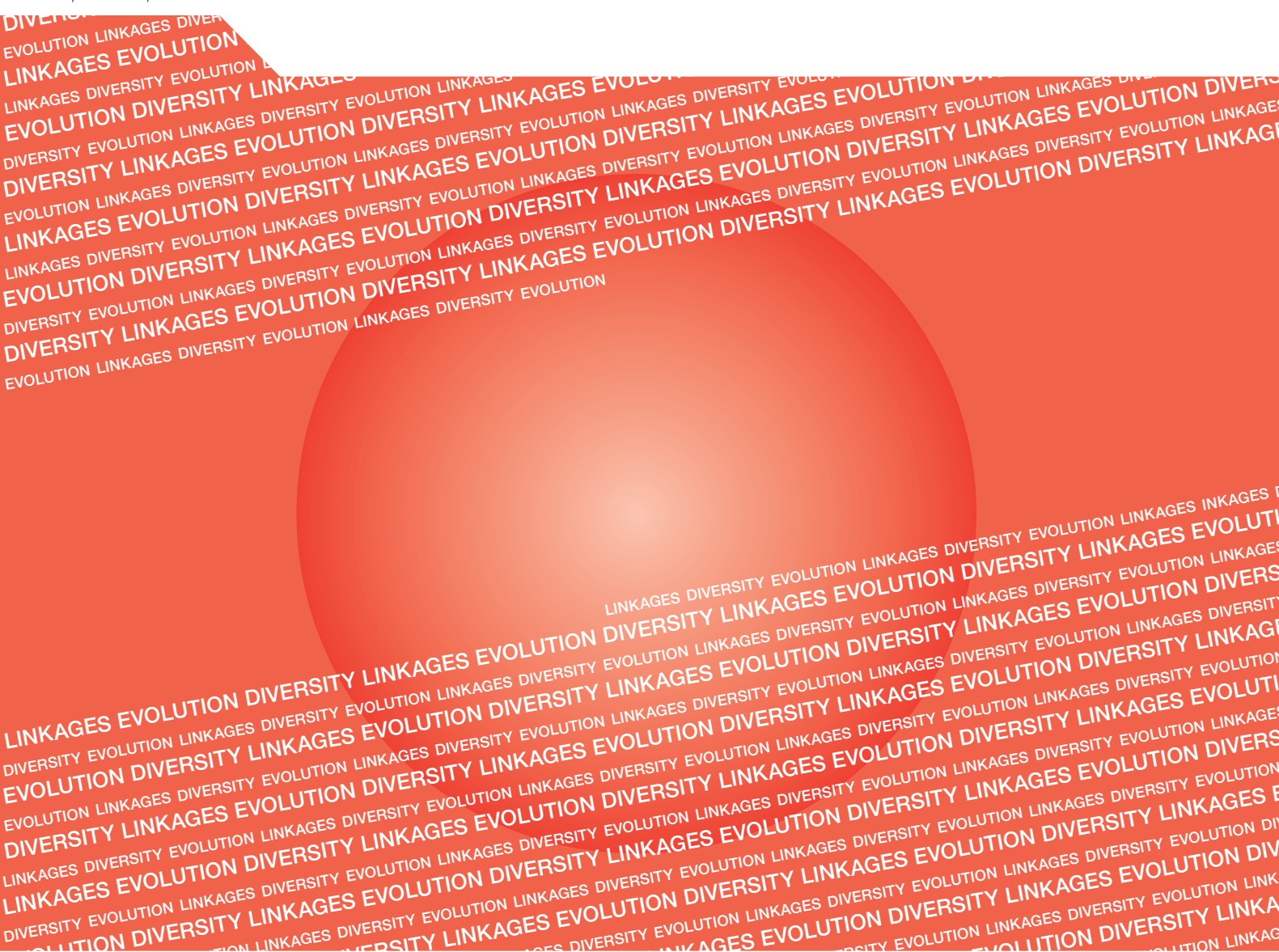




Public Research Institutions

MAPPING SECTOR TRENDS



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Foreword

This publication is the culmination of work undertaken by the OECD's Working Party on Research Institutions and Human Resources (RIHR) over 2009-10 on the transformation of public research institutions (PRIs). It provides a rich source of information on the changes and trends experienced by PRIs in recent years, which can be used by governments to enhance debate and inform policy making. The publication brings together extensive material provided by countries participating in the RIHR group, including "country context" notes, institutional case studies and a survey of institutes, as well as national-level data on PRIs. This material provides new insights into PRIs' orientations, organisational and institutional arrangements, funding, human resources and internationalisation.

The report was prepared by Sarah Box and Ester Basri of the OECD's Directorate for Science, Technology and Industry. It benefitted significantly from the efforts of RIHR delegates, particularly the project Steering Group, led by Wolfgang Polt and Reinhold Hofer (Joanneum Research, Austria), in providing oversight and contributing information and data on public research institutions. The authors would like to thank Keith Smith (Department for Business, Innovation and Skills, United Kingdom) for the original project proposal as well as Luis Sanz-Menendez and Laura Cruz-Castro (CSIC Institute of Public Goods and Policies, Spain) and participants at the project launch meeting in May 2008 for their input.

