintained by the Ministry of Education since 1981 ant that provides statistics on research outputs for universities (scientific publications, degrees, students, etc).[124] The database is made of 19 indicators dealing with teaching and research activities (i.e. applicants and admitted students, students, foreign students, graduate placement, median graduation time, scientific publications, researchers visits, expenditure by performance area, etc). Data are available from 1981 on for each university and each field of education. It is based on annual performance reports submitted by universities each year. The database is available online (in Finnish and English, https://kotaplus.csc.fi/online/Haku.do) and provides public information on research performance at universities or disciplines level. The purpose of this reporting system is to drive the annual allocation of performance based funding to universities (see section 3.4.1).

3.6.2 Cataloguing research publications

Finnish first attempts related to institutional repositories dated back to the early 1990s. The Repository Library was founded on March the 1st, 1989. It is meant to be a repository to be shared by all libraries in Finland as the most economical way of storing library material.

As far as research is concerned, the publishing activities mostly concentrated at first on doctoral and graduate theses. The Finnish Open Access Working Group (FinnOA) founded in 2003 had an important role both in creating awareness on open access to scholarly literature in Finland and also advocating the creation of open access policies especially on the national level. As part of this development the Finnish Council of University Rectors signed the Berlin declaration on open access in May 2006. As a result, new open source technological platforms like DSpace were developed in Finnish universities, and started to replace the older locally- developed publishing systems. Self-archiving is another issue that has been of growing interest in Finland over recent years.[125] Nowadays the cataloguing of research publications and data is rather well developed and almost all Finnish universities have at least some kind of repository with variable amounts of content.

These various initiatives have ended up in a strengthening the political support to institutional repositories. The Finnish Ministry of Education actually provides funding for a two-year project (2009-2010), which supports the building of a national infrastructure for institutional repositories. The project also promotes cooperation between repository managers and developers and the adoption of common policies and practices compatible with the international best practices on the national level. The recent universities reform and the related mergers and strategic alliances are also

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[121] Statistics Finland online: http://www.stat.fi/til/ttt_en.html (consulted october 2010)

[122] Finnish science and technology information service online: http://www.research.fi/

[123] Database of the academy's funded projects online: http://webfocus.aka.fi/ibi_apps/WFServlet?IBIF_ex=x_RahPaatYht_form&UILANG=en

[124] KOTA database online: https://kotaplus.csc.fi/online/Haku.do

[125] Jyrki Ilva, Building a repository infrastructure fo Finland, 2009, in: ScieCom info – Nordic-Baltic Forum for Scientific Communication website: http://www.sciecom.org/ojs/index.php/sciecominfo/index (consulted October 2010)

likely to have an impact on the reorganisation of the currently operating repositories.[126]

We cannot but notice that the National Library of Finland plays a key role in centralizing the initiatives in favour of cataloguing national publication, including research outputs. It is responsible for the development of national services offered to university libraries, public libraries, libraries of polytechnics and specialist libraries as well as to promote national and international cooperation in the library field. The Library has particularly improved archiving and search tools over recent years –e.g. Finnish Internet Archive with recorded and stored online materials; *Ask the Library* online service opened to customers conversion to international identification format, etc. Support to Finnish academic research is a main feature of the National Library's action for the upcoming years. This support should grant the libraries' access to efficient and cost effective information contents and technology and should develop the available resources together with the library network. [127]

Apart from the National Library, individual universities have always played a key role in developing their own digital Libraries and repositories. In this respect, the University of Helsinki has recently paved the way for further development at universities level. In May 2008 it has made a decision to impose a self-archiving mandate on its researchers from January 1, 2010. This initiative has enabled to pressure all the Finnish universities and also research funding agencies to adopt similar policies. The University's recently issued programme for Leadership, Management and Support Services also calls for[128]:

- Further development of data systems;
- Further development of the information environment through a multi-channel digital library that will supplement printed collections;
- Further development of the information environment through research data system, with the objective of providing an up-to-date overview of University research and the tools offered for research administration.

3.7 Example of successful goal oriented public governance

Goal-oriented public governance is part of the performance management tradition introduced with the New Public Management in the 1980s. Armstrong and Baron define performance management as 'a process which contributes to the effective management of individuals and teams in order to achieve high levels of organisational performance. As such, it establishes shared understanding about what is to be achieved and an approach to leading and developing people which will ensure that it is achieved'.[129] Goal oriented public governance refers therefore in our sense refers to:

- A policy whom launching follows clear objectives and priorities;
- A policy whom implementation strategy is oriented towards target achievements;
- A policy monitored with assessment systems and regular performance reviews.

Management by performance and by objective, reporting, evaluation of research impacts, etc - are standard practices in Finland. As we have reported, the steering of research organisations at governmental and agencies level is also rather well developed (see section 65).

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[126] Jyrki Ilva (2009)

[127] Website of the National library of Finland: http://www.nationallibrary.fi/ (consulted October 2009)

[128] University of Helsinki, Programme for Leadership, Management and Support Services 2010-2012, 2009

[129] ARMSTRONG, M. and BARON, A. (2004) *Managing performance: performance management in action*. London: Chartered Institute of Personnel and Development.

3.7.1 Towards the streamlining of funding instruments and the focus on competitive project funding

In 2010 the Academy has made substantive changes to its funding instruments to streamline the Academy's funding system. The purpose of the reform is to give the various funding instruments greater clarity and flexibility both for management purpose and for the applicants. In concrete terms, funding instruments have been streamlined. Grants to researcher training have for instance been discontinued as independent calls and the focus is increasingly put on project funding instead of grants targeting individual researchers. Alongside, the significance of the research projects for the promotion of professional careers in research and for researcher training, as well as the significance of research projects in terms of international cooperation, have become both core criteria in the allocation of research grants in the Academy. This goes hand in hand with the focus put on research careers and the internationalisation of Finnish research. Also, a new call has been introduced this year, namely the infrastructure call. It targets facilities for research and, once again, is oriented towards capacities strengthening, cooperation and international competitiveness of the universities that engage in research.

Apart from the redesign of funding instruments, the assessment process in the Academy has also been redesigned in order to better stick to the new priorities. In its revised guidelines on how to draft a research plan, the Academy has included a description of the mobility of researchers and the use of research infrastructures, as well as the description of the research environment (e.g. support to research team, site of research and its qualities as well as national and international support), as the international peers who review the applications do not necessarily have an overall picture of the Finnish research environment. For the monitoring of individual research grants by the Academy of Finland, time limits have been set regarding degree completion: applicants for research posts as Postdoctoral Researcher must have completed their doctorate no more than four years ago, applicants for research posts as Academy Research Fellows 3–9 years ago.

The reform of funding instrument also targets the centralisation and harmonisation of data on research projects funded by the Academy in the review of applications. For that purpose a new, more detailed classification of research fields has been issued. Interesting is that this classification is based on Statistics Finland's revised Field of Science and Technology (FOS) Classification and is therefore likely to be used in a greater extent in statistical data on the Finnish research system. Moreover, the new classification better matches the growing interdisciplinary character of projects. In addition to their primary field of research, applicants may indeed indicate four other research fields and subcategories in their applications, ranked according to their order of importance. Keywords have been introduced to describe the research and research methods are entered in the application form. The reform also includes an overhaul of the Academy's online website to enhance the services offered and changes to call times.

Interesting is also the use of the full cost model by the Academy of Finland and Tekes, by which applicants for grants are requested to give an overall cost estimate and a funding plan for the project. Applicants are therefore expected to give the percentage for indirect employee costs, the overheads percentage, and the coefficient for effective working hours applied by their own organisation at the time of application submission. It has raised issue in terms of how researchers allocate their working hours to research. Beforehand, it seems that no particular management system was in place on the allocation on time to research. So far, no top-down system has been implemented to develop the 'full-cost culture' among researchers. Rather, practices are expected to be developed on a bottom-up approach at the level of each university and

the administrative staff is in charge of helping researchers with the allocation of working hours and in the budgeting connected with the full cost model.[130]

3.7.2 Towards competitive funding support to research education

The Doctoral Programme launched by the Academy of Finland is of particular interest (see section 3.3.2). It is one of the best examples in recent Finnish R&D policy trends since it highlights both the greater use of competitive funding for research and the focus on research career and research education. Doctoral programmes ensure namely the funding of doctoral positions and the funding of operating grants for doctoral programmes through a competitive basis and for a fixed-term.

Doctoral programmes are quite original in comparison with grants for research education in other countries, since it is nation-wide and organised on a competitive basis. The fixed-term character of funding and the assessment of doctoral programmes through peer-reviews shall help ensuring the steering of research education towards excellence criteria.

3.7.3 Towards research assessment exercises at universities' level

Contrarily to other Nordic countries (e.g. Sweden, Denmark), the Finnish use of performance based funding for universities is rather old and well established, even if it has been deeply reformed in 2010 (see section 3.5). As aforementioned, performance based funding at governmental level is based on research outcomes (volume and quality criteria) as well as strategic objectives.

Once again however, Finnish situation is original in this respect. Indeed, no formal research assessment exercise involving a specific evaluation system is implemented at national level. Data on research performance is universities are entered in the KOTA HE database from annual reports provided by each university. The question of implementing a formal research assessment exercise was discussed at some point but rejected because of the political tradition that has always emphasised equality between universities. Interesting however is that Finnish universities have taken the lead on that question. Two research assessment exercises were implemented by the University of Helsinki in 1999 and 2005, and the practice has been extended since then to other universities. To some extent, it is a big shift in the Finnish research system. It was urged by the need to assess the quality of the University's research in order to profile the University on the international scene and to build on existing and emerging strengths.

The University of Helsinki Research Assessment Exercise 2005 combined an external assessment with an internal self-assessment exercise. The unit of assessment was a faculty department or an independent institute, evaluated mainly through the quality of research. 21 disciplinary panels with 148 international peers were in charge if the external assessment, based on information on staff, publications, doctoral theses and degrees, a self-assessment exercise, other academic activity, collaboration and funding during the period 1999–2004. The evaluators were chosen from suggestions obtained from the Research Council of the University of Helsinki, the four Research Councils of the Academy of Finland, Rectors of the League of European Research Universities[5], as well as from external high-profile scientists.

The scientific quality of the research was rated numerically using the same scale (1–7) as in 1999 (Figure 49). In this scale, "international level" refers to the level of research in European universities and research institutes. The assessment focused on the international quality of research performed during 1999–2004.

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[130] Tiina Ruulio, Interview of Mervi Taalas, Director of the Academy's Finance Unit, 12.12.2008, Academy's website: http://www.aka.fi/en-gb/A/Academy-of-Finland/The-Academy/Academy-news/13390/ (consulted November 2010)

Figure 49 Rating scale used in the last research assessment exercise led in 2005 in the University of Helsinki

Rating scale	Definition
7	The majority of the submitted works are at a high international level and virtually all others at a good international level
6	At least one third of the submitted works are at a high international level and many others at a good international level, these together comprising a clear majority
5	The majority of the submitted works are at least at a good international level and virtually all others at a fair international level
4	At least one third of the submitted works are at a good international level and many others at a fair international level, these together comprising a clear majority
3	The majority of the submitted works are at least at a fair international level.
2	A minority of the submitted works are at a fair international level
1	None, or virtually none, of the submitted works are at a fair international level

Source: University of Helsinki, Research Assessment Exercise 2005, Summary Report, 2006

Data used in the assessment were based only on publications registered in the university's official publication database, JULKI. Here one could point to the fact that research assessment exercises are often hampered by the lack of unified information sources and data with which to inform the assessment process. As we have mentioned previously, the cataloguing of research outputs at national level is still under development. In this respect, leading research assessment exercises at the level of universities, though it might be time-consuming and expensive, is also easier since it is built on an existing information system.

The results of the external evaluation of the quality of research had an effect on the funds within the University. Following the 2005 RAE, the University of Helsinki had spent a total of 15 M€ of its own funds over 2007-2012 to reward the units that were most successful in the evaluation through extra-funding, as follows:

- The units that obtained the maximum grade are rewarded financially for 6 years between EUR 30,000 to 300,000 per year, depending on the number of research-active staff;
- The units that increased their rating to 6 by at least two grades are rewarded for 3 years;
- The best faculties were also rewarded for 3 years. The rewards per unit of assessment will be about.

Such research assessment exercises were also implemented on the University of Oulu and in the 2009 funded University of Aalto, which resulted from the merger of the Helsinki University of Technology, Helsinki School of Economics and the University of Art and Design. These practices are of particular interest since they move away from practices in other countries where performance based research assessment exercise are implemented at governmental and national level and result from a strong central will (e.g. UK, Denmark, Sweden). On the contrary, in Finland, Universities lead research assessment exercises, which are seen as a way to improve their own research strategy and to enhance their research profile on the international scene.

It is likely that research assessment practices will be strengthened in Finnish universities in coming years. Indeed, following the Universities Act and the new basis calculation for performance based funding to universities, universities are in charge of distributing funding to the departments based on their own performance targets and performance in the past year. The decision for direct allocation of funding is therefore made at the level of the university and not by the central government (i.e. as in the United kingdom were research assessment exercises directly target research units and not the university as a whole). As such, the responsibility of research units assessment is therefore put on universities.

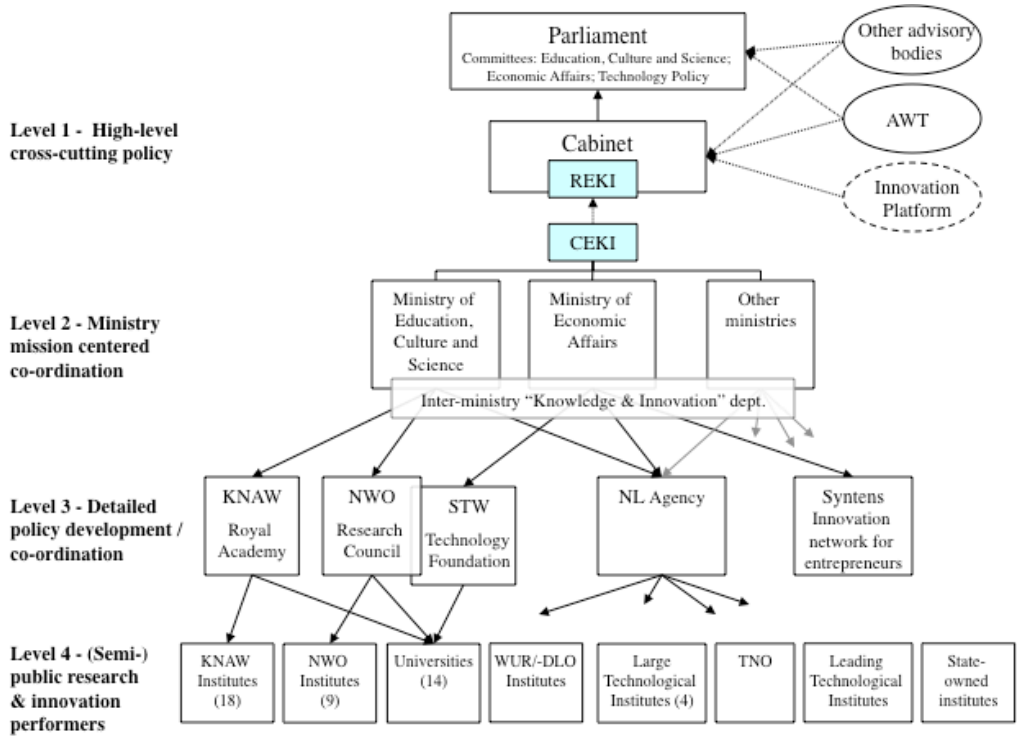
4. The Netherlands

4.1 Overview of NL research system

4.1.1 Overall

A stylised overview of the organisational structure for research and innovation policy in the Netherlands is shown in Figure 50. It depicts the situation in 2009.[131] The various actors are described in the following subsections.

Figure 50 Organisational Structure for Research and Innovation Policy



4.1.2 Advisory bodies

The Cabinet has a system of sub-councils of the Council of Ministers. The minister of EZ coordinates the Council for Economy, Knowledge and Innovation (REKI). This sub-council prepares the decisions to be taken by the plenary Cabinet, and takes place normally a few days before the Council of Ministers, which meets on Fridays. The agenda and the foreseen decisions are coordinated and prepared by the inter-departmental Committee on Economy, Knowledge and Innovation (CEKI). This committee consists of high-level civil servants of all ministries involved, and meets about two weeks before the REKI.

Several high-level advisory bodies deliver inputs to research and innovation policy. The Advisory Council for Science and Technology Policy (AWT) advises the Dutch government and parliament on policy in the areas of scientific research, technological development and innovation. It has an independent position towards the ministries. The AWT provides solicited and unsolicited advice. After broad consultation the AWT

[131] In October 2010, a new Cabinet was established. The ministry of Economic Affairs has merged with the ministry of Agriculture, Nature and Food Quality into the ministry of Economic Affairs, Agriculture and Innovation (EL&I). The (temporary) Inter-ministry "Knowledge & Innovation" programme department has been discontinued.

draws up its annual work programme with advisory topics. The Council consists of a maximum of 12 members, each originating from different sectors of society, such as research institutes and trade and industry. The members do not represent any special interests. The AWT is supported by an office of scientific and supporting staff.

In the period 2003-2010 the Dutch system also included the Innovation Platform. It was established in 2003 by the Cabinet as a temporary high-level coordination body, with members from the Cabinet and the business and S&T communities. It was re-established in 2007 by the new Cabinet with a redefined objective and new members. It had the task to create conditions, make connections, and develop the visions which are needed to give an impulse to innovation and entrepreneurship in the Netherlands. The Platform paid special attention to societal areas as care, education, energy and water management. It also contributed to the long-term strategy for innovation and entrepreneurship as part of a (temporary) inter-departmental project "The Netherlands Entrepreneurial Innovation Country". In this project several ministries worked together, and with the Innovation Platform, to develop a long-term strategy for innovation and entrepreneurship.

The Royal Netherlands Academy of Arts and Sciences (KNAW) provides advice on science policy. Furthermore, there are two strategic advisory councils that have relevance for research and innovation policy, i.e. the Scientific Council for Government Policy (WRR) and the Social Economic Council (SER). These are influential Councils, but their remits are broader and not focused on research and innovation as such. The Netherlands Bureau for Economic Policy Analysis (CPB) makes independent economic analyses to support (evidence-based) policymaking.

The independent Rathenau Institute includes since 2004 a Science System Assessment department. It develops knowledge about the science system itself to inform science policy. Target groups include parliament, ministries, other government departments, stakeholders such as organisations within the science system, societal organisations, the private sector, etc.

Other organisations that influence innovation policy making are the Confederation of Netherlands Industry and Employers VNO-NCW and the employer's organisation for SMEs MKB Nederland, which represent the interests of the private enterprise sector. The Association of Universities in the Netherlands (VSNU) represents the shared interests of the fourteen (research) universities in the Netherlands in the fields of research, education, knowledge transfer, funding, personnel policy and international affairs. Together with other organisations with a stake in research and innovation, these organisations have formed the KIA-coalition of 30 parties around the Knowledge Investment Agenda (KIA) of the Innovation Platform in 2006. It has taken up responsibility for updating the KIA and lobbying for more investments in knowledge.

Within ministries so-called knowledge chambers have been set up in which high-level policymakers (knowledge demand side) meet with knowledge institutes (knowledge supply side) in order to organise and coordinate 'knowledge for policy' and 'policy for knowledge'. The knowledge chambers aim to:

- increase dialogue and interaction between the worlds of policy and knowledge;
- improve the connection between policy demand and supply of knowledge;
- to enhance coherence in programming of knowledge institutes;
- to increase attention for strategic questions that cross borders within and between ministries and for foresight;
- to increase sensitivity of ministries for the outside world;
- to detect gaps in the knowledge base and to articulate knowledge demands;
- to build a (strategic) knowledge agenda.

In addition to knowledge chambers, various ministries have established a directorate knowledge, or strengthened its position. Several ministries have created the function

of chief scientist in order to create stronger linkages between policy and knowledge, especially at the top of the ministries.

4.1.3 Principal research policy making organisations

The two key ministries in the Dutch research and innovation system are the Ministry of Economic Affairs (EZ) and the Ministry of Science, Culture and Education (OCW). They have divided responsibilities, with EZ being responsible for industry-oriented R&D and innovation policy and OCW for scientific research and education.

In the cabinet period 2007-2010 an interdepartmental 'Knowledge and Innovation' programme department (K&I) was in place in which all relevant ministries collaborated on joint issues in knowledge and innovation policy. In 2008, K&I published a long-term strategy to guide investments in knowledge and innovation. Furthermore, it was responsible for developing innovation agendas for prioritised societal themes (sustainable energy, water, health care, education, sustainable agro-innovation and safety and security). K&I also had the task to introduce more coherence in the policies for knowledge, innovation and entrepreneurship of the various ministries. K&I collaborated with the Innovation Platform. In the same vein, an interdepartmental programme department for energy transition (IPE) has been established to stimulate a transition towards sustainable energy.

Recent development: new super-ministry EL&I

In the new cabinet period 2010-2014, the ministry of Economic Affairs has been strengthened by a merger with the ministry of Agriculture into the ministry of Economic Affairs, Agriculture and Innovation (EL&I). EL&I has received more responsibilities in research and innovation governance. For instance, the research institute TNO was brought under its wings (from OCW) and EL&I has a stronger say in the governance of the research council NWO. In this chapter, the situation before the merger in October 2010 is described.

The ministry of OCW has by far the largest budget for research. OCW has responsibility for science policy and for establishing the (four-annual) science budget. The last science budget was in 2007 (*Strategic agenda for higher education, research and science policy*). In this policy document, the minister of OCW sets out the main policy objectives and the accompanying policy measures.

OCW is responsible for the functioning of the national research system as a whole. OCW has the responsibility to define the framework within which the research system should operate, e.g. in terms of more or less internationalisation, more or less emphasis on knowledge valorisation, more or less focus and mass. Within these broad guidelines, the actors in the research system (TNO, NWO, KNAW, the Large Technological Institutes (GTIs), universities etc.) have their own responsibilities. They have a large degree of autonomy.

The role of the government and more specifically of OCW in strategy and planning is weak compared to other countries. For instance, in the Netherlands there is no national strategy and no tendency to strengthen coordination at the national level. The guiding idea is "governance at arm's length" with actors in the research system having relatively much freedom regarding strategy. Each ministry has its own budgets for R&D. There is no central coordination at the national level. There is no institutionalised priority setting for research policy. Parliament is responsible for endorsing the departmental budgets.

The ministry of Economic Affairs has the second largest R&D budget. It is responsible policies that stimulate the functioning of the economy and markets in the Netherlands and Europe, the innovativeness of the Dutch economy, and a good climate for entrepreneurship and business location.

Other ministries (e.g. Agriculture, Nature & Food Quality (LNV), Health, Welfare & Sport (VWS) and Transport, Public Works & Water Management (V&W)) also have their own specific research and innovation policies. The R&D budgets of these

ministries are, however, much smaller than the budgets of OCW and EZ. The R&D budgets of the other ministries are largely allocated to (semi-) public research institutes, but some ministries also have relatively large budgets for project-based R&D funding. For example, the ministry of Transport (V&W) allocates 71% via project-based funding.

The table below shows the government R&D funding by department in 2000 and 2009. The budgets have increased significantly (40%). The share of OCW has increased, while the shares of EZ and LNV have decreased.

Figure 51 Government R&D funding by department in 2000 and 2009 (in million euro and percentage)

Ministry	2000		2009	
OCW	2,042	(63.3%)	3,031	(67.0%)
EZ	572	(17.7%)	726	(16.0%)
LNV (Agriculture)	208	(6.5%)	225	(5.0%)
Others	404	(12.5%)	545	(12.0%)
Total	3,226	(100%)	4,527	(100%)

OCW (2010) Overzicht Totale Onderzoeksfinanciering (TOF) 2008-2014, TK 32123 VIII, nr. 111.

R&D funding of the ministries comes in two basic forms:

- institutional funding, i.e. long-term funding of research institutes, where these institutes have more or less autonomy in spending.
- project-based funding, i.e. temporary funding via projects or thematic programmes.

The ministry of OCW allocates the largest part of its R&D budget via institutional funding (81% in 2009). By far the largest part (2005.6 million euro, or 80%) is for block grant funding to the research universities.

OCW's project-based funding amounted to 19% (562.2 million euro). Large expenditures were on a targeted subsidy to NWO for a scheme to support talented researchers (the Innovational Research Incentives scheme), on other targeted subsidies to NWO for specific R&D programmes and on large projects funded via the FES fund[132]. The table below gives the largest expenditures on institutional and project-based R&D funding by OCW.

[132] The FES fund contains revenues from natural gas exploitation. Part of the revenues have been used for investments in the knowledge infrastructure. The funds were not allocated via the normal channels (NWO or NL Agency), but via dedicated (ad hoc) structures. NL Agency is usually involved in managing the FES projects. Note that the new government (2010-2014) has announced that it will no longer use the FES fund to invest in the knowledge infrastructure as part of an overall effort to reduce budget deficits.

Figure 52 R&D expenditures by OCW, 2009 (in million euro)

OCW institutional R&D funding		**OCW project-based R&D funding**	
Block grant universities (R&D share; estimation)	2005.6	Innovational Research Incentives Scheme (via NWO)	170.9
NWO institutes (via NWO)	138.5	NWO programmes (via NWO)	167.0
TNO	116.5	FES projects	103.4
KNAW institutes	81.2	Genomics (via the Netherlands Genomics Initiative)	36.0
CERN	35.3	Knowledge workers[133]	20.0
ESA	34.8	Large R&D infrastructure	16.0
Other	56.4	Other	48.9
Total	**2468.3**	**Total**	**562.2**

OCW (2010) TOF cijfers 2008-2014

EZ has a total budget of 725.6 million euro in 2009. 24% is for institutional base funding to various research institutes, including a contribution to the research council NWO/STW for programmes to support R&D in the technical sciences. The largest share (76%) is for project-based funding. This includes a broad range of programmes, most of which stimulate public-private collaboration in R&D. NL Agency is the main policy delivery mechanism for EZ's project-based funding.

Figure 53 R&D expenditures by EZ, 2009 (in million euro)

EZ institutional R&D funding		**EZ project-based R&D funding**	
EZ contribution to ECN[134]	48.1	International aerospace programmes	75.8
EZ contribution to TNO	29.8	Long-term R&D in energy	56.8
EZ contribution to NWO/STW	18.5	Innovation subsidies collaboration projects	43.9
EZ contribution to Nmi[135]	14.7	Knowledge workers scheme and High Tech Top-projects[136]	70.0
EZ contribution to other institutes[137]	61.4	BSIK-projects EZ (from FES fund)	41.9
		Innovation vouchers programme	28.1
		Innovative Research programmes (IOP)	19.0
		Other	218.2
Total	**172.5**	**Total**	**553.7**

OCW (2010) TOF cijfers 2008-2014

The institutional base funding to research universities is the largest funding flow in the Dutch public research system. The General University Funds are relatively large in the

[133] The Knowledge Workers scheme is a temporary scheme to counter the financial and economic crisis. It enables firms to temporarily second their R&D personnel to public knowledge institutes to work on relevant societal/economic themes.

[134] ECN is one of the so-called Large Technological Institutes. ECN works on energy R&D.

[135] Nmi is an independent institute for testing, certifying, calibrating and training in the fields of metrology and gaming.

[136] These are two temporary programmes to support firms that are seriously affected by the financial and economic crisis.

[137] These include other Large Technological Institutes (MARIN, NLR, Deltares), Leading Technological Institutes (public-private R&D collaborations).

Netherlands (75% of total funding for universities).[138] Each research university receives a formula-based lump sum (block grant) for teaching and research. The lump sum allocation is based on measures of volume (student numbers, diplomas), prices (rates per student) and historical considerations. The block grant is part of the so-called first stream of funding, which also includes the tuition fees paid by students.

The allocation model is largely formula-based. It distributes a given sum of money (set by Parliament) across the 13 research universities. The formula takes into account the relative performance of each university (as compared to the other universities). The allocation consists of a *teaching* component and a *research* component, but this distinction is for calculation purposes only. In fact, Executive Boards of universities are free to use their own models in distributing the first stream funding across teaching and research activities. The teaching component is 42% of the lump sum (excluding the Academic Hospital allocation), and the research component is 58%.

Overview of R&D funding streams

Total expenditure on R&D in the Netherlands amounted to 10.5 billion euro in 2008.[139] In the table below, the sources of R&D funding and sectors of R&D expenditure are summarised for 2007. The table shows that the government had a relatively large share (37%) in the funding of the total R&D expenditures. The shares of the government's R&D funding to the higher education sector and the research institutes are 81% and 62%, respectively.

Figure 54 Funding streams R&D in 2007 (x 1 billion euro)

Source	Higher education		Research institutes		Business		Total	
Government	2.9	(80.6%)	0.8	(61.5%)	0.1	(1.8%)	3.8	(36.9%)
Business	0.3	(8.3%)	0.2	(15.4%)	4.6	(83.6%)	5.1	(49.5%)
Private non-profit	0.3	(8.3%)	0.0	(0.0%)	0.0	(0.0%)	0.3	(2.9%)
Abroad	0.1	(2.8%)	0.2	(15.4%)	0.8	(14.5%)	1.1	(10.7%)
Total	**3.6**	**(100%)**	**1.3**	**(100%)**	**5.5**	**(100%)**	**10.3**	**(100%)**

OCW (2010) Kerncijfers 2005-2009; own calculations

In 2002 the government was responsible for 87% of R&D funding to universities, 67% of R&D funding to research institutes and 4% of R&D funding to the business sector. This means that the shares of government R&D funding to universities and research institutes have decreased in the period 2002–2007. It is noteworthy that the share of R&D funding from abroad has increased for research institutes (from 8% in 2002 to 14.5% in 2007).

Dutch participants receive more than 1 billion euro from FP7.[140] Universities receive the largest share (50%), followed by research institutes (25%), SMEs (12%), large firms (8%) and 'others' (5%).[141]

[138] OCW (2010) Wetenschaps- en Technologieindicatoren 2010, p. 40.

[139] OCW (2010) Kerncijfers 2005-2009, OCW40.006/1.650/08BK2009B032, See www.rijksoverheid.nl/documenten-en-publicaties/publicaties-pb51/kerncijfers-2005-2009.html.

[140] The Netherlands has a 'retour' of 6.6% of the allocated subsidies, which is higher than the contribution of circa 5% to FP7.

[141] Agentschap NL (2010) Nederland in KP7 2010, publication nr. 3EGLI1002.

4.1.4 Principal research funding organisations

The main policy implementation organisations are the research council NWO and NL Agency (formerly known as SenterNovem). Historically, there has always been a strong division of labour between the ministry of Education, Culture and Science (OCW), which is responsible for science and research policy, and the ministry of Economic Affairs (EZ), which is responsible for technology and innovation policy. OCW and EZ both had their own approach for policy design, policy implementation and policy evaluation. As a result, two different governance cultures in the science and innovation parts of the system have emerged. While EZ's approach can be characterised as "hands on" with an active role in policy design, programme design and programme management, OCW's approach is rather "hands off", delegating more responsibilities to the research council NWO and the various organisations in the science and research system. However, at different levels in the system these two spheres are gradually moving towards each other. In the new cabinet (2010–2014) EZ has gotten a stronger cross-departmental coordinative role in innovation policy, which comes with more influence on NWO's strategy process. The aim is to align NWO's thematic priorities with the priorities in innovation policy.

4.1.4.1 Research council NWO

The Netherlands Organisation for Scientific Research NWO was founded (by law) in 1950 (as ZWO) as an organisation for 'pure' scientific research. It was part of a general post-war reconstruction effort, in which infrastructures and intermediary structures were created to stimulate coordination and enable the distribution of funds. From the start, NWO was set up as a national body for all the sciences.

NWO is responsible for enhancing the quality and innovative nature of scientific research as well as initiating and stimulating new developments in scientific research. NWO mainly fulfils its task by allocating resources and facilitates, for the benefit of society, the dissemination of knowledge from the results of research that it has initiated and stimulated. NWO mainly focuses on university research in performing its task. Eight divisions comprise (by law) all different aspects of science. NWO has a large degree of autonomy within the broad guidelines given by OCW to perform its tasks. The four-yearly strategic plans of NWO plays a main role in the governance relation between NWO and OCW.

NWO has a range of different responsibilities and organisational divisions. It owns research institutes, has disciplinary boards and foundations to allocate competitive funding and manage research programmes and some of the national coordinating bodies for strategic funding (see below).

NWO is responsible for the so-called 'second stream' of research funding, which consists of funding allocated in competition to researchers and research groups in universities. NWO receives funding from the ministry of OCW and the ministry of EZ (the latter supports the natural/technical sciences). NWO then awards project funds after reviewing the research proposals submitted by researchers. Competition for this type of prestigious funding is high. Only universities can win competitive research council grants. Such grants have become more important over the years but are still not very large (ca. 13% of total research funding to universities).

NWO also allocated institutional base funding to its nine NWO institutes. These research institutes mainly perform basic research.

The Technology Foundation STW operates as an independent part of NWO. STW supports and finances scientific-technological research projects and promotes utilisation of results of research by third parties. EZ and NWO are main financers of STW (with contributions of 40% and 60% respectively).

The table below shows the sources of revenues of NWO. The largest part (71%) is in the form of a state contribution via OCW. This share has increased with almost 100 million euro in 2009 because of the transfer from the 'first stream' institutional base

funding to universities to the 'second stream' of competitive funding via NWO (with the intention to stimulate 'excellence' in research). NWO also receives a large share in the form of targeted subsidies from OCW, mainly for the large Innovational Research Incentive scheme (to support talented researchers in various stages of their careers).

Figure 55 Source of revenues NWO (in million euro)

	OCW		Other ministries	Total government	Other	Total
	State contribution	Targeted subsidies				
Revenues 2009	502	108	45	655	52	707
Share in total	71.0%	15.3%	6.4%	92.7%	7.3%	100%
Revenues 2008	404	99	50	552	49	601
Share in total	67.2%	16.5%	8.2%	91.9%	8.1%	100%

NWO Annual Report 2009.

The research universities received 376 million euro (58%) from NWO in 2009. The 9 NWO institutes (for basic research, typically with large research facilities) received 141 million euro (22%) from NWO, largely in the form of base funding. Other research institutes (e.g. KNAW institutes, TNO) received 50 million euro (8%). The rest was allocated to 'others' (8%) and management cost (5%).

NWO subsidies can be classified along the lines of action in the NWO Strategy 2007-2010:

Action line 1: Opportunities for researchers (289 million euro in 2009)

In this action line, NWO has three main categories of subsidies. These are summarised in the table below. The table also shows the budgets for the various programmes in the first action line. The largest share is for programmes aimed at stimulating individual talented researchers. This is mainly due to the large budget for the Innovational Research Incentives scheme. The Free Competition is the second largest set of programmes. This action line takes 46% of NWO budget for subsidies.

Action line 2: Consolidating strengths (189 million euro in 2009)

The programmes in this action line include programmes for infrastructure and internationalisation and funding of NWO institutes. The table below shows the allocation of NWO funds. This action line takes 30% of NWO budget for subsidies.

Action line 3: Science for Society (150 million euro in 2009)

This action line includes research programmes for societal themes, programmes for knowledge transfer and three temporary task force in strategic areas. The table below summarises the distribution of NWO funds. This action line takes 24% of NWO budget for subsidies.

Figure 56 Categories of subsidies and budgetary sizes of NWO programmes in the three action lines (in million euro)

		2009	2010 (budget)
Action line 1: Opportunities for researchers			
Talent	NWO has various programmes to stimulate talented researchers (also in specific target groups)		
	The **Innovational Research Incentives** Scheme (*Vernieuwingsimpuls*), which consists of three different personal subsidy forms, each of which is designed for a different phase in the scientific careers of researchers.	125.4	144.9
	The **Rubicon** programme is designed to encourage talented researchers who have completed their doctorates in the past year the chance to gain experience at a top research institution outside the Netherlands (maximum of two years).	6.7	6.8
	The **Aspasia** programme is designed to increase the number of women senior lecturers.	2.8	2.1
	The **Mosaic** programme is designed to attract more ethnic minority graduates into academic research, in order to promote diversity.	4.5	4.6
	TOP Grants offer top research groups the opportunity to innovate their lines of research in terms of content and collaboration. The goal is to create room for groundbreaking science of superb quality.	2.8	2.8
	Graduate Schools. National and local research schools or Graduate Schools can be nominated for a block grant that is intended for the appointment of PhD students who will carry out their research within the school.	0.8	10.4
	NWO **Spinoza prize**, a personal award for researchers with international reputations	7.5	10.0
	Other Talent programmes	4.9	5.5
	Subtotal Talent	**155.4**	**187.1**
Free competition	The Free competition programmes of the various NWO divisions stimulate bottom-up innovative research, without specific restrictions in terms of themes or target groups.		
	Subtotal Free competition programmes	**94.3**	**106.7**
Investments	NWO has investment programmes for large and medium-sized research infrastructures.		
	Subtotal Investments	**39.1**	**33.2**
Total	**Action line 1: Opportunities for researchers**	**288.8**	**327.0**

		2009	2010 (budget)
Action line 2: Consolidating strengths			
Infrastructure	The investments in large-scale infrastructure supplement the regular NWO programmes for research infrastructure (NWO Large and NWO Medium; see above).	60.9*	16.2
Internationalisation	The programmes for internationalisation are used for mobility (travel grants, joint seminars, networking), collaboration programmes (ERA-net and EUROCORES calls for proposals), for emerging science nations (China, India) and for contributions to the Millennium Development Goals.	29.1	30.5
NWO institutes	The 9 NWO institutes receive base funding.	98.9	95.3
Total	**Action line 2: Consolidating strengths**	**188.9**	**142.0**
Action line 3: Science for Society			
NWO programmes in societal themes	Research programmes for the 13 societal themes that NWO has selected[142],	65.2	84.1
Knowledge transfer	Programmes for knowledge transfer (Casimir and Valorisation Grant STW)	6.4	6.8
Temporary task forces	Three coordinative temporary task forces in strategic areas (ICT, genomics and advanced chemistry)	78.0	78.6
Total	**Action line 3: Science for Society**	**149.6**	**169.5**

NWO-Begroting 2010

The table shows that 15% of NWO funding was allocated 'bottom up' via the Free Competition programmes of the NWO Divisions.

4.1.4.2 NL Agency

NL Agency is the main agency for innovation and is part of the ministry of EZ. It implements innovation schemes for EZ (and other ministries). NL Agency is a merger (in 2010) of EVD (Netherlands Foreign Trade Agency), the Netherlands Patent Office and SenterNovem. NL Agency consists of five thematic divisions, defined by their areas of expertise: NL Innovation, NL Energy and Climate, NL Environment and Spatial Planning, NL Patent Office and NL EVD International. NL Innovation uses a broad mix of policy instruments to support business enterprises.

The Division NL Innovation, responsible for R&D and innovation policy, has EZ as its most important client (90%). In 2009, NL Innovation allocated 1365 million euro, largely from EZ, which included:

- 823 million euro via the 'basic package' (a mix of generic support schemes for innovating companies, including a large fiscal incentive which reduces R&D wage costs);
- 307 million euro via the 'programmatic package' (a set of innovation programmes for prioritised 'key areas' in the economy);
- 68 million euro via regional innovation support (a set of regional innovation programmes around clusters or 'valleys').

[142] In the NWO Strategy 2007-2010, 13 themes are identified: (1) Basic Energy Research (2) Brain and Cognition (3) Conflict and Security (4) Cultural Dynamics (5) Dynamics of Complex Systems (6) Dynamics of Life Courses (7) Knowledge Base for ICT Applications (8) New Instruments for Health Care (9) Responsible Innovation (10) Research & Innovation in Smart Creative Contexts (11) Sustainable Earth (12) Systems Biology (13) Use of Nanosciences and Nanotechnology.

4.1.4.3 Other (temporary) intermediary organisations

In strategic research areas (ICT, life sciences, nanotechnology, sustainable chemical technology) temporary coordination bodies (e.g. Netherlands Genomics Initiative (NGI), Advanced Chemical Technologies for Sustainability (ACTS) and ICTRegie) have been set up to co-ordinate and execute thematic programmes. The bodies have a semi-permanent status and are accommodated by NWO.

A typical feature of the Dutch innovation governance system is the upsurge in the number of public-private consortia that manage research and innovation programmes. These are mainly the result of investment impulses from the Fund for the Enhancement of the Economic Structure (FES) that bypassed the traditional channels of R&D and innovation funding. The FES is filled with revenues from natural gas exploitation, and part of it has been invested in the Dutch knowledge infrastructure. In the period since 2004 the intermediary level between the government and researchers became filled with new (temporary) intermediary structures, in addition to the main policy implementation bodies NL Agency (SenterNovem) and NWO.

4.1.5 Principal research organisations

The Dutch research system includes 14 government-approved research universities (including an Open University), the research institute TNO (contract research), research institutes under the umbrella's of NWO and KNAW (basic research), DLO-institutes (agricultural research), Large Technological Institutes, research institutes of ministries and a range of research institutes for public-private partnerships in strategic research.

4.1.5.1 Universities

There is hardly any reputational and quality differentiation between the universities in the Netherlands. Dutch universities have a good reputation, but none of the Dutch universities belong to the international elite or rank at the top of international ranking lists.[143]

Universities have a three-fold mission: teaching, research and utilisation of knowledge (valorisation). There are 14 universities (including an Open University) that spend almost 2.6 billion on R&D (2007), which amounts to 27% of total R&D expenditures in the Netherlands.[144] There are no data available on the R&D expenditures by individual universities (only on total expenditures on R&D and teaching). There are six general research universities, three universities of technology, four specialised research universities and the Open University.

[143] "In the Netherlands, policy instruments have been implemented which could have led to quality and reputational differences, like the systematic evaluation of research, funding of top graduate schools and the 'Vernieuwingsimpuls' [Innovational Research Incentive scheme], but this has not happened. Instead, some of these instruments have led to another remarkable system characteristic: the strong networking of university research into inter-organisational graduate schools, virtual institutes, research consortia and the like. These inter-organisational constructions seem to prevent the differentiation of universities instead of induce it. (James Dawson, Jan van Steen, Barend van der Meulen (2009) Science systems compared: A first description of governance innovations in six science systems, The Hague: Rathenau Institute, p. 27).

[144] OCW (2010) Wetenschaps- en Technologieindicatoren 2010.

Figure 57 Profile of Dutch universities (2007)

	Total personnel	Scientific personnel	as % of total	Students
General universities (6)				
Radboud Universiteit Nijmegen (RU)	4390	2275	51.8	17399
Universiteit Utrecht (UU)	4386	2446	55.8	29239
Universiteit van Amsterdam (UvA)	3550	1998	56.3	27175
Universiteit Groningen (RUG)	3280	1713	52.2	23794
Universiteit Leiden (LEI)	3159	1659	52.5	17657
Vrije Universiteit Amsterdam (VU)	2975	1664	55.9	19201
Universities of Technology (3)				
Technische Universiteit Delft (TUD)	4309	2495	57.9	14390
Technische Universiteit Eindhoven (TU/e)	2581	1577	61.1	7055
Universiteit Twente (UT)	2324	1368	58.9	8602
Specialised universities (4)				
Erasmus Universiteit Rotterdam (EUR)	1427	779	54.6	19474
Universiteit Maastricht (UM)	1441	668	54.2	12007
Universiteit van Tilburg (UvT)	1362	794	44.1	11326
Wageningen Universiteit en Research Centrum (WUR)	2221	1203	54.2	4676
Open University (1)	581	256	55.9	17238
Total	37986	20895	55.0	229233

OCW (2010) Wetenschaps- en Technologieindicatoren 2010.

The Dutch universities are mainly funded by the government (87%, largely block grant funds). 7% is funded by the business sector, 4% comes from foreign sources and the remaining 2% is funded by other sources (private non-profit).

The 1993 Higher Education and Research Act codified the institutional autonomy and introduced the principle of self-regulation for HEIs. In exchange for more autonomy, the HEIs were expected to play an active role in the establishment of a new quality assurance system for teaching and research. Quality assurance was based on self-evaluation reports prepared by the institutions and site visits were carried out by experts (peers) for each disciplinary area in a six year cycle. The acceptance of the system is partly due to the fact that government does not translate the outcomes of the quality assessments into its budget allocations. It was agreed that the intermediary bodies representing the institutions (the VSNU for the research universities) play the coordinating role with respect to quality assessment.

One effect of the introduction of self-regulation has been the increased importance of the central institutional management. In the 1997 Act 'Modernising University's Governance Structures' (MUB) executive leadership was further strengthened, powers became more concentrated, and representative bodies where academics, non-academics and students held seats became advisory instead of decision-making bodies. The Act promulgated a significant shift in internal authority distribution; new bodies were created (Supervisory board) and some old ones were formally abolished (disciplinary teaching and research units; *vakgroepen* in Dutch).

The Supervisory Board is made up of five highly respected persons from outside the university. Members are appointed by the minister. It is meant as a buffer between the government and the executives of the university and to enhance the university's role as a 'societal entrepreneur'. The central Executive Board is made up of three members, including the rector, that are appointed by the Supervisory Board.

Human resources policy has been decentralised to universities. At the end of the 1990s, the terms of employment were almost fully decentralised from the ministry to the universities. Universities are free to determine free to appoint 'regular' full-time senior academic staff, to determine the salaries of their staff; to borrow funds on the capital market, to build up reserves and/or carry over unspent financial resources from one year to the next; to determine how they spend their public operational grant; and to generate most categories of private funding.

In sum, universities have a large degree of autonomy in setting their own strategies and making their own personnel decisions.

Increasingly, universities are setting thematic research strategies. The Delft University of Technology (TU Delft), for instance, aims to enhance academic focus and critical mass. The TU Delft research agenda is geared to promoting internal cohesion in the curricula (academic focus) and the targeted bundling of resources (critical mass). The TU Delft has set up a transparent university-wide research portfolio, it has organisationally repositioned or phased out research programmes, and it has realised the Delft Research Centres in prioritised (multi-disciplinary) research areas.

Another example is the University of Utrecht (UU) that has selected fifteen research focus areas derived from the faculties' core research areas, most of which are multidisciplinary. The focus areas constitute a framework for policy in a variety of areas, from the development of new research lines to the details of the housing programme. One of the main objective in the UU's strategy is to concentrate scarce research resources in order to ensure the best output. Action lines are: (1) Link the appointment of professorial chairs to the development of focus areas; (2) Improve internal quality assessments and make use of assessment criteria based on bibliometrical data and earning capacity of the disciplines involved, taking into account their social profiling; (3) Reduce research activities that do not meet the quality requirements; and (4) Further clarify the link between focus areas and existing research organisation. Indicators of success are (1) The financial incentives for the focus areas have been matched by external resources; and (2) Mediocre research programmes have all been abolished.

In the Netherlands there is not a Performance-Based Research Funding system (PBRF) that affects universities' block grants for research, such as the Research Assessment Exercise in the UK. Public research organisations (and research programmes) are evaluated according to the Standard Evaluation Protocol 2009-2015 for public research organisations. The protocol stipulates that universities must carry out a self-evaluation of their research activities once every three years, and that these research activities must also be assessed by an external panel once every six years. The external assessment covers not only the content of the research programme but also the management, strategy and mission of the research centre where it is carried out. The evaluation protocol leaves scope for assessment of one or more research centres (Institutes) within the same university or for comparison with similar centres at home or abroad. The protocol has two objectives:

- Improvement of research quality based on an external peer review, including scientific and societal relevance of research, research policy and research management;
- Accountability to the board of the research organisation, and towards funding agencies, government and society at large.

The evaluation does not affect the institutional base (block grant) funding of the universities. The block grant is a formula-based lump sum (block grant) for teaching and research. The lump sum allocation is based on measures of volume (student numbers, diplomas), prices (rates per student) and historical considerations. The allocation model distributes a given sum of money (set by Parliament) across the 13 research universities. The formula takes into account the relative performance of each university (as compared to the other universities). The allocation consists of a *teaching* component and a *research* component, but this distinction is for calculation purposes

only. In fact, the Executive Board is free to use its own model in distributing the lump sum across teaching and research activities. The teaching component is 42% of the lump sum (excluding the Academic Hospital allocation), and the research component makes up the remaining 58%.

The teaching component consists of

(a) A new entrants allocation (about 15% of the teaching grant);
(b) A diploma (BA/MA) based allocation (about 60%);
(c) A basic allocation (about 25%), which consists of fixed amounts per university. Actual amounts differ across universities; they have a historical basis.

For individual universities, these shares may differ, due to their relative performance. The emphasis on performance increased in 2000, as degrees received a higher weight in the formula.

The research component of the funding model consists of six parts:

(a) A 'basic allocation' for each university depending on the number of BA and MA diplomas. On average the allocation is 20% of the research grant.

(b) Allocation for PhD degrees and designer certificates (in Dutch: *ontwerpers-certificaten*). The premiums for postgraduate research degrees represent on average 12-15%.

(c) Allocation for research schools (in Dutch: *onderzoekscholen*), representing 3% of research funds. The research school component is allocated proportional to each university's sum of parts (a), (b), and (f). This allocation is meant to stimulate universities to establish accredited research schools.

(d) Allocation for excellent research schools (in Dutch: *toponderzoekscholen*). representing 3% of research funds. This part is allocated to a selected number of research schools: only the ones that are regarded as excellent.

(e) Smart Mix, introduced in 2006 to 'dynamise research'. In 2007, an amount of 100 million euro was taken out of the strategic considerations component and redistributed according to each university's success in terms of winning research council grants (from NWO) and selected competitive research contracts in the third stream of funding. However, after a new Cabinet took office in 2007, the Smart Mix policy was abandoned and the 100 million was redistributed by the research council for strengthening fundamental research in universities.

(f) Strategic considerations allocation, which represents 55%. It consists of fixed allocations per university, based on historical reasons.

Because the share of the Strategic considerations allocation has been decreasing, the allocation has become more performance based.

4.1.5.2 Research institutes

The Dutch research system contains various types of research institutes:

- Institutes for fundamental and strategic basic research: Research institutes under the organisational umbrella's of the research council NWO (9) and the Royal Academy KNAW (19) that perform fundamental research
- Institutes for strategic and applied research: TNO, the Large Technological Institutes (4) and DLO-institutes (agricultural research)
- Other research institutes, including departmental institutes.

TNO is by far the largest research institute. It spent 355 million euro on R&D in 2005. The total turnover is circa 500 million euro; 47% is funded via contract research for the private sector, 15% via contract research for the public sector, and 38% via base

funding and targeted funding by the government.[145] Since 2000 is of targeted and base funding has increased with 5% points. In the coming years, the base and targeted funding by the government will be replaced by programme-based demand-oriented funding. The governments and other stakeholders will articulate their demands for knowledge together with TNO. In so-called knowledge arenas, the demands will be translated into R&D programmes for strategic basic research.

The second largest group are the Large Technological Research Institutes (GTIs). The four institutes spent 152 million euro on R&D in 2005. These institutes are active in strategic sectors for the Netherlands: e.g. water management, energy, aerospace. The collective turnover was 333 million euro in 2008, of which 41% was funded by contract research for the private sector, 28% contract research for the public sector and 30% by base and targeted funding by the government. As with TNO, the base and targeted funding are being replaced by programme-based demand-oriented funding.

The shift from institutional base funding to demand-oriented funding means the government steers TNO and the GTIs by deliberations (in 'knowledge arenas') on the programming of strategic R&D. Funding becomes more directly linked to the quality and relevance of the R&D. With the introduction of demand-oriented programming the government aims to increase the connection between knowledge demands (by the government, industry, society) and knowledge supply. Twelve themes have been identified to orient the long-term strategic research agendas of TNO and the GTIs.

Another central element in the governance relation between the government and TNO and the GTIs are the deliberations on the strategic plans of the institutes. The government and the institutes discuss the long-term orientation of the institutes, the developments in the technology portfolio and the (international) networks.

TNO and the GTIs have an independent position. The government does not participate in the Supervisory Boards of the institutes. The institutes perform a periodic self-evaluation, complemented with external evaluations commissioned by the government.

NWO spent 134 million on R&D via its nine NWO research institutes. KNAW spent 102 million euro on its 19 research institutes. These institutes mainly perform fundamental and strategic scientific research. The institutes of NWO and the KNAW are evaluated according to the Standard Evaluation Protocol (SEP) (see above, on universities). The NWO and KNAW institutes need to score at least "very good". Otherwise, the responsible umbrella organisation (i.e. NWO or KNAW) will intervene.

4.1.5.3 Business sector

The business sector is the largest R&D performer. The R&D expenditures increased from 4.8 billion euro in 2003 to 5.8 billion euro in 2007. The relative size of the industry has decreased as the services sector grew. The large companies are the biggest spenders on R&D. 14 companies are responsible for half of the business expenditures on R&D.

4.1.5.4 R&D personnel in the Netherlands

The table below shows the total amount of R&D personnel in the Netherlands for the period 2003-2007 and the distribution between the various sectors. The total number of R&D personnel increased with 6% in that period. While the number of researchers in universities and the services sector increased, the amount of researchers in the research institutes and the industry sector decreased.

[145] Base funding is for maintaining the knowledge base of TNO. Targeted funding is for strategic R&D for market parties (public and private).

Figure 58 R&D personnel (labour years)

	2003	2005	2007
University	27,209	28,408	29,140
Research institutes	14,292	12,706	12,140
Business	44,485	48,587	49,246
Industry	32,080	33,546	31,584
Services	10,645	13,238	15,344
Other	1,760	1,803	2,318
Total	85,986	89,701	91,124

OCW (2010) Wetenschaps- en Technologieindicatoren 2010, p. 64.

4.1.6 Distribution of funding to the main sectors

This section describes the allocation of public funding to the main sectors and the development in allocation patterns over time.

The table below shows the distribution of the funding for R&D by the government. It shows that the largest share is allocated via the Government University Funds (base funding). In international perspective, this is a relatively large share. The (semi-) public research institutes also receive a relatively large share, although in an international perspective, the Dutch research institutes receives a relatively large share of their revenues from other sources (business and international sources).

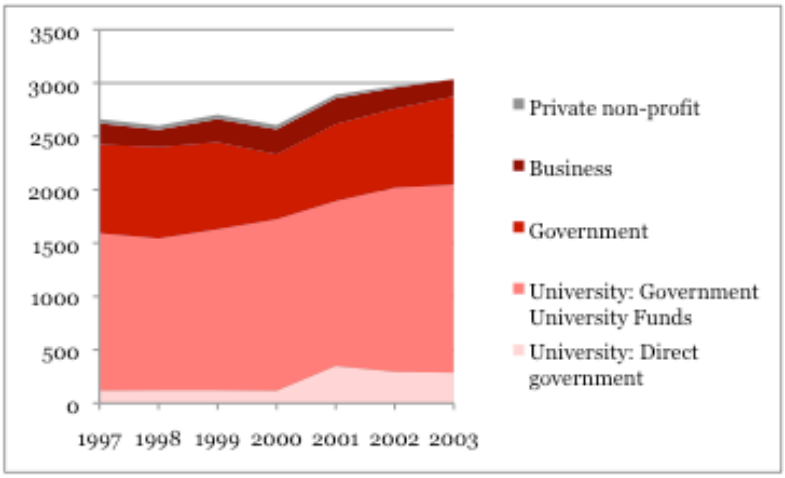
The trend is that the public funding for R&D is rising in the university sector. The share of direct government funding to universities increased from 4.4% in 1997 to 9.4% in 2003. Also the share of the Government University Funds increased in the same period from 55.4% to 58.0%. The share of the public funding to research institute decreased from 31.2% to 27.2%. Also the share of public funding to business declined, from 7.5% to 5.3%.

Figure 59 Trend in public funding for research carried out in the university, government and private sectors (million euro)

	1997	1998	1999	2000	2001	2002	2003
University	1593	1544	1630	1724	1894	2019	2047
Direct government	118	121	121	116	348	294	286
Government University Funds	1475	1423	1509	1608	1546	1725	1761
Government	831	856	815	608	720	740	827
Business	199	162	218	234	243	197	161
Private non-profit	39	39	41	40	35	16	
Total	2662	2601	2704	2606	2892	2972	3035

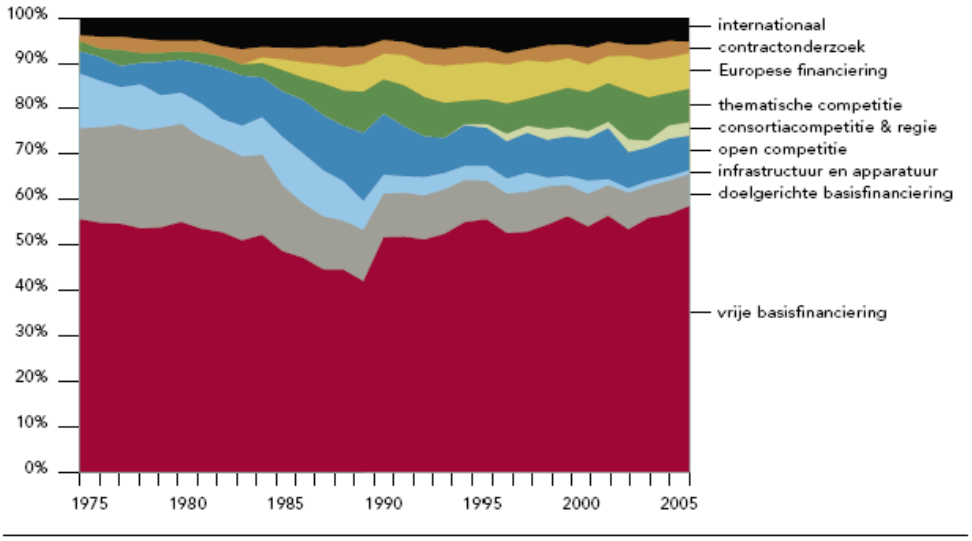
OECD Science, Technology and R&D Statistics

Figure 60 Trend in public funding for research carried out in the university, government and private sectors (million euro)



In the figure below, the shares of different types of public funding are presented.[146] The figure shows that the share of lump sum institutional base funding has increased in recent years. The shares of theme-based competition, consortia-based competition and funding of European projects have increased as well. The financing of international research collaboration is rather stable. The targeted base funding of research institutes and subsidies for infrastructure and apparatus, however, has decreased.

Figure 61 30 years of public R&D funding



Rathenau Institute (2007): Dertig jaar publieke onderzoeksfinanciering in Nederland 1975-2005

A relatively new mode of (programmatic) R&D funding since the 1990s is competition between consortia of public and private parties. The goal of this type of instrument is to create more "focus and mass" and to improve public-private interaction and coordination in the prioritised areas. Given its size, the Netherlands cannot excel in all

[146] Translation of the different types of funding from the bottom up: free base (lump sum) funding, targeted (institutional) base funding, infrastructure and apparatus, open competition, consortia competition & coordination, theme-based competition, European funding, contract research, international funding. Source: Rathenau (2007): Dertig jaar publieke onderzoeksfinanciering in Nederland 1975-2005.

areas, so choices have to be made (i.e. "focus and mass"). The total size of the consortia-based funding is relatively small, but because the funds are concentrated in a few areas and because there has been a quick succession of this type of instruments, these instruments have been very visible. Moreover, this type of funding often requires co-funding, thus tying up parts of the block grant to universities.

Another change in the government's approach to R&D funding has been a recent shift of €100m from the lump sum funding (block grant) of universities (ca. 5% of total lump sum funding) to competitive funding of talented researchers in an attempt to make R&D funding more performance-based and to create more room for talents. The rationale is that individual researchers know best how, where and with whom to achieve excellence (resulting in bottom-up focus and mass).

The balance between generic and thematic instruments has shifted somewhat with the introduction of the "programmatic approach" of the ministry of EZ in 2005 – as part of streamlining of the innovation policy mix. The total amount of funding for the thematic innovation programmes in key areas is, however, relatively small in comparison with the total governmental funding of R&D (*i.e.*, ca €100m/year or 2.5%). The generic fiscal scheme WBSO is, for instance, much larger with a budgetary weight of more than 0.5 billion euro/year).

It can be concluded that generic R&D funding remains higher than specific R&D funding. With regard to the balance between supporting existing strengths and new emerging areas, in broad lines the ministry of EZ supports current R&D specialisations in key areas, while the ministry of OCW supports new emerging areas (e.g. in nanotechnology, ICT, advanced chemistry and genomics/life sciences).

4.1.7 Priority setting at the national level

National thematic priorities evolved incrementally rather than in a centrally planned fashion. Many of the current priorities emerged as a result of multiple funding initiatives (e.g. investment impulses from the FES fund). For example, the priorities of NWO for its thematic programmes were developed rather independently from the priorities used by EZ / NL Agency for their innovation programmes. Priority setting has been a diffuse combination of top-down and bottom-up processes.

EZ's priorities are the so-called 'key areas' for which innovation programmes have been developed in close interaction with stakeholders. The key areas were based on an advisory report of the Innovation Platform in 2004. Between 2004 and 2006 a total of six key areas were identified: Creative Industry, Flowers & Food, High-Tech Systems and Materials, Water, Chemicals and Pensions & Social Security.

NWO's thematic priorities were based on a broad consultation. In the NWO Strategy 2007-2010, 13 themes are identified: (1) Basic Energy Research; (2) Brain and Cognition; (3) Conflict and Security; (4) Cultural Dynamics; (5) Dynamics of Complex Systems; (6) Dynamics of Life Courses; (7) Knowledge Base for ICT Applications; (8) New Instruments for Health Care; (9) Responsible Innovation; (10) Research & Innovation in Smart Creative Contexts; (11) Sustainable Earth; (12) Systems Biology; (13) Use of Nanosciences and Nanotechnology.

For the strategy period 2011–2014 NWO has chosen six broad themes, based on an inventory of the priorities of the government, TNO, innovation programmes and European themes. The six themes are: (1) Healthy living; (2) Water and climate; (3) Cultural and societal dynamics; (4) Sustainable energy; (5) Connecting sustainable cities; and (6) Materials: solutions for scarcity.

The priorities do not come with budgets attached. The priorities have to be filled in with programmes for which budgets have to be found. In the case of EZ's key areas, the innovation programmes are largely funded via the FES fund for which investment rounds were organised.

The previous government (2007-2010) has tried to streamline the process of priority setting in research and innovation after several critical advisory reports (e.g. from the

AWT, the Innovation Platform, the Rathenau Institute). These reports noted that a national strategic framework for investments in priority areas was lacking. This resulted in ad hoc investment impulses (e.g. from the FES fund) and an uncoordinated variety of thematic priorities set by the various actors in the research and innovation system.

The Dutch government responded with setting up a (temporary) inter-departmental Knowledge & Innovation (K&I) programme department in 2007. As part of the inter-departmental project "Netherlands Entrepreneurial Innovation Country" K&I developed a long-term strategy "Towards an agenda for sustainable productivity growth" in 2008. This strategy articulated the societal and economic ambitions for the Netherlands in 2030. Three themes were identified (Talents, Public and private research, and Innovative entrepreneurship) and a monitoring system was developed to monitor progress. In a next step, K&I developed a 'Multi-annual Innovation and Knowledge Compass' (MIKC) to identify (combinations of) knowledge and innovation themes based on economic and scientific (potential) strengths and contribution to solving societal challenges. The project consisted of four phases: (1) mapping the variety of themes in existing plans, agendas, strategies, thematic programmes etc. of ministries, research councils, national research institutes and others; (2) identifying (potential) coherence and overlaps between the identified themes; (3) making fact sheets for the themes; and (4) indicating which knowledge and innovation themes have strong contributions to recognised societal challenges.[147]

4.1.8 Steering, governance and administration

The governance relation between EZ and NL Agency is quite different from the relation between OCW and the research council NWO.

NL Agency is an agency of EZ, but also works for other ministries. In 2011 NL Agency implements programmes for 10 ministries and 18 clients outside the central government (provinces and EU). NL Agency writes proposals to get commissions to implement and manage programmes for its clients.

Since 2008, NL Agency had to meet certain efficiency criteria set by the government. As overhead costs were already low, further cost reductions have to be made by making the primary processes more efficient. In 2008 NL Agency's tariffs, in real terms, fell by 1%. Since 2004, tariffs have decreased by 13.6% (taking account of salary and cost increases).

EZ monitors NL Agency's efficiency. EZ uses a set of efficiency indicators. NL Agency reports on the basis of these indicators.

Indicators that are used, are shown in the table below.

[147] The website http://mikk.nl/ contains a full overview of all societal challenges, innovation themes and knowledge themes.

Figure 62 Performance indicators of EZ for NL Agency

	Core indicators	Explanatory / context variables
Input indicators	Direct/indirect personnel in FTEs	Personnel costs per fte; Total FTEs; Cost hiring external staff
Output indicators	Tariffs per hour; Number of declarable hours per fte and total; Number of workable and gross/net available hours	Operating result/turnover
Quality indicators	Customer satisfaction; Throughput time primary processes; Accepted notices of objection; Number of complaints; Employee satisfaction	Sickness absence

EZ Budget 2011.

NL Agency as an assets-liabilities department

NL Agency is a so-called assets-liabilities department (*Baten-lastendienst*). In general, such departments are a part of the ministry that are involved in policy implementation and delivery. An assets-liabilities department works in a businesslike fashion. Within the central government, such departments are quite common. They deliver services/products to clients that pay for them. The focus is on output (products and services), not only in the relation with the clients but also within the assets-liabilities departments. They are visible as separate organisations vis-à-vis the core ministry, but they are part of the hierarchy under the minister. Because these departments can work with a different financial regime they can operate in a businesslike fashion. Thus, an asset-liabilities department not only has a different administrative system than other governmental departments, but also a different (results-based) management model.

Higher efficiency is the main reason for the government to work with asset-liabilities departments. By working in a businesslike and transparent fashion, efficiency is stimulated. With the assets-liabilities system, costs are directly linked to products. In combination with the result-oriented management model this offers the opportunity to govern and fund such departments on the basis of performances.

The idea is that making clear agreements beforehand on the volume, the quality and the price of the products and services to be delivered as well as the settlement of accounts afterwards, have a positive effect on the efficiency and effectiveness of the assets-liabilities departments.

In comparison with regular government departments, an assets-liabilities department has several special characteristics, for instance:

- The assets-liabilities accounting system has the advantage that costs can be better linked to products;
- The assets-liabilities department has commissions from one or more principals that are responsible for financing these products or services;
- Beforehand, agreements are made on the output. Afterwards, an account is made. This is different than the normal regime where steering is based on input (e.g. via budgets or fte's);
- There is a clear distinction between the roles of client and owner, making an explicit weighing of different stakes possible. (E.g. inexpensive products versus a structural well-equipped department). Policy directorates within ministries tend to act as clients (responsible for the products, price and quality), and the secretary-general of the ministry acts as owner (responsible for the continuity and quality of the organisation);

- An assets-liabilities department may have own assets, it may loan and save money, and it may have an own current account relation with the ministry of Finance. This makes operating in a businesslike fashion possible;
- The planning and control systems and the financial administration of an assets-liabilities department are separated from other departmental organisations, making it visible as one separate organisation (with integral costs).

The research council NWO is a so-called Independent Governing Body (*Zelfstandig Bestuursorgaan*)[148]. It was established by law in 1950. The NWO Act lays down NWO's duties and powers. The NWO Regulations provide the framework within which the management and organisation of the governing body are regulated.

As an independent governing body of the central government with a public task (by law), NWO is not directly under the hierarchy of the minister. The minister is, however, politically responsible in Parliament for NWO. In order to carry out this ministerial responsibility correctly, the minister has a number of powers laid down in the NWO Act. The most important of these are: appointment and dismissal of members of the Governing Board, approval of changes to the NWO Regulations, determining the position as regards the strategic plan, and approval of the budget and annual accounts.

As an independent governing body, NWO is responsible for the adequate performance of its statutory tasks. NWO makes a four-annual strategy, in which the science budget of OCW, universities' strategic plans and other relevant documents have to be taken into account. The strategy plan is sent to the minister. NWO provides information on its functioning and performance in an annual report that is sent to the minister and Parliament. NWO also sends a (draft) annual budget to the minister, who has to formally approve the budget.

The annual report contains the NWO Governing Board's formal administrative account, which is based on the performance indicators and the annual accounts. The annual report includes performance indicators, which were agreed with OCW in a covenant in 2003.[149] This covenant contains the elaboration of the accountability information to OCW that originates in the policy lines and objectives of NWO and the multi-annual strategy of NWO. The results and effects of NWO have been expressed as quantitatively as possible. The covenant aims to improve transparency.

The information includes data on:

- Productivity and output (publications, press and media coverage)
- The process of subsidy allocation (applications, awarded applications)
- Specific programmes (thematic and individual-oriented programmes, internationalisation and investments in research infrastructure
- Volume of support and the number of funded research positions divided by subsidy receiver
- Management/administrative cost and data on the NWO office.

OCW is responsible for a careful treatment of the information and can only use it to form its own judgement. OCW deliberates with NWO on this judgement and the possible consequences. The information plays a role in the annual deliberations between OCW and NWO and is part of the annual planning and control cycle of NWO.

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[148] An important development for NWO in 2007 was the Autonomous Administrative Authorities Framework Act (*Kaderwet Zelfstandige Bestuursorganen*), introduced in order to strengthen the political direction of Independent Governing Bodies. NWO succeeded in being recognised as an exception (arguing this was necessary to be able to continue to function independently in the interests of Dutch science). The minister of OCW has created an appropriate status for NWO.

[149] "Convenant Rekenschap met indicatoren op maat", agreed by OCW and NWO on 29 April 2003.

4.2 Administrative efficiency of research performers

In general, not much information is available on the system cost of the Dutch research system. Indeed, the Advisory Council for Science and Technology Policy (AWT) is currently doing a study to quantify these costs. The efficiency of the allocation of R&D funding to the research system has been criticised widely. The AWT noted that the system costs were high because the division of responsibilities was unclear, policy was too much oriented at giving each party its 'fair share', and because of too much emphasis on accountability and reporting on how funds are spent. Moreover, many new organisational structures (public-private consortia, virtual institutes, etc.) have been established to allocate programmatic investments in R&D, each with their own director, administration and marketing.

At the same time, because researchers have become increasingly dependent upon funding via the 'second stream' (NWO grants) and the 'third stream' (contract research, regional/national/European R&D programmes), they have to spend more time on preparing proposals and reporting on progress. Moreover, the diversity of allocation mechanisms in the Dutch research system, increases the administrative burden for researchers. However, no quantitative information is available on how this has affected the shift between research and research management.

NWO gives an account of its administrative costs in its annual report. The administrative costs of NWO are the integral costs that have been made for allocating subsidies for research projects. In 2009, NWO spent 5.2% of total expenditures on administrative costs. In 2008, this was 6.2%.

NL Agency reports on its performance with various indicators, including the ratio direct / indirect personnel. This is an indicator for the administrative efficiency. In 2009 this was 1504 fte / 261 fte (= 15% indirect) for NL Agency (then SenterNovem).

In 2008 SenterNovem ensured that in total 2.4 billion euro in incentive funds (not just for R&D and innovation!) was allocated to companies, institutions and private citizens over. This meant issuing 162,000 declarations and statements.[150] Implementation costs (compared to the resources) amounted to 2.3% in 2008 (3.6% in 2007).

There is no information available on R&D expenditures by individual universities. The Higher Education and Research Act of 1993 codified an enhanced institutional autonomy of universities and introduced the principle of self-regulation for Higher Education Institutes. Since then, the government has kept a distance from the institutions and has taken the sector level as the point of application for steering, instead of the institutional level. The policy framework resolves mostly around funding and quality assurance. The government does not translate the outcomes of quality assessment of research and education into its budget allocations. One of the effects of the shift in governance has been the increased importance of central institutional management. With the Modernising University's Governance Structures Act (1997), executive management was strengthened, powers became more concentrated, and representative bodies became advisory rather than decision-making bodies. Universities set up Supervisory Boards, which act as a buffer between the government and the executives of the university and should enhance the role of universities as public (or societal) 'entrepreneurs'. In general, the modernisation of Dutch universities appears to have increased efficiency, because universities have become more entrepreneurial.

[150] SenterNovem also acted as knowledge centre, for example via InfoMil (legislation and regulations concerning the environment and spatial planning) and as EG Liaison (the National Contact Point for the EU Framework Programme in the Netherlands).

The government does not make multi-annual performance agreements with universities. The ministry of OCW does use indicators to monitor the dynamics in the research system. OCW publishes each years reports with quantitative information.[151]

For research institutes and companies, quantitative information on the split between research and research administration is not available. For research institutes like TNO and the Large Technological Institutes, it may be assumed that the cost of administration has increased because the institutional base funding is being replaced by programme-based demand-oriented funding (see above).

An indication of the administrative costs and efficiency of universities can be found by looking at the ratio Scientific personnel / Support and administrative personnel. For the largest university (the University Utrecht) this ratio was 3003/2379=1.26 in 2007. I.e., 44% of personnel is support and administrative staff. In 2003 the ratio was 2875/2588=1.11 , i.e. 47%. The TU Delft (the largest university of technology) had a ratio of 2579/1859=1.39 in 2007. In 2003 the ratio was 0.98. These figures indicate that universities have succeeded in improving their efficiency and lowering their administrative cost. This is no co-incidence, because universities have been faced with scarcity of resources.

In 2007, the Ministry of OCW published a report on how academics spend their time.[152] The report presents the time spending of scientific personnel of Dutch universities in the period March 2006–March 2007. It gives information on the relative time spent on four main categories: teaching, research, societal services, and other activities (e.g. management and administration). In comparison to a previous study on time spending (1982–1983) less time is spent on 'other activities'. In the sectors Language & Culture and Behaviour & Society) more time is spent on teaching. In the sector Technology, the relative time spent on teaching has decreased while the relative time spent on research has increased significantly.

Figure 63 Time spending by main category, by sector (in %)

	Behaviour and Society		Law		Technology		Language and Culture		Total
	2006/07	1982/83	2006/07	1982/83	2006/07	1982/83	2006/07	1982/83	2006/07
Teaching	41	31	41	40	29	34	42	35	37

[151] The ministry of OCW publishes several (partly overlapping) documents with information on the functioning of the research system.

- "Trends in Beeld" (Trends in the picture) presents charts and tables on the science system on 'accessibility', 'quality' and 'efficiency'. It accompanies the annual budget of the ministry, which is sent to Parliament. (See http://www.rijksoverheid.nl/ministeries/ocw/organisatie/begroting-en-jaarverslag).
- "Kennis in Kaart" (Mapping knowledge): core indicators on accessibility, quality and efficiency of the public science system. (http://www.rijksoverheid.nl/documenten-en-publicaties/publicaties-pb51/kennis-in-kaart-2009.html).
- "Kerncijfers 2005-2009 OCW" (Core figures), with a chapter on the science system that presents core indicators on R&D funding and R&D expenditures and various input and output indicators. (http://www.rijksoverheid.nl/documenten-en-publicaties/publicaties-pb51/kerncijfers-2005-2009.html).
- "Overzicht Totale Onderzoek Financiering (TOF) 2008-2014" (Overview Total Research Funding) with an elaborate overview of R&D funding by the ministries which is sent annually to Parliament (https://zoek.officielebekendmakingen.nl/kst-32123-VIII-111.pdf).
- "Science and Technology Indicators" of the Netherlands Observatory of Science and Technology, an elaborate annual publication by OCW on R&D funding and expenditures. R&D personnel/knowledge workers, scientific performance, public-private R&D collaborations (http://www.nowt.nl/nieuwste_rapport.php).

[152] J.M.P. de Kok, J. de Jonge and M. Tom (2007) "Tijdsbesteding universitair wetenschappelijk personeel", policy study nr. 130 in the series "Beleidsgerichte studies Hoger onderwijs en Wetenschappelijk onderzoek, Zoetermeer, 27 September 2007. (Downloadable at: http://www.rijksoverheid.nl/bestanden/documenten-en-publicaties/notas/2007/09/27/tijdsbesteding-universitair-wetenschappelijk-personeel/810360-bel-studies-130.pdf)

	Behaviour and Society		Law		Technology		Language and Culture		Total
Research	47	49	44	43	59	48	45	48	51
Societal services	1	20	2	17	1	18	1	17	1
Other	11		13		11		12		12
Total	100	100	100	100	100	100	100	100	100

J.M.P. de Kok, J. de Jonge and M. Tom (2007) "Tijdsbesteding universitair wetenschappelijk personeel", policy study nr. 130 in the series "Beleidsgerichte studies Hoger onderwijs en Wetenschappelijk onderzoek, Zoetermeer, 27 September 2007.

4.3 Postgraduate researcher training

4.3.1 Organisation of postgraduate researcher training

In the Netherlands, doctoral candidates (AiOs in Dutch) are typically employed by the university. PhD scholarships are very rare.

In the Dutch system there are six types of PhD graduates.

1. Employee–PhD candidate

This employee–PhD graduate is an employee of the university. This type fits well with research funded via NWO or contract research. Often, there is a research proposal written by the promoter for which a suitable PhD candidate is sought. The appointment is for the duration of the research project (typically 4 years). A large share of the PhD candidates subsumes under this category. The employee–PhD candidates are responsible for a large part of all university research. In addition, they have teaching tasks. The research training is often organised in (inter)university research schools or graduate schools.

2. Scientific staff member working on a PhD thesis

In scientific areas with a shortage of positions for employee–PhD candidates, universities may chose to make available teaching positions for PhD candidates. They are appointed as scientific staff members.

3. PhD student

The PhD student is very rare in the Dutch system (less than 1% of all PhD candidates). The emphasis is on training and less on scientific tasks (teaching) and output. PhD students are free in their choice of subject and their promoter is supervisor/coach rather than leader/manager.

4. Foreign scholarship PhD student

Foreign PhD students may decide to perform their research (partly) at a Dutch university, using their scholarships from their home countries. The status of employee usually is not attractive for them, because they would have to pay for social security funds.

5. The external PhD candidate (*buitenpromovendus*)

Almost half of all PhD candidates fits into this category. These PhD candidates typically have jobs outside the university and tend to perform their research in their free time.

6. Dual PhD graduation

Dual PhD graduation is on the rise. The PhD candidate is partly employed by the university and partly by another organisation. The target group is different from the 'normal' PhD candidates (older, more working experience)

In the Netherlands PhD posts can be obtained in three ways:

1. PhD vacancies

Most PhD vacancies are advertised on the websites of the university, the research institute, or in scientific journals. In that case the subject of the research project has already been determined. Most PhD candidates (Dutch and non-Dutch) are employed by the university as research assistants (*assistent in opleiding*, AIO) This generally means signing a 4-year employment contract with the university. The AIOs are paid via the block grant to universities or via research grants obtained by the research group.

2. Through (inter)national funding

Alternatively, a PhD post can be obtained through national or international funding, especially if candidates have their own research proposal. If this is the case, proposals may be submitted, together with a list of publications, to the appropriate graduate school or to the professor (future Supervisor) who is the expert in the field. This route applies mainly for international collaboration programmes, e.g. with China.

3. Application

It is also possible to write an open application letter to a Graduate School to see if there is interest in the research proposal or the candidate as a researcher.

The 'standard' PhD candidates (i.e. employees of the university) are remunerated according to the salary grades in the salary table in the Collective Labour Agreement (CAO) Dutch Universities. The salaries per month in the first, second, third and fourth years are, respectively, 2000 euro, 2330 euro, 2441 euro and 2558 euro. Employees are entitled to a holiday allowance amounting to 8% of their total remuneration.

4.3.1.1 National policy

In an effort to make PhD positions more attractive for talented Master students, postgraduate researcher training has received more attention since the 1990s. Intra- and interuniversity research schools have been established to create a recognisable environment for PhD candidates. The system of research school and the evaluation cycles has resulted in a better quality of postgraduate researcher training. In 2009 there were 81 recognised (accredited) research schools, two-thirds are inter-university.

There is a quality assurance system in place for the research schools. The Research School Accreditation Committee (ECOS) was established by the Royal Academy KNAW in 1992 at the request of the minister of OCW. ECOS organises annual assessment rounds, and ECOS decides on applications for the (re)accreditation of research schools, submitted by the Boards of Governors of Dutch universities. The assessment is based on a protocol established by the KNAW. The accreditation of a research school is valid for six years. After this period an application for reaccreditation needs to be submitted.

The ECOS accreditation procedure aims at granting a quality stamp to those research schools who, both in structure and in execution, provide high-quality Dutch research and training of young researchers. ECOS also provides advice to research schools on how to further improve their core activities. The main focus is on researcher education and supervision. The revision of the ECOS, effectuated in 2010, aims to synchronize the ECOS procedure and evaluations according to the Standard Evaluation Protocol (SEP). The SEP is used to evaluate research groups in universities.[153]

[153] The SEP provides common guidelines for the evaluation and improvement of research and research policy, based on expert assessments. It has two main objectives: (1) to improve the research quality based on external peer review, including scientific and societal relevance of research, research policy and research management; (2) to ensure accountability to the board of the research organisation, and towards funding agencies, government and society at large.
The assessment is based on four criteria:

Research school function as autonomous organisational units with their own budget and control responsibilities. The university (or universities) has (have) to guarantee sufficient funding for a research school to be accredited.

In the past five years, most universities have established local graduate school to support postgraduate researcher training throughout the institution. This new organisational principle was introduced as an answer to perceived lack of clarity in the divisions of responsibilities between research schools, institutes and faculties. The aim was to offer all PhD candidates a good environment. In time, the system of graduate schools should cover all PhD candidates in Dutch universities. The minister of OCW during 2007-2010 was a proponent of graduate schools based on the American model. This means: a fixed time of entry, a strong focus on training and an orientation within the research school, followed by the choice of a doctorate subject. In other words, the PhD candidate would be able to chose his/her own subject, promoter and university. NWO received funding to develop a programme for graduate schools.

The background for introducing the new system of graduate schools is formed by a combination of factors: the Bologna process; the increased premium on PhD degrees for universities (90,000 euro); the trend towards more freedom for the PhD candidate to chose his/her own subject and promoter; and career perspectives on the labour market.

Since 2002, the ministry of OCW explicitly pays attention to the postgraduates. The policy analysis identified several problems for which policy needed to finds answers:

- Aging of scientific staff
- Underrepresentation of specific groups
- Few career opportunities for talented researchers
- Too tight budgets
- Competition on the labour market (national and international)
- Low mobility of scientific staff within the research system.

Policy measures that address these problems include subsidies for stimulating researchers in different stages of their scientific career (NWO programmes for individual researchers); increase in salaries for PhD candidates (typically not students but employees in the Dutch system); and improving conditions for recruiting foreign researchers.

Policy instruments include:

- Subsidy to NWO for executing a strengthened and broadened programme (Innovational Research Incentives scheme; *Vernieuwingsimpuls*) that stimulates talented researchers in various stages of their careers via individual subsidies.
- Subsidies to NWO for programmes that specifically stimulate women and researchers from non-Western countries.
- Subsidy to NWO to execute the Rubicon programme that allows talented young researchers to gain experience after their PhD graduation at a research institute abroad or in the Netherlands.
- Subsidy to NWO for executing a programme to enable talented graduates to start a PhD.

- quality (including international academic reputation and PhD training)
- productivity (the relationship between input and output)
- societal relevance (including 'valorisation' of research results)
- vitality and feasibility (the ability to react adequately to important changes in the environment).

The SEP 2009-2015 is available (in English) at
http://www.knaw.nl/cfdata/publicaties/detail.cfm?boeken__ordernr=20091052.

- Subsidy to NWO, inspired by the American model of the graduate schools, to develop an instrument based on free competition for training grants. The aim is to give young talented researchers more freedom to steer their own research (careers). NWO has developed a pilot for a subsidy programme that focuses on Graduate Schools and research schools. In this pilot programme national and local research schools or Graduate Schools can be nominated for a block grant of about 800,000 euro that is intended for the appointment of PhD candidates who will carry out their research within the school.

In the Dutch system, universities have a large degree of autonomy. In the 'policy rich' dialogue between the minister of OCW and the universities, agreements have been made to strengthen HRM policy at the universities, aimed at improving career perspectives for young researchers (and women and migrants).

4.3.1.2 Research council NWO

NWO receives targeted subsidies from OCW to executive specific programmes for young talented researchers (see above). One of the action lines in the NWO strategy 2007-2010 is Opportunities for researchers. NWO wants to provide more opportunities for scientific talent. The programmes in this action line are targeted at specific groups (minorities, women, migrants), international collaboration, and supporting talented researchers throughout the various stages of their careers.[154]

In much of the research funded by NWO PhD candidates (and postdocs) perform research. PhD candidates are not employed by NWO, but by universities.

An interesting recent (pilot) scheme is the Graduate Programme. In this programme national and local research schools or Graduate Schools can be nominated for a block grant of about 800,000 euro that is intended for the appointment of PhD candidates who will carry out their research within the school.

The Governing Boards of the Dutch universities will be invited to nominate schools to NWO. The intention is that the schools nominated by the Governing Boards will write the application and that the Governing Boards will submit these to NWO. A committee drawn from a wide range of disciplines will assess the applications against the criteria related to the organisational form and will select the schools for the block grants on the basis of quality.

These Graduate Schools supplement the existing (interuniversity) research schools.

4.3.1.3 University

Postgraduate researcher training is offered by universities in local or interuniversity research schools and/or in graduate schools. (See above). Only universities can award PhD degrees. Often, PhD candidates work in larger research programmes and they may perform there research in other institutes or companies.

In the Collective Labour Agreement Dutch Universities it is stated that the employer shall see to it, following consultation with the doctoral candidate and in accordance with a customised plan for training and guidance set up for the doctoral assistant by the appointed mentor or supervisor, that this plan is forwarded to the doctoral assistant within 3 months of inception of the employment contract.

Towards the end of the first year the training and guidance plan is worked out in further detail for the remaining term of the employment contract and may be adjusted annually thereafter, if so required.

The training and guidance plan shall in any case establish:

- what knowledge and skills must be acquired and how this should be done;

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[154] See http://www.nwo.nl/nwohome.nsf/pages/NWOP_5S3F4I_Eng for an overview of all the NWO programmes in this action line.

- who shall act as mentor for the doctoral candidate, i.e. under whose supervision the doctoral candidate shall work and who shall be the promoter. If the mentor is not the promoter, it is also stipulated that the doctoral candidate shall discuss the doctoral research with the promoter at the beginning of the research project and at moments which are decisive for the progress of the research, at least once a year.
- the extent, in minimum hours per month, of personal guidance from the appointed mentor to which the doctoral candidate is entitled.

4.3.2 Funding of postgraduate researcher training

4.3.2.1 Funding of doctoral researcher training

Universities get a premium from OCW for each PhD degree of 90,000 euro.

The largest share of PhD candidates is employee–PhD candidate. They are funded via the so-called 'first stream' (institutional base funding, block grant), the 'second stream' (NWO programmes) or the 'third stream' (contract research, regional/national/EU programmes, etc.).

A few universities have experimented with scholarship PhD students in order to save cost. These PhD candidates are not employed by the university, but receive a scholarship. The premium on PhD degrees for universities remains the same. The introduction of scholarships is controversial, because it may undermine the attractiveness of a PhD position in the Netherlands. Recently, the court ruled that scholarship PhD students were in fact employees of the university, and that they have the same rights as employee–PhD candidates.

4.3.2.2 Numbers of PhD candidates

The number of PhD degrees increases annually with 4% on average.[155] The increase is above average in the sectors of agriculture, technology and medical.

[155] OCW (2010) Kennis in Kaart 2009.

Figure 64 Number of PhD candidates per university (2000-2008)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Erasmus Universiteit Rotterdam	165	143	150	179	181	220	253	237	265
Open Universiteit	4	0	2	3	5	8	3	5	10
Radboud Universiteit Nijmegen	191	214	192	206	214	226	241	262	260
Rijksuniversiteit Groningen	228	240	229	238	286	290	336	321	306
Technische Universiteit Delft	172	180	178	185	212	225	214	229	236
Technische Universiteit Eindhoven	99	128	128	126	143	163	148	176	191
Universiteit Leiden	232	231	233	236	240	289	302	269	302
Universiteit Maastricht	91	115	100	131	131	154	147	179	185
Universiteit Twente	103	111	111	144	160	166	168	147	160
Universiteit Utrecht	366	393	389	413	358	421	443	438	416
Universiteit van Amsterdam	288	319	335	325	329	323	327	378	353
Universiteit van Tilburg	59	58	57	56	52	67	92	83	85
Vrije Universiteit Amsterdam	177	195	213	220	244	240	246	269	264
Wageningen Universiteit	185	207	214	178	170	192	224	249	208
Totaal	2,360	2,534	2,531	2,640	2,725	2,984	3,144	3,242	3,241

OCW (2010) Kennis in Kaart 2009, p. 81

The first year enrolments of PhD candidates has increased in the period 2004-2008 with 43%. The table below shows the numbers of first year enrolments.

Figure 65 First year enrolments of PhD candidates

	2004	2005	2006	2007	2008
Total	1278	1306	1372	1442	1825

VSNU; http://www.vsnu.nl/web/show/id=89008/langid=43

The Association of Universities in the Netherlands (VSNU) publishes information on the output of postgraduates (PhD candidates). The following table shows the number of PhD graduates for the group of "standard" PhD candidates (i.e. employee PhD candidates).

Figure 66 Completion % of PhD candidates

Year	Size of the cohort	Graduated <= 4 years	Graduated <= 5 years	Graduated <= 6 years	Graduated <= 7 years	Total (incl. >7 years)
2001	1166	8	38	57	65	68
2002	1292	6	37	55	60	60
2003	1236	7	40	53		53
2004	1278	7	26			26
2005	1306	4				4

VSNU, 2010. (http://www.vsnu.nl/Universiteiten/Feiten-Cijfers/Onderzoek/Rendement-promovendi.htm)

The figures vary for the different sectors (Agriculture, Nature, Technology, Health, Economy, Law, Behaviour & Society, and Language & Culture. The highest completion % within 7 years (cohort 2001) are found in the sectors Nature, Economy, Agriculture and Technology. The lowest completion % within 7 years are found in the sectors Language & Culture, Law and Health.

Figure 67 Completion % of PhD candidates per sector (cohort 2001)

	Graduated <= 5 years	Graduated <= 7 years	Total (incl. > 7 years)
Agriculture	35	68	70
Nature	44	78	81
Technology	58	68	70
Health	27	58	60
Economy	49	76	78
Law	17	48	57
Behaviour & Society	35	64	68
Language & Culture	28	47	52
Total	38	65	68

VSNU, 2010. (http://www.vsnu.nl/Universiteiten/Feiten-Cijfers/Onderzoek/Rendement-promovendi-naar-HOOPgebied.htm)

4.4 Research funding criteria and mechanisms

4.4.1 Research council NWO

NWO promotes scientific research at Dutch universities and institutes through nearly 120 different research programmes and grants. Researchers can apply for subsidies within research programmes as defined by NWO or as apart of a Free Competition (research object is put forward by the researcher). Personal grants (like the relatively large Innovational Research Incentives scheme (*Vernieuwingsimpuls*)) stimulate individual researchers. Other subsidies facilitate (international) cooperation, finance the use of large-scale facilities and enable investments or publications. In practice researchers can apply for FTEs on a project basis (PhD candidates, research trainee assistants, postdocs) and supplementary budget for material costs.

The usual selection procedures of NWO include an assessment of the scientific quality and feasibility of the proposals by international experts in accordance with a system of hearing both sides of the argument. Based on this standard peer review procedure and the written reaction of the applicants on the comments of the reviewers, the independent international evaluation committee uses its scientific expertise to formulate a recommendation for funding for the involved NWO Division Boards, who will formalise the advice of the evaluation committee.

4.4.2 Government departments

The ministry of EZ has an elaborate mix of innovation policy instruments, which are executed by NL Agency (part of EZ).

The NL Innovation Division of NL Agency manages a broad mix of instrument that fall into four categories of support. In the figure below these categories, or 'packages', are shortly characterised.

Figure 68 Innovation NL | NL Agency support in four packages

	Starting, growing, transfer of firms	Regional economic strengths	Basic package innovation	Programmatic package innovation
Target group	All companies	Companies within regional priority areas	All innovative companies	Innovative leading companies within national priority areas
Effects	• More investments • Interaction Education and Labour market	• Regional clusters of world class	• More investments • Knowledge exchange with knowledge institutes	• International excellence in specific thematic areas
Means	• Guarantees • Start-up funds • Education linked to labour market	• Targeted investments in proven strengths of regional economies	• Tax reduction • Innovation vouchers • Joint innovation • Credits	• Innovation programmes with R&D agendas • Connection to international networks and programmes
Financial support (excl. guarantees)	167 million euro	68 million euro	823 million euro	307 million euro

Facts and figures Division NL Innovation, 2010

Especially the regional package and the two innovation packages are relevant for R&D funding. Combined, the budget is 1.2 billion (2009). This includes the fiscal scheme WBSO (R&D wage tax reduction) which accounts for 0.5 billion euro.

The basic package for innovation contains policy instruments for all companies, while the programmatic package for innovation consists of innovation programmes for prioritised areas in the Dutch economy.

The thematic innovation programmes can be developed in specific 'key areas' in which the Netherlands excels and can distinguish itself internationally. The aim of the innovation programmes in these prioritised areas is to identify economic opportunities and develop strengths in dialogue with the business sector and with knowledge institutes in the Netherlands. Another aim is to identify the bottlenecks in the innovation ecosystem and develop target-oriented activities to improve them. Via this programmatic approach, the Netherlands can create more focus and mass, and develop international hotspots that help to increase the attractiveness of the Netherlands as an international location for R&D and innovation. The innovation programmes should have a strong impact upon the potential for growth of the Dutch economy.

The programmes are developed bottom-up by companies and knowledge institutes, in close interaction with NL Agency. Participants are all relevant parties in a market or technology that want to (are have) develop(ed) a common vision and ambition. The innovation programmes have a broad scope as they may cover a broad range of possible applicants (companies, SMEs, universities, etc.), a broad range of eligible innovation activities (R&D, feasibility studies, human resource measures, knowledge valorisation, stimulating SMEs and start-ups, alignment of education and the labour market, etc.), and a broad range of support (grants, credits, guarantees, or combinations of that). The private sector parties have to show financial commitment and a willingness to make substantial investments.

An innovation programmes has several phases:

(1) Focus and ambition: within a promising area, a group of entrepreneurs establishes the themes it wants to focus on. If that is clear, other companies and knowledge institutes can be involved in the further elaboration. The business enterprise sector has the initiative. NL Agency can act as a facilitator in this phase.

(2) Vision and strategic agenda: stakeholders develop a vision and a strategic agenda. In the vision, the future opportunities and threats are described. In the strategic agenda it is described how the vision will be realised and which steps will be needed. NL Agency can act as a facilitator in this phase.

(3) Assessment: the minister of Economic Affairs has to endorse the vision and the strategic agenda.

(4) After endorsement, the strategic agenda can be further elaborated into an innovation programme. In this programme it is made clear which activities will be undertaken and what is expected of the government. NL Agency can act as facilitator.

(5) Assessment: the minister van Economic Affairs has to endorse the concept innovation programme. The Strategic Advisory Committee (SAC) advises the minister van Economic Affairs about the vision and strategic agenda and the subsequent innovation programme.

Most ministries fund R&D via their 'own' research institutes, that may part of the departmental structure, or may have been put 'at a distance'. In various cases, institutional base funding is being replaced by programme-based funding, based on jointly developed strategic research agendas that address the needs for knowledge articulated by the departments and other stakeholders. The ministries have set up 'knowledge arenas' for articulation of demand and the development of programmes for strategic research.

4.5 Monitoring of research grants

4.5.1 Overall

In this section we focus on the research council NWO and NL Agency. In general, the subsidies come with an obligation to perform the activities as outlined in the proposal. There are in general no formal performance contracts.

4.5.2 Research council NWO

NWO has a monitoring system in place. NWO puts relatively more efforts in selection of research proposals than in monitoring the progress of awarded projects. Project leaders are required to deliver periodic progress reports, with overviews of publications and results (via an electronic monitoring system Iris). It could be argued that NWO uses a trust-based monitoring system with relatively light reporting requirements for project leaders. NWO does not have a tradition of ex post evaluation of programmes (by external parties).

An periodic progress report usually must contain a section on progress related to the targets in the proposal, a section on (deviations in) planning, and a section on broader audiences (whether results are interesting for a broader audience).

NWO uses the progress reports of the projects for its annual report in which NWO's performance is demonstrated to the minister (with reference to the four-annual strategic plan and the annual budget).

At the end of a project, a final report is required in order to get the final part of the subsidy[156]. This report serves several goals simultaneously:

[156] Typically, the subsidy is paid in four parts. The last part (25%) is paid after the final report is submitted. There may be variations for different subsidy schemes.

- It enables NWO to check whether the project has met its goals;
- It enables NWO to finalise the project administratively, e.g. pay the final part of the personnel costs of the project;
- It provides some of the information needed for evaluation purposes;
- It provides information which can be publicised, e.g. via a web site.

The final report usually contains sections on research results, scientific relevance, societal/economic relevance and on finance.

In case of larger research programmes, a programme committee is responsible for monitoring progress.

4.5.3 NL Agency

NL Agency executes programmes for clients (ministries). Agreements on monitoring and evaluation vary for each assignment. Obligations for receivers of subsidies are outlined in the regulation of the subsidy.

Typically, NL Agency uses performance indicators to monitor progress and project leaders, but indicators vary per programme and client. In the annual monitoring, the emphasis is on output indicators, which provide evidence of the activities that have been performed and their outputs. In addition, programmes have a mid-term review and an ex post evaluation.

Project leaders of awarded proposals need to deliver annual reports. An annual report may have required sections on outputs/results (and commercial use of results); bottlenecks/issues (e.g. delays and consequences for progress); changes in the project and their consequences.

For larger programmes, EZ / NL Agency usually implement a full monitoring and evaluation cycle. The cycle starts with a baseline measurement.

The difference in monitoring and evaluation systems between NWO and NL Agency is related to the objectives of the programmes. The innovation programmes of NL Agency have economic objectives, and NL Agency's clients need evidence on goal achievement.

4.6 Cataloguing research outputs

4.6.1 Scientific outputs

In the Netherlands, a National Academic Research and Collaborations Information System (NARCIS) is in place. NARCIS has been developed by the Royal Academy KNAW to increase visibility and retrievability of Dutch scientific research. This development takes place in close cooperation with the Dutch universities, NWO and other research institutes. NARCIS gives access to scientific information consisting of (open access) publications from the repositories of all the Dutch universities, KNAW, NWO, and a number of research institutes, the datasets of the institute DANS[157], as well as descriptions of research projects, institutes and researchers. This means that NARCIS cannot be used as an entry point to access complete overviews of publications of researchers (yet). On a national scale there are plans, however, to incorporate the publication data from the academic Metis-systems into NARCIS. By doing so, it will become possible to create much more complete publication lists of researchers. This system is not set up to drive the allocation of institutional funding for research (i.e. the research component of the block grant).

Dutch universities have their own repositories. Several use METIS, which is a research information database system on the World Wide Web. It enables universities,

[157] Data Archiving and Networked Services (DANS) is the Netherlands' national organisation responsible for storing and providing permanent access to research data from the humanities and social sciences.

organisational units within universities, research institutes, research groups or individual researchers to on line register information about their research and to make this information worldwide available in a multitude of ways. METIS is suited for both research management and information supply purposes. For research project leaders METIS is a detailed instrument for the planning and control of their project(s). A university or institute manager will be able to derive from METIS the management information tables and overviews necessary for the periodical evaluation and monitoring of the research activities within the institution, while an individual researcher will mainly use the system for the worldwide exposure of his personal research activities and their outcomes.

Among others, the following information can be registered and communicated by means of METIS :

- Full description of the content (field, aims, methodology…) of the research
- Data on the research groups or institutes involved in the research
- Information on individual researchers participating in the research
- Detailed information on the output (publications) of the research, including an abstract for each publication
- Data on the research input, in terms of full time equivalents and/or men year equivalents
- Information on the funding of the research
- The organisational structure of the research

4.6.2 Societal relevance

In addition to cataloguing and measuring scientific output, the societal impacts has also received increasing attention in the Netherlands. The new Standard Evaluation Protocol places a stronger emphasis on measuring the societal impact of research. The platform Evaluating Research in Context (ERiC) was set up to promote the measurement of societal impact among scientists and the managers of scientific organisations in particular. ERiC's main objectives are stimulating the exchange of knowledge and developing methodology at both a national and international level.

ERiC emerged out of a project from the Consultative Committee of Sector Councils for Research and Development (COS) concerning how to measure the social impact of research. This project yielded the measuring method sci_Quest method. Following on from this a broader platform representing the full spectrum of higher education was set up in 2006, the EriC project. Since then the Royal Academy KNAW, NWO, Netherlands Association of Universities of Applied Sciences (HBO-Raad), and Quality Assurance Netherlands Universities (QANU) have participated in the project, and OCW, Rathenau Institute and Hogeschool Utrecht have been involved as observers.

ERiC undertakes various activities:

- ERiC develops and disseminates information about how to measure the social impact of research.
- ERiC raises awareness of the possibilities for assessing the social impact of research.
- ERiC develops methods for measuring the social impact of research, by carrying out projects with universities and universities for applied sciences.
- ERiC responds to issues faced by the research community:

4.7 Examples of successful research policy

4.7.1 Netherlands Genomics Initiative

In the "Strategic agenda for higher education, research and science policy" (2007) of OCW, one of the ambitions is to achieve an excellent research climate. One of the means is a greater focus on national research priorities. While Dutch science policy leaves choices relating to research priorities as far as possible to those involved, the government has designated a few national priorities. Genomics[158] is one of these priorities. An amount of 245 million euro has been made available from the Economic Structure Enhancing Fund (FES) for a second period of the genomics programme. Together with resources already made available, the subsidy for the Netherlands Genomics Initiative amounts to 271 million euro for the 2008-2012 period. Government funding helps mobilise supplementary resources from knowledge institutions and the business community. In total, the Netherlands Genomics Initiative (NGI) – a temporary task force or governing body especially set up to coordinate the field – expects to be able to invest some 500 million euro in excellent research and valorisation in the field of genomics in the Netherlands during the second period.

The Netherlands Genomics Initiative (NGI) was founded in January 2002, with a view to advancing the performance and application of genomics research in the Netherlands. For the second phase a new business plan 2008-2012 was drawn up for and at the behest of the government. It builds forth on the strategic plan drawn up in 2006. The strategic plan built on broad consultations[159] and the Mid-Term Review of NGI, which was carried out in 2005 under the auspices of NWO. The Mid-Term Review panel formulated a positive opinion of NGI an advised the government to continue investing in genomics. The committee recommended that NGI sharpen its attention to focus and mass, especially within an international perspective, to social and economic return and to integrating the social perspective in research. On the basis of the Mid-Term Review, the government requested NGI to draw up a Strategic Plan 2008–2012.

The performance of NGI and its Genomics Centres has since been assessed by means of a science review and a valorisation review, while the NGI Genomics Centres' business plans have been drawn up, submitted and selected.

The science review was organised by Quality Assurance Netherlands Universities (QANU) and was performed by panels comprising solely international experts. The review of the valorisation activities pursued by both NGI and its Genomics Centres was performed by Technopolis, assisted by a panel of international experts.

According to the business plan, NGI is dedicated to creating social and economic value by developing focus and mass in research with sustainable embedding in centres of international standing. NGI has set ambitious goals. NGI will, by 2012, make the Dutch infrastructure for the valorisation of genomics leading in Europe. Therefore, only those initiatives that after strict selection have been judged as scientifically excellent, socially relevant and high-potential in the area of valorisation will take part in the second round. All Genomics Centres within NGI will in 2012 meet standards of global excellence.

NGI has invited a limited number of existing and new initiatives to submit a business plan for the 2008-2012 period. The submitted business plans were assessed by international experts and tested against criteria for valorisation, scientific excellence,

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[158] Genomics forms the foundation for the Netherlands' life sciences knowledge infrastructure. Genomics is not a field of research in itself, but rather a toolkit containing various state-of-the-art technologies with possible applications in key social themes such as health, food, sustainability and safety.

[159] Consultations were organised in order to define those subareas in which the social urgency is greatest and the fields in which the Netherlands has high scientific quality. NGI organised 4 Round Table meetings in the spring of 2006 with stakeholders from science, industry and societal organisations.

societal relevance and continuity.[160] In the 2008-2012 period, NGI will comprise four research centres (CGC, CBSG, Kluyver Centre and Forensic Genomics), one centre specialising in research and infrastructure (Toxicogenomics), four infrastructure initiatives (Proteomics, Bioinformatics, Metabolomics and Systems Biology), a programme for talents (Horizon) and a programme for societal research and communication with the general public under the direction of the Centre for Society and Genomics (CSG).

NGI realises societal value from genomics in collaboration with its Genomics Centres and the companies and knowledge institutions participating therein. NGI identifies (new) promising areas and takes the initiative to bundle leading research efforts in coherent programmes. Once selected, these research programmes are then managed, coordinated and continually monitored in order to ensure that the original selection criteria are met. NGI supports these programmes by creating the best possible preconditions for excellent research and valorisation.

As a part of its initiatory role, NGI uses exploratory programmes and consultations in order to bring together societal needs and scientific quality, stimulation subsidies for the further development of programme proposals and stringent selection procedures in order to ensure focus and mass.

As a part of its instructive role, NGI will make use of content-related and financial stimuli. All programmes are continuously monitored to assess quality and the output of scientific and valorisation activities. The Genomics Centres will have to demonstrate that they have achieved the concrete (quantified) targets to which they have committed themselves in advance. Where necessary, NGI will intervene in various ways, such as offering financial incentives over the coming period in order to reward good performances.

NGI is a small, compact organisation. NGI has an autonomous position with NWO. This allows NGI to operate efficiently, while having access to the facilities and expertise within NWO and its various units. If the work being carried out is similar, (e.g., in case of programme secretariats), NGI will entrust the realisation of certain parts of its programmes to other NWO divisions.

*4.7.2 Innovational Research Incentives scheme (*Vernieuwingsimpuls)

The Innovational Research Incentives Scheme has been set up in 2000 by NWO, KNAW and the universities jointly. The aim is to promote innovation in the academic research field. The scheme is directed at providing encouragement for individual researchers and gives talented, creative researchers the opportunity to conduct their own research programme independently and promote talented researchers to enter and remain committed to the scientific profession.

The scheme has three parts:

- Veni for researchers who have recently taken their PhD, to allow them to continue to develop their ideas; a maximum of 250,000 euro.
- Vidi for researchers who want to develop their own innovative line of research and appoint one or more researchers; a maximum of 800,000 euro.
- Vici for senior researchers to build their own research group; a maximum of 1,500,000 euro.

The two main purposes of the Innovational Research Incentives Scheme are to provide the scope for adventurous, talented and pioneering researchers to conduct creative research of their own choice and to encourage them to make a permanent career of

[160] In April 2007, all the business plans were reviewed by international referees. On the basis of the international referees' assessments, the NGI Supervisory Board decided to incorporate a limited number of the business plans in an integrated NGI business plan, which was submitted to the government for funding.

academic research. The grants give the individuals concerned the opportunity to develop their own innovative lines of research within the research programmes of the host institutions. Vidi and Vici candidates also have the opportunity to establish and/or expand their own research teams. The candidate is free to choose the particular host institution at which he or she wishes to conduct the research. By arrangement with that host institution, part of the research may be conducted outside the Netherlands.

The budget is 150 million euro for the Veni, Vidi and Vici grants on a yearly basis. The funding comes from the ministry of OCW via a targeted subsidy to NWO.

In 2007, the programme was positively evaluated. The minister responded by making funds available for its extension and expansion over a number of years to come.

In the assessment procedure, candidates are assessed in a centrally coordinated nationwide competition. Assessment and ranking takes place within the NWO Divisions. The Divisions use broad-based committees of academics to advise on the merits and prioritisation of the applications. Since 2009, there is a separate selection committee to deal with cross-disciplinary or 'interdivisional' applications. The committees for interdivisional applications operate in the same way as divisional selection committees.

There is a two-stage selection procedure: the divisional stage and the domain stage. At the divisional stage, all the applications within the field of study of a particular division are assessed by the appropriate (inter)divisional selection committee and a decision is taken about the use of approximately two-thirds of the available resources. The NWO Governing Board then awards grants to the successful candidates and candidates with no further chance of a grant are informed of the fact.

Candidates of outstanding merit who could not be awarded grants at the divisional stage will then go to the different domain panels. The domain panels rate candidates in relation to each other across disciplinary boundaries. The aim of this stage is to compare across the whole field of scholarship and to award grants to the best candidates, irrespective of discipline. There are three different domain panels: 'Alpha-Gamma' (humanities and social sciences), 'Beta' (earth sciences, chemical sciences, physical sciences, physics and technical sciences), and 'Life Sciences' (life sciences, agricultural and food sciences, biochemistry, medical sciences and technical sciences).

These three domain panels consider a limited number of promising candidates from different disciplinary areas in relation to each other. At this second stage of the selection procedure, still a third of the overall budget for the Scheme is awarded by the NWO Governing Board to the best candidates.

Panel members are drawn from the divisional selection committees and each panel has an independent chairman to ensure the domain procedural correctness of its deliberations. Final responsibility for the overall procedure and decision-making lies with the Governing Board of NWO.

Applications will invariably be assessed on the basis of :

- the quality of the researcher
- the quality, innovative nature and academic impact of the proposed research.

Candidates in all disciplines may also respond to discuss the utility of their research. Via a separate section on the application form, the candidate can choose to give a description of the intended cultural, policy-related, societal, technological or economic use of the knowledge or insights to be developed over a period of 5 to 10 years.

4.7.3 Demand-oriented programming of TNO and the Large Technological Institutes

As described above in this chapter, the government introduced demand-oriented steering of TNO and the Large Technological Institutes (GTIs) in 2005 to replace the institutional base funding. The main objective was to better align knowledge demand

(by the government, industry, society) and knowledge supply (by TNO and the GTIs). The new steering philosophy is focus on the long-term strategic R&D agendas of the institutes.

The process of demand-oriented steering had three objectives:

- Central coordination by the government
- Demand-driven programming of research
- Demand-driven funding of research
- Funding of large research facilities
- Involvement of industry
- Collaboration with education institutes and universities
- International positioning and collaboration

'Knowledge arenas' have been established in which stakeholders meet to articulate knowledge demands and translated them into long-term agendas.

The government has divided research into 12 themes. In addition, the are cross-cutting research themes which are defined by the research institutes. Under each theme, several multi-annual research programmes are developed.

4.7.4 Standard Evaluation Protocol (SEP) for public research organisations

The Standard Evaluation Protocol 2009-2015 (SEP) is the fourth protocol for evaluation of scientific research in the Netherlands, following the protocols of 1994, 1998 and 2003. The aim of the SEP is to provide common guidelines for the evaluation and improvement of research and research policy, based on expert assessments.

In 2008, an evaluation of the SEP 2003-2009 undertaken by VSNU (universities' association), KNAW (royal academy) and NWO (research council) showed positive results and users emphasised the importance of continuity in the guidelines for research assessment. In this evaluation, universities and KNAW- and NWO-institutes also underlined that the administrative burden should be diminished and that more emphasis should be placed on societal relevance, on positioning and on benchmarking. The SEP 2009-2015 has incorporated these elements. Lessening of the administrative burden is achieved in this protocol by, among other things, limiting the size of the self-evaluation report and by making the midterm review a very light procedure.

The external evaluation of scientific research applies at two levels: the research institute as a whole and its research programmes. Three main tasks of the research institute and its research programmes are to be assessed:

- The production of results relevant to the scientific community;
- The production of results relevant to society;
- The training of PhD-students.

Four main criteria are considered in the assessment:

- Quality;
- Productivity;
- Societal relevance and vitality;
- Feasibility.

Since the boards of KNAW and NWO and the executive boards of universities are responsible for the external evaluation of the research units under their authority, they are the primary users of the SEP. Regarding the meta-evaluation of the system, the universities are represented in the board of the VSNU. Next to the boards, the research

institutes (as units to be evaluated) and the external evaluation committee fulfil key roles in the evaluation process. The SEP therefore provides guidelines for the boards, the institutes and the evaluation committees.

The SEP 2009-2015 aims at two objectives with regard to the evaluation of research (including PhD training) and research management:

- Improvement of research quality based on an external peer review, including scientific and societal relevance of research, research policy and research management.
- Accountability to the board of the research organisation, and towards funding agencies, government and society at large.

The rhythm of the SEP consists of a self-evaluation and an external review, including a site visit once every six years, and an internal mid-term review in between two external reviews. In the SEP, guidelines regarding assessment criteria, minimum information requirements and the procedure of the external review are formulated.

After the site visit, the evaluation committee will report its findings to the board of the research organisation. The board will publish the report after internal discussion with the assessed research unit and will make its position regarding the evaluation outcomes public. The evaluation report and the position of the board together constitute the results of the evaluation.

The objective of improvement is aimed at both the research and its management. External evaluations are of great value to the institute and its researchers, since international experts in the field formulate recommendations regarding the research, including the strategy and policies which direct and provide the conditions for the conduct of research.

With the external evaluation, the institute and its research groups account for their research activities to the board of the university, KNAW or NWO. In a broader sense, the external evaluations inform funding agencies, government and society at large of the quality and relevance of research activities, thus accounting for the public investments made in scientific research.

The four main criteria are elaborated in the table below in terms of a number of sub-criteria and further in terms of aspects that may be considered in the evaluation.

Figure 69 Criteria in the Standard Evaluation Protocol

CRITERIA	SUB-CRITERIA	ASPECTS THAT MAY BE CONSIDERED
Quality	A1. Quality and scientific relevance of the research	Originality of the ideas and the research approach, including technological aspects; Significance of the contribution to the field; Coherence of the programme; Quality of the scientific publications; Quality of other output; Scientific and technological relevance
	A2. Leadership	Leadership of primary individuals; Mission and goals; Strategy and policy
	A3. Academic reputation	(Inter)national position and recognition; Prominence of the programme director and other research staff; Impact and significance of research results in the field
	A4. Resources	Human resources; Funding policies and earning capacity; Relevance of research facilities
	A5 PhD training	Objectives and institutional embedding; Structure of programmes; Supervision; Success rates; Educational resources
Productivity	B1. Productivity strategy	Productivity goals; Publication strategy; Rewards and sanctions
	B2. Productivity	Scientific publications and PhD-theses; Professional publications; Output for wider audiences; Use of research facilities by third parties
Relevance	C Societal relevance	Societal quality; Societal impact; Valorisation
Vitality and feasibility	D1. Strategy	Strategic planning; Investments and collaboration; Research topics planned for the near future and their perspectives; Flexibility and anticipation of expected changes.
	D2. SWOT-analysis	Analysis of the position of institute and programmes; Analysis of strengths and weaknesses
	D3. Robustness and stability	Research facilities; Financial resources; Staff competition; Mobility and attractiveness; Expertise within the institute

KNAW, NWO, VSNU, Standard Evaluation Protocol (SEP) 2009-2015.

4.7.5 Programme-based approach to innovation policy

One of the pillars in the 2007–2011 policy programme of the previous cabinet (2007–2010) was Knowledge, innovation and entrepreneurship. The government wanted to encourage an enterprising, competitive and innovative economy which will meet the needs of society. The aim of the Ministry of Economic Affairs' (EZ) innovation policy is to strengthen the innovative capacity of the Dutch economy. EZ has developed a broadly accessible 'basic package' of policy instruments that support firms (SMEs) in various stages of their life cycle. EZ has also introduced a 'programme-based package' for innovation, based on and inspired by the 'key areas' approach of the previous Innovation Platform. The programme-based package brings together different resources, including the FES fund. The aim is to deliver top performances in key innovative themes. EZ is therefore working with the entire innovation chain to develop innovation programmes in sectors where the Netherlands can excel. Programmes are wide-ranging and tackle all the relevant problems in a particular sector (for instance by investing in R&D, marketing knowledge, boosting SME participation, stimulating exports and investing in human capital). The intention of EZ is that the innovation programmes are coordinated with ongoing initiatives such as those run by NWO and TNO and that they tie in (wherever possible) with international programmes such as the EU Framework Programme and EUREKA.

The initiative for launching innovation programmes lies with the companies and knowledge institutes. The government facilitates their development. EZ works with other relevant ministries in this area. Companies and knowledge institutes begin by compiling a joint vision and goals as well as a strategic agenda indicating how these goals can best be realised. If the goals and agenda are developed, a concrete innovation programme will then be devised and submitted to EZ. The plans are assessed against the following criteria: international excellence, contribution to the economy and to

society, degree of cohesion and (international) cooperation, presence of obstacles, effectiveness and efficiency of government interventions and confidence in the approach. If the detailed innovation programme satisfies these criteria, the government may agree to support it. EZ is advised in this by a Strategic Advisory Committee (SAC).

Customised tools are then used to reach the goals as efficiently as possible, depending on the specified aims, agenda and identified bottle- necks. Programmes will generally run for four to five years. A standard shared toolkit (the 'omnibus') is available to provide a customised approach. The omnibus brings together all the various options and resources. It ties in with EU and member states' legislation and will take the form of a General Administrative Order. By combining uniformity and customisation, each programme can be given a tailor-made mix of support tools.

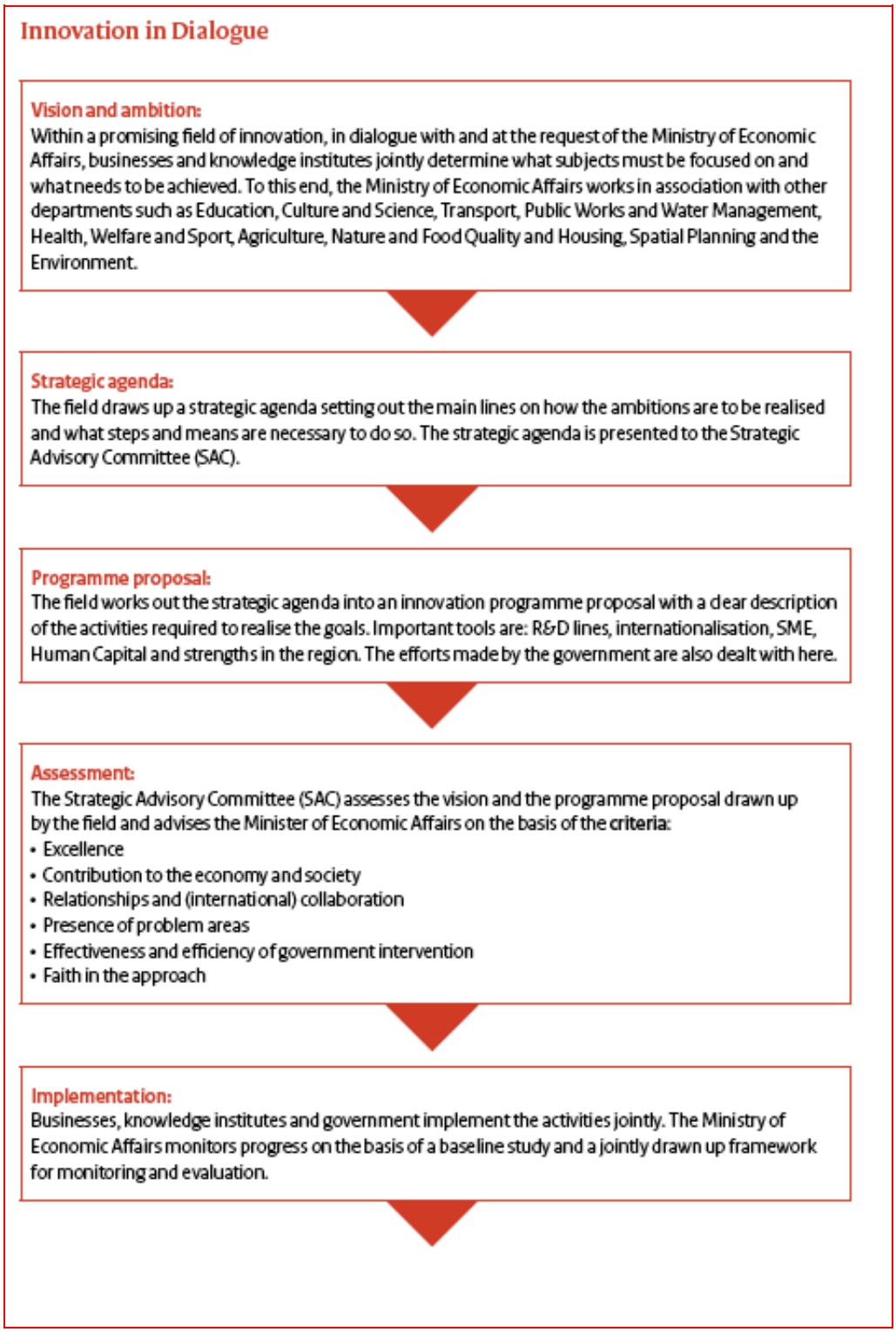
When programmes are implemented, they must be sufficiently open so that all the relevant parties who can make a contribution to the goals of the programme can in fact participate. Special measures are taken to encourage the participation of SMEs. The innovation programme is allocated a governance structure which assumes responsibility for it. The governance structure includes the relevant stakeholders. Its job is to adjust, monitor and, where necessary, improve the programme at strategic level throughout its life-cycle.

Since 2006 a total of nine Dutch innovation programmes have been started up in the key areas. A total policy budget of 1.1 billion euro has been earmarked for the period 2005-2014 for the nine innovation programmes. This includes funding (largely from the FES fund) for the Leading Technological Institutes that are active in these programmes.

The innovation programmes are monitored and evaluated based on an agreed set of indicators. A full evaluation cycle is used: baseline study, mid-term review and ex-post evaluation (by external party).

The figure below shows the programme-based process.

Figure 70 Programme-based approach



EZ, 2009, Innovation Programmes – The driving force behind the innovation network

5. New Zealand

5.1 Overview

5.1.1 The Research System

The research system of New Zealand is highly reliant upon government support. Public funding provides the largest share of total R&D support, 42% (See Figure 71). This percentage is also significant in an international context; comparatively OECD countries average a 30% share of total R&D support from public funding. New Zealand businesses are approaching the level of government funding with 40% total R&D expenditure.

Figure 71 New Zealand Research and Development Funding 2008

Source of Funds	$(million)	Percent
NZ business	859	40
NZ government	912	42
NZ universities	187	9
Overseas	103	5
Other Funding Sources	79	4
Total	2140	100

Source: Statistics New Zealand, Research and Development in New Zealand 2008

Following the report "Science and Technology Review: A New Deal" published in 1988 by the Science and Technology Advisory Committee, the Government acknowledged a need for reforming the science system. A core recommendation in the report which was later implemented, was to separate the core functions of the science system into a) advisory and policy development, b) decision making regarding funding allocation, and c) the operational level where science is carried out. In practical terms, this resulted in the development of a new structure centred around the following organisational units:

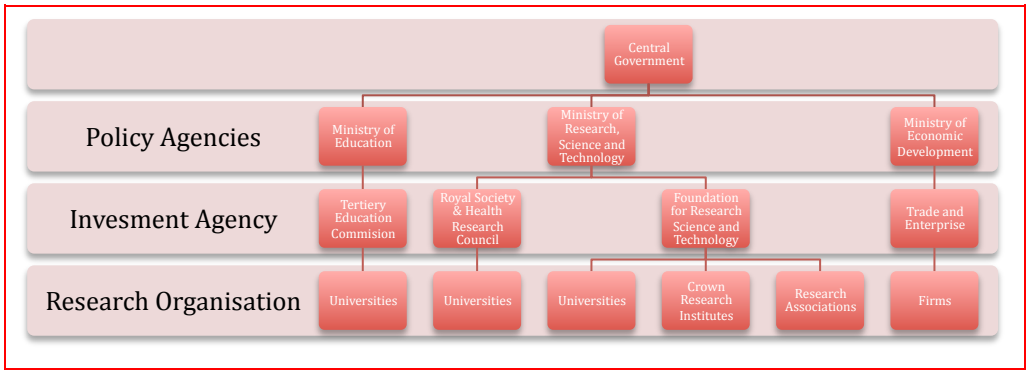
- The **Ministry of Research, Science and Technology** (MoRST) that provides science policy advice
- The **Foundation for Research, Science and Technology** (FRST) that is primarily responsible for funding science outputs
- The **Crown Research Institutes** (CRIs) that perform actual scientific research[161].

Additionally, there is a new position of a Science Advisor to the President. As of February 1, 2001, the Ministry of Science and Innovation will be instated. It will be created by merging two agencies – the Foundation for Research, Science and Technology (FRST) and the Ministry of Research, Science and Technology (MoRST). It will be responsible for the policy and investment functions of both those agencies. The rest of this chapter represents the situation as it currently stands in 2010[162]. At the time of writing it is unclear to what degree matters will change once the new Ministry takes effect. The current New Zealand research system is shown in Figure 72. A description of the actors is given subsequently.

[161] Ministry of Research, Science and Technology (MoRST). "Research and Development in New Zealand: A decade in Review," 2008.

[162] New Zealand Cabinet. "State Sector Management Bill 193-1 (2010), Government Bill – New Zealand Legislation," 2010. http://www.legislation.govt.nz/bill/government/2010/0193/latest/whole.html?search=ts_bill_state+sector_resel&p=1#DLM3166958.

Figure 72 Distribution of research, science and technology funding



Source: Husted, Kenneth. "ERAWATCH National profiles: New Zealand," 2009.

The government allocates funding through a combination of policy agencies and purchase agencies. Policy agencies are concerned with strategic policy development. The Ministry for Research Science and Technology (MoRST) is the pivotal policy agency for research. MoRST oversees the government's investment in RS&T and shapes the overall direction of the sector by developing science and technology policy. This is contrary to many other countries in which a series of ministries take responsibility for funding research in their area of expertise. While the Ministry of Education and the Ministry for Economic Development (MED) also have influence on research direction and influence they are not as significant as MoRST. These three policy portfolios have corresponding budget channels. MoRST does not directly fund research and innovation projects, but influences investment through policy advice on the Government's RS&T portfolio. It also works with other innovation/research-focused departments, Crown Research Institutes, universities and the private sector to ensure alignment across the system.

The corresponding budget channels for government support in research and innovation is provided through "votes": the Vote Research, Science and Technology (R, S&T), by far the largest, accounting for about two-thirds of government support for R&D, administered by MoRST; the Vote Education, administered by Ministry of Education; and the Vote Economic, Industry and Regional Development, administered by MED. The Cabinet decides how much new money (if any) the VOTE RST gets. Each Vote has a number of "purchasing objectives" which provide the framework for purchase agencies to allocate funds. Ministers from MoRST have to convince the Cabinet to increase funding every year based on advice from the purchase agencies. Often specific allocations are difficult to determine. For example, in 2006/07 58% (€240 million or NZ$548 million) of R&D investment was not allocated to a specific type of research provider. This is because there is an emphasis on funding for public service R&D to be contestable by all research providers. Where allocations had been made, €3 million (NZ$7m) was allocated to in-house research units, €33 million (NZ$76m) to government-owned research facilities, €117 million (NZ$267m) to universities and polytechnics, €6 million (NZ$14m) elsewhere in New Zealand, and €440,000 (NZ$1 million) internationally.

Purchase agencies are contracted by the policy agency to deliver certain outputs by allocating funding in the policy area that they have been contracted. Each purchase agency operates with discretion to the relevant ministry. Under the auspices of MoRST the relevant purchase agencies are the **Foundation for Research, Science and Technology (FRST)**; **Royal Society of New Zealand (RSNZ)**; and the **Health Research Council (HRC)**. All three invest funds in R&D. Other relevant purchase agencies are New Zealand Trade and Enterprise (NZTE) under MED, which is responsible for economic, industry, and regional development and innovation. For research and education, under the auspice of the Ministry of Education, is the Tertiary Education Commission (TEC). Its functions and responsibilities cover all forms of

tertiary education and training. Often, the various ministries and agencies cooperate to direct research.

FRST is the Government's principal purchaser of RS&T and manager of RS&T funds. FRST allocates around half of the government's investment in RS&T in accordance with government priorities set down by the Minister of RS&T. It plays a key role in stimulating economic growth through the innovation system – directly, through its investments, and indirectly, by supporting the scientists and technologists, as well as the organisations in which they work. FRST is the biggest single funder of research in New Zealand and has funding relationships with virtually every type of research organisation. FRST also provides the Minister with independent policy advice on matters relating to research, science and technology, including advice on research needs and priorities. The Estimates of Appropriations, or budget, sets out the funds allocated through FRST and defines their purpose. The Foundation's funds are managed through a number of investment programmes, including but not limited to, those in Figure 73. Other bodies relevant to research are presented in the relevant following sections[163].

5.1.2 Allocation of Funding

For the most part, funds are primarily spent within the same sector as the source. For instance, 82 percent of funds from business enterprises are spent by industry. Similarly, 97 percent of funds from universities are received by higher education organisations[164]. Figure 73 and Figure 74 show the source and recipient of funding in 2004 and 2008. These figures show a similar trend in funding flows over time.

Figure 73 Source and Recipient of Funding 2004

		Recipient of Funding							
		Business (NZ $Mil)	**%**	**Government (NZ$Mil)**	**%**	**Higher Education (NZ$Mil)**	**%**	**Total Source**	**%**
NZ business	Source of Funding	516	73.2%	80.6	17.5%	16.3	3.6%	612.9	38.5%
NZ Government		67.6	10.0%	359.4	77.9%	290.8	63.9%	717.8	45.1%
NZ Universities		--	--	--	--	113.5	25.0%	113.5	7.1%
Overseas		80.7	11.9%	18.4	4.0%	9.7	2.1%	100.7	6.8%
Other Funding Source		12.8	1.9%	2.9	.6%	24.5	5.4%	10.2	2.5%
Total Recipients		677.1	100%	461.2	100%	454.8	100%	1593.1	100%

Source: Ministry of Research, Science and Technology (MoRST), "Science for New Zealand" 2006

[163]Ministry of Research, Science and Technology (MoRST). "Science for New Zealand," 2006. http://www.morst.govt.nz/publications/govt-policy-statements/science-for-nz/.

[164] EraWatch National Profile: New Zealand, 2009

Figure 74 Source and Recipient of Funding 2009

		Business (NZ $Mil)	%	Government (NZ$Mil)	%	Higher Education (NZ$MIL)	%	Total Source	%
		Recipient of Funding							
NZ business	Source of Funding	725	80%	114	20%	20	3%	859	40%
NZ Government		80	9%	429	74%	403	63%	912	43%
NZ Universities		2	0%	8	1%	177	28%	187	9%
Overseas		54	6%	27	5%	22	3%	103	5%
Other Funding Source		52	6%	5	1%	22	3%	79	4%
Total Recipients of Funding		913	100 %	584	100%	643	100%	2140	100%

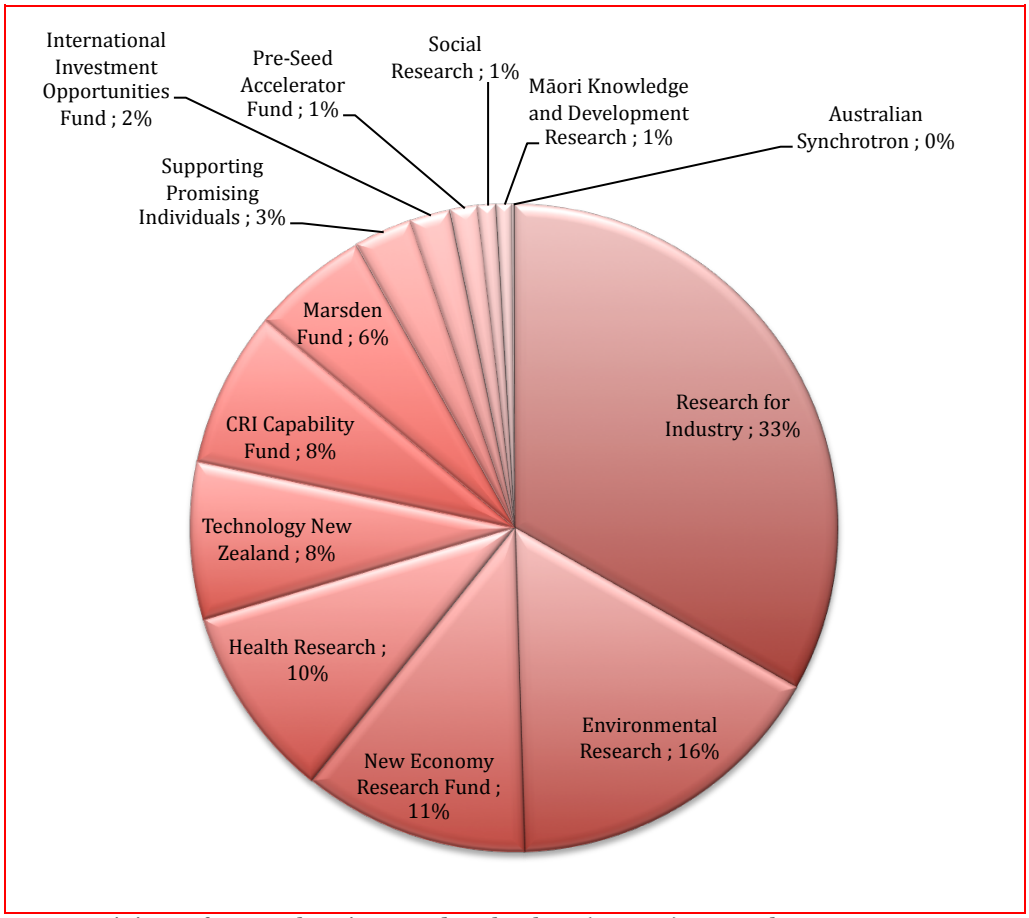
Source: New Zealand Statistics. "RS&T Scorecard" 2009

These figures show that there has been little fluctuation in the source and recipient of funding. Other than for universities, funding tends to remain in the sector in which it came from.

5.1.2.1 How the Ministry allocates funding

VOTE RS&T research budget is not split amongst purchase agencies but amongst the specific investment programmes within the various agencies. Vote Research, Science and Technology (RS&T) - currently stands at $768 million as of the 2010/11 Budget. Vote RS&T for the 2008/09 reference year total was NZ 650 Million. A breakdown of the 2008/09 budget by major investment programmes is given in following figure:

Figure 75 Vote RS&T Output Class, 2009



Source: Ministry of Research, Science and Technology (MoRST). Annual Report 2009

Project based funding may be 'bottom-up'/free-funding or in the form of research programmes. 'Bottom-up'/'free funding' projects are funding of specific projects of the researchers own choosing to organisations that are involved in basic research. It is channelled through (a) the Marsden Fund (administered by the independent national academy of sciences, The Royal Society of New Zealand) and (b) The Health Research Council. Government funding for targeted or thematic research in universities and Crown Research institutes and other research organizations is channelled through FRST –Funds are allocated in a competitive context. Current thematic priorities of FRST programmes are listed in the descriptions of

Figure 76. Research programmes, or mission-orientated research is funded by the government through all three organisations. They allocate research funding and manage research contracts that are allocated by grant-based output or outcome-focused contestable funding. In

Figure 76, we give a description of some of the programmes, the type of investment (targeted or bottom-up) and a comparison of the budget to 2001.

Figure 76 Vote RS&T Output Class, in Detail (2009,2001)

Fund and Description	Year	Budget (NZ$Mil)	% of Total	Type of Funding
Research for Industry • Innovative Foods (INF) funding is for research that improves the value of New Zealand's food production. • High Value Manufacturing Products, Processes and Services (MAN) funding is for research that contributes to manufactured goods, materials and related services. • Niche Biological Products, Processes and Services (NBP) funding is for research that develops value-added non-food products from biological raw materials. • Optimising Physical Resources and Infrastructure (ORI) funding is for research to improve energy management and infrastructure. • Production, Quality and Assurance (PQA) funding is for research that improves the primary sector industries productivity and efficiency by producing high-quality products for export. • Resilient Infrastructure and Communities (RIC) funding is for research that identifies, prepares and allows for prompt recovery from hazards and risks. • Building Knowledge Intensive Service Industries (SER) funding is for research on increasing the benefits to New Zealand through international tourism. • Sustaining New Zealand's Economic and Technological Advancement (SET) funding is for research that contributes to understanding how New Zealand can achieve improved wellbeing for its people through economic and technological development. • Sustainable Productive Systems (SPS) funding is for research that allows for primary production to be environmentally sustainable and not adversely affected by pests.	2009 2001	215.8 171.1	33% 36%	Targeted/Thematic
Environmental Research • Resilient, Functioning and Restored Ecosystems (ECO) funding is for research that supports New Zealand's land, freshwater and marine ecosystems to operate, adapt or recover. • ·Understanding and Adapting to Global Processes and Change (GLO) funding is for research to understand and adapt to global environmental change. • Building Sustainable Cities and Settlements (SCS) funding is for research that improves environmental, social, cultural and economic management of New Zealand's cities and settlements. • Maintaining Environmental Integrity for Sustainable Resource Use (SRU) funding is for research related to productive resource use, emphasising maintaining environmental integrity.	2009 2001	106.1 84	16% 18%	Targeted/Thematic Funding
New Economy Research Fund • Future Human Technologies (FHT) funding is for generating new knowledge about human health, function and wellbeing. • Creating Opportunities Through New Physical Technologies (NPT) funding is for research into physical materials, information and communications technologies. • Technologies to Leverage New Zealand's Strengths (NZS) funding is for research that contributes to developing technology platforms that leverage New Zealand's strengths.	2009 2001	73 50.8	11% 11%	Targeted/Thematic Funding
Health Research • Various programmes and scholarships related to health	2009 2001	63 33.4	10% 7%	'Bottom-up'/'free funding' projects (though inherently thematic)
Technology New Zealand • Encourages private firms to undertake research and development	2009 2001	50.9 24.7	8% 5%	'Bottom-up'/'free funding' projects
CRI Capability Fund • Each CRI has a specific thematic function.	2009 2001	50.6 n/a	8% n/a	Targeted/Thematic funding

Marsden Fund • Explained below	2009	37.9	6%	'Bottom-up'/'free funding' projects
	2001	25.8	5%	
Supporting Promising Individuals • Scholarships for students at all age levels	2009	19.1	3%	Both
	2001	17.1	2%	
International Investment Opportunities Fund • Funding supports research that offers significant benefit in terms of international science collaboration, capability building or economic benefit to New Zealand, with good prospects of capturing those benefits.	2009	13	2%	'Bottom-up'/'free funding' projects
	2001	n/a	n/a	
Pre-Seed Accelerator Fund • PreSeed (PSAF) funding to maximise the commercial benefits to New Zealand from publicly-funded research in science and technology.	2009	9.2	1%	Targeted/Thematic Funding
	2001	n/a	n/a	
Social Research • Building an Inclusive Society (BIS) funding supports research that contributes to improved social outcomes and achieving or sustaining an inclusive society in New Zealand.	2009	5.9	1%	Targeted/Thematic Funding
	2001	4.3	<1%	
Maori Knowledge and Development Research • Te Tipu o te Wananga (TTW) funding supports research that helps to achieve the innovation potential of Maori knowledge, people or resources.	2009	4.9	1%	Targeted/Thematic Funding
	• 001	• 4	• < 1%	
Australian Synchrotron	2009	.8	<1%	--
	2001	n/a	n/a	
Other	2001	64.2	14%	--
Total	2009	650.1	100%	--
	2001	473.1	100%	--

Source: Technopolis with data from MoRST Annual Report 2009, 2001. EraWatch National Profile: New Zealand

The breakdown of bottom up funding is given in the following table.

Organisation	Thematic focus	Research Council or Other?	% of 'bottom up' funding
Vote RST Output Class (MoRST and FRST)	Depends on programme (See Figure 76)	Innovation Agency	Targetted: 72.5% Bottom Up: 27.5% (Estimated) Source: Figure 76 above.
Royal Society of New Zealand	None	Research Council	100%
Health Research Council	Health	Research Council	Majority (Estimated) Source: Erawatch HRC website
Ministry of Science and Innovation (started Feb 2011)	None	Potentially Both. Research Council and Innovation Agency (Details to be disclosed late 2011)	Information not yet available.

The structure of research ministries in New Zealand is changing. The two main agencies, MoRST and FRST are currently being assimilated into one agency, the Ministry of Science and Innovation (MSI) in which policy and funding are linked. The press release about the changeover states that the reason for the new ministry is that current system is overly complex and bureaucratic. The ties between research organisations and the users of the research, such as business, needed strengthening. Businesses were not investing enough in research and development compared to other developed nations. There are two expected results. In the first place, it means a simpler, more efficient system. This will make it easier for scientists and users to work with the Government. Second, it will act as a bridge between science and industry.

This will help bring together researchers, entrepreneurs, businesspeople, and financiers – all of whom are needed to turn good ideas into export successes. The New Zealand government states the objective of competing with Asia- so that, scientific results are combined with market savvy and business flair.

According to the Minister, "This is an important part of the Government's Science and Innovation programme. It will ensure that investment is going to the right areas, enable more strategic funding decisions to be made, and simplify the system so that researchers can focus on their work instead of funding applications." Research funding decisions are to be independent. New legislation will require the Minister to appoint boards that will make independent funding decisions based on published criteria. The Minister will not be able to direct decisions on individual research proposals.

Whether science will be treated as a subcategory of economic goals is to be seen. In fact, any judgements about the adequacy of this new system are difficult to make since the structure of the agency is still being worked out. This change in the research policy infrastructure is welcome by authors such as Judy Whitcombe, who take the stance that New Public Management policies, that resulted in separation of policy ministries and operational departments and departments that operated independently led to fragmentation and siloisation. The combining of agencies would lead to sector-wide standards to deliver services. A 2005 OECD study stated similar recommendations- joined up government and whole of government approaches should be favoured in New Zealand.

Although Funding is not allocated based on the type of research- whether it is basic or applied- information on the contracts is collected afterwards. The information for 2008/09 is given in Figure 77. Basic untargeted research is the largest percentage of the contracts funded through Vote RS&T. This followed by applied research.

Figure 77 Contracts profiled by type of research (basic untargeted, basic targeted, applied, experimental development, product development), 2008/09

•	Funding and Investment Agent	Basic Untargeted	Basic Targeted	Applied	Experimental Development	Product Development	Not Known	Total (Rounded)
Environmental Research	FRST	7	39	43	6	2	3	101
Health Research	HRC	-	42	89	14	-	52	197
Māori Knowledge	FRST	0	4	11	1	2	0	18
Māori Knowledge	HRC	-	7	22	1	-	7	37
Marsden Fund	RSNZ	409	-	-	-	-	-	409
New Economy Research Fund	FRST	1	45	20	8	4	0	78
Research for Industry	FRST	3	64	102	33	21	2	226
Social Research	FRST	1	3	9	0	1	0	13
Sustainable Energy Development	FRST	0	0	1	2	0	0	2
Total Investment	All	420.29	204.73	297.57	63.74	29.66	64.00	1,080.00
Percentage of Total Contracts	--	39%	19%	28%	6%	3%	6%	100%

Source: Ministry of Research, Science and Technology (MoRST). Performance Measures 2008-2009

Contracts are allocated via the investment agency to business, universities, CRIs, TEIs, and others (non-profits). The details as to which sector will incur contracts vary depending on the programme. Figure 78 details the contracts from Vote RS&T for the 2008/09 reference year. More contracts from public funding are for tertiary education institutes than are for the crown research institutes. There are few contracts to businesses.

Figure 78 Vote RS&T Contracts profiled by provider type, 2008/09

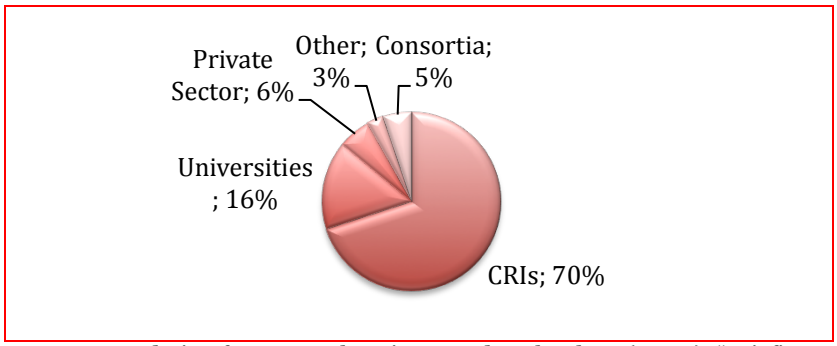
	Funding and Investment Agent	Contracts to Business	Contracts to Crown Research Institutes	Contracts to Tertiary Education Institutions	Contracts to All Others
Environmental Research	FRST	6	74	20	1
Health Research	HRC	26	3	159	9
Māori Knowledge	FRST	2	7	7	2
Māori Knowledge	HRC	11	2	23	1
Marsden Fund	RSNZ	8	38	362	1
New Economy Research Fund	FRST	2	41	35	0
Research for Industry	FRST	43	134	48	1
Social Research	FRST	1	0	12	0
Sustainable Energy Development	FRST	1	1	0	0

Source: Ministry of Research, Science and Technology (MoRST). Performance Measures (2008-2009)

5.1.2.2 How investment agencies allocate funding

The main investment agency is the Foundation for Research, Science and Technology (FRST). FRST invests in Crown Research Institutes, universities, the private sector, research consortia and government agencies as well as students via fellowships. The proportion invested in these types of organisations in 2007/08 is shown in Figure 79. The figure excludes Technology New Zealand, where all contracts are with firms. FRST allocates funding based on socioeconomic objectives including, among others: defense, expanding knowledge, and environment. This is different from the Marsden Fund administered by the Royal Society of New Zealand- the other major investment agency. The Marsden Fund funds individual academics or small teams and the funds are allocated not on the basis of projects that contribute towards national goals but on the basis of the best research.

Figure 79 FRST Allocation of Funding, 2008



Source: Foundation for Research, Science and Technology (FRST). "Briefing to the Minister" 2008

FRST does not spend much more than that which is allocated from MoRST.

Figure 80 Total 2008/09 Funding and Spend for each Research Fund in FRST

Output Expense (Research Fund)	Funding ($ million)	Spend ($ million)
Research for Industry	231.8	236.1
Environmental Research	112.5	114.6
New Economy Research Fund	78.6	79.6
TechNZ	38.7	42.2
Pre-Seed Accelerator Fund	7.5	6.8
Supporting Promising Individuals	7.2	7.1
International Investment Opportunities Fund	5.1	8.3
Social Research	6.6	6.7
Sustainable Energy Development	4.3	4.4
Maori Knowledge and Development Research	3.2	3.7
Total	495.5	509.5

Source: Foundation for Research Science & Technology (FRST). Annual Report 2009

5.1.2.3 Allocation of public funding to universities

To fund R&D, universities draw on three main types of funding. These are:

- R&D contracts and earmarked grants received from government sources. These funds are recorded at their agency source (Vote Research, Science and Technology) and are distributed through FRST, Royal Society, or the HRC.
- Own income from endowments, shareholdings and property; and surplus from sale of non-R&D services such as fees from individual students, subscriptions to journals, and sale of products such as produce. These are universities' 'own funds' and are excluded from this survey.
- The general grant they receive from the government through Vote Education. A total of over NZ $208 Million. With funds from that Vote, the Tertiary Education Commission (TEC) is responsible for providing the government' contribution to tertiary education, including some support for research in the country's eight universities. PBRF is the largest component, consisting of 84 % of total university funds. The funds through this Vote allocated for R&D are detailed in Figure 81 below. The Performance-Based Research Fund will reach NZ$250 million per year in 2010/11.

The first two research income types generally finance specific research projects and are often referred to as "external research income". Vote Education, is administered through the Ministry of Education for various pruposes. In 2007/08 the Vote allocated €128 million (NZ$291m) for discretionary purposes. A total of just over $27 million was allocated for tertiary scholarships, international education and other grants. Finally, $811 million was set aside for educational services from tertiary education institutions (including capability and research funding), the adult and community education sector and other education providers, as well as other expenses.

Researchers in the higher education sector obtain support through the TEC, primarily the Performance-based Research Fund (PBRF), the Royal Society of New Zealand, primarily through the Marsden Fund for basic research, the Health Research Council for medical research and FRST for strategic research (see above). The CRIs (and firms) can also seek funding from the Marsden Fund, the HRC and FRST. However, most of the Marsden Fund and Health Research Council support is provided to university researchers. The universities receive a relatively small share of FRST funding[165].

Some funds may be directed to the seven Centres of Research Excellence (CoREs) established in 2002-03. Their purpose is to incentivise researchers in the tertiary education sector to conduct internationally competitive research, contribute to New Zealand's future development, and incorporate knowledge transfer activities. Each CoRE is hosted by a university and comprises a number of partner organisations including other universities.

Science policy advice is often received from the following two agencies. The Association of University Staff (AUS) is the union representing the industrial and professional interests of over 6,500 staff employed in universities across New Zealand. The mission of AUS is to further and safeguard interests of its members e.g. negotiating salaries and conditions of employment, providing expert advice and help on all employment-related matters and representation and advocacy on tertiary education and industrial matters to universities, government and major political parties and Government Ministries.

The New Zealand Vice-Chancellors' Committee (NZVCC) was established by the Universities Act 1961, which replaced the federal University of New Zealand with separate institutions. Today the Committee represents the interests of New Zealand's

[165] Goedeegebuure, Leo. *OECD Reviews of Tertiary Education New Zealand*. OECD Publishing, 2008.

eight universities; Auckland, Auckland University of Technology, Waikato, Massey, Victoria, Canterbury, Lincoln and Otago.

Figure 81 Vote Education Output Class, 2009

Vote Education Output Class	Amount (NZ$)	Percent
TEC- PBRF	236,114,000	84%
Centres of Research Excellence (CoRE)	35,295,000	13%
University of Auckland Starpath Project	3,900,000	1%
National Institute of Innovation in ICT	3,700,000	1%
University of Auckland Institute for Innovation in Biotechnology	1,000,000	<1%
TOTAL	280,009,000	100%

Source: Ministry of Education Website

5.1.2.4 Allocation of public funding to institutes

Public funding to research institutes is primarily allocated to the Royal Society of New Zealand (RSNZ), the Crown Research Institutes (CRI), and the Health Research Council (HRC). These institutes often also fund research in universities- often creating competition between researchers in institutes and researchers at universities who are applying for the same funds. The RSNZ is the national academy of sciences, a principal science policy advice organization comprising of a federation of 60 scientific and technological societies, as well as individual members. Besides funding institutes, It supports numerous scientific societies, promotes a critical awareness of science and technology in schools, industry and society and fosters international science links. Royal Society has in 2006 launched a National Science Panel (NSP). The goal of NSP is to enlist the nation's foremost strategic thinkers from fields as diverse as science, engineering, health, education, business and economics to address science directions, organisation, as well as scientific and technological aspects of society's most pressing problems.

On behalf of the Government, the RSNZ manages various research funds including the Marsden Fund, New Zealand's premier source of basic research funding, and publishes seven scientific journals. The Society provides expert independent advice to government and enables the scientific community to have a voice in the national science debate. The Marsden Fund supports research and researchers, in research institutions as well as in universities. Research funded from the Marsden Fund is not subject to priorities set by government.

The eight Crown Research Institutes (CRI) are state-owned, semi-commercialized entities charged with conducting scientific research. Government Cabinet Ministers hold the controlling shares of all CRIs, and the Cabinet appoints a Board. Each institute is based around a productive sector of the economy or a grouping of natural resources. The CRI Act requires CRIs to be viable companies and compete for public- and private- sector research contracts. FRST funding to CRIs may be considered thematic because each has its own area of research expertise.

Finally, the Health Research Council (HRC) funds and coordinates health research, a strong sector in New Zealand. While the HRC reports to the Minister of Health, its funding comes from Vote Research, Science and Technology. This funding may be considered inherently thematic.

5.1.2.5 Allocation of public funding to business and industry

According to the OECD, the government funds 61 percent of the total scientific research industry. Businesses fund 27 percent of scientific research industry R&D. Government carries out 39 percent of scientific research industry R&D, and businesses the remaining 61 percent

Figure 82 Scientific Research Industry Funding (2008)

Source of Funds	$(million)	Percent
NZ business	170	27
NZ government	378	61
NZ universities	7	1
Overseas	33	5
Other Funding Sources	35	6
Total	622	100

Source: OECD Science and Technology Indicators 2008

New Zealand lacks the large high-technology firms which are responsible for a large part of business R&D in the more advanced OECD countries. The Minister for Economic Development is responsible for leading the government's Economic Transformation Agenda as well as the industry and regional development portfolio. There are two forms of funding for research in industry, funding direct to businesses and tax incentives. In the 2008 reference year, 80 percent of R&D expenditure in the business sector came from businesses' own funds, 9 percent was directly funded by the government sector, 6 percent was funded by overseas sources, and 6 percent was funded by other sources. Business expenditure on research and development (BERD) funded by businesses' own funds increased 21 percent from $549 million in 2006 to $663 million in 2008.New Zealand's tax treatment of R&D expenditure has been changed to reflect financial accounting practice in recent years. New Zealand did not provide tax incentives for business R&D, low-interest loans or loan guarantees to high-growth firms. That was considered to be one of the reasons that New Zealand lagged well behind most OECD economies that enjoy far higher R&D intensity. The introduction of a 15 percent R&D tax credit in the 2008/09 income year was intended to encourage New Zealand businesses to invest more in R&D. The tax credit is meant to improve productivity and international competitiveness across the broad base of New Zealand firms and industries. It is applicable to businesses conducting in-house R&D or contracting R&D from external research providers. MoRST is leading a four-year evaluation project to assess the impact of this R&D tax credit.

Along with direct funding and tax incentives, a relevant body for allocating funds to industry is the New Zealand Venture Investment Fund Ltd (NZVIF). It is owned by the executive branch (and thereby a 'Crown-owned company'). While not specifically focused on commercialising RS&T, it plays an important role in supporting the government's objectives for improving productivity and innovation. It was incorporated in 2002. NZVIF is contracted by the New Zealand Government to administer two programmes:

1. **Venture Capital Programme**-This is a "Fund of Funds" equity investment programme that is investing NZ$160 million alongside private sector co-investors in a series of privately managed venture capital investment funds.
2. **Seed Co-Investment Programme (SCIF)**-SCIF provides $40 million of matched seed funding to support the further development of early-stage investment markets through a co-investment fund alongside selected Seed Co-Investment Partners.

5.1.2.6 Role of International funding

International funding accounts for 5% of total R&D funding in New Zealand. While over 20 teams from New Zealand participated in projects under the Sixth Framework Programme, this involvement was largely based on self-funding. The ambition is to offer coordinated funding with FP7. The EU and New Zealand signed a Science and Technical cooperation agreement in 2008 that aims to achieve this goal. Furthermore, FRENZ (Facilitating Research co-operation between Europe and New Zealand) has been established between MoRST and the European Commission to enhance the engagement of the New Zealand research, science and technology community with the

European Union's Framework Programme for Research and Technological Development (FP7)[166].

5.1.2.7 Some Patterns over Time

While public policies have increasingly recognized the importance of research, the proportion of R&D expenditure from public funds has decreased. During the 1990s, the prevailing view was that getting foundational policies right was generally sufficient for achieving competitive markets, dynamic efficiency and good innovation and growth outcomes. Although specific policy instruments in the Research, Science and Technology portfolio funded R&D to improve international competitiveness and lift firms' technological capabilities, prior to 2000, the New Zealand government did not have a strong focus on innovation as part of its economic policy. In 2000, the government's strategy for growth through innovation (later known as the Growth and Innovation Framework – GIF) put innovation much more at the centre of economic policy. The government explicitly recognised the importance of innovation to economic growth and development. In March 2006, the government's Economic Transformation Agenda (ETA) replaced the GIF. It continues to place innovation at the core of the economic development strategy as a means of contributing to productivity growth[167].

In the last ten years gross expenditure on research and development between all the sectors has doubled. The GIF policies may be a factor in the three-fold increase of private expenditure on research and development.

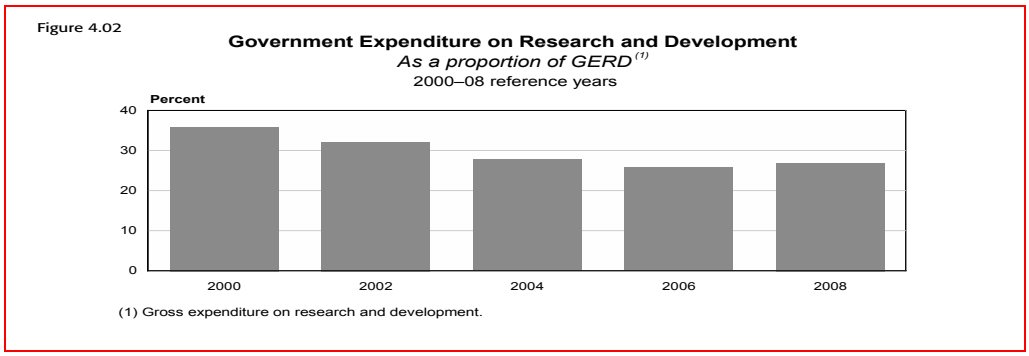
Figure 83 Gross Expenditure on Research and Development Over Time(By Sector)

Sector	2000	2002	2004	2006	2008
	$(Million)				
Business	324	524	677	760	913
Government	393	456	461	473	584
Higher Education	374	436	522	593	643
Total	1091	1416	1660	1826	2140

Source: OECD Science and Technology Indicators 2008

However, the public portion of the gross research and development expenditure has decreased.

Figure 84 Government Expenditure on Research and Development as a proportion of GERD[168] (2000-2008)



Source: OECD, Main Science and Technology Indicators

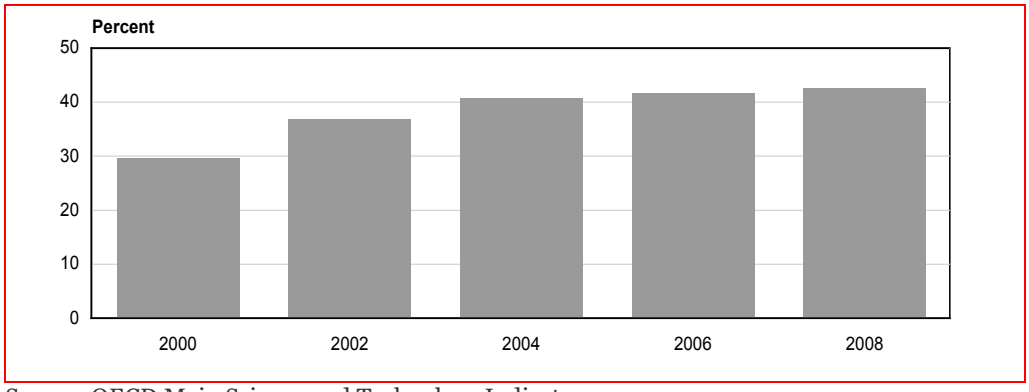
[166] Husted, Kenneth. EraWatch National Profile: New Zealand. 2009

[167] "Science for New Zealand,"2009. http://www.morst.govt.nz/publications/govt-policy-statements/science-for-nz/.

[168] Gross Expenditure on Research and Development

This decrease in the public funding proportion maybe attributed to an increase private sector funding (See Figure 85).

Figure 85 Business Expenditure on Research and Development as a proportion of GERD (2000-2008)



Source: OECD Main Science and Technology Indicators

However, the total percentage of funds for government research and development has remained steady at around 75%.

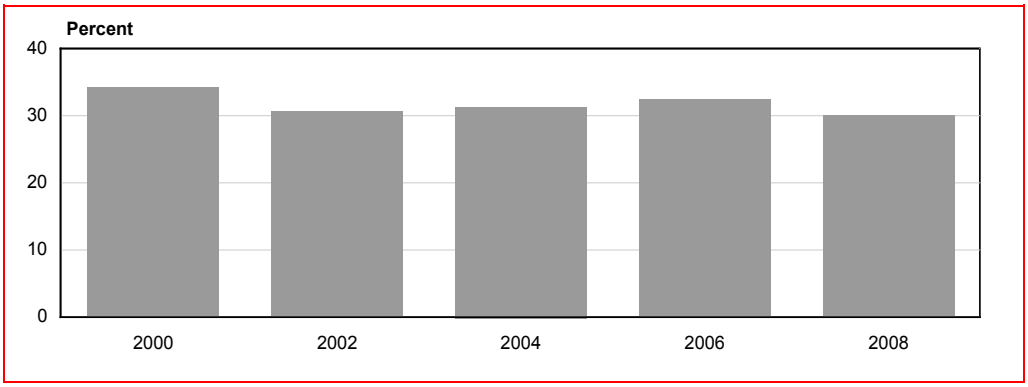
Figure 86 Sources of Funds for Government Research and Development

Source of Funds	2000	2002	2004	2006	2008
	$(Million)				
Government Funding Agencies	235.7	266.0	239.9	256.6	273.5
Other Government Department	36.2	44.3	30.8	40.3	60.0
Local Government	3.1	12.8	2.7	6.9	7.5
Own Funds	15.8	32.6	85.9	51.4	88.3
NZ Government	308.8	355.7	359.4	355.2	429.4
NZ Private Sector	80.2	96.7	80.6	89.5	114.1
Overseas	11.4	18.6	18.4	22.1	26.8
Tertiary Education	1.2	1.8	Confidential	4.6	8.5
Other sources	0.9	1.2	Confidential	1.7	5.3
Other Funding Sources	2.1	3.0	2.9	6.3	13.8
Total	402.6	474.0	461.2	473.2	584.1
•	Percent				
Government Funding Agencies	63	56	52	54	47
Other Government Department	9	9	7	9	10
Local Government	1	3	1	1	1
Own Funds	4	7	19	11	15
NZ Government	77	75	78	75	74
NZ Private Sector	20	20	18	19	20
Overseas	3	4	4	5	5
Tertiary Education	0	0	Confidential	1	1
Other sources	0	0	Confidential	0	1
Other Funding Sources	1	1	1	1	2
Total	100	100	100	100	100

Source: OECD Science and Technology Indicators 2008

The higher education proportion of research and development expenditure, much of which comes from the government, also remained steady at around 30%.

Figure 87 Higher Education Expenditure on Research and Development as a proportion of GERD (2000-2008)



Source: OECD Main Science and Technology Indicators

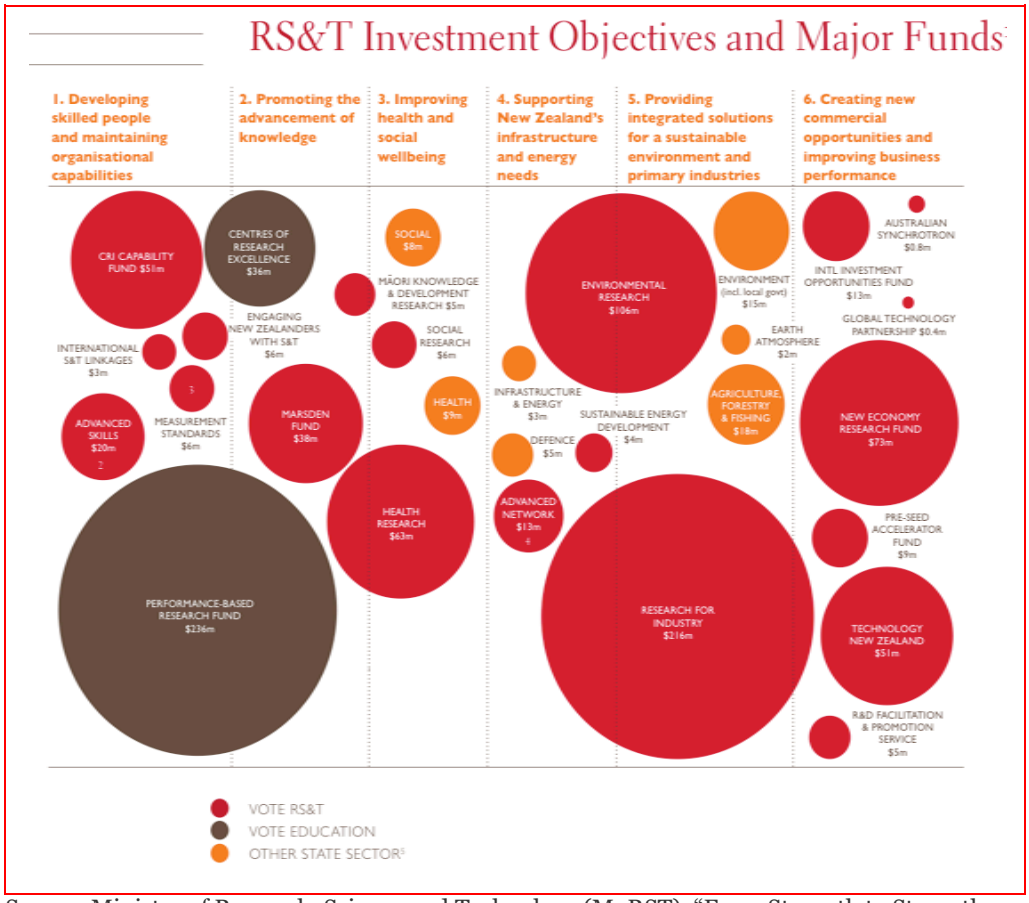
5.1.3 Priority Setting at the National Level

At the national level the government sets six goals divided between the three relevant ministries. Figure 88 lists these goals, the relevant output classes and the Ministries responsible for the goal. Budgets, once decided are aligned to the six goals but they are *not* initially allocated by the six goals[169]. Instead outcomes and priorities are determined by the goals[170].

[169] , Ministry of Research, Science and Technology (MoRST). "From Strength to Strength: Government's Agenda for New Zealand Research, Science and Technology," 2009. http://www.morst.govt.nz/publications/a-z/g/govt-agenda/.

[170] See: Ministry of Research, Science and Technology (MoRST), "Medium-term investment objectives for Vote Research, Science & Technology 2008-2011" (2008). http://www.morst.govt.nz/publications/a-z/m/medium-term-investment-2008-11/

Figure 88 Central Government Goals



Source: Ministry of Research, Science and Technology (MoRST). "From Strength to Strength: Government's Agenda for New Zealand Research, Science and Technology," http://www.morst.govt.nz/publications/a-z/g/govt-agenda/.

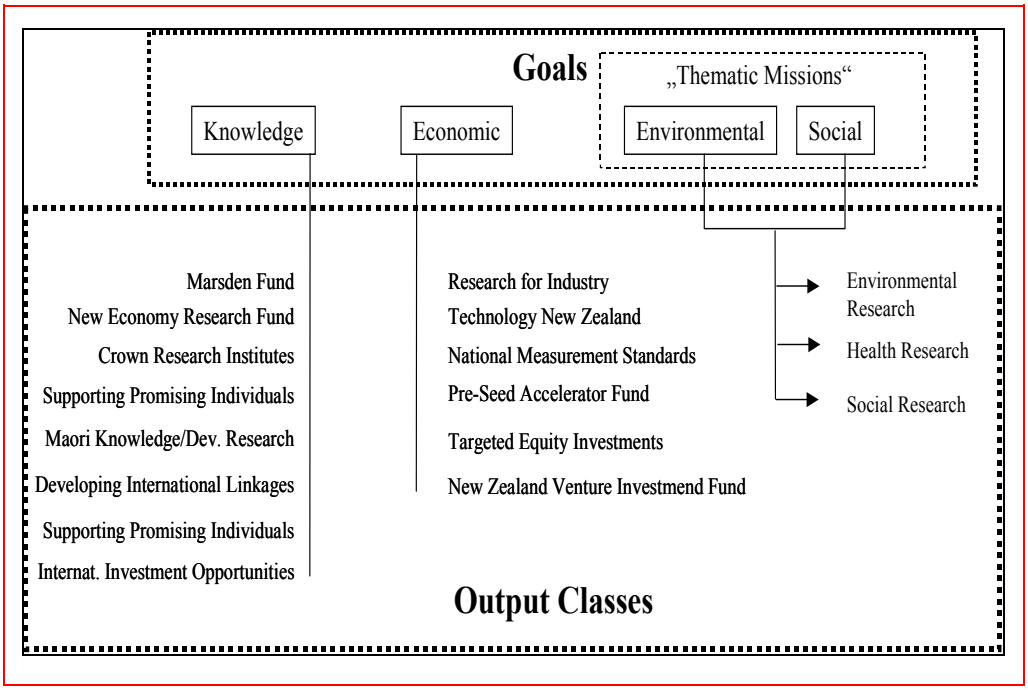
These goals are:

1. Developing Skilled People and Maintaining Organisational Capabilities
2. Promoting the Advancement of Knowledge
3. Improving Health and Social Well Being
4. Supporting New Zealand Infrastructure and Energy Needs
5. Providing Integrated Solutions for a sustainable environment and primary industries
6. Creating new commercial opportunities and improving business performance

MoRST has four broad goals- knowledge, economic, environmental, and social and the output classes are divided amongst these[171].

[171] Gassler, H. Austrian Council for Research and Technology Development, 2004, Priorities in Science and Technology Policy-An International Comparison

Figure 89 MoRST goals

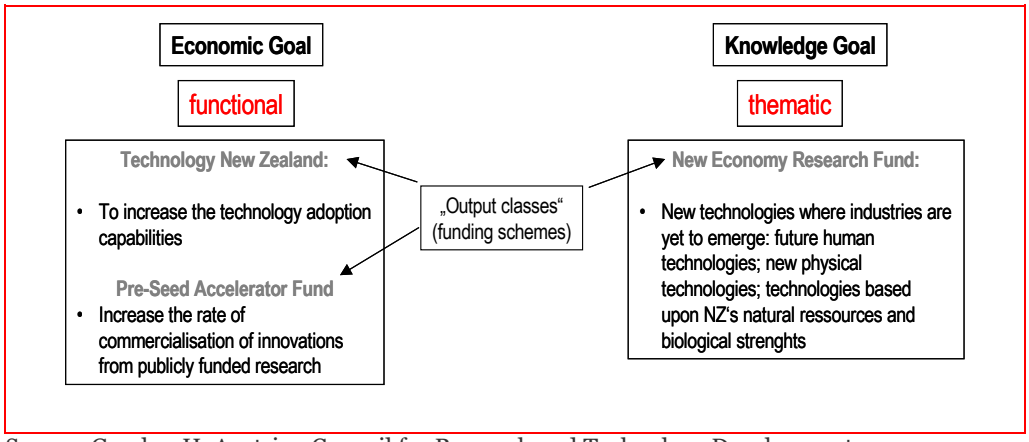


Source: Gassler, H. Austrian Council for Research and Technology Development, 2004, Priorities in Science and Technology Policy-An International Comparison

Thematic and functional priority setting takes place mainly at the level of the individual investment/funding schemes, shows earlier. However, the broader goals for the RS&T system define the principle aim and scope under which the specific funding schemes have to operate. In general, the priority setting process may be characterized as organized around a set of different hierarchical layers. The top-level layer is constituted by the four strategic goals, which are highly general and encompass both, thematic as well as functional elements.

Two of the four general goals (i.e. “environmental goal” and “social goal”) have a scope which may be characterised as a “mission”. Thematic priorities are inherent in both of these missions. Within the environmental goal a broad range of environmental research is covered, particularly in areas which directly affect the status quo and the sustainability of New Zealand’s environment, like biodiversity, climatic change, biosecurity and oceanography. Within the social goal, health research (as a cross-disciplinary thematic priority) accounts for the major share of available funds whereas the second thematic priority within this goal, social research, attracts only a smaller fraction of available funding. Priority setting may be characterized as matrix-orientated with the two dimensions of functional elements on the one hand, and thematic orientation on the other hand.

Figure 90 Priority Setting



Source: Gassler, H. Austrian Council for Research and Technology Development, 2004, Priorities in Science and Technology Policy-An International Comparison

The degree of generalization is still quite high (varying between the different funding schemes) and both aspects of priority setting (functional and thematic) can be found within a specific output class. For example the New Economy Research Fund (NERF) has the following functional elements: Complex technology/science/knowledge, higher risk for potentially high reward, and a greater emphasis on science excellence including assessment by peer review. NERF also has the following thematic elements: leveraging New Zealand's natural resources and biological strengths through technology, creating opportunities through physical technologies, and future human technologies

MoRST's strategic direction is driven by government priorities informed through consultation with people and organisations that have a stake in the RS&T system. On regular basis, MoRST has: meetings with the Minister; senior officials' meetings; context-sharing and environment scanning workshops with FRST, HRC and RSNZ; advisory groups such as the Research Infrastructure Advisory Group also offer advice; findings from research and evaluations of the various investment mechanisms undertaken by MoRST; and it participates in international policy forums such as the OECD and Asia-Pacific Economic Cooperation (APEC)[172]. Finally, the Ministry uses a series of feedback documents in order to refine its priorities.

5.1.4 Steering Governance and Administration

Until 1989, New Zealand's budgeting process was based upon a cash accounting system. With the passage of the Public Finance Act of 1989, New Zealand redefined the government's budget process, making it output-based, and also required that all budgeting and reporting at the department level use accrual methods. In an output-based budgeting process, government agencies and departments are viewed as producing outputs (for instance, maintenance of the environment), which Parliament then purchases. As such, the departments must use accrual-based projections and reports so that Parliament can know the full costs of the outputs and compare costs with private suppliers if possible. In addition to requiring department reporting and budgeting based on accrual measures, the Public Finance Act also implemented accrual-based performance assessments. The Government has set the amount available for each broad research area (output class), and directed where it should be invested. They then get advice from research users and providers about the needs and opportunities in each area. Investment strategies are developed setting out research priorities and objectives. Currently funding is allocated to 10 output expenses or research funds. It is then subdivided into smaller parts, with clear investment

[172] Ministry of Science and Technology (MoRST). "Statement of Intent" 2009

strategies for each part (this funding structure changes in 2011)[173]. An example of performance measures set out by the Cabinet for MoRST is given in Figure 91 below. Many of the funds are further specified in ministerial directions or funding agreements.

Figure 91 Performance Measures for MoRST's budget

Fund	Performance Measures (2009)
Research for Industry	• Number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard in alignment with content guidelines specified in the contract. • At least 50% of contracts reporting co-funding greater than 5% of each contract's value. • Research Consortia is used to leverage private sector investment: – At least 50% planned cash co-funding contributed to consortia by the private sector. – At least 50% reported co-funding accumulated over the life of the contract.
Environmental Research	• Number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract. Envirolink: • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract. • 100% of information will be reported as per the Information Sharing Agreement between MoRST and the Foundation.
New Economy Research Fund	• Number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract.
Health Research	• Number and total dollar value of new and active contracts reported in six monthly reports. • 100% of contracts are awarded in line with the process and criteria set out for each output in the contract between the Minister of RST and the Health Research Council (HRC). • Provision of data for RST Scorecard supplied to MoRST by 30 September 2010 and in alignment with content guidelines specified in the Output Agreement.
Technology New Zealand	• At least 15% of participants have not previously had assistance from Technology New Zealand schemes. • The FIA reports quarterly on the number and value of grants made under the grant schemes, identifying their individual purpose and application. • Capability grants. Number and total value disbursed of new and active contracts is reported in all quarterly reports for 2009/10. • Capacity grants. Number and total value disbursed of new and active contracts is reported in all quarterly reports for 2009/10. • The Foundation will ensure that on average the value of targeted grants is not more than 50% of the proposed cost of research and development projects. • 100% of information as required will be reported as per the Information Sharing Agreement between MoRST and the Foundation.
CRI Capability Fund	• Each CRI reports shows adequate reporting of the application of funding • A quarterly exception report to CCMAU from each CRI recipient of a grant identifies

[173] Champoux, Mark. "Accrual Accounting in New Zealand and Australia: Issues and Solutions" 2006 Harvard Law School Federal Budget Policy Seminar, Briefing Paper No. 27, Draft

Fund	Performance Measures (2009)
	changes in the use and application of the grant received
Marsden Fund	• Number and total dollar value of existing contracts reported in six monthly reports. • 100% of contracts will be awarded on the basis of research excellence. • Provision of data for RST Scorecard supplied to MoRST by 30 September 2010 and in alignment with content guidelines specified in the contract between the Minister of RST and the Royal Society of NZ (RSNZ).
Supporting Promising Individuals	• Number and total dollar value of new and active contracts or number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports or six-monthly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract. • Science and Technology Post-Doctoral Fellowships: At least 80 active fellowships. • Health Research Council awards: 50-70 active fellowships and scholarships. • Science, Mathematics and Technology Teacher Fellowships: Number of active contracts as set out in the relevant contract., • Etc (List of scholarships)
International Investment Opportunities Fund	• Number of active and new contracts and total dollar value or number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly or six- monthly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract.
Pre-Seed Accelerator Fund	• Number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract. • At least 75% of contracts produce investor-ready milestones
Social Research	• Number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and align with content guidelines specified in the contract.
Maori Knowledge and Development Research	• Number of active and new contracts and dollars disbursed during the financial year will be reported in quarterly reports. • 100% of contracts meet the criteria set out in the funding agreement and any Ministerial Direction. • Provision of data for the RST Scorecard supplied by 30 September 2010 and in alignment with content guidelines specified in the contract.
Australian Synchrotron	• The agreed contribution is paid in full and on time, as the Crown's contribution to ensure New Zealand access to the Australian Synchrotron.

Source: New Zealand Cabinet. "State Sector Management Bill 193-1" Government Bill – New Zealand Legislation, 2010 http://www.legislation.govt.nz/bill/government/2010/0193/latest/whole.html?search=ts_bill_state+sector_resel&p=1#DLM3166958.

Although agencies must report on a series of input and output performance indicators, there aren't specific targets to be met in relation to these indicators. Examples of indicators include: contracts profiled by emerging technology (nanotechnology, biotechnology, etc), number of peer -reviewed journal articles and books or book chapters, number of key-note addresses and awards (national/international) for science achievement, amongst others (see complete list in Section 5.6). Targets and performance measures are also specified at the agency level. These are usually related to reporting, not to indicators.

5.1.5 Research Performers

According to policy documents on New Zealand, research decisions should occur at the most appropriate level in the system. For example, ministers and the government are best placed for deciding high-level outcomes from public research and their relative weighting; research organisations and users, together with funding and investment agents, are usually best placed to decide 'what' research is undertaken; while research organisations are best placed to decide 'how' research is carried out. Four types of research funding are directed via MoRST: FRST and HRC contracts, PBRF, and the Marsden Fund. Each has very different priorities. The Marsden Fund funds individual academics or small teams and the funds are allocated not on the basis of projects that contribute towards national goals but on the basis of the best research; it is basic-untargeted research. As a result it can cover anything from the study of earthquakes to the role of women in Tudor England. Funding allocated by the HRC and FRST is very competitive and each contract will have a review clause that will cover mid-term and end of contract reviews to ensure that the projects aims were met and that the quality of the assignment was up to the level expected; the research is either basic-targeted or applied. Given that between them the HRC and FRST award about 2-300 major contracts a year it is not too difficult for the staff to monitor progress against objectives. Both organisations have a regular process of reviewing the objectives of the various schemes/funding portfolios they handle to ensure that they are meeting national objectives. Finally the PBRF allocates funding to universities for the purpose of research education. When it is given to the universities it is not tagged for specific projects and can be used for whatever the university chooses. The following table gives an idea of the amount of money that each university receives from the PBRF. Further information on the PBRF is in Section 5.3.

Figure 92 PBRF Funding by Tertiary Education Institute

University	PBRF Funding (NZ$000)
Auckland University of Technology	$7,094
Lincoln University	$8,039
Massey University	$38,122
University of Auckland	$68,951
University of Canterbury	$21,979
University of Otago	$47,670
University of Waikato	$15,091
Victoria University of Wellington	$19,671
All universities	**$226,617**

Source: New Zealand Tertiary Education Commission. *PBRF 2009 Performance by individual TEI*, 2009. http://www.tec.govt.nz/Resource-Centre/Reports/2009-Performance-by-individual-TEIs/.

5.1.6 Setting and Monitoring Priorities at the Agency Level

Priority research areas are set by the Cabinet based on research advice from all RS&T agencies. FRST sets investment strategies to specify the types of science and technology research that needs to be prioritised. The investment signals derived from investment strategies form the first part of the requests for proposals (RfPs) for each investment area. The RfPs invite researchers to submit research proposals that focus on these specific topics. FRST has a team of investment managers responsible for setting investment strategies for all Foundation investments. This team employs a number of activities to understand and respond to the environment in which the science system operates. They form connections and networks with key government policy and delivery agencies, industry sectors, research organisations and end-users of research – both national and international. They carry out horizon scanning of national and international science developments, and attend seminars, conferences and workshops. They convene expert focus groups. As discussed above, they receive formal and informal feedback on their investment signals- which form the first part of RfPs, inviting researchers to submit research proposals in the specified areas.

FRST then uses a range of processes to select proposals to invest in. The type of process that an output class will use is determined by the Ministerial direction. These processes are:

- Contestable- These are either one-stage or two-stage. In one-stage processes, researchers submit a complete description of their proposed research as the first step (proposal). In two-stage processes, researchers submit a short outline of their intended research first (concept). Once advisory groups have screened the concepts, FRST invite the researchers whose concepts best meet their criteria to submit full proposals.
- Negotiated- FRST negotiates directly with researchers who have an established track record to determine the scope of a new research contract that builds on an existing one. Research teams with a long-term, substantial Foundation research contract (at least six years in duration and $1 million in value) are eligible to renew this contract through negotiation.
- Closed Tender- The Foundation may from time to time use a "closed tender" process rather than its default contestable investment process for a contract. In a closed tender investment process, invitations to tender are issued to a pre-determined list of organisations. There must be at least two organisations.

FRST assesses 'public good' proposals differently from business proposals. There are four criteria for public-good proposals. Two criteria assess the benefits the proposal may deliver (1 and 3 below), and two assess the likelihood the benefit will be realised by assessing risk and success factors (2 and 4):

Figure 93 Criteria for Public Good Proposals (FRST)

Investment Benefits	Success factors and risk management
Economic, social or environmental benefits to New Zealand	Implementation Pathway
Research science and technology benefits to New Zealand	Ability to deliver research results

Source: FRST Website

The overall score for a proposal is calculated by adding up scores for the four assessment criteria. However, the weighting each assessment criteria receives varies between portfolio or scheme. For example, proposals in portfolios that are part of the new technology platforms investment area (output expense), building science capability and excellence is given more weight as a key goal in this area.

FRST assessment criteria are modified slightly for research and development proposals from businesses to reflect the different drivers in this area:

Figure 94 FRST Criteria for Business Proposals

Investment Benefits	Success factors and risk management
Investment Returns	Pathway to Market
Technology stretch and capability building	Ability to deliver research results

Source: FRST Website

An important distinction for the Foundation's impacts (outputs from our funds) is that they are not directly produced by the Foundation but rather produced by the research organisations funded by the Foundation. These impacts fall into three categories:

- Uptake- intellectual property being used to enhance wellbeing
- Knowledge- a body of research, scientific and technological knowledge that can be used to enhance wellbeing
- Capability- capability that can meet current and future research, science and technology needs.

Performance measures for each of these impacts are given in the following figure.

Figure 95 FRST Performance Measure by Impact

Impact	Performance Measures
Uptake	• Number of new products, processes and services reported • Number of spinouts reported • Other revenue (relating to new or improved products, processes and services or to the sale or use of intellectual property to which the Foundation funding made a critical contribution)
Knowledge	• Number of commissioned reports to users • Peer reviewed journal articles accepted for science publications • Number of keynote presentations
Capability	• Number of formalised research collaborations • Amount of co-funding

Source: Foundation for science, technology and research (FRST), 'Statement of Intent 2009-2012', 2009

5.2 Administrative Efficiency

5.2.1 By Sector

The OECD accounts for the different types of personnel involved in research. Administration is recorded as support staff in the data available and are thereby separated from researchers and technicians. The definition for support staff is, "administrative and general service employees whose work supports research, for example administration officers." As the data is for research and development, it should not include support staff for activities not related to staff.

The definitions of the different types of personnel according to the OECD are as follows:

- *Researchers*- Staff engaged in the conception and / or creation of new knowledge / products. Personnel involved in the planning or management of scientific and technical aspects of R&D projects, and software developers.
- *Technicians*- Staff engaged in technical tasks in support of R&D, normally under the direction and supervision of a researcher.
- *Support Staff*- Includes administrative and managerial staff working on, or directly associated with, R&D activity. Doesn't include staff outside the R&D performing unit providing indirect support. For example central finance or personnel services and central support services e.g. information services and cleaning.

There were 24700 full-time equivalent (FTEs) workers involved in R&D during the 2007 reference year. Comparisons for government, business and higher education respectively are as follows. Researchers comprised 62%, 58%, and 87% of total R&D personnel in the given sectors. The highest percentage of researchers was in higher education. Technicians represented 29% of government personnel, 27% in business, and 4% in higher education. Finally, support staff comprised of 8% in government, 15% in business, and 8% in higher education. Business had the largest percentage of support staff. For further information refer to Figure 96.

Figure 96 Distribution of R&D personnel by occupation and sector of activity (New Zealand, 2007)

Year	2007							
Sector of employment	Total intramural		Business enterprise		Government		Higher education	
	%	FTE	%	FTE	%	FTE	%	FTE
Total R&D personnel	100	24700	100	8100	100	3400	100	13200
Researchers	74	18300	58	4700	62	2100	87	11500
Technicians	15	3750	27	2200	29	1000	4	550
Support Staff	10	2580	15	1200	8	280	8	1100

Source: Technopolis, based on OECD Science, Technology and R&D statistics

The percentage of FTE support staff over the 1989-2007 reference years declined. In addition, there has been an increase in researchers over the years with a levelling out around 2003. For further information refer to Figure 97.

5.2.1.1 Patterns over Time

Figure 97 Distribution of R&D personnel by occupation (New Zealand, 1989-2007)

Sector of employment		Total intramural				
Year		1989	1995	1999	2003	2007
Total R&D personnel (FTE)		9148	10547	13085	21664	24700
% of Total R&D personnel	Researchers	53	58	67	73	74
	Technicians	31	27	20	15	15
	Support Staff	16	15	13	12	10

Source: Technopolis, based on OECD Science, Technology and R&D statistics

In the government sector there was a 72% decrease over 18 years in the percentage of FTE support staff. In 1989 support staff consisted 28% of the total number of personnel, in 2008 they represented a mere 8%. For further information refer to Figure 98.

Figure 98 Distribution of R&D personnel by occupation in the government sector (New Zealand, 1989-2007)

Sector of employment		Government sector				
Year		1989	1995	1999	2003	2007
Total R&D personnel (FTE)		3996	3984	3444	3448	3400
% of Total R&D personnel	Researchers	36	38	47	54	62
	Technicians	36	38	32	33	29
	Support Staff	29	24	20	13	8

Source: Technopolis, based on OECD Science, Technology and R&D statistics

In contrast, the business sector had a slight increase in the percentage of support staff from 1989 to 2007. In 1989 the support staff accounted for 12% of all personnel involved with business research and development, whereas in 2007 support staff accounted for 15% of total personnel involved with research and development. While there was a decline in staff in 1999 to 10% the percentage has risen once again. For further information refer to Figure 99.

Figure 99 Distribution of R&D personnel by occupation in the business sector (New-Zealand, 1989-2007)

Sector of employment		Business enterprise				
Year		1989	1995	1999	2003	2007
Total R&D personnel (FTE)		2826	2828	3287	6440	8100
% of Total R&D personnel	Researchers	54	56	65	62	58
	Technicians	34	29	25	22	27
	Support Staff	12	15	10	16	15

Source: Technopolis, based on OECD Science, Technology and R&D statistics

Finally, in higher education support staff percentage has increased and decreased, but for the most part remained steady at 10%. The research staff in higher education comprises 87% in 2007. This is the highest percentage of researchers of all the countries in this comparison[174]. For further information refer to Figure 100.

Figure 100 Distribution of R&D personnel by occupation in the higher education sector (New Zealand, 1989-2007)

Sector of employment		Higher Education				
Year		1989	1995	1999	2003	2007
Total R&D personnel (FTE)		2326	3735	6353	11776	13200
% of Total R&D personnel	Researchers	80	81	79	85	87
	Technicians	20	13	10	6	4
	Support Staff	---	6	11	9	8

Source: Technopolis, based on OECD Science, Technology and R&D statistics

While businesses in NZ invest in support staff it seems that they are not a priority for other sectors. The government especially has reduced staff from a third of all personnel in R&D to a mere 8%, signifying a preference for researchers.

5.2.2 Public Funding Categories

Total public sector financing of research related activities is a survey undertaken by MoRST every year. It breaks down funding by the category of research. The category of general purpose data collection and policy related studies is relevant to understanding administrative efficiency. The definitions of the categories are as follows:

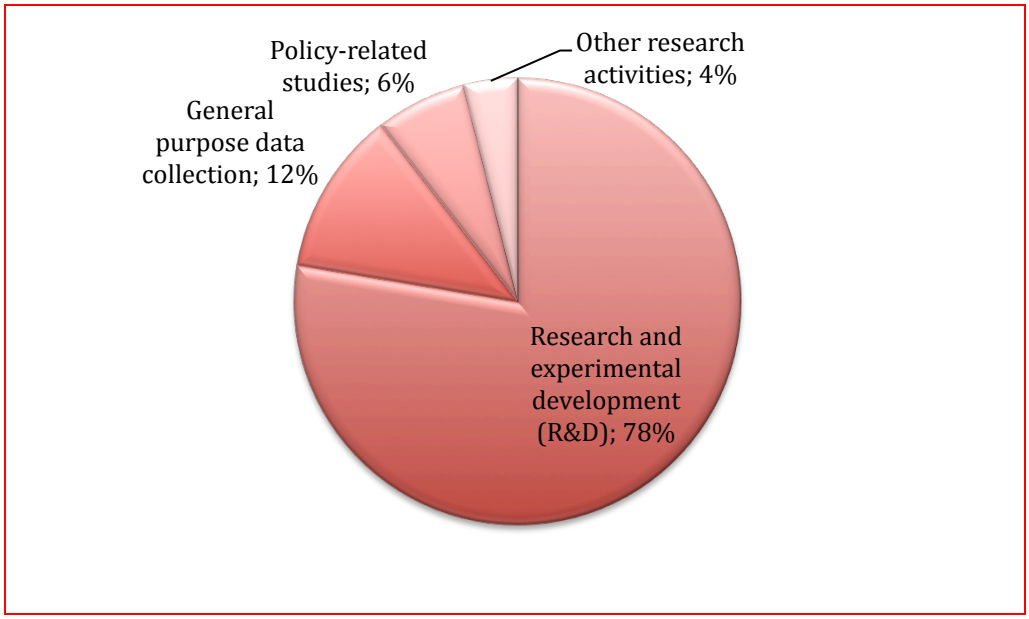
- Policy-related studies- Local or national government or business enterprise policy work. It includes analysis and assessment of existing programmes, policies and operations (evaluation services); defence and security analysis; and legislative commissions of inquiry concerned with general government, departmental policy or operations.
- General purpose data collection- Routine sampling or monitoring, including regular market or stakeholder surveys. Examples include routine water level or air quality monitoring relevant to the Resource Management Act 1991 or the Local Government Act 2002.
- Other research related activities- These activities include research activities described below.
  - Routine software development- Work on system-specific or programme-specific advances on publicly available software; and solving technical problems that have been previously.
  - Scientific and technical info services- For example, advisory services, production of conference proceedings, bibliographic services, and patent services.
  - Testing and standardisation-Maintenance of national standards, calibration of secondary standards and routine testing and analysis of materials, components, products, processes, soils, atmosphere, etc.
  - Feasibility studies- Studies for proposed engineering projects, including socio-economic impact assessments. However, feasibility studies on research projects are part of R&D.

In the 2008/09 financial year, public sector agencies planned to invest $1.315 billion in research-related activities. Of this investment, 78% ($1.020 billion) was budgeted for R&D (Figure 101). 12% ($156 million) was budgeted for general-purpose data collection, such as topographic and hydrographical surveying and mapping; monitoring plant and animal stocks and other environmental indicators; and

[174] Assuming UK figures are miscalculated. They state researchers are 93% in 2008 while support staff amount to 0. This seems incorrect and is likely inflating researchers percentage.

collecting social statistics. While these activities are not considered to be R&D by Frascati definitions, they are often a precursor to R&D, and a key element in expanding knowledge. Of the remaining investment $87 million (7%) was budgeted for policy-related studies, and $51 million (4%) for other research-related activities. Using this data administrative funcitons only account for 10% of total spending on R&D.

Figure 101 Allocation of research funding by category of research



Source: Ministry of Research, Science and Technology (MoRST). "Public Sector Financing of Research" 2008

5.2.3 Research Agencies

The annual reports present some information on administrative costs. The most important agency for research is FRST. In 2005 FRST' research commitment was 331Mil, this figure reached 480 million in 2009. In 2005 FRST reported 12Million in operating costs and 1.9Million in administration cost. By 2009 these figures were 20.8 Mil and 2.5 Mil respectively. Administration costs were less than 1% in both years.

Another important agency for research is the Health Research Council. Their research commitment was 50Mil in 2005 and 75Mil in 2009. While there has been a significant increase in research commitment, there hasn't been a similar increase in research support. According to the annual report research support cost NZ$298000 in 2005 and NZ$300000 in 2009. The research support reported by HRC was also less than 1% of research commitment.

5.2.4 Universities

The top two universities in terms of research are the University of Auckland and the University of Otago. Comparable data is available from 2003 onwards. At the University of Auckland research expenditure was $100Mil in 2003 and fell to $93Mil. Operating costs rose from $432 Mil to $711 Mil. There was a decrease in the percentage of research to operations from 23% to 13%.

At the University of Otago research expenditure was $12 Million in 2003 and $89 Mil in 2009. Operating expenses have also increased; from $286Mil in 2003 to $470Million in 2009. Thereby research expenditure as a percentage of the operating expense has increased from 4% to 19%. Information for these universities and others is given in Figure 102.

Figure 102 Operating Cost and Research Expenditure for TEIs

(NZ$000s)	Auckland University of Technology (AUT)	Lincoln University	Massey University	University of Auckland	University of Canterbury	University of Otago
2009 Operating Cost	213,180	83,984	369,191	711,091	250,086	470,130
2003 Operating Cost	152231	63223	281696	432054	154578	286637
2009 Research Expenditure	18998	21822	69088	93286	25251	89099
2003 Research Expenditure	9341	9184	48409	100903	14219	12387
Ratio Research/Operating 2009	9%	26%	19%	13%	10%	19%
Ratio Research/Operating 2003	6%	15%	17%	23%	9%	4%

Source: Tertiary Education Commission, Individual Performance of Tertiary Education Institutes 2003 and 2009 http://www.tec.govt.nz/Resource-Centre/Reports/2003-Performance-by-individual-TEIs/

5.3 Research Education

5.3.1 Organisation

Contrary to many other countries, New Zealand has adopted a very broad definition of tertiary education. It includes all post-school education – in the international literature commonly identified as post-secondary education – and thus covers the full spectrum from adult literacy and second chance education for those without previous formal or low schooling, through to certificates, diplomas, bachelors, masters and PhD's. It also covers industry training, apprenticeships and adult and community education. This definition makes the tertiary education sector a diverse amalgam of institutions, in New Zealand commonly identified as tertiary education organisations (TEOs). The type of research in New Zealand universities is primarily pure basic research.

Figure 103 Type of Research at Universities

Research Type	Universities	All research sectors
Pure basic research	53%	30%
Strategic research	28%	34%
Applied Knowledge/Experimental Development	18%	36%

Source: Education Counts (2010) Resources: Financial and human resources, http://www.educationcounts.govt.nz/statistics/tertiary_education/resources

Research Education in New Zealand is in the form of a doctoral degree (PhD) which normally takes three years of full time study and research. The degree is awarded upon the completion of a thesis requiring original research and an oral examination. Sometimes the PhD candidate may also be required to take a written examination or other exercise(s). Eight universities and two institutes of technology are currently designated "research active", meaning they are able to grant a PhD, in science and technology areas. Domestic enrolment by field of study is listed below.

Figure 104 Domestic Enrolments by Field of Study

Field of Study	Doctorates
Natural and Physical Sciences	1093
Information Technology	230
Engineering and Related Technologies	502
Architecture and Building	47
Agriculture, Environmental and Related Studies	92
Health	750
Education	457
Management and Commerce	390
Society and Culture	1298
Creative Arts	185
Total	**5004**

Source: Tertiary Education Commission and Ministry of Education

Vote Education allocates funding to universities. They, then distribute scholarships for doctoral research. The allocation of funds made through Vote Education is determined by the institutions themselves and, as a result, the tertiary institutions and the scientists they employ, play an important role in determining what RS&T is undertaken in New Zealand. Universities obtain funds from the TEC. Each tertiary education organisation is required to develop a plan outlining the education and training they will provide over a three-year period, and to show how that education or training meets the needs of stakeholders and reflects government priorities. These plans, to be agreed with the TEC, will also contain performance measures and capability development activities. All institutions, whether public or private, charge tuition fees for research education. The fees vary depending on the university. In 2004, the government introduced a policy of fee and course-costs maxima (FCCM), which limit the extent to which institutions could raise fees. Under the FCCM policy, there is a set of upper limits for fees with a maximum in each field.

Funding and Investment agents who obtain funding from Vote RS&T also fund a number of post-doctorate researchers. These are external grants in which the university gets funding to pay for research education. Sometimes, though far from the majority, the grants are for personal stipends. The figure below gives the number funded, by output class, for 2008/09.

Figure 105 Number of students (PhD) undertaking qualifications, and post-doctoral research supported

Vote Output Class	Funding and Investment Agent	Number of post-doctorate researchers supported
Environmental Research	FRST	39
Health Research	HRC	66
Māori Knowledge and Development Research	FRST	3
Māori Knowledge and Development Research	HRC	6
Marsden Fund	RSNZ	64
New Economy Research Fund	FRST	80
Research for Industry	FRST	67
Social Research	FRST	3
Sustainable Energy Development	FRST	0

Source: Ministry of Research, Science and Technology (MoRST). 2008-09 Performance Measures

TEOs have three sources of research income direct from the purchase agencies: Royal Society, HRC and FRST. They funded a total of 832 doctoral researchers in 2007 in comparison through Vote Education, universities provided funding to 8205 students (2009 figures).

Figure 106 Full Time Equivalents Supported By Research Funding (2007)

Type of Funding	PhDs
HRC	2.4
Royal Society	146.0
FRST	684.6
Total	832.0

Source: Foundation for Research Science and Technology (FRST) Website

The largest source of scholarships are offered directly by the TEOs. TEOs select candidates for funding by reviewing the application submitted by students. Students are not allowed to use multiple sources of funding for one degree other than in special cases. Scholarships usually cover the full cost of tuition and living expenses. Decisions about funding, special conditions, and stipends are decided upon by the senate of the TEO. Some scholarships have special conditions beyond academic merit. These conditions may be time spent in industry, scholarships for certain ethnic background (usually for the Maori or Pasifika population of New Zealand) or for interest in an area of study that is growing and/or lacking researchers.

The attractiveness of completing a PhD for a student can be estimated by seeing the earning potential from completing one. The following table lists annual pays for some of New Zealand's largest universities.

Country	Institution, if applicable	Annual pay/stipend	Tax status of the income	Source
New Zealand	Victoria University	21,000-24,000NZD (11769€-13450€)	Tax exempt	Victoria University Website
	University of Otago	20,000 NZD (11 209€)	Tax exempt	University of Otago Website
	Lincoln University	20000- 26000 NZD (11,209€- 15564€)	Tax exempt	Lincoln University Website

Universities and industry may offer higher stipends to degrees targeted in certain subjects. However, this is not the norm. These scholarships are few in number. They may be for a general subjects (Business scholarships) or may be for those that undertake a certain research theme (aging population). Scholarships up to 40000NZD (22,418 €) were found on university web pages.

5.3.1.1 Performance Based Research Funding (PBRF)

Until 2004, the main funding for research was provided as part of the Student Component funding which combined research funding with funding for teaching and learning. Research funding to TEOs was based on student enrolments in degree and postgraduate level courses, with the funding for all domestic degree and postgraduate level enrolments being supplemented by a research "top-up". This funding system was phased out by 2007 and replaced by the Performance-Based Research Fund (PBRF), which separates teaching and research. It is the largest source of research education funding. Other sources of income for research include funds for Centres of Research Excellence (CoREs), the Marsden Fund mentioned earlier, and competitive grants from the Ministry for Research, Science and Technology. The PBRF (Performance Based Research Funding) has some similarities to and was inspired by the established United Kingdom Research Assessment Exercise (UK RAE).

In comparison to the research top-up system, the PBRF is deemed to be quite beneficial. The previous system for funding research – based on student enrolments in degree and postgraduate level courses and research 'top-ups' - had several negative effects. First, research allocation based on student enrolments resulted in extensive internal cross-subsidization that in turn created market distortions and tensions in the tertiary education sector. Second, the fields that were most successful in generating enrolments – and thus research funding – were not necessarily those that were most

active in research or of high strategic importance. Overall, the research funding system did not encourage excellence, nor did it ensure that top researchers received adequate resources. The shift in the approach to fund research – using the PBRF and initiatives such as the CoREs, that is, block grant and institutional funding, presents a number of advantages. First, it aligns research funding with the research performance of TEOs, rewarding excellence in research and second, it provides incentives for research to be undertaken in areas of priority for the country. Competition in these programmes to distribute research money ensures both excellence in academic research as well university-industry networks which prioritize practical application. Also, as is the case with CoREs, programmatic policy instruments that stimulate multidisciplinary research or cooperation between specific TEOs and firms are useful additional instruments to create a policy-mix of research funding. These priorities can be seen in the types of scholarships offered by TEOs for research education. For example, some scholarships require a supervisor from a non-academic institution in their application for funding[175].

Had the old research top-up system continued, the polytechnics are likely to have made inroads into the universities' dominance of the research funding pool data. As a result of the introduction of the PBRF, the universities have been able to increase their share of the pool from 94 percent in 2003 to more than 97 percent in 2007. The PBRF pool is larger than the research funding pool would have been under the old top-up system[176].

Under the PBRF, funding is allocated to institutions on the basis of research performance, using a set of indicators complemented by peer review quality assessment. The primary purpose of the PBRF is to ensure that quality research in the tertiary education sector is encouraged and rewarded. The PBRF has three components: assessment through periodic peer evaluations (60%), completions of research degrees (25%) and external research income (15%). The strategic dimension to PBRF funding, in that 'relevance' of a TEO's research, recognised through their ability to earn external research income. It was administered in 2003 and 2006, and is now administered every 6 years.

Under the peer evaluation all 'eligible staff' are assessed individually on the basis of an 'Evidence Portfolio' containing information about their research. Each staff member is then graded by one of 12 peer review panels. They may receive any of the following grades.

Figure 107 PBRF Peer grading system

Grade	Description
0	Research inactive
1	Regular application of existing research methodologies with acknowledgement by peers of sound research basis.
3	Original or innovative research that is recognised within New Zealand or elsewhere and is esteemed by the academic community beyond the researcher's own institution
5	Highly original or innovative research that ranks with the best of its kind in the world and is esteemed by the international academic community.

Source: Ministry of Education Website

The other two PBRF measures – external research income and retention in doctoral degrees – are calculated at the provider level. Each TEO's share of funding for each of these three measures will be determined by their relative performance against other participating TEOs in that particular measure. Their total funding is the sum of their funding under each measure.

[175] OECD. "OECD Reviews of Innovation Policy: New Zealand," 2007.

[176] Education Counts, Ministry of Education. "How the PBRF has shifted research funding," 2006 http://www.educationcounts.govt.nz/publications/tertiary_education/18792.

5.3.2 How the PBRF is calculated

Calculating the funding for the Qualify Measure:

- The final Quality Category for each staff member assigned a funded Quality Category ("A", "B", "C", or "C (NE)") resulting from the evaluation of EPs
- The funding weighting for the subject area that the staff member has been assigned to
- The Full Time Equivalent (FTE) status of the staff member for the TEO that they are employed by (or in some cases, were employed by during any part of the 12 months prior to the PBRF Census)

The funding formula for the quality measure is Σ [(base funding unit) x (quality weighting) x (FTE status of researcher) x (funding weighting for relevant subject area)]

The base funding is derived through the following formula: (Total amount of funding available for research quality) divided by Σ [(FTE status of researcher) x (quality weighting) x (funding weighting for relevant subject area)]

Calculating the funding for the research degree completions measure:

- The number of research degree course completions
- The 'volume of research factor' based on the volume of research (in EFTS terms) of the degree programme.
- The relative weighting of the subject area as per the quality measure (see the table describing subject area weightings above); and
- Equity weightings for course completions depending on student ethnicity as follows:
  - 2 for Maori students
  - 2 for Pacific students
  - 1 for all other students.

The funding formula for the research degree completions (RDC) measure is Σ [(base funding unit) x (RDC numbers) x (weighting for course level) x (cost weighting for relevant subject area) x (equity weighting)].

The base funding unit is derived by the following formula:

(Total amount of funding available for research degree completions) divided by Σ [(RDC numbers) x (weighting for course level) x (cost weighting for relevant subject area) x (equity weighting)]

Calculating External Research Income measure:

The external research income (ERI) measure will allocate funding to TEOs in proportion to the extent to which they attract external research income.

The funding formula for the external research income measure is:

[(Total ERI for TEO) divided by (Total ERI for all TEOs)] x Total amount of funding available for ERI Measure

5.3.3 Evaluation of PBRF

A significant influence on where money goes is the subject weightings. The PBRF subject weightings tend to shift funding towards those universities with substantial research activities in the sciences and the applied sciences – more sharply than the old research top-ups system. In large part, this is a consequence of the fact that in some universities these fields are the focus of considerable research activity but may not

attract large numbers of enrolments. Conversely, some lower-funded fields that draw significant enrolments may have lower research performance.

Between the universities, the effects of the PBRF are more complicated. Discounting for the effects of subject-based weightings, there are five universities whose research quality allocations are clustered in a similar range on a full-time equivalent staff basis. The other two dimensions of the PBRF – research degree completions and external research income – produce greater variations of performance and thus are more important drivers of funding shifts.

The PBRF funding system was designed to reward research excellence. In doing so, the funding system creates incentives for lower performing TEOs to strive for research excellence. An analysis of the PBRF allocations in 2004 suggests that strong financial incentives have indeed been created that should encourage TEOs to aim for higher research performance. The incentives exist in both the staffing and research degree completion areas.

Before the introduction of the PBRF, there was no direct financial incentive from government for TEOs to employ high performing staff. Now there are significant financial gains for a TEO from having high performing researchers on their staff. Lower performing staff attract relatively small amounts of PBRF funding, if any. This may well result in a reallocation of academics' time between teaching and research.

The underlying principal of the PBRF was to improve the average quality of the research in New Zealand tertiary education organisations through linking government funding directly to research performance. According to the OECD, there are signs that the PBRF has already heightened universities' increased focus on research quality. There have been many evaluations of the PBRF. Quality Evaluation results showed that research quality increased by 14 percent between 2003 and 2006 as a result[177]. Other studies by the Ministry of Education have also shown favourable results. A different study has shown that the greater scrutiny the PBRF has placed on the research activities of the New Zealand universities has been associated with a significant increase in research productivity at most universities, measured by the number of articles and reviews listed in the Web of Science per FTE research staff[178]. This increase in Web of Science research publications has not been at the expense of other types of research output. Given the selective nature of the peer reviewed journal set included in the Web of Science, the increase in the number of research outputs appearing in the Web of Science database implies that the quality of research being produced by New Zealand universities has also improved. This study has been confirmed through exercises such as the PBRF Quality Evaluations mentioned earlier. However, the increase in research productivity raises questions of whether it involves a trade off in other areas of university activity, such as teaching and service, and whether the productivity increase can be sustained over the long term. The study does confirm that linking government funding directly to institutional research performance and ensuring the publication of that performance has been associated with significant changes in institutional behaviour.

Significant changes in institutional behaviour are further seen in a different evaluation by the Ministry of Education. Improvement in measured research performance allocated to the sample of staff used in that study was driven mainly by significant improvement in their peer esteem and contribution to the research environment scores. The greater improvement in the average peer esteem and average contribution to research environment score, compared with the average research output score, suggests that the improvement in measured performance was at least partly due to

[177] Education Counts. "Trends in measured research quality: An analysis of PBRF Quality Evaluation results," http://www.educationcounts.govt.nz/publications/tertiary_education/29355/29398.

[178] Smart, Warren. "Quality vs Impact: A comparison of Performance-Based Research Fund quality scores with citations." *Ministry of Education*, August 2007. http://www.educationcounts.govt.nz/publications/tertiary_education/11766.

improved presentation in evidence portfolios given that there is a greater subjective element in the assessment of these dimensions. Nonetheless, there was also a rise in Research Output score, if to a lesser extent than the other research component scores. Given this research component is potentially less subject to change as a result of improved presentation of evidence portfolios, the study concluded that this provides some evidence of an increase in quality of the research carried out by the staff selected for this study.

Generally, the strength of the correlation between research quality and academic impact is lower than was found in studies of narrow subject disciplines in the British Research Assessment Exercise – although the smaller number of observations available for New Zealand in each subject panel would be a factor contributing to the result. However, the degree of variation between the research quality scores and academic impact suggests that the peer review process used in the PBRF Quality Evaluations is not simply mirroring what is shown in the citations data. In other words, peer assessment of research quality appears to be measuring something that citations alone do not. Therefore, this would suggest that the assessment of quality through peer assessment cannot simply be replaced by metrics such as citations. In addition, it is clear from the 2003 and 2006 Quality Evaluation results that, with a few exceptions, the highest-performing subject areas tended to be those fields with higher funding weightings. In the 2006 Quality Evaluation, four of the five highest-performing subject areas were fields that draw funding at higher weightings.

5.3.4 Finance

TEOs have research income can be disaggregated into several types. First, funding provided by the government through Vote: RST (Research, Science and Technology, the governmental budget for these areas) and awarded through competitive bidding rounds. Second, funding provided by philanthropists and philanthropic organisations to foster research activities. Third, income earned by TEOs as subcontractors in large research contracts where other organisations such as the Crown institutes (CRIs) are the principal contractor. Fourth, 'contract research' is another form of external research income, i.e. TEOs conduct specific research for firms or other purchasers. R&D contracts and earmarked grants received from government sources are recorded at their agency source. Fourth, their own income from endowments, shareholdings and property; and surplus from sale of non-R&D services such as fees from individual students, subscriptions to journals, and sale of serum or agricultural produce. The latter three types of research income are often referred to as "external research income", although often they are often indirect public funding sources that generate the income. The figure shows the total income over the years for the universities by income type.

Figure 108 Total research income by income type in the universities 2002-2008 ($million)

Income type	2002	2003	2004	2005	2006	2007	2008	2002-2008	2007-2008	2002	2008
								Percentage change		Percentage share	
Research top-ups	$101.3	$110.4	$107.5	$99.7	$72.6	n/a	n/a	n/a	n/a	34.1%	n/a
PBRF			$16.3	$39.2	$120.3	$201.1	$225.5	n/a	12.1%	n/a	37.5%
CoREs	$6.5	$19.4	$20.4	$21.3	$21.4	$21.5	$29.1	348.4%	35.4%	2.2%	4.8%
Other research contracts	$187.7	$203.1	$236.0	$261.3	$279.8	$297.1	$340.5	81.4%	14.6%	63.2%	56.7%
Other	$1.4	$1.8	$3.0	$3.7	$3.1	$3.1	$5.6	290.6%	83.8%	0.5%	0.9%
Total	$297.0	$334.8	$383.2	$425.2	$497.2	$522.8	$600.6	102.2%	14.9%	100.0%	100.0%
As a percentage of all university income	10.2%	10.7%	11.4%	11.5%	12.2%	12.0%	13.2%				

Source: Tertiary Education Commission and Ministry of Education

The first PBRF (Performance Based Research Fund) evaluation was completed in 2003-2004 and provided a baseline for future assessments. It also uncovered specific needs for adjustments of the operation of PBRF. The second round was completed in 2007. The PBRF is one of six TEC funding elements. In 2008 it provided $57,913,562 (NZ) in research degree funding. It determines the amount of funding allocated to universities. The size of the PBRF funding pool is determined by government through its annual budget. PBRF funding is agreed upon through the investment plan. Once the funding is dispersed to the universities, they have full autonomy as to how the funding is actually allocated. For that reason, some do not consider it a 'research' fund, as there is a possibility that the funding is not going to research.

The New Zealand universities receive approximately 45% of their annual income from government grants - $1.14 billion of the combined total income of $2.5 billion recorded in 2007. The remaining income is split evenly between student fees and other sources – principally research contracts and trading income. Nearly 60% of the sector's expenditure of $2.4 billion went on staff salaries and related costs.

MoRST classified each funding source by which career stage they were targeted at. The table below presents these findings; it was found that post-graduate and post-doctorate students are being provided relatively more support than the other career stages.

Figure 109 Public Funding of Researchers by Career Stage

Career Stage	Dollar Value ($000 NZ)
Post-graduate	$40349
Post-doctorate	$9417
Developing new scientists	$7494
Early Career Stage	$5664
Mid-Career Stage	$190
Late-Career Stage	$720
Other	$10318
Total	$74153

Source: Ministry of Research, Science and Technology (MoRST). "Evaluation of support for people in research, science and technology," 2007 http://www.morst.govt.nz/publications/evaluations/support-hrst/.

5.3.5 Criteria for Research Funding

Criteria for research education funding is determined by the university and the relevant scholarship. In general, acceptance is based on a relevant bachelors degree with first class or second class (division 1) honours, or a masters degree with first class

or second class (division 1) honours, or its equivalent at a recognised institution. Acceptance is also subject to the availability of staff for supervision and appropriate facilities.

One example of non-university research education funding is the Marsden fund provided via the Royal Society of New Zealand. According to Fund, doctoral researchers must submit a proposal. Primary consideration is given to:

- The merit of the proposal, including originality, novelty, insight and rigour
- The ability of the postgraduate to carry out the research
- The potential of the research to contribute to the advancement of knowledge
- Consideration may then be given to the cost of proposals.

5.4 Basis for the Allocation of Public Funding

5.4.1 Criteria for the allocation of funds

New Zealand's research system sets long-term directions for RS&T from which criteria is determined for funding to institutions. The criteria is not strict and meant to be flexible so that there are opportunities for change. Past direction-setting processes have included Science Priorities Review Panel (SPiR) and the Foresight Projects of the mid to late 1990s, both led by MoRST. Since then, RS&T direction setting has changed from the approach of periodic national processes to a wider range of processes occurring on a continuous basis and often focused on particular areas or topics. This is usually in the form of a government-led strategy around particular areas of national need or opportunity. These lead to decisions resulting in new institutional arrangements, policies, communications and funding. For example, The Biodiversity Strategy, Biosecurity Strategy, and the Biotechnology Strategy from recent years have prioritized biotechnology funding in the various public bodies. Other attempts consist of developing more focused processes by research organizations and user communities about how a particular area of science could better support national needs, or may be needed to retain or build new capability. These may be endorsed by Ministers or implemented directly by research organisations. An example of this are the 'Roadmaps for Science'. They are an initiative lead by MoRST to develop and coordinate RS&T directions. Roadmaps cover a diverse range of topics such as energy, environment, biotechnology and nanotechnology. Roadmaps describe New Zealand's current research activity, interpret the government's objectives and strategies relevant to the area, and provide criteria to public research investment agencies as well as other participants in the science system.

According to MoRST, overarching Government documents rarely indicate a preference for any specific research discipline, but rather concentrate on specifying the goal for research. MoRST has set four major categories to divide its research funding, mentioned earlier. They are

i) Knowledge- the creation of new knowledge a primary goal for science

ii) Economic- Research and science provide the basic knowledge needed to create new and improved products, processes, systems and services in order to enhance the competitiveness of New Zealand enterprises and achieve the government's goal for sustainable economic growth.

iii) Environment- environmental science and research seeks to increase understanding of the environment, including the biological, physical, social, economic and cultural factors that affect it.

iv) Social- increased understanding of the social, biological, environmental, cultural, economic and physical determinants of wellbeing.

In December 2009 Cabinet set out the new science priorities for the Government's investment in RS&T. These include priority areas for research outcomes and

additional capabilities and infrastructure priorities to meet the needs of a successful science system. The new priorities came into effect on 1 July 2010. Priority research outcome areas[179] are:

- **High value manufacturing and services:** Research to develop new technologies, materials, products, processes and services for the manufacturing and technology sectors.
- **Biological industries:** Research to support productivity growth and sustainability in primary industries, and the development of premium food and industrial biological products and technologies that meet global demand.
- **Energy and minerals:** Research to improve mineral extraction and energy security, and on efficient and affordable energy use.
- **Hazards and infrastructure:** Research to support hazard management and improve building and infrastructure durability.
- **Environment:** Research to underpin the management, protection and improvement of ecosystems, land and freshwater resources, climate and atmosphere – both in New Zealand and Antarctica.
- **Health and society:** Research to improve health and social well-being.

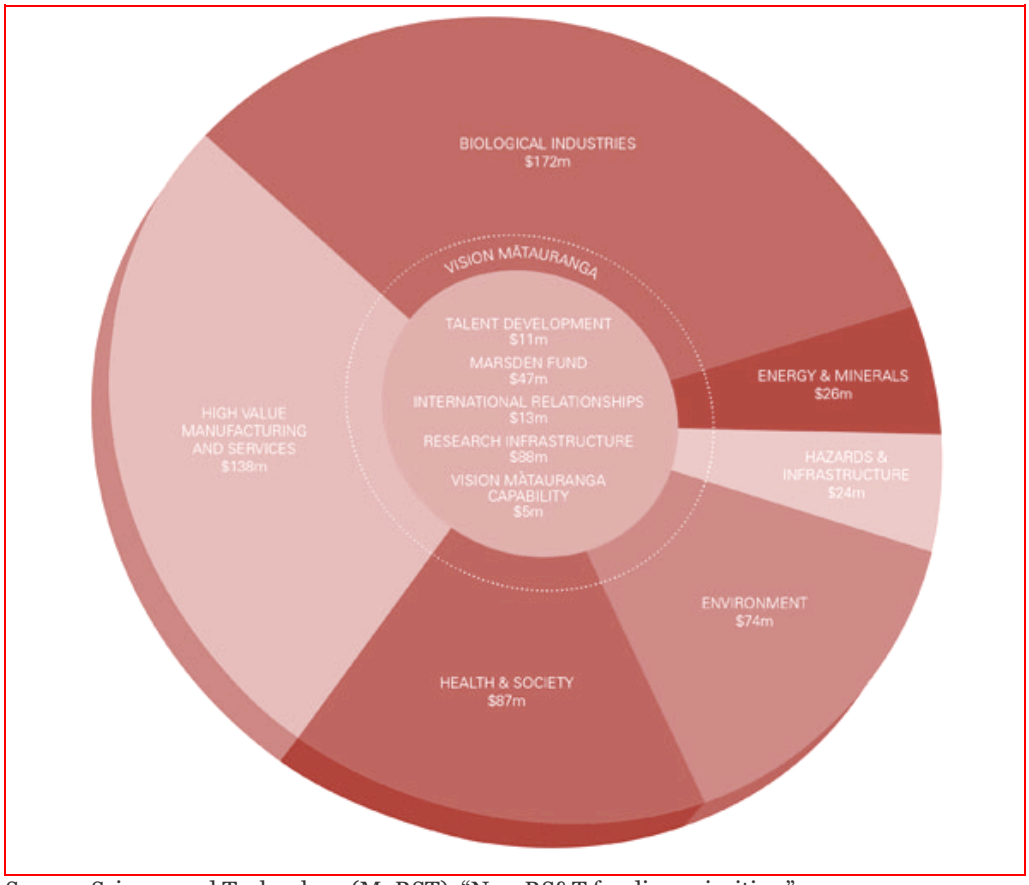
Additional priorities include

- **Fellowships for Excellence:** To provide a supply of excellent researchers by encouraging the career development of talented early and mid-career researchers.
- **The Marsden Fund:** For excellent basic research initiated by researchers.
- **Research infrastructure:** To improve the quality of science infrastructure and access to it.
- **International Science Relationships:** Strong international partnerships and other links.
- **Vision Mutauranga Capability Fund:** Developing and supporting skilled researchers and organisations doing research relevant to Māori innovation and communities.

The allocation of funding to these priorities is shown in the following figure. It is important to note that New Zealand does not undertake large-scale defence, pharmaceutical and manufacturing research and development.

[179] Foundation for Research Science & Technology (FRST) "Statement of Investment Outcomes 2008/09," March 25, 2010. http://www.frst.govt.nz/library/corporate-reports/statement-of-investment-outcome/08-09.

Figure 110 MoRST Allocation of Funding by priority area



Source: Science and Technology (MoRST). "New RS&T funding priorities," 2010. http://www.morst.govt.nz/current-work/New-RST-funding-priorities/.

5.4.2 Mechanism for the allocation of funds

The mechanism for identifying directions and priorities is often through strategic discussions and consultations. This is usually a top-down process. The roles of the various bodies in identifying these directions are as follows. Ministers lead national strategy processes identifying outcomes for RS&T; departments manage these processes on behalf of ministers seeking wide participation. MoRST facilitates science sector input into these national processes. Minister of RS&T leads science-focused strategic processes that MoRST then coordinates (e.g. Roadmaps). Funding and investment agents and research organisations lead and participate in processes to identify how and what RS&T can contribute to the national benefit. Research users participate contributing information about needs and opportunities from science.

The mechanism for implementation, including decision making on investment in research is also a top-down process. First, ministers make decisions on the policies and investments in RS&T to contribute to national outcomes, (e.g. through annual budget to output classes). Departments contribute advice to this process. Then, ministers signal research directions to their funding and investment agents through output agreements, letters of expectation and, in the case of FRST, a gazetted statement of priorities. For example, the minister for CRIs and the minister of finance set ownership expectations for CRIs and support CRI strategic plans from a government ownership perspective. The departments implement policy by putting into place any new funds. After which, funding and investment agents make decisions on research portfolios and programmes, invest funds and manage contracts. They are expected to take account of national strategies for RS&T. Finally, research organisations design and implement research programmes.

In addition to these mechanisms, there are 'bottom-up' processes such as 'free-funding' projects. This involves funding of specific projects of their own choosing to organisations that are involved in basic research. These bottom-up projects are channelled through organizations such as the Marsden Fund and The Health Research Council.

One final mechanism worth mentioning are the programmes that fund mission–oriented research by the government through several organizations. They allocate research funding and manage research contracts by grant-based output or outcome-focused contestable funding. The organizations that organize these grants are once again, FRST, HRC, and RSNZ. These mission-oriented schemes vary as to whether they have been influenced by top-down or bottom-up processes.

5.5 Monitoring of Research Grants

The monitoring of research and reporting of achievements is conducted at all levels of government relevant to research. Ministers table Annual Reports in Parliament, and respond to Parliamentary Select committees. Departments lead and coordinate evaluation and reporting processes (of research funds, purchase agent activities, and outcomes). Research organisations report to purchase agents; and any shareholding minister (eg the minister for CRIs). The monitoring of all research funding has the following objectives according to MoRST:

- Focus on results that bring benefit New Zealand
- Consider how research contributes to outcomes rather than focusing only on the purchase of outputs
- Finding demonstration of best practice research management, including robust contract procedures and paying the full cost of research activity
- Seek out collaboration with other government agencies beyond the ones that have direct involvement
- Seek out collaboration with science users
- Determine the capability needed by existing sectors and industries in order to support and retain them
- Meet the statutory requirements including those set out in the Crown Entities Act in 2004.

The monitoring of research grants usually takes the form of a technical review. The review will first determine the proposal of MoRST to determine the larger policy objective. It will then compare all programmes by an organisation. Technical reviews place emphasis on a programme's track record and the actual delivery of outcomes over its lifetime. They are lead by funding and investment agents, consulting collaborators and end users when relevant[180].

In 2010/11 MoRST is also developing a series of measures to assess the impact of New Zealand's RS&T investment. It is expected that these measures will make up a significant part of how MoRST assesses the impact of public investment in RS&T. This will then form part of the impact measures for future Statements of Intent. The following list presents the different methods of monitoring that MoRST uses:

- Output agreements and funding agreements- MoRST prepares output agreements with the Foundation, HRC and Industrial Research Ltd (for measurement standards). Output agreements are also established with each CRI to cover CRI capability funding. These agreements are monitored regularly throughout the year through quarterly and six-monthly reports. MoRST will advise the Minister on

[180] Ministry of Research, Science and Technology (MoRST). "Statement of Intent 2009-2012 - MoRST," 2009. http://www.morst.govt.nz/publications/corporate-reports/soi/SoI-2009-2012/.

their content of these reports and any areas of outstanding performance or areas of concern. CRI Capability Fund agreements are monitored by both CCMAU and MoRST.

- Statements of intent (SOI)- In February, the Minister writes to the Foundation outlining expectations for the coming year. This letter informs the development of the Foundation's SOI, which the Minister tables in the House of Representatives on Budget day. FRST contributes to the HRC's SOI on the Minister's behalf through the Ministry of Health.
- Statement of Science Priorities- Under the Foundation for Research, Science and Technology Act 1990 the Minister needs to advise the Foundation, by notice in writing, of the priorities that the Foundation shall adhere to in carrying out its functions to allocate funds for the production of outputs relating to public good science and technology. This needs to be done at intervals of not more than three years. The output expenses covered by the Statement of Science Priorities are Research for Industry, Environmental Research, Maori Knowledge and Development Research, and Social Research. The Statement of Science Priorities was last updated in 2008.
- Ministerial directions and Ministerial terms of reference- The Minister instructs the Foundation and the Marsden Fund Council of the objectives for their investment schemes that are not included in the Statement of Science Priorities via Ministerial directions and Ministerial terms of reference. The Minister may revise Ministerial directions and terms of reference at any time of the year.
- Annual reports and the section 32A report- Under the Crown Entities Act 2004, the Minister is required to table the Foundation's annual report within the timeframe calculated under that Act. Typically this will be in early November. FRST advises the Minister on whether the content of the annual report is an accurate account of the performance of the Foundation and whether the Minister should accept the report and table it in the House.
- Directing other agencies- The figure below summarises the most significant research-related organisations MoRST can influence and the mechanisms for doing so. The extent of MoRST' influence depends on their structures and funding methods.

Figure 111 MoRST mechanisms of control

Agency	Institutional Control
The Foundation for Research, Science and Technology (FRST)	Letter of Expectations Statement of Intent Appointment of Board Ministerial Directions which set the objectives for the Foundation's investment programmes Statement of Science Priorities- the Foundation must adhere to government priorities as set by MoRST (Every three years)
Health Research Council (HRC)	Input into Statement of Intent, board appointements and priority setting Minister of Health has governance control
Crown Research Institutes (CRIs)	The Minister of Finance and the Minister of Research, Science and Technology are shareholding ministers
Marsden Fund Council (Part of RSNZ)	Appointement of members Setting Terms of Reference
Royal Society of New Zealand (RSNZ)	Non-government organisation governed by a Private Act

Source: Foundation for Research, Science and Technology (FRST). "Briefing to the Minister" 2008

Recently changes in monitoring have been made by MoRST to lower the transaction costs for research, science and technology. The benefits and changes vary by agency. In FRST, the changes are meant to help researchers because it will take less time to complete paperwork. This will give researchers more flexibility. Changes include, less

information in annual reports, no milestone reporting, and that most contracts will be ready to sign with no negotiation required[181].

FRST provides many research grants and so we can turn to it as an example of monitoring processes. FRST uses many types of review. The information gathered from the reviews is used to update the Foundation's investment strategies. Research organisation with public good research contracts are asked to supply FRST with information about the success of their projects. Specifically FRST asks for measures of: benefits (such as new or improved products, processes or services), revenue (such as co-funding), knowledge generation (such as patents), knowledge transfer (such as journal articles), sector relationships (such as user collaborations), capability development (such as PhDs).

These measures show us how the outcomes resulting from our funding change over time. The frequency of the review varies on the type of review being conducted. Specifically, the review types are:

- Domain reviews -assess all investment contracts in an area of research
- Reviews of outcome-based investments - government and expert panel process
- Quality assurance reviews - part of the negotiation contract process
- Reviews of research consortia - government and expert panel process
- Terminating contract reviews - assess the contracts in a portfolio that are due to be completed at the end of the next financial year
- Ad-hoc reviews[182].

FRST uses a range of evaluation tools to assess outputs and outcomes from its investments into research. An outcome or output may be a new product process or service that builds science and technology capability in forms or research organisations. The tools used are case studies, standards case studies, cost-benefit analyses, and surveys.

Similarly the Ministry of Education also monitors research performance using evaluation tools[183]. These include counts of research output, peer-reviewed research quality, external research contract income, research degree completions, commercialisation data, staffing trends, bibliometric data

5.6 Cataloguing Research Outputs

There is no New Zealand system for cataloguing research outputs. MoRST periodically publishes an analysis of the volume of publications produced by New Zealanders, but this is based on data from organisations such as Thomson ISI, rather than any New Zealand collection of data. While there are a number of organisations which provide online access to New Zealand produced material, there is no New Zealand wide service. The closest would be the Kiwi Research and Information Service (KRIS) run by the National Library which deals mainly with material produced by the eight universities. It has some data on the most popular downloaded items, but it is not complete. Also, KRIS tends to be a harvester of recent theses and some articles and does not include all the research outputs of the universities.

Universities in New Zealand are faced with nineteen forms of 'compliance activities' or academic audits. These audits require systems for cataloguing research because many take into account the number of publications, amount of research, quality etc. The PBRF, the largest and most important audit -as it determines the largest portion of

[181] Ministry of Research, Science and Technology (MoRST). "Reducing RS&T Transaction Costs" 2010.

[182] EraWatch National Profiles: New Zealand, Research Organisations, 2009

[183] Smart, Warren. "The Use of Bibliometrics to Monitor the Performance of the New Zealand Tertiary Education System," September 3, 2010. http://espace.library.uq.edu.au/view/UQ:177905.

public funding to universities- asks for an assessment of research quality by encouraging staff at eligible TEOs to submit Nominated Research Outputs (NROs). NROs are the researcher's four best pieces of research and they are made available to assessors to assist in assessment. In the 2012 PBRF NROs can only be submitted by TEOs to the TEC in electronic format. NROs will be accessed either as links to an existing repository or a copy can be uploaded to the TEC in electronic format. This marks a significant shift in the availability of NROs. Rather than being requested as physical items from TEOs, which is what occurred in 2006, as far as possible all NROs will be electronically accessible by the TEC from 20 July 2012. The government is not providing a universal platform for cataloguing research outputs. Therefore, TEOs are considering how best to electronically capture the four NROs of their PBRF-eligible staff. For most researchers this will involve the TEO creating a PDF version of a journal article, book chapter, book or other piece of text. For some researchers this will involve the TEO creating digital photographs, sound recordings or videos. For researchers who have one or more of their NROs published on a website, the TEO will document, for each NRO, a Uniform Resource Identifier (URI) (or equivalent, such as DOI) link leading directly to the NRO. Many universities have developed research output catalougues in preparation of the 2012 PBRF and some are even sharing their system with other universities. For example the University of Auckland has worked with the company Websol to develop ROMS, the Research Output Management System which collects, collates and reports on research output data and submits reports that meet the specifications to the government for the purpose of allocating research funding to universities.

There are few concerted initiatives to present research results for use in practice. Two that are mentioned are SET, designed for practitioners, and the more recent Ministry of Education on-line resource Te Kete Ipurangi (TKI), a bi-lingual portal education website which aims to provide New Zealand school communities with easy access to useful information, including research information, on the Internet. There are other more project-based examples of research that has presented its findings in such a way as to make them immediately useful to practitioners. The reports produced by the National Education Monitoring Project are considered to be a good example of evidence-based research results presented in a way that makes them immediately available for use by practitioners.

Finally, some evidence exists for the intent to catalogue research outputs in the future. First, MoRST has stated supporting eResearch initiatives which may in turn lead to the cataloguing of research outputs. These initiatives include: grid computing and grid middleware, collaboration tools, high performance computing and supercomputers, data and publication repositories, ultra high speed broadband networks and safe data transit methods. Once these initiatives take effect, the infrastructure to catalogue research data will be in place. Though there is some evidence of the use of bibliometric methods used by New Zealand agencies, and thereby, bibliometric databases, information on the nature and specifics of the databases were not found. MoRST has acknowledged using bibliometric analyses such as co-authorship/collaboration data, unit record datasets, and New Zealand published papers data. Second, members of the TEC have stated concerns about the changing nature of scholarly communication[184]. While traditional journal articles remain strong, there is a need to address the open access repositories, institution and multidisciplinary working papers, pre-prints, blog posts, wiki content, and social networking sites. Addressing the difficulty of measuring or reviewing such research output coupled with increased data management capability may initiate cataloguing attempts in the near future. Third, in a recent publication, "Reducing RS&T Transaction Costs", MoRST has stated that it is working with other agencies to facilitate better collection and use of existing statistics. They hope to develop a common approach to post-contract relationships and capturing information on the long-term outcomes of New Zealand's investment in RS&T.

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Currently MoRST collects information on the following performance indicators for every budget:

- Inputs
  - Dollar value of new and active contracts
  - Contracts profiled by provider type (standard classification for organisation type)
  - Contracts profiled by purpose of research (using standard socio-economic objective classification)
  - Contracts profiled by emerging technology (biotechnology, nanotechnology, , other)
  - Contracts profiled by type of research (basic untargeted, basic targeted, applied, experimental development, product development)
  - FTEs supported in contracts (researcher, technician, post-doctorates, post-graduate students, other)
  - Dollar value sub-contracted out to other organisations (subcontracted organisation classified by standard classification for organisation type)
  - Contract profiled by extent of alignment to Vision Matauranga research themes
  - Overbidding (number of applications/number of contracts issued)
- Outputs
  - Number of peer -reviewed journal articles and books or book chapters
  - Number of key-note addresses and awards (national/international) for science achievement
  - Number of students (Masters, PhD) undertaking qualifications and post-doctoral research supported
  - Number of new IP applications (provisional, PCT, PVR) and patents granted (New Zealand, the USA, European Union, other)
  - Number of new or improved products, processes, and services (classified by user type)
  - Dollar value of co-investment into research activities (direct/related, cash/in kind) by co-funder type
  - Dollar value of revenue from research outputs by user type and output type
  - FTEs, sales revenue and export revenue of spinouts by industry sector
  - Number of research dissemination activities to users by user type
  - Number of international collaborations classified by country

An example of the type of data that is collected is given in figure below.

Figure 112 Number of new or imported products, processes and services

	Funding and Investment Agent	Used by Business (including private not-for-profit organisations)			Used by Government (including local and central Government and CRIs)			Used by Tertiary Education Institutions			Used by Other Organisations (including overseas researchers, users)		
		Products	Processes	Services	Products	Processes	Services	Products	Processes	Services	Products	Processes	Services
Environmental Research	FRST	10	6	20	97	28	369	0	0	0	0	1	11
Health Research	HRC	1	0	27	1	0	50	0	0	3	1	0	41
Māori Knowledge	FRST	0	4	0	0	0	7	0	0	0	0	0	0
Māori Knowledge	HRC	0	0	0	0	0	0	0	0	0	0	0	0
eNew Economy Research Fund	FRST	9	13	11	0	0	0	0	0	0	12	1	1
Research for Industry	FRST	144	99	488	40	23	87	0	0	0	12	0	30
Social Research	FRST	1	0	1	0	0	14	0	0	0	0	0	0
Sustainable Energy Development	FRST	0	0	0	0	0	0	0	0	0	0	0	0

Source: Ministry of Research, Science and Technology (MoRST). Performance Measures, 2008-09

5.7 Examples of Successful Research Policy

5.7.1 Completion Rates of Doctoral Students

In 2002, New Zealand ranked 14th out of 27 OECD countries in graduation rates from advanced research programmes. The inclusion of the Research Degree Completion (RDC) component in the PBRF was partly in acknowledgement that the completion rates of postgraduate research students in New Zealand was low[185]. It created a significant financial incentive for tertiary institutions to maximise the number of postgraduate research students who complete their studies and do so in a timely manner. Tertiary institutions responded to the changed incentives by reviewing the selection more carefully, monitoring their experience and increasing pastoral care of doctoral candidates. A report by the Ministry of Education, *Persistence in doctoral research: Analysing the impact of the PBRF on the retention of doctoral students*, concluded a significant increase in completion rates. The long-term completion rate for doctoral students is more than 60 percent. The study found that students who studied in the sciences and students in the early stages of their doctoral studies had a higher likelihood of retention. The study also found that the gender and residency status of doctoral students did not have a statistically significant impact on the likelihood of retention.

[185] PBRF Working Group, 2002

Figure 113 Students completing doctor of philosophy degrees by main subject of study 2003-2008

Main subject of study	2003	2004	2005	2006	2007	2008	% Change 2007 - 2008	% Change 1998 - 2008
Agriculture, Food, Forestry and Environment	20	20	23	22	19	25	31.6%	25.0%
Biology/Biological Science	98	115	106	123	118	141	19.5%	62.1%
Engineering and Architecture	40	43	46	41	59	69	16.9%	115.6%
Humanities	69	81	66	80	90	83	-7.8%	186.2%
Law, Business and Commerce	47	58	60	59	57	66	15.8%	187.0%
Mathematics and computer and Information Science	25	44	28	33	44	53	20.5%	89.3%
Medicine and Health sciences	45	65	71	55	73	92	26.0%	253.8%
Physical Sciences	72	68	91	54	80	100	25.0%	28.2%
Social Sciences	120	105	130	121	89	132	48.3%	88.6%
Not stated	12	18	18	26	31	31	0.0%	244.4%
Total	548	617	639	614	660	792	20.0%	97.0%

Source: Tertiary Education Commission and Ministry of Education

The seven-year completion rates for doctoral students increased from 49 percent for students who began their doctorate degrees in 1998 to 54 percent for students who started in 2000. The long-term completion rate for doctoral students is more than 60 percent.

Figure 114 *Domestic* Doctoral Student Completions by Year

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	% change 98-08	% change 07-08
Total	402	471	456	444	499	548	617	639	614	660	792	97.00%	20.00%

Source: Tertiary Education Commission and Ministry of Education

Country	Completion %	Period	Source
New Zealand	60%	10 years	Smart, Warren. "Persistence in doctoral research: analysing the impact of the PBRF on the retention of doctoral students," 2007. http://www.educationcounts.govt.nz/publications/tertiary_education/16344.

According to Warren Smart[186]: Previous studies on the completion of postgraduate qualifications have found that students in the sciences have a higher likelihood of completion than those in the social sciences/arts areas[187]. A study by the Higher Education Funding Council for England[188] suggested that a reason for the sciences

[186] Smart, Warren. "Persistence in doctoral research: analysing the impact of the PBRF on the retention of doctoral students," 2007. http://www.educationcounts.govt.nz/publications/tertiary_education/16344.

[187] Martin, Y., Maclachlan, M & Karmel, T. (2001) Postgraduate completion rates, Occasional paper series, Canberra: Department of Education, Training and Youth Affairs.

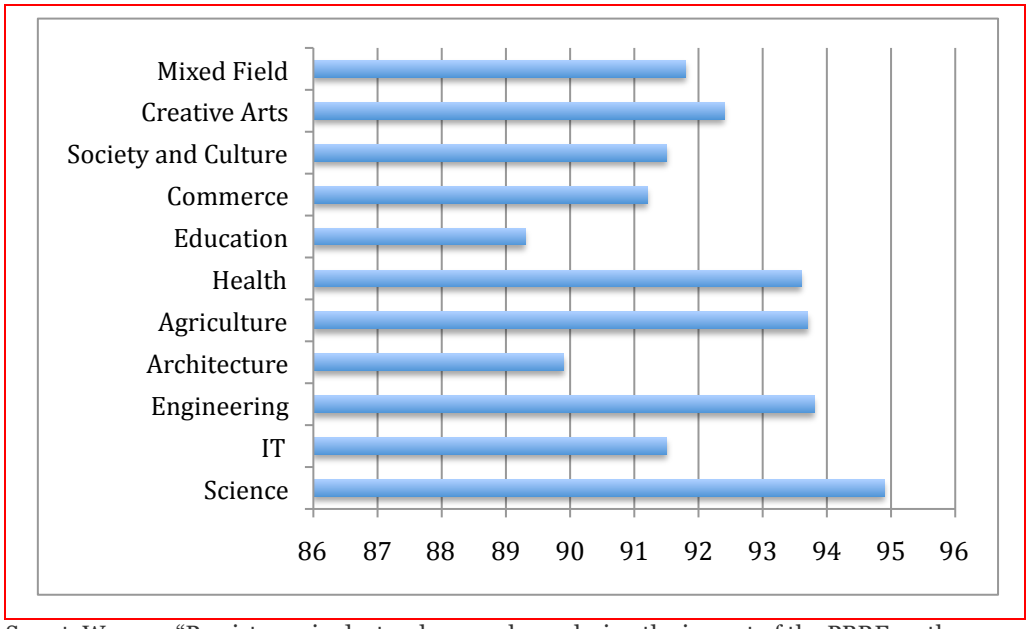
[188] HEFCE (2005) PhD research degrees. Entry and retention, UK: Higher Education Funding Council for England.

having higher rates of completion at the doctoral level was because research in this area was well established and that basic methodological disputes were rare. This compares with some areas in the social sciences and humanities which the study suggested may be less well established and where methodologies may still be disputed.

It is also possible that in sciences a doctorate is the standard terminal qualification. This is less so in other fields, where a masters may be an appropriate end qualification. This may lead to a lower incentive for these students to stay.

The same report, also estimates, predicted probability of retention. The reference group used in the regression was a student aged 25 in their first year of doctoral study, studying on a full-time basis at an average New Zealand university in the period prior to the introduction of the PBRF (See Figure 115). Of the subjects taken by doctoral students, science, agriculture and health generally had a higher retention rate than for society and culture, although the magnitude of the difference in the likelihood of retention was small. The higher retention rate for students in the sciences, agriculture and health mirrors the results of studies by HEFCE (2005) and Martin et al (2001) of completion rates at the doctoral level in the United Kingdom and Australia, respectively.

Figure 115 Predicted Probability of retention by field of study (%)



Smart, Warren. "Persistence in doctoral research: analysing the impact of the PBRF on the retention of doctoral students," 2007.
http://www.educationcounts.govt.nz/publications/tertiary_education/16344.

5.7.2 Recent changes

Public Sector Financing of Research is a survey conducted yearly by MoRST. Public sector investment in R&D has increased considerably during the three years in which the survey has been conducted: $881 million in 2006, $946 million in 2007, and $1020 million in 2008.

Compared with the 2007 survey, there has been a decline in the proportion of public sector spending going to CRIs. In 2007 CRIs accounted for one-third of central government investment in R&D (excluding Vote RS&T). This figure has dropped to just 18% in 2008. This change comes while central government is increasing the portion of R&D it conducts in-house (from 15% to 27%) and contracts to universities (from 15% to 20%). While some of this decline can be attributed to improved respondent understanding of the survey, it still represents a significant change.

The other apparent change has been an increase in environmental research. In 2007, reported expenditure on R&D aimed at environmental purposes (excluding Vote RS&T) was small- about 7% of central government R&D expenditure. In 2008 it accounted for 33%, and is the most common socio-economic objective of both central and local government R&D.

6. Sweden

6.1 Overview of research system

The ministry responsible for the research policy is the Ministry of Education and Research. Sweden is a bit particular in international comparison insofar as it has rather small ministries which essentially only direct the policy and distribute funding. Under the ministries, there are national agencies, which can be rather large and in practice carry out and monitor much of the policies. Most national agencies in the research sector sort under the Ministry of Education and Research. The other ministries, with sector interests in research, communicate and interact with the Ministry of Education and Research in order to push their own priorities through.

One rather unique trait of character in the Swedish public administration is the distinct separation between the ministries and the agencies. Ministries in Sweden are organised together in a formal organisation headed by the Prime Minister – the Government Offices (Regeringskansliet).

6.1.1 Trend

Swedish research policy has traditionally been characterised by a balance between basic research, at universities, and sectoral research of a more applied kind, at institutes. Over the years, the balance has shifted back and forth, but not dramatically. The governmental inquiry *Forskning 2000* which proposed the new order with today's four research funding organisations (it came into effect 2001) meant a slight shift towards stronger support for basic research.

The liberal government that took office in 2006 initiated an agenda which so far have given strong additional funds to the universities themselves as well as to basic research, distributed via the research councils, *and* to goal oriented applied research, generally, but especially within specified strategic areas. The innovation agency VINNOVA has also seen its funds increase these past years.

While increasing the financial support to essentially all areas and thus maintaining the balance, the government has strongly emphasised utilisation of the scientific results. This can be interpreted as a slight shift back from what was the previous policy. Innovation offices have been created at the major universities, and the universities' holding companies have got additional funds. University staff is now obliged to report to the employer any outcome of their research that potentially could lead to commercialisation. The employer (a university, most often) can then chose to drop the case or carry on with further evaluation and patenting etc.

There has also been a strong trend towards a quality-driven agenda through all parts of the academic sector. A research-performance based system for distribution of the direct funds to universities has been launched, and a system for quality based distribution of funds for teaching is also decided upon. The research institutes have been re-organised. On 1 January 2011 the Swedish HEIs will wake up with a new legislation which will mean very far reaching university autonomy, again with the purpose to increase the quality. Whether they are prepared for such freedom and have plans for how to use it and take position on their own in the increasingly competitive climate, remains to be seen.

6.1.2 Steering and governance

As mentioned, the agencies are separate organisations with considerable autonomy, in relation to the responsible ministry. Of course this has a profound effect on steering and the control system. The steering of the public administration can be described as management by results. This model of steering embraces two main ideas: one regarding delegation, the other regarding information. According to the first, politicians leave smaller decisions, for example about agencies' internal organisation

and staffing, to the agency itself. Politicians should instead be focused on formulating goals and guidelines for the administration and following up the results. The second idea is that agencies can be controlled through a certain kind of information flow. The ministries send instructions in the form of regulations with general objectives and annual allocation letters, which include both what kind of activities the agencies should prioritise and the amount of resources they are assigned for these different activities. In turn, the agencies are obligated to annually report back to the ministries about both results and costs in relation to the allocation letters. This information then forms the foundation for future new objectives and requirements. Agencies also can receive special objectives, which often are reported respectively.

In other words, the government's job is to formulate the overall goals for the different parts of the administration and to distribute the financial means that are considered necessary for the task at hand. The agencies' duty is to execute their tasks in line with the assigned objectives. Objectives are to include both activities and outcomes. Furthermore, they should be as precise as possible, preferably measurable and time specified.

In practice, the respective ministry has a number of options to exercise steering and control over their agencies. The goals can for example be formulated in a way that allows more or less room for interpretation. The amount of money that is assigned to the different objectives has a very imperative effect and can limit the agencies' room for action. Studies also show that the agencies are very responsive in relation to the ministries' intentions. Though ministers are not allowed to have an official opinion on individual cases that is handled by the administration, their public statements are often interpreted by the agencies and can, according to studies, be a factor in the priorities that the agencies make.

The Swedish central administration has during the recent years gone through some reforms and re-organisations in an attempt to make steering more efficient. One major change is that the requirements of agencies to report their results have been made more streamlined. A problem with the old system was that the agencies at a certain period during year became overwhelmed with work because of the production of the thorough annual reports demanded by the ministries. The form of this reporting has now been made less formalised and the agencies have more freedom in designing the annual reports. The allocation letters, which in fact stipulates the different agencies' objectives and areas of responsibilities, is another issue that has gone through some changes. The letters no longer contain so much of the "obvious" tasks and general objectives, which are set out in the regulations for the respective agency. The agencies therefore no longer need to report every aspect of their work, which is supposed to ease the workload for all parts involved. It is yet to be determined to what extent these changes in the routines will affect the agencies' situation and their ambitions of becoming more efficient, and also the capabilities for the ministries to exercise steering and control.

6.1.3 Principal research policy making organisations

The Swedish Parliament decides on research policy every four years by signing a research policy bill prepared by the government in power and in particular by two major research policy-forming bodies (plus, in a specific sense, the Ministry of Defence, not further included here):

- Ministry of Education and Research
- Ministry of Enterprise, Energy and Communications

The Ministries of Education and Enterprise encompass a research policy council (established in 1962) and an innovation policy council (established in 2004), respectively, which coordinate policy development yet have only an advisory function to the government. Due to its recent establishment, the innovation policy council is yet to make a firm mark on policy formation. The Growth Analysis Agency under the umbrella of the Ministry of Enterprise also supports the government with statistical

and particularly economic analyses related to R&D, among other things. Policies are implemented by various agencies that act semi-independently within the framework of government white papers.

6.1.4 Principal research funding organisations

There are three main research councils. In addition there is one innovation agency which also supports research, but with the purpose to bridge academic research and industry in the widest possible way. They are:

- The Swedish Research Council (Vetenskapsrådet, VR)
- The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas)
- The Swedish Council for Working Life and Social Research (FAS)
- The Swedish Governmental Agency for Innovation Systems (VINNOVA)

In addition, the Swedish Energy Agency and the Swedish Space Board also supports targeted research to some Essentially, the funding is distributed on a bottom-up principle; it is the researchers themselves who design and propose a research idea, and apply for funding. However, the funding organisations often launch certain themes or other kind of strategic funding channels, with specific requirements for applicants. In this way there is often an in-built top-down principle at work as well. Within such themes or strategic areas, a bottom-up approach is still applied. There are no significant differences between the four organisations, but the requirements for funding from VINNOVA are naturally different from the three research councils' requirements.

The current organisation with these four main funding bodies is just ten years old. When it was launched, it meant the closure of a range of smaller research councils or other governmental funding organisations, which in reality were cut up and merged into the four larger organisations. The idea was to enhance scientific relevance, collaboration across disciplinary borders, and internationalisation. There was a feeling that the previous organisation with a range of field specific research councils had become outdated, and could not meet the perceived challenges of the 21st century. Larger units seemed like the solution.

Why did Sweden not go all the way, like Norway, and create one single research council? According to the governmental bill from 2000 where the current order is outlined for parliamentary decision, there is no clear explanation of why two smaller research councils are needed beside the Swedish Research Council (Prop 1999/2000:81). The explanation should perhaps be sought in the tradition of the Ministry of Social Affairs having had a research council for social issues under its umbrella (Socialvetenskapliga forskningsrådet, SFR) before, and the Ministry of Agriculture having had a council for forestry and agricultural issues (Skogs- och jordbrukets forskningsråd, SJFR). It was probably for political reasons easy to keep this order (or difficult to break it up). FAS took over much of SFR's responsibilities and it is placed under the Ministry of Social Affairs, and Formas took over most of SJFR's responsibilities, and it is placed under the Ministry of Agriculture and the Ministry of Environment, in cooperation.

Else, it is clear that the creation of the Swedish Research Council was motivated by the perceived need to unify the support to all disciplines within one main funding body, with overall responsibility for the bottom-up research funding in Sweden. It is similarly clear that the creation of the innovation agency VINNOVA was motivated by the increasingly strong need to better utilise the scientific results and strengthen Sweden's industrial competitiveness.

6.1.5 Principal research organisations

The principal public research performing organisations are the universities (fourteen) and to some extent the university colleges (högskolor). All universities and university colleges except three are in the form of national agencies. There are 29 state universities or university colleges (the latter typically do not provide research training); in addition seven state art colleges. A handful of private small schools, many of which give education in theology, complement these ones.

The Swedish institute sector is small in international comparison. Research Institutes of Sweden (RISE) functions as an umbrella organisation for 19 institutes in various industrial areas. Funding comes from the government and VINNOVA, EU-funds and from private firms.

6.1.6 Distribution of funding

Sweden is one of the countries that invest the most public resources in research and development (R&D) in relation to the size of its population as well as its GDP. Public funds to R&D in the central government budget amounted to SEK 25.6 billion in 2008 (app. divide by ten for euros; € 2.5 billion). For 2010 the governmental research budget is estimated to reach SEK 29.5 billion. Central government funds to R&D combined with R&D funds from municipalities, county councils and research foundations amounted to some 0.94 per cent of GDP in 2008.

R&D activities are carried out in different sectors of society to various degrees. The main part of R&D expenditure in Sweden is in the business enterprise sector and accounts for about three quarters of all R&D expenditure in Sweden. The remaining quarter is what we include in the notion of public R&D.

Figure 116 R&D expenditure in Sweden, 2007

Funding of R&D conducted in Sweden						
Million SEK						
2007						
Funding sources	Total	Private sector	HEI sector	Govern-mental agencies	Private not for profit org.	Regions and municip alities
Total R&D expenditure in Sweden	110 454	81 449	23 520	3 298	179	2 008
Private funding	73 166	69 304	3 497	88	74	203
of which from:						
private sector	70 588	69 187	1 156	65	6	174
private not for profit org.	2 072	46	1 906	23	68	29
Public funding	26 990	3 593	18 398	3 116	98	1 785
of which from:						
governmental funding	23 214	3 358	16 650	3 097	59	50
Sum Swedish funding bodies	100 156	72 897	21 895	3 204	172	1 988
From abroad	10 291	8 552	1 623	93	6	17
of which from:						
foreign companies	7 883	7 589	276	7	-	11
EU	1 602	548	996	53	-	5

Source: Statistics Sweden.

Figure 116 describes how R&D expenditures in Sweden are split between the HEI sector, the private sector, governmental agencies, other private not for profit organisations, like foundations, and regions (where hospitals are included) and municipalities. Foreign funding, from the EU or from other sources, primarily foreign companies, makes up for less than one tenth of the conducted R&D.

Comparisons of R&D expenditures from previous years are given in Figure 117.

Figure 117 R&D expenditures 1997–2007, million SEK

Year	Companies	HEI sector	Governmental agencies	Private not for profit	Regions and municipalities	Total
1997	50 151	14 452	2 372	50	..	67 025
1999	56 954	16 983	2 547	86	..	76 570
2001	75 135	19 013	2 751	89	..	96 988
2003	71 953	21 062	3 382	377	..	96 774
2005 [1]	71 702	21 660	3 089	306	1 717[2]	98 474
2007	81 449	23 520	3 298	179	2 008	110 454

Source: *Statistics Sweden*. Agencies, regions and municipalities are classified as Public sector.

[1] 2005 was the first year when companies with 10-49 employees were included.

[2] 2005 was the first year when regions and municipalities were included. So called ALF-money (for medical candidates' research training) is included in the HEI sector although administered by regional authorities.

Since World War II, Swedish central government-supported basic research has in principle been funded in two ways: through direct appropriations to universities (faculty funds) and through appropriations via the research councils (council appropriations). The first way or funding stream contains the basic funding of universities. The second stream is the external funding (external from a university perspective; not a direct resource from the state). This second stream comes from research councils, agencies for support of directed research and so on (for example public or semiprivate foundations for strategic research, environmental research etc.).

Figure 118 presents the 2010 figures split between the research councils, the universities and other R&D funding agencies.

Figure 118 Governmental R&D expenditures/recipient 2010. Million SEK.

Recipient	2010	Share (%)
Universities and colleges	13 636	46.3
Swedish Research Council	4 500	15.3
VINNOVA	1 905	6.5
Formas	895	3.0
FAS	393	1.3
Defence Agencies	2 178	7.4
Other agencies	5 953	20.2
Total	29 469	100

Source: Statistics Sweden

6.1.7 University autonomy

It is impossible in an overview of the Swedish research system of 2010 not to mention the changes regarding university autonomy that will take effect as of 1 January 2011. Today's detailed regulation of the higher education legislation will be made significantly less extensive.

Higher education institutions will be free to shape their internal organisation as best suits each institution's situation and needs. Consequently, a higher education institution should decide on its own internal organisation apart from board and vice-chancellor. When a higher education institution decides on its organisation two principles are always to be observed:

- Decisions requiring a particular, qualified assessment must be taken by people with scientific or artistic qualifications.
- The students must have the right to representation when decisions are taken or preparations are made that significantly affect the education or the situation of the students.

One key area of change is academic positions. Apart from professors and senior lecturers, higher education institutions will be free to decide for themselves on the categories of teacher that should be employed by the institution and the qualifying requirements and assessment criteria that should apply to these teachers. Higher education institutions will be free to decide for themselves on the procedure for appointments. Higher education institutions will also be free to decide on the promotion opportunities that should be available to the teachers employed by the institution.

6.2 Administrative efficiency of research performers

6.2.1 Administrative costs at the HEIs

Regrettably, there is no way to calculate the administrative costs at the principal public research performing bodies in Sweden, the universities and the colleges. There is no single way to measure this – each and everyone do it in their own manner – and in any case, it is not specified in the annual reports. The administrative costs are incorporated in the respective institutions' budgets, and administrative costs on university level like the library and the rector's office are not singled out.

The former head budget officer (until 2009) at the Division for Higher Education, Ministry of Education and Research, responsible for calculating all universities' budget allocations as well as being the recipient of their financial reporting, was contacted in order to understand how the administrative costs could be calculated. The answer was prompt: "It is not possible".

6.2.2 Administrative costs at the funding agencies

It is however possible to find figures for the funding agencies. Their annual reports have a fairly clear and consequent definition of administrative costs. These numbers are presented here in both absolute numbers and as a percentage in relation to the total appropriation for the respective agency. VR and VINNOVA are by far the two largest actors. In 2001 VR funded research for almost SEK 2 billion in total, while VINNOVA funded research for more than SEK 1 billion. In 2009 the same figures reached a total of more than SEK 4 billion for VR and SEK 2 billion for VINNOVA. Formas and FAS are significantly smaller organisations, and managed budgets of SEK 900 and SEK 400 million, respectively, in 2009.

There has been a significant increase in funding over the past decade. Roughly speaking there has been a doubling in funding between 2001 and 2009. This circumstance leads to an increase of the administrative costs too. In 2001 the operative expenses of VR amounted a total of SEK 249 million; in 2009 the same figure was SEK 363 million. This increase of the administrative costs occurred almost entirely between 2001 and 2002; after that the costs have been stable but with some variation from year to year. VINNOVA reported a cost of 148 million in 2001 and in 2009 it was SEK 294 million. This increase is more gradual and constant. These two large funding agencies show a substantial increase in administrative costs over time. However, the smaller funding agencies present another picture. Formas reported a cost of SEK 59 million in 2001; in 2009 the administrative costs had only gone up to SEK 66 million. FAS had costs of SEK 30 million in 2003 and SEK 38 million 2009.

Figure 119 Administrative costs (million SEK) for funding agencies

	2001	2002	2003	2004	2005	2006	2007	2008	2009
VINNOVA	148	150	161	181	170	222	236	279	294
VR	249	344	354	363	337	369	395	363	363
Formas	59	54	54	59	64	61	59	61	66
FAS	-	-	31	34	32	34	37	36	38

Source: Annual budgets of VINNOVA, VR, Formas and FAS

There is an increase of administrative costs in absolute numbers in all four organisations but when looking at the increase in relation to the appropriations, which have almost doubled over the same period of time, we find that three out of the four agencies have managed to reduce administrative costs in proportion to the total spending. As mentioned above, FAS and Formas have had nearly constant administration costs during the decade. As funding has increased, the relative share of administration costs has decreased.

VR presents a similar pattern although with larger variations. The cost of administration has been rather stable from 2002 and onward, but since 2006 the funding has gone up significantly which in turn have lead to a relative decrease in administrative costs.

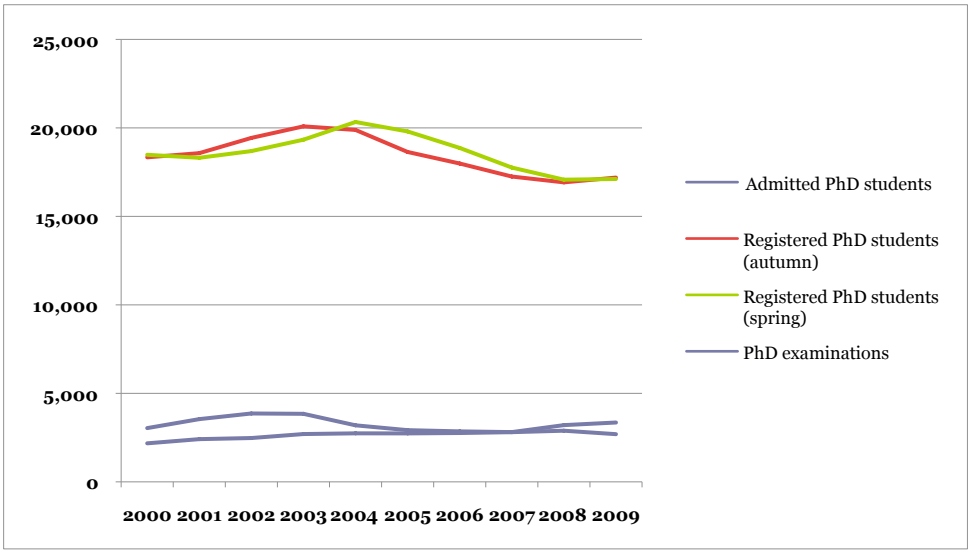
6.3 Research education

Postgraduate training builds on a completed programme of undergraduate education. Furthermore, the faculty board in question may add other requirements for admission. An assessment is also made of an applicant's ability to complete postgraduate studies. Postgraduate training is financed out of the funding allocated to each university faculty. There is also funding from external sources such as research councils.

Admission to doctoral studies and research training is restricted and competition is keen. Universities and university colleges can only admit students who are funded for the entire study period, or who have been awarded a postgraduate studentship (doktorandtjänst) or a study grant (utbildningsbidrag) by the university. In other cases the applicant must have guaranteed study funding from other sources for the whole period of study. The faculty boards decide whether the ear-marked resources should be used for postgraduate positions or for study grants. Both positions and grants run for four years.

Postgraduate students holding postgraduate positions are obliged to concentrate on their studies, but are allowed to combine them with teaching or other work to a limited extent. A relatively common way of financing postgraduate studies is to combine them with work on a research project which may be externally funded by a research council or a sectoral agency.

Figure 120 Swedish research education. Key figures; no. of PhD students per year



The four research funding organisations do provide indirect funding for research education; it is not one of their main tasks and they do not provide such funding as ear-marked scholarships. Instead, when granting a research project, it may be understood that parts of the grant will be used for the employment of a PhD student. This can be the result of a negotiation between the university and the funding organisation, predominantly in the case of VINNOVA, or in the case of any of the three research councils, it may simply be the choice of the receiving institution. Parts of the grant will then be used by the receiving institution for a position as 'doktorand' – an employed PhD student. This position will be announced like any other position and the candidates will be evaluated according to their merits and qualifications for the working tasks. The funding organisations have no insight in this process or the selection of the PhD student; they may not even know for sure if and to what extent the grant will be used for research education.

The proportion of new doctoral students who finish their doctoral studies within five years has increased during the last 20 years. In 1980 the proportion was 18%, in 2004 the proportion was 45%. The proportion of new doctoral students who do not finish their PhD is decreasing. 46% of the new doctoral students of 1980 did not finish their PhD, while only 29% of the new doctoral students of 2000 did not.

Figure 121 Length of study for new doctoral students

Initial Year	New doctoral students	Finished PhDs within						Not finished PhDs until 2009	
		5 years		6 years		8 years			
	Number	Number	%	Number	%	Number	%	Number	%
1980	1 750	310	18	440	25	630	36	810	46
1985	2 050	380	19	550	27	820	40	880	43
1990	2 310	520	23	800	34	1 130	49	850	37
1995	3 020	970	32	1 350	45	1 780	59	980	32
2000	3 060	1 310	43	1 740	57	2 110	69	870	29
2004	3 200	1 430	45	.	.	.	.	1 770	55

Source: *SCB and HSV*. UF 21 SM 1001, p 36.

Figure 122 Length of study for new doctoral students in the year 2001 who passed a doctoral degree or not, by field

Field	New doctoral students 2001	Proportion of finished PhDs whit in					Not finished PhDs until 2009
		4 years	5 years	6 years	7 years	8 years	
Total	3 548	23	45	58	66	71	29
Social sciences	823	10	28	43	55	63	37
Medical sciences	1 058	40	59	70	76	81	19
Natural sciences	525	20	49	62	69	74	26
Enginee-ring	986	19	42	56	61	64	36
Agricult-ural sciences	157	27	50	63	73	79	21

Source: *SCB and HSV*. UF 21 SM 1001, p 95.

How economically attractive it is to do a PhD? How much is a PhD candidate paid per year, whether in the form of wages or via a stipend or grant?

Figure 123 provides a picture, and those numbers are based on a study made by the main labour union SULF (Sveriges Universitetslärarförbund) and relates to their members. According to the study the mean salary per month is between SEK 23 650-24 710. This level sums to an approximate income per year of SEK 283 800-296 520. All figures are before tax. The income tax on this income level is approximately 30%.

Figure 123 Mean salary in 2010, for SULF-members employed within academia

Field	Mean salary/year
Arts & Humanities	284,400
Social sciences	283,800
Technical & Natural sciences	296,520
Medical sciences	289,080

Source: Humanisterna och den svenska arbetsmarknaden

6.4 Research funding criteria and mechanisms

6.4.1 Performance-based research funding

A new model for allocation of direct funding to the universities was introduced in 2009. The model attempts to promote quality in the research performance, and redistribute funding to those universities which show the best performance.

The first year (2009) only the new funding (additional funding compared to 2008) was affected and was allocated based on the indicators *external funding* and *bibliometrics*. Thus, that annual increase was not distributed according to the same fixed proportions that had so far been the case, but according to the new quality based model.

In 2010 all new funding was again allocated based on the same indicators. On top of that, 10 % of the fixed basic funding was also redistributed. However, before the redistribution a guarantee sum is deducted, based on the number of students at each university. In effect about 8 % was redistributed.

From 2011 and onwards each university put in the same amount they received from the redistribution the year before minus the guarantee sum plus 10 % of the new basic funding, if any. It turns out that the loss or gain for a specific university is at most 2 % and for the vast majority of universities is well below 1 %.

Since 2010, the former Director General of the National Agency for Higher Education professor Anders Flodström is leading a governmental inquiry with the task of developing the indicators and proposes additional indicators to be used. No preliminary results are available at this stage.

Research funding is also distributed through the national agencies which are principally free to set priorities on field or programme level according to their own understanding. On a more general level, distribution of government funds on certain main scientific areas is spelled out in the annual allocation letters. The research councils use the money for the respective areas primarily through open calls for tenders from individual researchers or from institutional bidders. Some money may be earmarked for international exchange or young researchers, for instance. Rarely is governmental funds earmarked for a more narrow scientific field. Thus, bottom-up is the dominating way of creating projects.

6.4.2 Priority-setting at the national level

In the governmental research and innovation bill of 2008, twenty strategic areas were pointed out and SEK 1.8 billion was allocated for the period 2009–2012. The funding are to be distributed through the research funding agencies, and ten of those areas are managed by the Swedish Research Council, the remaining ten by other agencies.

Strategic areas:

- Energy
- Sustainable exploitation of natural resources
- Effects on natural resources, ecosystems and biological diversity
- Climate models
- Sea environmental research
- Cancer
- Diabetes
- Epidemiology
- Molecular biology
- Neuroscience, incl. brain- and nerve system diseases
- Stem cells and regenerative medicine
- Health
- Nanoscience and nanotechnology
- E-science
- Material science, incl. functional materials
- IT and mobile communication, incl. future solutions for communication and monitoring systems
- Production technology
- Transport research
- Security and crisis management
- Politically important geographical regions

Even though these strategic areas are specifically pointed out by the government, calls are to a large extent open and follow the regular procedure where proposals are submitted by the research community.

6.4.3 Swedish Research Council

The Swedish Research Council is Sweden's largest financer of basic research. In 2008, the agency allocated approximately SEK 3.6 billion in state funding for research and research information. The agency also receives a state appropriation of SEK 40 million for the Swedish University Computer Network (SUNET) and SEK 110 million for administration. Within the council, so called scientific councils for the main scientific areas are responsible for the distribution of the funding. Research financing is divided into research projects, infrastructures, positions, scholarships, research environments, and various types of national and international collaboration. Of these funding categories the most extensive is research project funding, which comprised about half of all funding allocated by the agency in 2008. Research in the natural and engineering sciences received the greatest share of funding (approximately 50%), followed by medicine (approximately 30%).

Figure 124 Swedish Research Council budget 2008.

Swedish Research Council budget for research and research information	**Budget 2008 (1000 SEK)**
Scientific Council for Humanities and Social Sciences	257 752
Scientific Council for Medicine	804 142
Scientific Council for Natural and Engineering Sciences	969 188
Scientific Committee on Educational Sciences	145 235
Swedish Research Council Board of Directors	1 416 564
Total	**3 592 881**
Swedish Research Council budget for Swedish University Computer Network (Sunet)	40 408
Swedish Research Council budget for administration	109 885

6.4.4 VINNOVA

An important part of VINNOVA's activities consists of increasing the cooperation between companies, universities, research institutes and other organisations in the Swedish innovation system. This is done in a number of ways, including long-term investment in strong research and innovation milieus, investment in projects to increase commercialisation of research results and by creating catalytic meeting places in the form of conferences and seminars. The support programmes target universities, SMEs, research institutes, local and regional authorities, and individual researchers.

Programmes by subject:

- Biotechnology
- Environmental and Energy Technology
- Gender
- Health
- Information and Communications Technology
- IT Implementation Materials
- Product Realisation
- Security
- Services
- Transportation
- Working Life

VINNOVA has a strong focus on coordination as well as synergies between regional, national and international initiatives. This is a prerequisite to counteract fragmentation and dilution of Sweden's resources, on both regional and national level. In its future strategy, VINNOVA identifies specific opportunities stimulating innovation investments especially in five different areas:

- Adaptation of Swedish automotive industry to meet future demand
- Innovation in small and medium sized companies and innovation based start-ups
- Measures for strengthening demand in future growth areas
- Regional mobilisations of resources and actors for innovation and competitiveness
- Internationalisation for economic growth and job creation in Sweden

6.4.5 Formas

Formas is a national research council that comes under the Ministry of the Environment. This means that Formas receives most of its financial allocation from this ministry. The rest of the allocation comes from the Ministry of Agriculture. The mission of Formas is to promote and support basic research and need-driven research in the areas Environment, Agricultural Sciences and Spatial Planning. Formas may also fund development projects to a limited extent.

6.4.5.1 Annual calls

Within Formas' annual calls for proposals, applications can be submitted for research and development projects, postdoctoral grants, open postdoctoral grants and positions as assistant professor. Funding can either take form of open calls where the applicants define the contribution to a sustainable development in their applications, or of thematic calls within a specific area of importance for sustainable development.

Formas is assisted by eight standing evaluation panels in the assessment of research proposals submitted in the big annual call.

Areas of responsibility for Formas' eight standing evaluation panels:

1. Climate change
2. The natural environment
3. Use of natural resources
4. Products and processes based on renewable and recycled resources
5. Environmental pollution
6. Food and animal welfare
7. Urban and rural development
8. The built environment

6.4.5.2 Strategic calls

In addition to the annual call for proposals, Formas also announces strategic calls in one or more thematic areas. These calls may be at any time during the year. They may be either solely financed by Formas or jointly financed by one or more additional funding agencies. The source of joint financing may be national or international. The priorities of Formas are reflected in both research programmes and in special key action areas. These range over several R&D areas and are characterised by a holistic approach, a high degree of relevance and topicality. The intention is that these should generate results of general practical applicability within a limited period of time.

6.4.5.3 Jointly financed research

Formas also has jointly financed research in areas including agriculture and environmental engineering, forestry research, horticultural research and within plant

breeding. This means that Formas allocates sums fixed by the government to a few selected organisations.

The foundations and institutes that Formas has agreements with are JTI (The Swedish Institute of Agricultural and Environmental Engineering) and Skogforsk (The Forestry Research Institute of Sweden). Within the framework of jointly financed research Formas has also in collaboration with SLF (The Swedish Farmers Foundation for Agricultural Research), announced a call for proposals for research grants within the area of plant breeding. Together with the national organisation GRO and with the SLF foundation a joint call has been announced targeted towards horticultural research within the climate area.

6.4.6 FAS

6.4.6.1 Mission, organization, and budget

FAS was formed in 2001 and promotes and supports research relevant to the labour market and public health. FAS will also examine the research needs that are important within its field of operation; initiate and promote the research needed to meet these needs and to promote and initiate multi-and interdisciplinary research. The agency is headed by a board, in which the government appoints the president and five public representatives. Seven scientists are elected by the scientific community. Scientists are therefore in the majority. The organization is headed by a Secretary General.

The Board has appointed seven priority committees with the task of reviewing and evaluating applications for project grants and postdoctoral grants. Over one third of the funding goes to the targeted priority areas which are long term in the form of centres, programme grants and contracts. More than half of the funds go to research initiated by researchers, where the scientists themselves formulate the area and research problems.

The Secretary, in collaboration with preparing the organization influence the selection of priorities and what needs to be strengthened and developed, and also oversee the various areas to identify prominent scientists. Forms and priorities FAS is working with include a variety of support and contribution forms. The bulk of the funds consists of individual project grants and programme support. A special effort is strong research, so-called FAS centres, which can be compared with the Swedish Research Council's Linnaeus Grant. FAS' support concerns the following six main areas:

- Work and health
- Work organisation
- Labour market
- Public health
- Welfare
- Social work and relationships

In addition, FAS has coordination responsibility for five additional priority areas decided by the government:

- Elderly
- Disabled
- Social alcohol research
- Children and adolescents
- IMER (International Migration and Ethnic Relations)

6.4.6.2 Processes for identifying, prioritizing and deciding of areas

The six main areas of priority within FAS are mainly inherited from the previous agencies which merged and formed FAS in 2001. In recent years, special funds have been allocated for research on elderly (SEK 30-35 million per year), women's health

(SEK 30 million per year for three years) as well as research on children's health (a joint mission of FAS and VR with total funds of just over SEK 57 million). Usefulness of research and relevance to society are particularly important in the decisions on grants. Competence-building and decision to post specific, targeted calls are done after evaluation and assessment of areas considered to be disadvantaged. The government allocates the annual funds, but leaves it to FAS to decide upon forms for support, such as grants or employment positions. Examples of such targeted initiatives are support to creation of professorships, support for research on child health and disability or support to strong research groups. Regardless of assignment or form of support, funding is distributed after calls and in open competition. Evaluation of proposals are conducted through peer review.

6.5 Monitoring of research grants

The three research councils – VR, Formas and FAS, have no monitoring or follow-up of single granted projects and their achievement of results. They do undertake evaluations of larger scientific areas now and then, sometimes upon request from the government, sometimes on their own initiative. Examples are 'Working life research in Sweden 2008 – the current position' and 'Evaluation of Marine Environmental Research in Sweden 2003-2008'. There are examples of evaluations where the councils cooperate.

The prevailing type of evaluation carried out at VR has hitherto been directed towards the academic quality in research areas, often directed at projects financed by VR. Evaluations are normally based on collegial assessments in the form of panels of assessors (peer reviews), and often carried out by foreign experts.

6.6 Cataloguing research outputs

There is no national system for cataloguing the research output, like FRIDA in Norway. However, the Department of Research Policy Analysis at the Swedish Research Council maintains and develops a database for bibliometric analyses. The bibliometric analyses are based on scientific publication data records licensed from the US-based company Thomson Reuters. The database corresponds approximately to the data that can be retrieved in the Thomson Reuters' web service Web of Science. This database is among other things used for the redistribution of governmental funding which is described in section 1.4.

DiVA – Academic Archive On-line, is a publishing system for research and student theses and a digital archive for long-term preservation of publications. DiVA began its development in the year 2000 at the Electronic Publishing Centre (EPC) at Uppsala University Library. Today the technical development is driven by the EPC in cooperation with the participating universities and colleges. All universities and publicly financed research institutions both in Sweden and abroad are welcome to join DiVA. The research publications and student theses found in DiVA have been published and registered at the university or college of origin. There is bibliographic information in the database for every title and usually an abstract and a link to the full text at the university or college where it was published.

So far, 28 HEIs have joined DiVA, of which one is from abroad (NTNU, Norway). This means that although many Swedish universities have joined, some major ones like Lund University and Gothenburg University still have not; they have developed their own publication catalogues.

6.7 Examples of successful research policy

6.7.1 Institute Excellence Centres

In the last years, the Swedish government has placed more emphasis on the establishment of a national evaluation culture as well as increased utilisation of research. This has been partly done by highlighting the importance of measurability of

policy objectives and the use of performance indicators. VINNOVA has responded to this by implementing a 'programme culture' in all activities. The main ingredient in this culture is to make sure that before commencing, VINNOVA's efforts undergo an impact logic assessment, that both are monitored for their duration and evaluated (whilst ongoing and at their conclusion). In addition, there is a posterior evaluation of the efforts regarding what impact they have generated on sustainable growth in Sweden.

While there are several policy measures in Sweden, one of the most interesting from a policy perspective is the initiative Institute Excellence Centres (IEC). This joint six-year programme has been set up to use institutes in Sweden as a foundation for a strong research and innovation environment. In a Swedish context the programme has several unusual features. It is organised and managed by three organisations, it uses actively an *ex ante* impact assessment (including an agreed set of indicators) and it has been able to create a substantial contribution, both cash and in kind, from industry. While there is still room for improvements the programme has exceeded expectations during its first year.

The core of the programme is eight CoEs located at seven different institutes. The programme has a budget of SEK 100 million a year and was subjected to a first-year-evaluation by an external team of experts in 2008. In an overall assessment of the programme the evaluators stressed that the programme has "contributed in a very positive way to not only the participating institutes but also to the involved universities and companies". Despite the limited timeframe, the centres in the programme have been able to carry out fruitful cooperative research, involve several senior researchers, appoint international advisory boards and create knowledge that "will be used to develop innovative products and processes for the Swedish industry". An identified explanation for the successful first year is a professional approach to the leadership among the centre managers. In particular, the challenge of coordinating participants from universities and many companies has been handled well.

6.7.2 Support programmes to R&D in six industrial sectors

Late in 2004, the government took initiative to round table discussions with representatives from six selected key industrial sectors. This resulted in significant support programmes to R&D in those six industrial sectors, starting in 2006:

- Air- and Space
- Automotives
- IT/Telecom
- Forestry- and Wood
- Metallurgy
- Pharmaceuticals/Biotechnology

The programmes have duration of six years and are co-financed by the state and the respective industrial sector. A range of projects typically run in each programme.

The programmes are still running but the results so far are generally promising. Collaboration is established between the industry, institutes and academia, and knowledge transfer and competence development has been extensive. The programmes already seem to have strengthened Sweden's competitive position in the respective sectors.

6.7.3 National support to rejected ERC applicants

Out of the approximately 430 applicants to European Research Council's first round of Starting Grants that was regarded 'excellent', about 300 were given the grant. Some 130 applicants were rejected despite that they were labelled excellent. Several countries felt that these young and highly talented individuals had been passing

through a very extensive evaluation process, and their qualifications were actually beyond doubt.

In the Swedish case, the seven applicants who got rejected were invited to hand in all application documents to the Swedish Research Council. There was an adjustment of the project to a downsized budget of app. € 100 000 per year during five years. By doing this, they were in principal guaranteed this support from the council.

A good handful of other European countries undertook similar actions. Although this was a single initiative from the Swedish Research Council, the idea of a similar action will probably be raised regarding later rounds at ERC.

There have been published a few studies which compare the merits of rejected and rewarded young researchers, and compare their achievements after having been rejected or approved. To generalize, there seems to be a significant proportion of rejected applicants who hold just as good or better merits and potential as the approved ones, why there is at least indication in the science studies literature that initiatives of the abovementioned kind can prove to be both of great value to the community as well as simply fair to the applicants.

7. UK

7.1 Overview

The majority of UK public sector R&D is undertaken by the higher education sector, that is, within universities. Research is also undertaken, although to a much lesser extent, in research institutes (aligned with, and funded by, specific Research Councils and/or government departments).[189] Very low levels of public funding flow to the private sector (Figure 125).

Figure 125 Recipients of Public Research Funds (Non-defence)

Research Performing Sector	% of Research Budget (2005/06)
Universities	55%
Within government departments (this includes research institutes aligned with the Research Council and/or with specific government departments)	29%
Private Industry/Public corporations	6%
Overseas	7%
Other	3%
TOTAL	**100%**

Source: Derived from DIUS/BIS SET statistics (2005/06 latest figures available)

The majority of the research budget (70-75%) is the responsibility of the Department for Business, Innovation and Skills (BIS) via the Higher Education Funding Councils (HFCs)[190] and seven Research Councils, with the remaining funds coming from a number of other government departments (Figure 126) The public research budgets allocated to universities, the largest recipient of public funds, is distributed via a so-called 'dual support' system comprised of:

- 'Block grants (or institutional funding) from the Higher Education Funding councils (HFCs). All of the HFC funding is allocated to universities.
- Grants from the seven Research Councils allocated to individual researchers for specific research projects or to research groups for defined programmes of research. Funding. Around 60% of Research Council funding is allocated to researchers and research groups in universities with the remaining going to research institutes and large international projects/infrastructures (CERN, European Southern Observatory etc.)

The third strand of public (non-defence) research funding, provided by other government departments, is dominated by research funded by the Department of Health (55% in 2008/09) (in addition to that funded by the Medical Research Council). Other funding is provided by: the Devolved Administrations of Scotland, Wales and Northern Ireland (13%); the Department of Environment, Food and Agriculture (10%); the Department of International Development (10%) and the Department of Transport (5%). This funding departments with this funding is

[189] These are often referred to as Public Sector Research Establishment (PSREs). Many of these organisations previously classed as PSREs were been privatised during the 1990s but may still receive funding from public research funding departments and agencies.

[190] There are three Higher Education Funding Councils for England (HEFCE), Wales (HEFCW) and Scotland (SFC). In Northern Ireland higher education funding is distributed by the Department for Employment and Learning (DELNI).

distributed to a range of research sectors – research institutes, universities and the private sector.

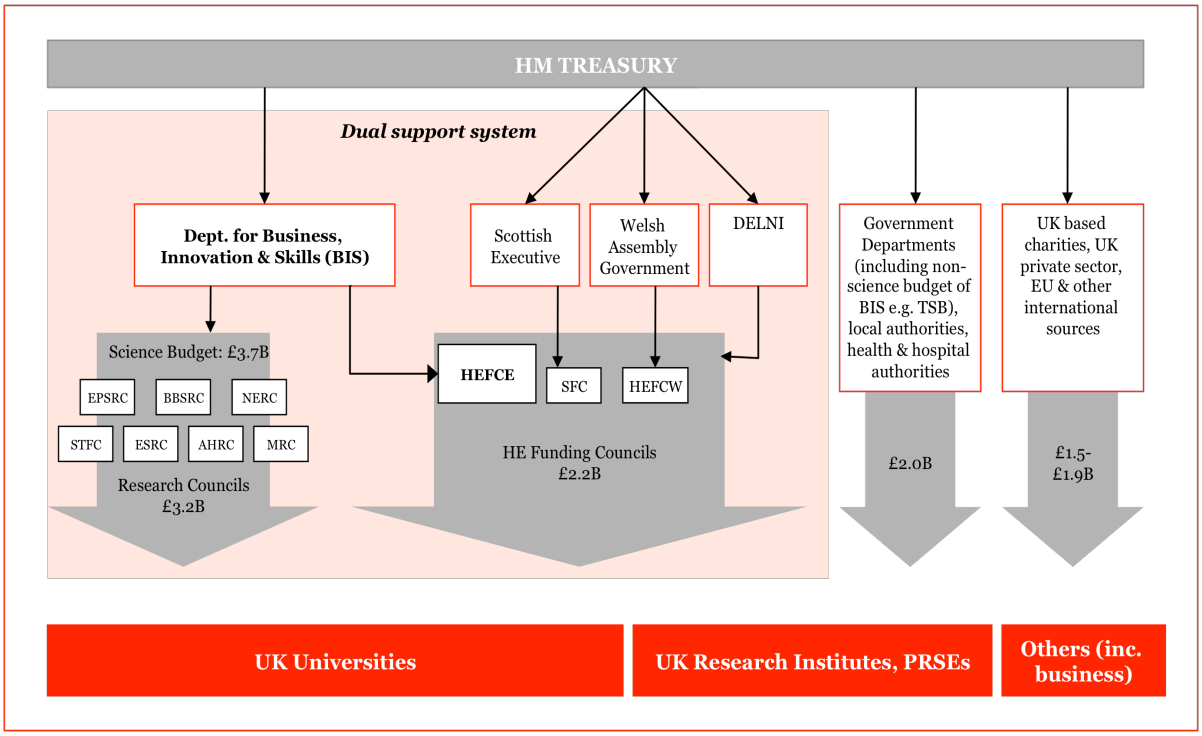
Overall, non-defence public research funding represents around 75% of total public funding. The 25% of public research funding that is focused on defence research is largely allocated to the private sector (75% - 80%) and specialist defence PRSEs (14%).

The rest of this report is focused on the non-defence research budgets.

7.1.1 Research Budgets

Figure 126 illustrates the flow of research funding from departmental sources via allocation agencies to research performers.

Figure 126 Flow of (Non-defence) Funding in the UK Research System (2009/10)



N.B. Public non-defence research (i.e. civil research) funding makes up 73% of total public research funding

Source: Based RIN publication (Making Sense of HE Funding, Sept 2010) adapted and updated by Technopolis

The different funding sources are allocated to different research performing sectors and use different allocation mechanisms. The main funding routes are:

- The HFC budgets are allocated only to universities and are distributed at the institutional level. The level of the grant is determined on the basis of quality as determined by the Research Assessment Exercise (RAE). Although the RAE is conducted at disciplinary level, the grant is allocated at institutional level, giving each university the freedom to allocate the grant within the institution as it sees fit. (See section 7.4.)
- The Research Councils grants are allocated to individual researchers for specific research projects or to research groups or research centres for defined programmes of research based at UK universities. Allocation is based on open competition and selection via peer review. Project funding is assigned to a principal researcher for a project and then further assigned to the research team

members as defined in the project plan. Research programmes are assigned at research group level against a programme of work defined in the research proposal. Programmes/centre grants are larger and have more freedom to allocate funds within a research group than an individual project grant. Some Councils also fund individual researchers through Fellowship schemes. Four of the Research Councils also directly fund research institutes and research infrastructures (such as synchotrons and observatories) at the institutional level.

- The third strand of public (non-defence) research funding, held by various government departments and their agencies and is allocated to research institutes at the institutional level and via research programmes allocated to research institutes, universities and, in some cases, businesses.

In addition to the three public funding streams described above other research funding is available via charities, the European Framework Programmes and the private sector (of the order of £1.5-1.9B) (Figure 127) with the balance very much dependent on research discipline. For example, in the medical and biological fields there are several other major sources medical research charities such as the Wellcome Trust and industry also funds a significant levels of research in these areas. Whereas in the arts and humanities the research councils and funding councils will dominate the funding environment. Much of this type of research funding (excluding the EC Framework Programmes) has no highly formalised process for the allocation of funds.

Figure 127 presents the research budgets of the three main civilian research funding sources, from 1990 to 2010. In terms of the dual support system for universities, it shows that the balance of funding has shifted away from a balance in favour of institutional block grants to one in favour of funding individual research researchers/projects.

Figure 127 Sources of UK Research Funding (Budgets in Cash Terms) 1998/90 to 2009/10[191]

Source	1989/90* (£m)	1994/95 (£m)	1999/2000 (£m)	2004/05 (£m)	2009/10 (£m)
DUAL SUPPORT					
Science Budget *(Research Councils)*	767 (29%)	1174 (37%)	1339 (35%)	2281 (40%)	3715 (47%)
HFCs[192]	830 (32%)	1017 (32%)	1157 (30%)	1804 (31%)	2206 (28%)
OTHER ('third strand')					
Other Government Depts (Civil)	1035 (40%)	978 (31%)	1351 (35%)	1666 (30%)	2020 (25%)
TOTAL	**2632**	**3169**	**3847**	**5751**	**7941**

Figure 128 below presents the breakdown of the Science Budget across the seven Research Councils for 2009/10. Despite its title, the 'Science Budget' funds all disciplines and, along with the HFC block grant, is the main source of university funding in the UK. Figure 128 shows that science, technology, engineering and mathematics make up the bulk of the funding (92%) with the remainder going to the social sciences, arts and humanities.

[191] Data sources: 1998/90 to 2004/05 figures from the DIUS/BIS SET Statistics; 2009/10 figure from the 2009/10 from 'Allocation of Science Budget2008-09 to 2010-11' DIUS, 2007.
The 2009/10 figures for *Other (civil)* is an estimate based on the 2008/09 figures.
The majority of the Science Budget (currently 80%) is allocated to the Research Councils.

[192] 80% of the HFC budget is allocated to the Higher Education Funding Council for England (HEFCE) and 12%, 4% and 3% to its equivalents in Wales, Scotland and Northern Ireland respectively

Figure 128 Research Council Budgets 2009/2010

Research Council	Budget (£m) 2009/10
Arts and Humanities Research Council (AHRC)	104
Biotechnology and Biological Sciences Research Council (BBSC)	453
Economic and Social Research Council (ESRC)	171
Engineering and Physical Sciences Research Council (EPSRC)	815
Medical Research Council (MRC)	659
Natural Environment Research Council (NERC)	408
Science and Technology Facilities Council (STFC)	630
Total (Research Councils)	**3240**
Other Science Budget expenditure (e.g. Academy fellowships, Higher Education Innovation Fund etc.)	476
TOTAL (Science Budget)	**3716**

The distribution of the Science Budget among the Research Councils over time is shown in Figure 128.

7.1.2 Type of Research Funded

The breakdown of research expenditure by the type of research activity undertaken on research (using the Frascati Manual categories and definitions)[193] has been recorded by the government department responsible for the Science Budget up to 2007/08. Figure 129 and Figure 130 below present the data for the Science Budget and the research expenditure of other government departments from 1994/95 to 2007/08.

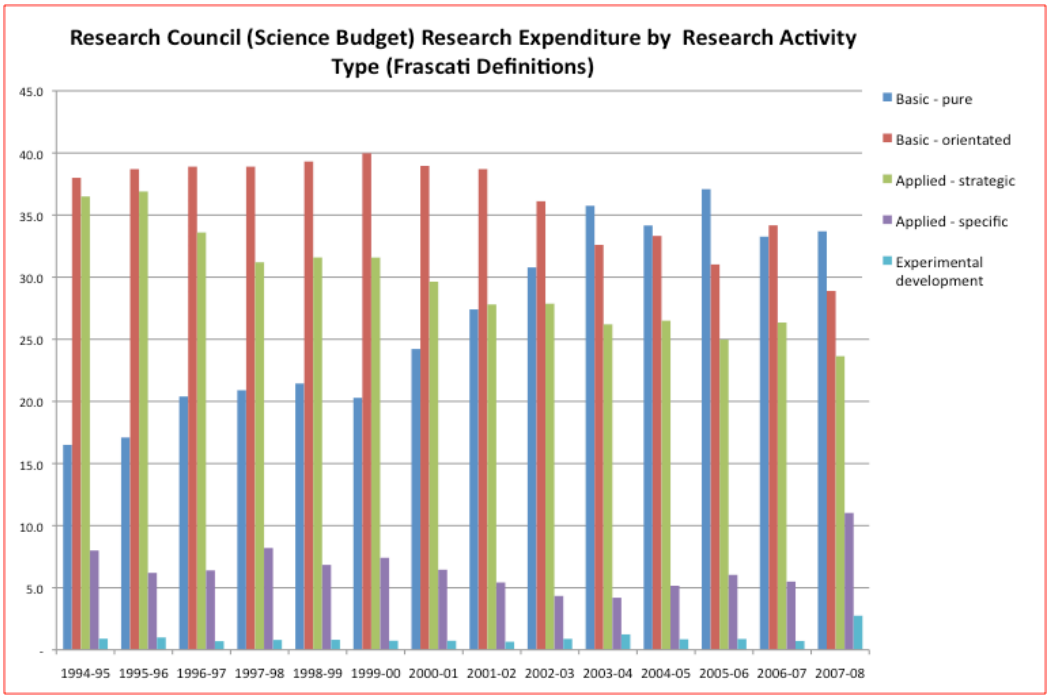
These show:

- Expenditure by other government departments is focused on applied research, both strategic and specific. This is in line with the mission-based role of departmental research (outside of BIS).
- The Science Budget is focused on basic research in the main, both pure and oriented plus strategic applied research. It funds very little specific applied research.
- The pattern of Science Budget expenditure across the different research activity types has changed over time. The level of oriented basic research has remained relatively stable although decreasing somewhat from 2000 onwards. By contrast the proportion of pure basic research has increased steadily while the proportion of strategic applied research has declined steadily.

This latter point is important, as the increasing policy emphasis for research (particularly scientific, technology and engineering research) to drive innovation and therefore economic growth and quality of life, along with the increasing influence of government over Research Councils and HFC strategies and plans, has led to concern that pure basic research would inevitably suffer (See sections 7.1.4 & 7.1.5). However the data in the figures below show that this has not happened and, in fact, pure basic research has increased its share of the research activity. It would seem that the existence of programmatic research within the Research Councils has not shifted research towards the more applied end of the spectrum, and that the peer review process is fairly effective at ensuring that pure basic research is undertaken.

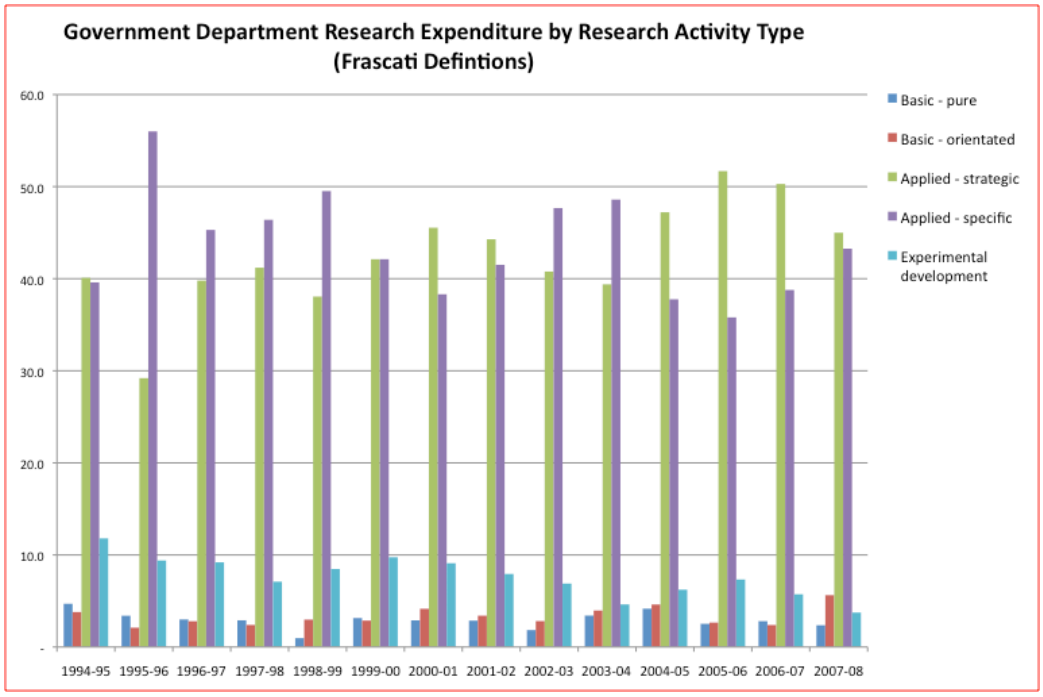
[193] Frascati Manual, OECD, 2002

Figure 129 Science Budget Expenditure by Research Activity Type



DIUS/BIS SET Statistics

Figure 130 Government Department Research Expenditure by Research Activity Type



DIUS/BIS SET Statistics

7.1.3 Budget Changes

While the higher education and research funding councils have seen reasonably steady growth across the last decade, spend by government departments has been more variable. This has been a period of changing priorities with some departments and their executive agencies experiencing substantial gains in the period, for example the departments for health and international development, while several of the more traditional big R&D spenders, such as agriculture, environment, energy, transport and industry, have all seen budget cuts.

However the growth in budgets for research has now come to a halt. As a result of the economic downturn the new UK Coalition Government has imposed budget cuts across the entire public sector. Steering, Governance and Administration.

Departmental Responsibility for Research Budgets

The Department for Business, Innovation and Skills (BIS) is responsible for both aspects of the dual support system for research funding i.e. the HFCs and the Research Councils. BIS takes its authority from the Government, reporting to the Cabinet.

BIS is responsible for the HFC in England (HEFCE), while the Devolved Administrations in Scotland, Wales and Northern Ireland take responsibility for their respective HFCs. Therefore strictly speaking, BIS is only responsible for the block grant aspect of dual support in England. However each of the HFCs makes use of the outputs of the RAE (which is implemented across the UK by HEFCE), albeit using their own criteria to allocate the funding to the universities in their region. Therefore the RAE process to measure research excellence covers all universities in the UK.

HEFCE was set up by the Government in 1992 as a 'non-departmental public body' and works within a policy framework set by the Secretary of State at BIS, but is not part of the department and has distinct statutory duties that are free from direct political control.

HEFCE and other HFCs are also responsible for the allocation block grants for undergraduate teaching to universities, a system (currently) principally based on student numbers.

In addition to the HEFCE budget, BIS holds the Science Budget which funds the seven Research Councils.[194] Around 90% of the Science Budget goes to the Research Councils who then distribute the funds to universities and research institutes across the entire UK. BIS has statutory control of each of the seven Research Councils. The secretary of state delegates his or her legal authority and responsibility to a senior departmental official, the Director General of Science and Research, who, in turn delegates responsibility to the Chief Executive of each Research Council.

The third strand of research funding, the Departmental research budgets, is the responsibility of individual departments with funding focused on research to meet departmental policy needs (i.e. mission-based research). Responsibility for funding is typically delegated to the departmental Chief Scientific Advisor and his/her team of departmental officials.

Changes in Departmental Responsibility for Research Funding

The two strands of the dual support research system have not always been the responsibility of BIS:

- Prior to 1993 the Science Budget was not aligned with an individual department and was instead the responsibility of the central Cabinet Office reporting directly to the Prime Minister. It was then transferred, as the result of the 1993 White paper 'Realising Our Potential', into the department responsible for business– at the time, the Department for Trade and Industry

[194] Despite being called the 'Science Budget', it covers all fields of research (i.e. its includes the social sciences, arts and humanities)

The Research Councils were established as a result of the Science and Technology Act in 1965 with a quite distant relationship with central Government. However over time this distance has decreased, with the 1993 the White Paper 'Realising Our Potential' making explicit the aim to harness the intellectual resources of the science and engineering base to improve economic performance and quality of life.

- Prior to 2007 the block grant for research administered by HEFCE, and undertaken at universities, came under the department with responsibility for all aspects of education, from primary to tertiary.[195]
- In 2007 the two strands of dual support were brought together in the short-lived Department for Innovation, Universities and Skills (DIUS), which soon merged with the business department into the Department of Business, Innovation and Skills (BIS).

The earlier division in responsibility for research funding between departments essentially separated policies that aligned research funding with education and policies that aligned it with innovation (i.e. business). This situation remained in place until 2007 when statutory responsibility for the two research policy remits came together for the first under the DIUS. For two years the entire research budget was separated from the department responsible for business (BERR) until, in 2009, when the responsibility for the entire portfolio of research policy and finding re-joined 'business' under BIS. The two strands of the dual support system for research funding remain together, with policies for higher education, research and business under one department.

These departmental transitions have essentially completed a shift of research policy and funding away from a function of government deemed independent of departmental policies and/or strongly linked to education policy, to being closely aligned with business policy under the auspices of its responsibility for innovation.

Furthermore, a new funding agency was created by DIUS in 2007 (now the responsibility of BIS) – the Technology Strategy Board, sometimes referred to as the UK's innovation agency. Its main focus is business innovation through funding collaborative R&D between the research base and industry (and/or research 'users' in the public sector) and between industry partners. Its budget of around £240M a year represents only 3% of the total research budget although its influence stretches further as additional funds (1%-1.5% of the total research budget) are aligned to its activities by the Research Councils (to fund university participation in collaborative R&D) and the (soon to be defunct) Regional Development Agencies. The majority of the TSB's budget goes to business.

The research budgets of individual departments continue to be their 'local' responsibility.

Governance, Funding and Performance Monitoring: Overview

Governance and funding tend to go hand in hand, with a tiered arrangement of policy and performance frameworks, which set objectives and specific testable targets (Public Service Agreements, PSAs) for the responsible department (BIS) which filter down into operational plans and performance targets of the research funding agencies.

Performance is aggregated and feeds forward into BIS negotiations with the HM Treasury during the periodical comprehensive spending reviews, and influences the size and overall shape of the science budget. This annual process of reporting, competition and negotiation has permitted government to end the previous Research

[195] The HFCs in Scotland, Wales and Northern Ireland became the responsibility of their respective devolved administrations in 1998

Council review mechanism, which were the periodical (5-yearly) external independent reviews.

The system of performance monitoring at departmental level has been in place (for all government departments) since the late 1990s, and has gradually flowed downwards into the performance monitoring processes for the research funding agencies. Prior to this the funding councils had a much more distant relationship with their sponsor government departments.

In addition to this formal performance measurement, BIS, the Research Councils and Funding Councils have governance councils or boards that comprise a large number of independent members. These bodies bring in the views of the agencies' user communities in the broadest sense (as they include members from the academic, business and public sectors) and provide input to strategic and operational plans. While these boards are required to work within the policy guidelines of the sponsoring department they do provide some degree of balance between policy, the academic community and 'end-users' of research.

There is also a Council for Science and Technology (CST), an independent advisory body on science and technology that reports directly to Prime Minister.[196]

Overall funding for the higher education funding council in England (HEFCE) and Research Councils is determined by Parliament based on recommendations from Treasury, which are themselves based on its negotiations with all government departments (including BIS) and modified by other priorities and financial pressures. In practice, the overall budget evolves gradually, and even in the past decade of sustained growth in the science budget, year on year increases have been in the 5-10% range. A similar process goes on within the devolved administrations to determine the higher education funding budgets of their respective HFCs.

Regular Spending Reviews are the UK government's main tool for deciding how much money will be spent on which policies and public services. A spending review is carried out every two years by HM Treasury (the finance ministry) to set three-year Departmental expenditure limits (for all departments). Public Service Agreements (PSAs) define the key deliverables and improvements the public can expect from this expenditure. Prior to 1998, public expenditure had been planned on an annual basis, with the potential for more short-term volatility and uncertainty. In 1998 and in 2007 (originally planned to be 2006), the biennial spending review in question was a Comprehensive Spending Review (CSR, CSR2007), where the word *comprehensive* is used to signal a strategic review of all government priorities working from a zero-based budget.

(N.B. As HEFCE is the largest HFC in the UK (distributing 80%-85% of the higher education budget) and manages the RAE in behalf of all the UK HFCs, its is the main focus of this report wherever the block grant aspect of the dual support system is discussed.)

Governance, Funding and Performance Monitoring: Departmental Level

BIS is responsible to the Government via the Cabinet. Under the previous government a series of Service Agreements (PSAs) with objectives and specific testable targets were defined by the Treasury (on behalf of the Cabinet), with responsibility for delivery against the PSA delegated to the relevant government department, via their secretary of state. PSAs are reported twice yearly to the Cabinet via the Treasury.

Departments are required to develop a series of Departmental Strategic objectives (DSOs), and appropriate indicators, to deliver progress against the relevant PSAs.

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[196] BIS is also responsible for the Government Office for Science which aims to ensure the effective use of scientific advice in policy making, and supports the Government Chief Scientific Advisor and similar advisors at departmental level

The public service agreement target covering both aspects of the dual support system of research funding, *PSA No.4:* for *science and innovation,* is the responsibility of BIS, with its policies and programmes intended to contribute to the PSA measures and targets. The PSA has six performance assessment indicators and associated 'targets' of which three would be expected to be impacted directly by the public research investment (these are highlighted in Figure 131). These targets and indicators filter down, not only into the Department Strategic Objectives (Figure 131 with DSO for research highlighted) but also into the strategies and performance targets of HEFCE and the Research Councils.

Figure 131 PSA No. 4 Promote World Class Science and Innovation in the UK

PSA 4: Promote World Class Science and Innovation in the UK
VISION: World-class science and innovation in the UK are crucial to maintaining economic prosperity and responding to the challenges and opportunities of globalisation. In the global knowledge economy the UK's competitive advantage will rely on the ingenuity and capabilities of the UK population and will be dependent on the UK having an innovation system that can take advantage of the opportunities on offer. As well as maintaining the UK's prosperity, science and innovation play a vital part in addressing key global and domestic challenges, such as climate change and security. Science and innovation also deliver improvements in public service delivery and contribute to improvements in areas such as education, health and culture.
Priorities
1. World class research at the UK's strongest centres of excellence and sustainable and financially robust universities and research institutes across the UK. This is essential in generating the new ideas, trained people and technologies now and for the future;
2. Greater responsiveness of the publicly-funded research base to the needs of the economy and public services. This will generate greater impact from the UK's public Research and Development (R&D) expenditure;
3. Increased business investment in R&D and increased business engagement with the UK science base for ideas and talent. The *Science and Innovation Investment Framework 2004-142* and the preceding *Lambert Review*3 and *DTI Innovation Report4* all drew attention to the importance of business engaging with the research base if it is to create value through innovation. The ten-year Science and Innovation framework set out the Government's overall ambition to raise investment in R&D to 2.5 per cent of GDP by 2014 with business investment in R&D increasing from 1.25 per cent of GDP towards a goal of 1.7 per cent. However, business engagement with the research base is just as important in non-R&D intensive sectors
4. A strong supply of Scientists, Engineers and Technologists. This is critical for the future sustainability of the research base as well as for giving UK businesses and public services the drive and capability to innovate
5. Confidence and increased awareness across UK society in scientific research and its innovative applications. This is central to creating an environment where science and technology can be developed and deployed to economic and social advantage
6. Improving the use and management of science and innovation across Government. Government departments fund some £4.2 billion of R&D outside the science budget to support their policy and delivery objectives. It is important that the knowledge generated is used to best effect both in the policy-making process and in generating innovation more widely.
Indicators
Indicator 1: Percentage UK share of citations in leading scientific journals **Data provider:** BIS although the analysis involved is prepared by an independent contractor **Baseline:** Data on citations in 2006, the latest available data in 2008/09. **Frequency of Reporting:** Annual. **Minimum movement required for performance assessment:** UK to maintain its relative share of citations and subsequent world ranking in the face of rapidly growing shares from emerging economies.
Indicator 2: Amount of income generated by UK HEIs and PSREs through research, consultancy and licensing of intellectual property

Data provider: HESA collect data from HEIs. An independent contractor is engaged to administer the survey of PSREs.

Baseline: £437m. Baseline is calculated as the average of the last three years of data (2003-4 to 2005-06). An average is used, given past experience showing some of the items in the data are very volatile from year to year.

Frequency of Reporting: Annual

Minimum movement required for performance assessment: To increase or at least maintain current levels in the face of increased international competition.

Indicator 3: Percentage of UK businesses with 10+ employees that are "innovation active"

Data provider: Office for National Statistics on behalf of BIS

Baseline: Baseline uses data for 2004 based on the 2005 survey, which shows 57 per cent of businesses are innovation active with a confidence interval of ±1 per cent.

Frequency of Reporting: Biannual

Minimum movement required for performance assessment: Maintain the UK position relative to the EU15. Cyclical variation will need to be taken into account in the UK and other countries' data, though insufficient data points are available to enable a precise cyclical adjustment

Indicator 4: The number of students who qualify with PhDs in Science, Technology, Engineering and Mathematics (STEM) at UK Higher Education Institutes (HEIs)

Data provider: The Higher Education Statistics Agency (HESA).

Baseline: 2007- 08. The figure for 2007- 08 will be available in January 2009. The latest available figure, for 2005-06, is 11,340.

Frequency of Reporting: Annual

Minimum movement required for performance assessment: UK to maintain the number of students qualifying in Science PhDs

Indicator 5: Number of young people in England taking A levels in mathematics, physics, chemistry and biological sciences

Data provider: Department for Children, Families and Schools

Baseline: 2005 entry figures: Chemistry: 33,164; Physics: 24,094; Maths: 46,034; Biology: 47,925.

Frequency of Reporting: Annual

Minimum movement required for performance assessment: UK to maintain year on year increase in take up levels in each of the subject's mathematics, physics and chemistry in order to meet 2014 ambitions. Any decrease in numbers taking up biological sciences not explained by demographics or other factors will prompt further investigation.

Indicator 6: UK R&D intensity in the 6 most R&D intensive industries, relative to other G7 economies

Data provider: ONS/OECD

Baseline: Baseline for UK Direction of movement is 2005 data. For the relativity to G7, baseline data is 2003

Frequency of Reporting: Annual

Minimum movement required for performance assessment: Positive movement or at least maintain UK position relative to the G7 economies. Cyclical variation will need to be taken into account in the UK and other countries' data. A fall in the absolute or relative position in the indicator or its components would initiate investigation at a disaggregated level

Figure 132 BIS Departmental Strategic Objectives

DSO	Description
DSO 1: Science and Research	Foster a world-class science and knowledge base and promote the commercial exploitation of knowledge, global excellence in research and better use of science in Government
DSO 2: Innovation, Enterprise and Business	Increase innovation, enterprise and the growth of business, with a focus on new industrial opportunities and bringing benefits to all regions
DSO 3: Fair Markets	Deliver free and fair markets, with greater competition
DSO 4: Better Regulation	Ensure that Government departments and agencies deliver better regulation
DSO 5: Universities and Skills	Improve the skills of the population through excellent further education and world-class universities, to build a more economically competitive, socially mobile and cohesive society
DSO 6: Capability	Provide the professional support, capability and infrastructure needed to deliver our objectives and programmes, working effectively with our partner organisations to deliver public service excellence
DSO 7: Government as a shareholder	Ensure that Government acts as an effective and intelligent shareholder, and provide excellent corporate finance expertise within Government Statements

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The indicators selected for DSO 1 are essentially the same as for PSA 4 albeit at a (very) slightly more detailed level.

There do not appear to be any sanctions, at the departmental level, for failure to meet PSA targets, although increasingly the remuneration of senior officials in departments is informed by departmental performance against PSA targets.[197]

Governance and Funding and Performance Monitoring: HEFCE

HEFCE's aims and objectives, responsibilities, accountability and operational framework are set out in a Management Statement and the terms and conditions under which BIS makes funds available is set out in a Financial Memorandum. Both documents are revised periodically by BIS and HEFCE. HEFCE's strategy, operational plans and key performance targets are agreed with the department annually and performance is reported to the department quarterly and in a published annual report. HEFCE also provide regular financial reports and the department undertakes period risk assessments of HEFCE and its activities.

HEFCE receives a financial allocation letter annually from the government that defines the size of HEFCE's budget and assigns it to broad funding categories including the 'recurrent grant for research' (i.e. the block grant for research) and the 'recurrent grant for teaching'.

HEFCE's strategy and performance measures are must be aligned to the department's (BIS) own strategy and relevant Public Service Agreements (PSAs). For HEFCE the two relevant PSAs are shown below with PSA4 relating to research funding:

- For Teaching: PSA2: Improve the skills of the population, on the way to ensuring a world-class skills base by 2020
- For Research: PSA 4: Promote world class science & innovation in the UK

Any changes to government policy will be reflected in changes to departmental objectives, which in turn will result in changes to HEFCE's strategic objectives, performance targets and operational plans. While HEFCE's distance from government allows it to determine how to allocate funds, in practice the policy framework provides fairly considerable guidance. For example the concept of using a process of research

[197] Background Paper: The UK Government's Public Service Agreement Framework, Alex Hill, Better Public Services team, HM Treasury, 2003

quality assessment as a basis for allocating research funding (i.e. the RAE) is a result of a much earlier decision made in the mid 1980s by the department for education (not the HFCs) in a bid to improve the accountability of public funding at universities. Furthermore, government departments have strong influence on the measures in the RAE (e.g. its more recent focus on impact of research) and its use to concentrate research funding in high quality departments. (The RAE is described in more detail in section 7.4.)

Governance and Funding and Performance Monitoring: Research Councils

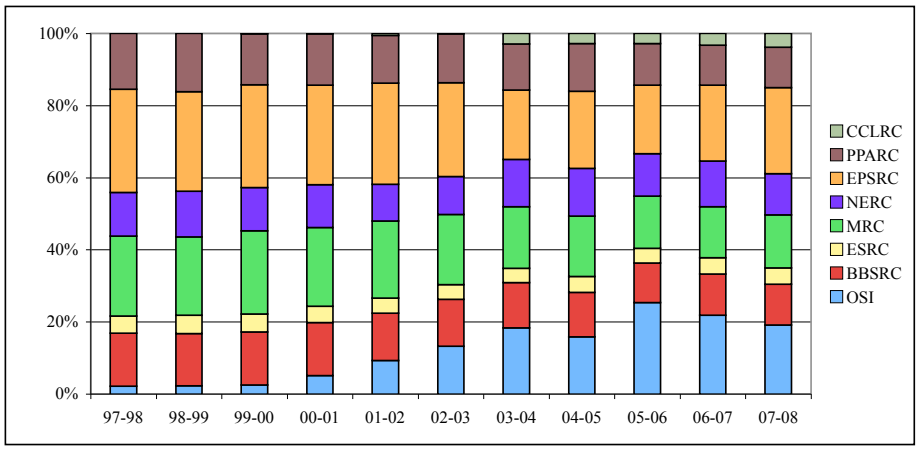
BIS is responsible for the allocating the overall science budget to different research areas, based on its "negotiation" with each Council. The BIS submission to the Treasury spending reviews includes a range of supporting documents including Research Councils' draft strategic plans and annual reports detailing past performance. The budgeting / approvals procedures have become more elaborate in each comprehensive spending review, with more feedback loops and tighter connections between finances, activity, outcomes and national public targets.

The distribution of funding across the individual councils is arguably more art than science, however the process is becoming more rationalised and more transparent over time with the evolution in experience on both sides (BIS and the Research Councils) following each successive annual round of financial discussions and the periodical strategic 'zero-base' planning associated with the comprehensive spending review.

Formally, BIS will start by considering a statement of need/opportunity for each Research Council (its business case), factored by analysis of past performance of each Council (outputs, outcomes, impacts) and the degree of alignment between its priorities/capacities and the current national research and innovation plans. In practice, the Councils and their individual BIS sponsor teams iterate the budget, to help strengthen the presentation and its alignment with wider policy ambitions.

While BIS and the Director General for Science and Research do have the power to make quite dramatic changes in the budgets, the balance across research councils has changed relatively little from one budget period to the next (Figure 133), which reflects the reality of forward commitments to research centres and institutes on the one hand and a reasonably fixed research community on the other, which few policy makers or administrators have chosen to try to alter radically. Figure 127 (above) shows the Research Councils' budgets for 2009/10.

Figure 133 Share of Net Government Expenditure on R&D for the Research Councils and the Office of Science and Innovation, 1996/97 to 2007/08[198]



Historically there was a quite substantial operational distance maintained between the individual Councils and the Secretary of State's delegated officials, with the Councils being given pretty well total strategic autonomy to pursue their academic missions, advancing understanding and facilitating the training of future scientists and engineers. This hands-off approach to the relationship between ministry and research councils had been the basis of research policy in the UK since the end of the first world war and the report of the Haldane Committee which recommended a separation between research of direct utility to government, which ministries should control, and research carried out for more general social objectives, which was to be administered by research councils, with decisions on where to expend money being decided by the research community itself, through peer review. This self-regulating, bottom up character to research investment came to be known as the Haldane Principle.

Central government would no doubt insist that the Haldane Principle still holds today, with peer review determining individual grant decisions pretty well across the board. However, it is also true that central government has worked with the research councils to expand their mission, to include some degree of responsibility for the use and commercialisation of the research they fund, and also being accountable for keeping the general public aware of and engaged with the research endeavour. These third and fourth missions are reflected in the peer-review process, wherein assessment criteria will include dimensions such as relevance (to policy or programme mission) and anticipated impact (likelihood and potential size of the economic and social benefits that might well arise as a result of a piece of work being supported). Equally, this evolving mission has led to changes in the composition of the peer review panels, with academic peers increasingly being joined by research-literature business people and end users. It is also changing the nature and extent of the individual research projects, and their relationships with non-academic constituencies in policy, industry and society.

As for HEFCE, the Research Councils develop annual plans that aim to deliver activities to contribute to PSA no. 4. The Research Councils worked together and with their umbrella organisation Research Councils UK (RCUK) to develop a common reporting framework known as Economic Impact Reporting Frameworks (EIRFs).

The EIRFs capture a range of performance metrics to measure progress towards the objectives set out in each Research Council's delivery plan. While predominantly qualitative in nature, each Council's report contains narrative to explain the context in

[198] During the period illustrated the Arts & Humanities Research Council (AHRC) & the Science & Technology Facilities Council (STFC) were created (not shown in the figure). STFC merged the budgets of PPARC & CCLRC

which data should be interpreted. The EIRFs are structured around the following categories as identified in the BIS report 'Economic impacts of investment in research and innovation':

- Overall economic impacts
- Innovation outcomes and outputs of firms and governments
- Knowledge generated by the research base
- Investment in the research base and innovation
- Framework conditions
- Knowledge exchange efficiency
- Demand for innovation

Performance against the EIRFs is reported to BIS and published annually on each Council's website. The Research Councils continue to work together and with BIS to further develop and streamline these metrics to maximise their usefulness in interpreting Councils' performance.

Impact of Stronger Governance Processes

The increase in processes to manage and monitor performance of the funding councils, the Research Councils in particular, has enabled BIS to dispense with its previous performance assessment process via quinquennial reviews of each council.

At present, however, it is not clear what the sanctions might be for underperformance against targets, aside from a presumed disadvantage in any spending review negotiations over the distribution of the Science Budget to the seven Research Council. At the current time, with a reduction of the science budget in real terms, such sanctions are likely to become more tangible.

Furthermore, the use of sanctions is hindered by the fact that the links between performance measures at the level of the funding councils and performance at the departmental PSA level are not well-defined, with the former focused on the research inputs, activities and direct outputs in broad disciplinary areas and the latter on targets at the national level in terms of longer-term outcomes and impacts. This is not a criticism of the performance monitoring processes per se but a reflection of the complex links between research funding, activities and private sector innovation and wider economic performance. Again, the need to meet budgetary cuts will no doubt increase the focus on the performance measures and their usefulness, or otherwise, in aiding decision making.

7.1.4 Priority Setting at the National level

Priority setting at the national level occurs via periodic White Papers (on roughly 5-7 year cycles) that present both an analysis of the current situation and projected needs and the policy response, Inputs come from a wide range of sources – reviews, reports and studies commissioned by the department, reports from learned societies, foresight activities (also funded and managed by BIS), departmental and government advisory committees (such as the Council for Science and Technology, the Technology Strategy Board,[199] sector based innovation and growth committees, the non-executive members of the BIS Management Board, etc.) and lobbying reports/statements from trade bodies.

National priorities are also set by detailed strategies developed as result of the periodic comprehensive spending reviews such as the 10-year Science and innovation Investment Framework 2004-2014.

[199] The Technology Strategy Board is an expert committee that advised the Department of Trade and Industry until the agency of the same name was established. It now serves as the Board of the agency.

From 1993 onwards White Papers (in 1993, 1998, 2000, 2001 and 2008)[200] have all place research (mainly scientific research) firmly within the domain of innovation and enterprise and its contribution to economic performance and quality of life. In the main, the White Papers reiterate the argument for publicly funded R&D and define its general direction and focus rather than specify research priorities or themes. However each paper typically identifies a number of (often broad) areas of specific priority. The 2000 White Paper, for example identified the need for continued research to capitalise on the de-coding of the human genome and informatics and e-science, and the most recent White paper in 2008 identified a number of grand-challenges to be addressed by activity across the Research Councils. However the White Papers typically do not set budgets nor identify areas where research will cease or decrease, and therefore the exact detail of implementation is negotiated between the department and Chief Executives and management teams of Research Councils.

7.1.5 Changes in Priorities at Funding Council Level

Despite a history of a 'hands off' approach to the relationship between government department and the Research Councils (the so-called 'Haldane Principle'), in recent years the system of accountability through alignment with a single department and its Public Service Agreements, has enabled the government to increase its influence over Research Councils activities. This is often manifested in terms of themed research programmes in areas viewed as of national importance (as identified by the White Papers for example) and a stronger focus on research application and impact. These changes are reflected in the criteria used for peer review for programme-based funding and changes in the composition of the peer review panels, with academic peers increasingly being joined by research-literature business people and end users.

Most recently five cross-council research themes (to address grand challenges) have been identified and funding made available:

- Energy: bringing together energy-related research and training across the Councils to address the vital international issues of climate change and security of energy supply.
- Living With Environmental Change (LWEC): an interdisciplinary research and policy partnership programme to increase resilience to, and reduce costs of, environmental change, addressing the associated pressures on natural resources, ecosystem services, economic growth and social progress.
- Global Threats to Security: a programme to integrate research in crime, terrorism, environmental stress and global poverty, to address causes of threats to security, their detection, and possible interventions to prevent harm.
- Ageing - lifelong health and wellbeing: an initiative to establish new interdisciplinary research centres targeting the major determinants of health and wellbeing at every stage of life, reducing dependency in later life.

It should be noted that historic and committed investments in research (people, equipment and research infrastructure) leave limited room for rapid radical changes in direction, and change is generally incremental occurring over several years.

Similarly, HEFCE responds to changes of direction identified in education and/or research White Papers through modification of its funding allocation processes and rules. For research this tends to occur on the 5 to 7 year time horizon of the RAE, with policy either driving changes in the RAE methodology or in the calculation of funding based on RAE outputs.

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[200] Realising Our Potential (1993), Our Competitive Future: Building the Knowledge-Driven Economy (1998), Excellence and Opportunity - a science and innovation policy for the 21st century (2000) Opportunity for All in a World of Change (2001), Innovation Nation (2008).

The final section of this report (section 7.9) provides information on the themes of the individual Research Councils.

7.1.6 Research Performers

In the UK universities are autonomous organisations able to set their own research strategies and make their own personnel decisions.

Most UK universities have been through a process over the last 15-20 years of professionalisation of the management structure and system. This has seen a move away from an academic-led collegiate management structure to one that tries to strike a balance between a stronger and more 'corporate' central management system and a collegiate system. This centralisation more readily facilitates the setting of strategies and organisational plans.

However, for most universities much of their research is funded from public funds and therefore they only have the flexibility that the public funding system allows. The block grant from the HFCs is the only source of research income truly at the discretion of university management. However, as block grant income is linked to research performance at the discipline level (via the RAE, see section 7.4), individual departments and research groups have considerable influence over its allocation.

The increase in Research Council funds at the expense of the block grant also affects the ability of central management to directly implement a central research strategy. This is not to say that universities cannot implement a strategy but that the methods to do so are intimately tied to the public funding processes - for example 'star' researchers can be hired to both improve RAE scores and increase Research Council income, research groups can be merged to improve RAE scores, the university can decide to not submit certain research groups for assessment under the RAE process (they would then be less likely to receive any allocation from the block grant).

7.2 Administrative Efficiency

At the level of the research funding agencies, HEFCE expends around 0.25%[201] of its budget (research and teaching) on administration and the Research Councils expend around 3-4%.[202] The difference reflects the different costs of administering institutional block grants (HEFCE) versus administering individual projects (Research Councils).

The HEFCE administration figures do not include the costs of administering the RAE which occurs roughly every five years. The RAE is estimated to have cost HEFCE £7.1M in 2008 and £5.6M in 2001 plus some on-going costs of around £0.5M - £1M in other years to develop and RAE and it's potential replacement the Research Excellence Framework (REF). For the 2001 RAE this administrative cost equated to about 0.05% of the £10.5B of research funds subsequently allocated by HEFCE based on its outputs.[203]

The costs described above do not include the cost of research administration in the research conducting institutions. These costs will include a range of activities including the cost of: developing research proposals, participating in the RAE, participating in the peer review of other researchers' proposals (within the quid pro quo system of peer review) as well the costs of supporting and managing the research itself once in progress. Data on research administration is not systematically collected in the UK but a number of studies have examined parts of the research system:

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[201] The figure is higher for the smaller HFCs with lower economies of scale. HEFCW, for example, reports administration costs at 0.7% of its budget.

[202] HEFCE and Research Council annual reports

[203] Using metrics to allocate research funds: A short evaluation of alternatives to the Research Assessment Exercise, Tom Sastry and Bahram Bekhradnia, Higher Education Policy Institute, June 2006

Efficiency of Grant Allocation by Block Grant (RAE)

The full costs of the RAE to participating universities were estimated by the Higher Education Policy Institute (in 2006) to be a maximum of £90M with a further £10M incurred by HEFCE.[204] Bearing in mind that it occurs once every 5 to 7 years (the periodicity of the RAE has varied over time). This equates to £13-18M a year in costs for the universities. The total cost of RAE, at £100M, represented about 1% of the approximately £10B funds distributed based on the RAE.

The costing was based upon fieldwork in a sample of UK universities selected to be representative of the sector as a whole. However the £90M figure was reported as an upper bound as the study was not able to determine exactly how much of the administration costs would remain in the absence of the RAE.

Efficiency of Grant Allocation by Peer Review

The central coordinating body for the Research Councils (RCUK) conducted a study of the costs of peer review in 2007.[205] The total cost of Research Council peer review – across all activities and including the costs incurred within both the Research Councils and the research performers – was estimated to be £200 million a year (2005/06), which is around double the cost of the seven research councils administrative costs, and around 6% of the total research council budget. These costs are dominated by the preparation of full research proposals by applicants, which might take 6-12 months in calendar time and several person years in non-cash investment, and this is estimated to account for around two-thirds of the cost to the research system. The second biggest charge to the budget is the time taken by reviewers to complete and record their appraisal of any given proposal, which is estimated to account for around 20% of the total cost. The internal administrative costs of Research Councils account for around 15% of this total endeavour.

The study report warned against simply considering an unfunded application to be an inefficiency in the system and emphasised the value that a competitive process provides. It also, however, stressed that increasing numbers of applications and ever falling success rates will ultimately reduce both efficiency and effectiveness.

The study by the Higher Education Policy Institute (refereed to above) estimated the total administration costs of the Research Council peer review system – that is the costs to the universities as well as the Research Councils - to be 10% of value of grants distributed. Which is in line with the RCUK study of 6% plus the Research Council costs of 3-4%.

Comparison of Efficiency of RAE and Peer Review

The block grant system of grant allocation based on the RAE would appear to cost around 1% of the value of the grant distributed, while the Research Councils peer review system costs about 10% of the value of the grant distributed. Therefore the block grant system is considerably cheaper to administer, by a factor of ten, than the peer review system, for all stakeholders involved.

Efficiency of Research Administration at Research Performers

No data is available to determine or estimate the administrative costs at UK universities. Not least because in universities teaching and research is inextricably linked and therefore it is not necessarily possible to separate research and teaching costs.

However UK universities have been through a detailed process to determine the real costs of conducting research (including direct and indirect costs) to enable the

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[204] Ibid.

[205] Report available at www.rcuk.ac.uk/research/peer/efficiencypr.htm

Research Councils to fund research at Full Economic Costs (FEC). A report on this process, while not identifying research administration costs explicitly, did identify that more than half (55%) of indirect costs to research are staff costs (libraries, central services, local support staff and academic administration time costs etc.), with the remainder being estate costs.[206] The report authors took the view that efficiencies could be made (in all but the those universities with the highest levels of efficiency already) and recommended that all universities work to reduce their indirect costs by 5% a year for the next three years.

The report estimates that the measures set out above will reduce the cost of research as funded by the Research Councils by about £5 million a year in 2011-12 growing to some £40 million by 2013-14.

7.3 Research Education

7.3.1 National Policy

In the UK, there is no overarching policy or singular strategy governing the organisation of postgraduate researcher training.

However the 10-year Science and Innovation Investment Framework does include an explicit commitment to ensure the future supply of scientists, engineers and technologists. This commitment explicitly recognised in the fourth of six priorities set out in PSA4. This human resources objective is a commitment to sustain the public sector research base and to provide businesses and public services with the skilled labour and maintain and enhance their capability to innovate. Importantly, the specific indicator for this priority is focused on postgraduates and, in line with the priorities main definition, only in science, technology, engineering and mathematics (STEM), with a target to maintain the numbers of students qualifying in science PhDs.

BIS delegates responsibility for postgraduate researcher trainer to the Research Councils, through their respective royal charters and constitutions, for determining strategy on researcher training – numbers, financing, organisation. Notwithstanding this constitutional division of labour, the science minister does have the ability to steer the Research Councils at the margins and there are various points where both parties have agreed to work together to evolve the system to better meet national as well as disciplinary interests.

The link between policy objectives and outcomes is made through the annual monitoring and reporting against the skills indicator in PSA4 (the numbers of science PhDs). Since 2006, the ministry has required each council to submit an annual report on outputs and impacts, which includes amongst many other things, an account of PhD financing, enrolments and completions. This in turn is submitted to HM Treasury, and success – as measured by these indicators – is expected to have some material if non-specific impact on future financial settlements (size of the science budget).

BIS has also asked the Research Councils to launch an annual survey of student satisfaction targeting postgraduates.

BIS also delegate responsibility for postgraduate researcher trainer to the HFCs, albeit a more indirect mechanism. The HFCs allocate a portion of their block grant to enable universities to contribute to the funding the training and supervision of doctorands.

In 2008/09 and 2009/10 the split between Research Council and HFC funding for postgraduate researcher training was approximately 60:40. With a total annual expenditure of around £625M.

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[206] Report of RCUK/UUK Task Group, chaired by Sir William Wakeham: Financial Sustainability and Efficiency in Full Economic Costing of Research in UK Higher Education Institutions, June 2010

7.3.2 Funding of Postgraduate Researcher Training

In the UK postgraduate researchers, or doctorands, are considered to be students and therefore their funding is in the form of fees to the university and a stipend for living expenses.

The individual Research Councils take the lead in determining how much of their total budget to allocate to postgraduate researcher training, as well as the mix of scheme types they deem to be relevant to their particular community. The subject mix is often arrived at bottom-up, through student demand and university promotion, however, most Councils also elect to fund selected or targeted programmes addressing strategic areas of anticipated demand, from emerging fields (e.g. energy or nanotechnology) to more vocational qualifications (e.g. industrial doctorates) to international progammes.

Research Councils fund PhDs via universities, though two primary routes:

- Competitions or allocations, where the Research Councils provide funding to certain faculties, departments or research groups for a number of PhD grants (fees and stipends). The faculties, departments or research groups then identify and recruit the doctorands.
- Via research (project) grants the Research Council where the proposed research project includes the deployment and training of a postgraduate. The university receives the funds to pay for the doctorand(s) as part of the research grant.

There are both similarities and differences in the approach taken by each Research Council. Figure 134 illustrates some of the variants in the schemes for supporting PhDs. Funding is also available from a number of charities and businesses and doctorands can also fund themselves. Non-EU students fall into this latter category with their 'own' funds coming from either their personal finances or from support schemes provided by their 'home' government.

The 'standard PhD' funded through a Research Council block grant to faculties, departments or research groups is the most common form of funding. Funding is typically allocated through two routes - a competition or an allocation based on research income from the specific Research Council.

Figure 134 Selected Variants of Doctoral Research Programmes

Type	Objective	Examples	Definition	Criteria
Standard PhD	Support with higher academic degree	Doctoral Training Accounts (EPSRC) Centres for Doctoral Training (EPSRC) Block Grant Partnership (AHRC) Standard (ESRC) Algorithm (NERC)	Block grant to an Academic department	Prior educational attainment and future potential
Project (grant) research	Support with higher academic degree while supporting research to extend forefront researchers/ topic areas.	From response mode (i.e. open calls) research budgets or programme budgets	Grant to a researcher with a winning proposal- includes studentships as part of support	Winning proposal by experienced researcher
Collaborative	To promote research that may be useful to industry, non-profits, etc, and other non-academic organizations	Collaborative Grant (AHRC) CASE (STFC, NERC, BBSRC)	Joint studentships where one supervisor must be non-academic	Strength of industrial collaboration. Offer of transferrable skills within the doctoral programme.

Type	Objective	Examples	Definition	Criteria
Professional	To promote technology transfer	CASE Industrial (BBRSC) International Doctoral Studentships (EPSRC)	Similar to collaborative studentship but with a stronger industry focus such as final year spent at a firm. Often jointly-funded	Often require that training in business skills is offered be the department receiving the funding (project management, business proposals)
Direct to Student	To develop networks and build capacity at research institutes or in research areas which do not often receive funding through the standard method.	Studentship Competition (AHRC), Research Studentship (STFC)	Students may apply with a topic/ research institute of their choice	Excellence amongst students
Interdisciplinary	To support interdisciplinarity and cross-institutional research	MRC/ESRC Interdisciplinary studentships MRC/Parliamentary Office of Science and Technology fellowship in medical research (MRC)	Studentship that is partly funded by a different research council or public body.	Interdisciplinary approach, accepted by both parties.
Project-Oriented	To promote research that is publicly useful (defined by Research Council)	Capacity building studentships (MRC)	Awarded to those that are interested in a topic deemed important by the research council	Based on topic- may be to a department or to an individual student
International (Outbound)	To promote an international network and technology transfer	International Doctoral Studentships (EPSRC)	Studentship for a doctorate at an institute outside the UK	International focus, must demonstrate need to leave UK
International (Inbound)	Excellence based on merit, To promote an international network and technology transfer	The Dorothy Hodgkin Postgraduate Awards (EPSRC)	Studentship for non-UK students	International excellence

In 2008/09 the Research Councils funded 25% of fell-time doctorands – 19,200 at a cost of £376M.[207]

The institutions themselves also support postgraduate researchers through waiving tuition fees. It is estimated that with English HEIs offered fee waivers to almost a fifth of UK and EU students in 2007-08.

The HFC contribution to finding postgraduate researchers is based on a portion of the block grant received being allocated to this activity. The actual figure allocated to each university is based on a fixed fee per student and total student numbers (in terms of students form UK and other EU countries). Historically, there was a quality criterion, with only certain institutions being deemed eligible (based on performance at the 4-yearly national Research Assessment Exercise), however this changed with the 2008 RAE for technical reasons to do with the profiling of institutions

HEFCE research suggests that income from all sources for postgraduates amounts to perhaps 30-40% of actual costs, when all costs are included. Universities minimise the impact of these deficits in many cases through the involvement of research students as

[207] One Step Beyond: Making the Most of Postgraduate Education, BIS Report, March 2010

members of research teams carrying out work that is paid for by project funding: doctoral students are an important component of the HE sectors research workforce.

7.3.3 Criteria for Postgraduate Researcher Training

Institutional factors

The Research Councils award 4-yearly doctoral training grants each year, based on universities' research grant income, while the majority of other studentship schemes are awarded to universities on a competitive basis through calls for proposals.

The award criteria vary from one scheme to another, however the EPSRC's centres for doctoral training (DTCs) have been launched through three calls for proposals and the latest call invoked three broad criteria:

- Strategic alignment with national need for the number and type of doctorates
- International standing of the related research groups
- Training, supervision and management quality

Individual Requirements

Universities admit applicants to PhD programmes on case-by-case basis. Depending on the university, admission is typically conditional on the prospective student having successfully completed an undergraduate degree with at least upper second-class honours, or a postgraduate master's degree, but requirements can vary. In the case of the University of Oxford, for example, 'The one essential condition of being accepted…is evidence of previous academic excellence, and of future potential." Similarly, the EPSRC guidelines note:

> *Students must be able to demonstrate "a capability to undertake and benefit from research training through to completion, to the standard necessary to qualify for a PhD." This normally requires an upper second class honours degree, or a combination of qualifications and/or experience equivalent to that level. However, universities can use their discretion in deciding whether candidates are suitable for research training.*

Analysis of the Higher Education Statistics Agency (HESA) statistics show that a majority of students enrolled on postgraduate research degrees had completed a master degree first. It is more common for STEM graduates to progress to a PhD directly following completion of their first degree, although even here it is increasingly common for universities to seek applicants from prospective students with a master degree. Where this does happen, HESA statistics show a majority of newly-enrolled research students will have a first class degree (53%).

For certain studentships – industrial, international, collaborative – research councils and universities require candidates to satisfy additional criteria, including professional qualifications and/or experience, interviews, references, and motivation/potential to complete the program amongst others.

7.4 Basis for Allocating of Public Funds

Block Grant: RAE

The HRCs allocate funds to universities based on a standard formula based on university (past) performance as judged by the Research Assessment Exercise (RAE). The RAE is a large-scale, periodic (every 5 to 7 years) review of the UK's research outputs, involving all UK faculties and departments in a process of self-assessment and peer review.

- Analysis is made at made over 67 research disciplines (referred to as 'units of assessment' or UoA)

- Universities make submissions in each UoA of relevance to them (i.e. one submission = research activity in one discipline at one university)
- A submission consists of data about research activity undertaken, in the years since the previous RAE, including information on the number of research active staff and their published research outputs, the research environment in which they operated and indicators of esteem conferred on those staff as individuals or groups. The submission includes a fixed number of research outputs (typically publications such as journal papers, book chapters, monographs) per researcher (four per researcher in RAE 2008). These outputs are physically deposited with the RAE administrators for distribution to the relevant panel members.
- The submissions are peer reviewed by a panel of experts, with each panel covering between three and eight UoAs.
- The output is a 'score' of the quality of the research activity. The scoring system has evolved over the years - for the most recent RAE in 2008, each submission was awarded a quality profile. This profiled the proportions of research activity in the submission that was judged by the panel to meet each of five quality levels from unclassified, through to world-leading (4*). This system has enabled 'pockets of excellence' within UoAs to be identified and recognised. Figure 135 and Figure 136 show the quality level definitions and an example of how the quality profile is presented.
- The HFCs use the quality profiles as the basis for awarding research funding to the universities within their geographical coverage. Allocation of HFC funds it is at the institutional level even tough the assessment is conducted at disciplinary (UoA) level, funding is awarded at institutional level.
- That actual formula for the allocation of funds is fairly complex, taking into account the RAE outputs plus other factors such as the differential costs of conducting research (e.g. laboratory or clinical research versus non-laboratory fields)[208]

Figure 135 RAE Quality Level Definitions

Quality Level	Definition
4*	Quality that is world-leading in terms of originality, significance and rigour
3*	Quality that is internationally excellent in terms of originality, significance and rigour but which nonetheless falls short of the highest standards of excellence
2*	Quality that is recognised internationally in terms of originality, significance and rigour
1*	Quality that is recognised nationally in terms of originality, significance and rigour
Unclassified	Quality that falls below the standard of nationally recognised work. Or work which does not meet the published definition of research for the purposes of this assessment

http://www.rae.ac.uk

Figure 136 Example RAE Output

Unit of Assessment Title	No. of full-time equivalent research staff submitted for assessment	Percentage of research activity in the submission judged to meet the standard for:				
		4*	**3***	**2***	**1***	**Unclassified**
University X	50	15	25	40	15	5
University Y	20	0	5	40	45	10
University Z	95	30	35	25	10	0

[208] Details can be found in the HEFCE report: Recurrent Grant for 2010-2011, March 2010/08

Future of the RAE

The 2008 RAE was the last to be conducted in its current form, that is a process centred on peer review. It will be replaced in 2014 with the Research Excellence Framework (REF) which has a stronger focus on quantitative assessments based on bibliometric analysis.

The initial intention of the government was to abolish the costly RAE and move to an entirely metrics based system. The initial concept to allocate the block grant based on (non-block grant) research grant income as it had been shown that there was a strong correlation between RAE based allocations and research income from other sources (Research Councils, charities, private sector etc.). However this was deemed unacceptable by the research community and instead a system based on research excellence as determined by bibliometric citation analysis was developed and trialled in a number of universities in 2009/10. However an allocation system based on purely quantitative measures was also not viewed as acceptable by the academic community. This has resulted in a REF system that will combine bibliometrics and peer review along with a qualitative assessment of research impact. The final system is still under development and test, but is unlikely to result in any significant reduction to the cost of assessment.

Peer Review

The great majority of the Research Councils' investments – whether for an individual research grant or a major interdisciplinary research programme or centre – are decided through open competitions and a rigorous process of peer review. The process is confidential and anonymous, and typically at least four reviewers, including at least one nominated by the applicant, review the research proposal. At present the review process is different in each council but they are currently working together to streamline and harmonise the process across the councils. The streamlining process, including the greater use on on-line processes for application and peer review, is aiming to reduce the costs of peer review by £30M over several years.

Most Research Councils operate a peer review 'college' made of anywhere between a few hundred and a few thousand experts depending on the breadth of the remit of the council (for example, NERC currently has 440 members and ESPRC over 4,000) from which peer reviewers are selected. Appointment to the panels is a mixture of open calls recruitment, third-party nomination and more pro-active methods to seek experts.

Members of the panels are usually active members of the research community plus, for some Research Councils, members from business and the public sector that may represent both external research communities and potential research users. The involvement of this latter group is intended to increase the potential for research application and creation of economic and social benefits.

A number of Research Councils pay a fee or an annual honorarium to college members plus out-of-pocket expenses (travel etc in return for their input. Although it is not clear of this system is deployed in all Councils. EPSRC provides an added incentive to become a member of their peer review college through aiming to limit the number of reviews a year (to 12) and offering a Reviewers' Incentive Scheme for academics whereby points are allocated based on the number and timeliness of reviews that can be converted into research funds. EPSRC report that they have distributed £4.5M additional research funding via this method.

Individual Research Councils provide guidance for reviewers which are typically tailored for each funding scheme (project, programme, fellowship etc.)and/or programmatic focus. Typically reviews cover factors such as the following, with reviewers providing qualitative information plus a score on a simple three point scale:

- Quality of the research
- Likely impact of the research

- The ability of the researcher to conduct the research
- Resources and management

The Research Council funding schemes are heavily over-subscribed with an average success rate, across all councils, of around 30%. This means that the quality criteria of peer review will often lead to the selection of more proposal than can be funded. In these circumstances a peer review panel is established to prioritise proposals that have 'passed' the peer review test.

The panel does not re-review proposals, nor does it make detailed study of proposal costings. Instead, it orders the proposals based on a relative assessment of quality. The panel draws on the comments of the expert reviewers and on the applicants' responses to the reviewers' comments. The review panels are responsible for placing the proposals before it in a funding priority order. From this list, the final decision is made on funding.

7.5 Monitoring of Research Grants

HEFCE: The Block Grant

The block grant is allocated to institutions to expend on research as they see fit and there is no system of goal or target management associated with the funding, other than future assessments via RAE/REF exercises.

HEFCE uses past performance (as determined by the RAE) as an indicator of future performance and applies minimal monitoring processes on the grant holders, placing their trust in the governance structures at individual institutions to ensure the money is well spent.

Research Councils: Peer Review Grants

To some degree the peer review process of the Research Councils also places a great deal of trust in individual researchers and their institutions, and in the wider research system. The peer review system is essentially a self-regulating system. However, in contrast to the block grant, there are monitoring systems place, with these systems based, in large part, on the increasing requirement from government for professional management and the need to demonstrate the effective implementation of policy and the resulting outcomes and impacts.

The Public Service Agreements signed between each departments and HM Treasury filters down to their delivery agencies. In the case of the science budget this is operationalised as annual reports from each council to BIS, and final reports from grant holders to their funding council.

Research Councils are obliged to develop an annual reporting structure that provides data to demonstrate their contribution to the PSA targets. While this is referred to as the Economic Impact Reporting Framework for the Research Councils, each council has developed its own system. These record data such as: research expenditure (by type: projects grants, PhD grant etc.) and administration costs; framework conditions (i.e. spend on research infrastructure and equipment); knowledge generation – stock of knowledge (citations, publications, international collaborators); knowledge generation - human capital (no. of researchers funded, PhDs funded etc.); public engagement; knowledge exchange (e.g. collaboration levels with non-academic communities). Data is collected from a range of sources – the councils' management information systems, external data sources, contracted data collection (e.g. on citations) and from grant holders' reports.

From a researcher perspective, grant monitoring is rather light; all grant holders are required to submit a final report once their research within three months of project completion. Some grants (such as those over 2 years in length) also require interim reports which are usually reviewed before the projects may continue. All reports are

submitted online on standard forms, with final reports providing a summary of research inputs and activities (written for a non-specialist audience) and outputs in terms of publications and 'other' results such as potential or actual exploitation of the research results, patents, licences etc. These outputs contribute the council annual reports to BIS.

While for most councils the final reports are submitted via a centralised online system (used by all Research Councils) the collation and extraction of data on research outputs appears to be a manual task. One research council (MRC) is currently testing an online annual questionnaire of grant holders to gather data on research outputs and impacts. This will standardise and automate data collection and collation. It collects data on publications, knowledge, development of the research group, dissemination, tools and methods, product or intervention, policy and educational impact, intellectual property, spin outs and measures of esteem.

Despite these different levels of output data collection there is not a clear or strong ink between outputs and goals. At grant holder and Research Council level data is reported against agreed indicators but it is only department level that links are made between indicators and targets. This is largely due to difficulties of aggregation and attribution. The data collected at each level do not, in many cases, lend themselves to a to a simple aggregation process. The PSA targets are at national level and while, for example, any individual publication is obviously connected to UK research performance as measured by citations, the link cannot be made by simply aggregating counts of publications. Furthermore research performance cannot be attributed in its entirety to science budget (or for that matter, block grant) expenditure.

7.6 Cataloguing Research Outputs

As described above each Research Council collects output data via a variety of different form and templates albeit on a centralised IT based respository, and each uses them to report against a range of indicators on different formats to the central government department (BIS). The grant administration and monitoring system is slowly becoming more coordinated and harmonised across the councils but differences in collection and use is still the norm.

The forthcoming introduction of the REF, and its use of bibliometrics, might have led to a centralised repository or catalogue of research outputs (publications). However, despite the bibliometrics trial making use of international publication catalogues (e.g. Thomson Reuters Web of Knowledge) to identify UK publications, future implementation of the REF will most likely be based upon localised (i.e. university level) cataloguing activities. This is largely due to concerns among the academic community as to the accuracy of the data collated by a central system. However this concern may decrease with time as the 'new' system becomes embedded. Furthermore the cost of multiple local collection activities may result in a move towards amore centralised system.

7.7 Examples of Successful Goal Oriented Public Governance in Research Policy

Impact of the RAE

The RAE has developed over many years from its first use in 1986, with refinements being made after each RAE deployment. From the outset it was designed a tool to, not only to assess and identify high quality research, but to allocate research funding on a more selective basis based on that quality assessment - in fact its initial title was the *Research Selectivity Exercise*.

Although the first application of the RAE made limited changes to the distribution of research funding across UK universities, later deployments have resulted in an ever increasing concentration of block grants/ institutional funds in research departments rated as high quality by the RAE process and therefore, by extension, a concentration

of funds in universities with large numbers of highly rated departments. Over time, RAE results have been used to justify the progressive withdrawal of funds from lower-rated departments. In 1989 only 33% of the HFC research funding was allocated by RES (as it was called at the time) scores; but by 1992, it was 90%. From 1996 onwards the differentials in the proportion of HFC funding allocated to high and low scoring departments has increased, with the lowest scores receiving no funding via this mechanism, so much so that low rated departments are often not submitted to RAE at all. The most recent RAE in 2008 devised a new scoring method that created a profile of departmental research quality across the quality categories rather than a single score. This led to a slightly flatter distribution of funds as it enabled 'pockets' of excellence within departments to be indentified and funded.

In terms of a tool to concentrate funding on high quality research, the RAE has been reasonably successful, within the limits of its ability to objectively measure quality. However the process has been progressively refined and has resulted in a system that many stakeholders are comfortable with. While it is criticized for being cumbersome and costly, as section 7.2 has shown, it is significantly cheaper in its totality than the project-by-project peer review process of the Research Councils.

The RAE was not explicitly designed to directly improve research quality, but over time, the proportion of staff in 5-rated departments has increased from 23% in 1992 to 31% (in 5 and 5* departments) in 1996 and to 55% in 2001.[209] One interpretation of these figures is that the very process of research quality assessment, i.e. the RAE, has been a major driver of a significant improvement research quality. However, this increase in high scoring departments is also seen to be an effect of universities learning to play the RAE 'game' more effectively (e.g. who and what to submit, and how best to present their submissions).[210]

There is also concern among universities, mainly the traditional research-intensive universities, that the RAE and its successor the Research Excellence Framework (REF) are not simply tools to assess research quality, but is also a policy implementation tool. The government would be unlikely to disagree; the REF for example will, in line with government requirements for research to stimulate economic growth and improve quality of life, include measures to assess the impact of research (in the widest sense). This leads to the criticism that the RAE increases the influence of government, via the HFCs, on universities and research departments and groups, thereby reducing their independent and autonomous role in society.

Over recent years the proportion of research funding allocated as a result of the RAE i.e. the block grant from the HFCs has diminished in proportion to the project grants allocated by the Research Councils. It is not clear what a continued move in this direction would mean for the RAE/REF in the future.

7.8 The Future

The description of the UK system for funding research provided above is highly likely to change in the near future - a change of government with focus on budget cuts to meet the UK economic deficit has already led to budget and administrative change. The science budget fared reasonably well, in the circumstances, with no reduction in cash terms for the lifetime of the current Parliament (up to five years). In real terms this equates to a reduction of around 10% of the coming 5 years.

However, more importantly, it appears that the dual support research budgets have been merged with Science Budget - a change which may well have significant implications for the balance between the two strands and the importance of the

[209] The UK Research Assessment Exercise: A Case of Regulatory Capture? Ben R Martin and Richard Whitley (to be published)

[210] Ibid.

methods by which funds are allocated. At the present time the exact details of this apparent change are not yet known.

7.9 Priorities of the Research Councils

The following tables present the strategic priorities and research themes of the seven Research Councils.

Arts and Humanities Research Council (AHRC)
Our funding initiatives address issues of intellectual and wider cultural, social or economic urgency that the Council considers are best supported by concentrated and coherent funding initiatives. The Arts and Humanities Research Council [AHRC] supports world-class research that furthers our understanding of human culture and creativity. From ancient history and heritage science to modern dance and digital content. Research into the following subjects helps us to interpret our experiences, probe our identities, interrogate our cultural assumptions and understand our historical, social, economic and political context. It adds to the economic success of the UK, through its contributions to the knowledge economy and innovation agenda. The research we fund can lead to improvements in social and intellectual capital, community identity, learning skills, technological evolution and the quality of life of the nation. • **History, philosophy, religious studies and law**. • **Contemporary arts practice, theory in art, design and media, architecture, visual arts, creative writing, music, dance, drama and theatre studies**. • **Art history, conservation of art and textiles, dictionaries and databases, cultural geography, archaeology, classics and library, information and museum studies**. • **Journalism, media and communication studies, American studies, cultural studies and popular culture, gender and sexuality, lifewriting, literary and cultural theory, post-colonial studies, text editing and bibliography, English language and literature, linguistics and modern languages**
Funding initiatives • Beyond Text: Performances, Sounds, Voices, Images and Objects • Designing for the 21st Century • Diasporas, Migration and Identities • Digital Economy Programme • Global Uncertainties • ICT in and Arts and Humanities Research • Landscape and Environment • Museums and Galleries Research • New Dynamics of Ageing • Religion and Society • Science and Heritage
New cross-Council Programme • Connected Communities
Emerging themes • Science in Culture • Digital Transformations in Arts and Humanities • Care for Future • Translating Cultures
Other activities • Countering Terrorism in Public Places • Franco-British Social Science and Humanities Collaborative Workshops links to ESRC website • Language Based Area Studies (LBAS) • Lifelong Health and Wellbeing • Nature of Creativity workshops • Networks in Synthetic Biology • New Security Challenges: 'Radicalisation' and Violence
Strategic Plan available at: http://www.ahrc.ac.uk/About/Policy/Pages/CorporateDocuments.aspx

Source: AHRC website

Biotechnology and Biological Sciences Research Council (BBSRC)
Strategic priorities BBSRC has a set of Council-wide strategic priorities (research and policy) that are applicable to all aspects of our funding. • Ageing research: lifelong health and wellbeing • Bioenergy • Global security • Living with environmental change • Nanoscience through engineering to application: bionanotechnology • Systems approach to biological research • Synthetic biology • Technology development for bioscience • Animal health • Crop science (food security)
Response mode funding is considered in the following 4 areas: • Animal systems, health and wellbeing • Plants, microbes, food & sustainability • Technological and methodological development • Molecules, cells and industrial biotechnology
Strategic plan available at: http://www.bbsrc.ac.uk/science/strategic-overview.aspx

Source: BBSRC website

Engineering and Physical Sciences Research Council (EPSRC)
Programmes We manage our portfolio through programmes. Research base programmes - investigator-led. Business innovation programmes - priority research themes and maximise the economic and social impact of funding. We manage our portfolio through programmes. Research base programmes focus on investigator-led research and training. Business innovation programmes deliver our priority research themes and maximise the economic and social impact of the research and training we fund.
Research base programmes • Cross-disciplinary interfaces • Information and communications technology • Materials, mechanical and medical engineering • Mathematical sciences • Physical sciences • Process, environment and sustainability • Public engagement • Research infrastructure and international
Mission programmes • Digital economy • Energy • Nanoscience through engineering to application • Towards next-generation healthcare
User-led knowledge, skills and research • Towards better exploitation
Cross programme • Manufacturing
Contribution to cross-council programmes • Ageing - lifelong health and wellbeing • Global uncertainties - security for all in a changing world • Living with environmental change

Engineering and Physical Sciences Research Council (EPSRC)
Strategic Plan available at: http://www.epsrc.ac.uk/plans/approach/strategicplan/Pages/default.aspx

Source: EPSRC website

Economics and Social Research Council (ESRC)
The Economic and Social Research Council (ESRC) funds research and training in social and economic issues. Seven key research challenges for 2009-2014: • Global economic performance, policy and management • Health and wellbeing • Understanding individual behaviour • New technology, innovation and skills • Environment, energy and resilience • Security, conflict and justice • Social diversity and population dynamics
Our Research • Economic Performance & Development • Environmental & Human Behaviour • Governance and Citizenship • Knowledge, Communication and Learning • Lifecourse, Lifestyles and Health • Social Stability and Exclusion • Work and Organisation • Capacity Building Clusters • Research Methods
Current Programmes Below is the list of current ESRC-funded research programmes (end dates in brackets). – Geography, Environment, Urban/Rural and Transport Studies, Area Studies – Living with Environmental Change Programme (LWEC) (2017) – ural Economy and Land Use (RELU) (August 2011) – Research Councils Energy Programme (ongoing) (link to EPSRC website) – Climate Change Leadership Fellowships (Various) • Management and Business Studies and Innovation – Public Services: Quality, Performance and Delivery (July 2010) – Advanced Institute of Management Research (AIM) (October 2011) • Sociology, Social Policy, Social Work and Social Anthropology – Teaching and Learning Research Programme (TLRP) (September 2009) – New Dynamics of Ageing (December 2012) – Religion and Society (December 2011) – Global Uncertainties (2018)
Strategic Plan available at: http://www.esrcsocietytoday.ac.uk/ESRCInfoCentre/strategicplan/challenges/default.aspx

Source: ESRC website

Medical Research Council (MRC)

Overview of MRC Research Portfolio:
Since October 2008 the MRC research portfolio is divided into four broad scientific areas, each of which is represented by an MRC research board. This page shows which research topics fall within which area of our overall portfolio.

The research portfolio is dividied into 4 broad areas:
- Infections and Immunity Research Board (IIB)
- Molecular and Cellular Medicine Board (MCMB)
- Neurosciences and Mental Health Board (NMHB)
- Population and Systems Medicine Board (PSMB)

Current research priorities - the MRC's has identified two research priority themes:
- Resilience, repair and replacement
  - Natural protection
  - Tissue disease and degeneration
  - Mental health and wellbeing
  - Repair and replacement
- Living a long and healthy life
  - Genetics and disease
  - Life course perspective
  - Lifestyles affecting health
  - Environment and health

Research initiatives
The MRC focuses its funding on research areas which make a difference to human health, on behalf of the taxpayer. Here is an overview of the different research areas we fund, including broad research initiatives such as speeding the development of basic discoveries into new drugs and treatments.

- Addiction research strategy

  The MRC is leading a strategy for addiction research involving discussions with stakeholders about areas of priority need and calls for grant applications
- Autism

  Our work with scientists, professional groups and families to increase understanding of the causes and epidemiology of autism
- CFS/ME

  Chronic fatigue syndrome (CFS) or myalgic encephalomyelitis (ME) is a complex and debilitating condition with a wide range of symptoms
- Experimental Medicine

  The MRC is the lead public sector organisation for Experimental Medicine and co-ordinates activities on behalf of UK Clinical Research Collaboration partners
- Lifelong Health and Wellbeing

  Multi-disciplinary research addressing factors across the life course that influence healthy ageing and wellbeing in later life
- National Prevention Research Initiative (NPRI)

  A national initiative to encourage and support research into chronic disease prevention
- Methodology Research Programme

  Supports development of methodological tools and theories to underpin health research
- Translational research

  Aims to increase the scale and speed of progress from scientific discovery to clinical benefit

Strategic Plan available at:
www.mrc.ac.uk/strategicplan

MRC website

Natural Environment Research Council (NERC)
At the heart of NERC's science strategy are plans to deliver the science needed to provide solutions to the global environmental challenges that the world is facing today and will face in the future. Research programmes (previously known as *directed programmes*) explicitly address science challenges and priorities within these seven themes: climate system; biodiversity; sustainable use of natural resources; Earth system science; natural hazards; environment, pollution & human health; and technologies. NERC has identified seven themes under which this science will be delivered. • Climate system • Biodiversity • Sustainable use of natural resources • Earth system science • Natural hazards • Environment, pollution and human health • Technologies
Research programmes • Aerosol Properties, PRocesses And InfluenceS on the Earth's climate (APPRAISE) • Aerosols & Clouds • Analytical Science & Technology • Arctic Research Programme • Arctic-IPY • Biodiversity & Ecosystem Service Sustainability (BESS) • Changing Water Cycle • Ecosystems Services & Poverty Alleviation (ESPA) • Environment & Human Health (EHH) • Environmental Exposure & Health Initiative (EEHI) • Environmental Nanoscience Initiative • Environmental & Social Ecology of Human Infectious Diseases (ESEI) • Flood Risk from Extreme Events (FREE) • Ice Sheet Stability • Increasing Resilience to Natural Hazards in Earthquake-prone & Volcanic Regions • Joint Weather & Climate Research Programme • Land Based Renewables • Macronutrient Cycles • Marine Renewable Energy • Methane Network • Networks of Sensors - Demonstration High Resolution Networks • Next Generation Weather and Climate Prediction • Ocean Shelf-Edge Exchange • Oceans 2025 • Post-Genomics & Proteomics (PGP) • Quantifying & Understanding the Earth System (QUEST) • Quantifying Uncertainty • RAPID-WATCH • Storm Risk Mitigation through Improved Prediction & Impact Modelling • Sustainable Marine Bioresources • Taxonomy & Systematics • Technology Clusters • Technology Proof of Concept • UK Integrated Ocean Drilling Program (UKIODP) • Understanding & Predicting the Ocean Surface Boundary Layer • Urban Atmospheric Science • Valuation Network • Virtual Observatory

Natural Environment Research Council (NERC)
Other programmes • Earth Observation Enabling Fund • Geostationary Earth Radiation Budget Experiment (GERB) • High Resolution Dynamics Limb Sounder (HIRDLS) • UK Population Biology Network (UKPopNet)
Cross-council programmes • Living With Environmental Change (LWEC) • A major interdisciplinary partnership to tackle environmental change • Rural Economy & Land Use (RELU) • Towards a Sustainable Energy Economy (TSEC)
Strategic Plan available at: http://www.nerc.ac.uk/about/strategy/ngscience.asp

Source: NERC website

Science and Technology Facilities Council (STFC)
STFC makes it possible for a broad range of scientists to do the highest quality research, tackling some of the most fundamental scientific questions. We do this by: • Funding researchers in universities directly through grants particularly in astronomy, particle physics, space science and nuclear physics. • Providing in the UK access to world-class facilities, including ISIS (link opens in a new window), the Central Laser Facility (link opens in a new window), and High-End Computing Terascale Resource (link opens in a new window) (HECToR). We are also a major stakeholder in the Diamond Light Source, which started operations in 2007. • Providing in the UK a broad range of scientific and technical expertise in space and ground-based astronomy technologies, microelectronics, wafer scale manufacturing, particle and nuclear physics, alternative energy production, radio communications and radar. • Providing access to world-class facilities overseas, including through CERN (link opens in a new window), the European Space Agency (link opens in a new window) (ESA), the European Southern Observatory (link opens in a new window) (ESO), the European Synchrotron Radiation Facility (ESRF), the Institut Laue-Langevin (ILL) and telescope facilities in Chile (link opens in a new window), Hawaii (link opens in a new window), La Palma (link opens in a new window) and the MERLIN/VLBI National Facility, which includes the Lovell Telescope at Jodrell Bank Observatory
Research Areas: • Aurora • Astronomy • Biology and Medicine • Computational Science • Energy Research • Environment • Nuclear Physics • Other Programmes • Research Programme Planning • Particle Physics • Space Science • Underpinning Research with Technology
Research facilities • Lasers – Central Laser Facility (CLF) at RAL • Neutron and muon sources – ISIS pulsed neutron and muon source at RAL – Research facilities access scheme • MICE experiment and facility at ISIS – MICE is a facility to investigate muon ionization cooling or to perform tests with high-quality, low-energy

Science and Technology Facilities Council (STFC)

beams of muons, electrons, protons or pions.

- Computational Science and Engineering
  - HECToR
  - High Performance Computing
- Atmospheric, Astronomy and Space Science
  - Chilbolton Facility for Astmospheric and Radio Research (CFARR) - Chilbolton Observatory
  - The Isaac Newton Group of Telescopes (ING) - La Palma
  - The Joint Astronomy Centre (JAC) - Hawaii
  - Molecular Spectroscopy Facility - Rutherford Appleton Laboratory
  - Space Test Facilities - Rutherford Appleton Laboratory
  - The UK Astronomy Technology Centre (ATC) - Edinburgh
- Innovations Technology Access Centre (I-TAC)
  - Based at Daresbury Science and Innovation Campus, a unique, fully equipped space for innovation, research and development, providing flexible access to laboratory space, "hot-labs" and £3m scientific equipment.
- Synchrotron light sources and free electron lasers
  - Accelerators and Lasers In Combined Experiments (ALICE)
  - Diamond Light Source (DLS) - Rutherford Appleton Laboratory
  - European Synchrotron Radiation Facility (ESRF) - Grenoble
  - New Light Source
- Facilities for Materials Analysis
  - Medium Energy Ion Scattering Facility (MEIS)
  - National Centre for Electron Spectroscopy and Surface Analysis (NCESS) - Daresbury Laboratory
- Partner Facilities/Organisations - Neutron sources
  - Institut Laue-Langevin (ILL) - Grenoble
- Partner Facilities/Organisations - Atmospheric, Astronomy and Space Science
  - British National Space Centre
  - European Organisation for Astronomical Research in the Southern Hemisphere (ESO)
  - European Space Agency
  - Gemini Observatory
- Partner Facilities/Organisations - Particle physics
  - CERN

Strategic Plan available at:
http://www.stfc.ac.uk/About+STFC/130.aspx

Source: STFC website

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