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Acronyms

ATS	Approved Technological Service institutes (Denmark)
CDG	Christian Doppler Association (Austria)
CERN	European Organisation for Nuclear Research
CIS	Community Innovation Survey
CNR	National Research Council (Italy)
CONICYT	National Commission for Scientific and Technological Research (Chile)
CRI	Crown Research Institute (New Zealand)
CSIC	Spanish National Research Council
DFO	Department of Fisheries and Oceans (Canada)
DSTO	Defence Science and Technology Organisation (Australia)
EPO	European Patent Office
EU	European Union
EUR	Euro currency unit
FFRDC	Federally funded research and development center (United States)
FNR	Fonds National de la Recherche (Luxembourg)
FTE	Full-time equivalent
GBAORD	Government budget appropriations or outlays on research and development
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
GMO	Genetically modified organism
GOVERD	Government intramural expenditure on research and development
GTI	Large technological institute (the Netherlands)
HERD	Expenditure on research and development in the higher education sector
ICPC	Institute for Chemical Processing of Coal (Poland)
ICT	Information and communication technology
IHPP	Institute of High Pressure Physics of the Polish Academy of Sciences
IP	Intellectual property
IPR	Intellectual property rights
JRC	Joint Research Centre (European Union)
KIST	Korea Institute of Science and Technology
KNAW	Royal Netherlands Academy of Arts and Sciences
KORDI	Korea Ocean Research and Development Institute
KRISS	Korea Research Institute of Standards and Science
LTI	Leading Technological Institute (the Netherlands)

MNE	Multinational enterprise
MSTI	OECD Main Science and Technology Indicators database
NABS	Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets
NESTI	OECD Working Party of National Experts on Science and Technology Indicators
NIS	National innovation system
NRNU	National Research Nuclear University (Russia)
NTNU	Norwegian University of Science and Technology
NWO	Netherlands Organisation for Scientific Research
PCT	Patent Co-operation Treaty
PGI	Polish Geological Institute
PPP	Purchasing power parity
P-PP	Public-private partnership
PRI	Public research institution
PSRE	Public sector research establishment (United Kingdom)
R&D	Research and development
R&D&I	Research and development and innovation
RIHR	OECD Working Party on Research Institutions and Human Resources
S&T	Science and technology
SCI	Science Citation Index
SEO	Socio-economic objective
SFI	Centre for Research-based Innovation (Norway)
SME	Small- and medium-sized enterprise
SSCI	Social Sciences Citation Index
THL	National Institute for Health and Welfare (Finland)
TNO	Netherlands Organisation for Applied Scientific Research
TRIPS	Trade-Related Aspects of Intellectual Property Rights (World Trade Organisation)
USD	United States dollar
VET	Vocational education and training

Executive summary

Public research institutions are crucial for innovation due to their role in knowledge creation and diffusion

Public research institutions (PRIs) are one of the two main actors in the public research system and are a primary tool for governments seeking to spur research and innovation in their economies. PRIs remain critical for countries' innovation and economic performance through their activities in creating, discovering, using and diffusing knowledge. Their structures, functions and performance are diverse across countries, and their activities vary according to their mission and type. Some perform “blue sky” research, while others focus on more short-term market oriented projects. Other roles can include education and training, technology transfer, the provision of major scientific infrastructure, and the support of public policy. Their activities can help firms to expand their capabilities and generate spillovers for the wider economy.

This report presents the results of a project by the OECD Working Party on Research Institutions and Human Resources (RIHR), on “the Transformation of Public Research Institutions”. To date, PRIs have been the subject of fewer analyses, and work has often been at the national or institutional level. Yet PRIs have seen much change in recent years, the results of which have implications for current and future policy approaches. To enhance the level of policy debate and provide input into policy making, the project aimed to provide new information on PRIs and government strategies. The project benefited from an array of rich material contributed by countries participating in the RIHR group; submissions included 20 “country context” notes, 12 institutional case studies, and a survey of 449 institutes. It also drew on national-level data to help describe the PRI sector and the changes it has seen in recent years.

Traditional statistics on PRIs may give a blurred view of the sector

The evolution of PRIs means that data on the *Frascati Manual**-defined government sector, as is usually used to analyse PRIs, may not fully capture the group of institutes considered to be public research entities. For this project, a wider definition of PRIs was developed, which sought to include relevant institutes regardless of their statistically-defined sector. Its focus was on public and semi-public research entities, excluding pure university institutes; the scope aimed to provide information about new types of research institutes that serve public objectives. As well as analysis of the Frascati government sector, the report describes the results of a re-tabulation of national data that gives a snapshot of the wider project-defined PRI population in selected countries.

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

Data showed that absolute real expenditure on R&D in the Frascati government sector has risen, but this expenditure now accounts for a smaller share of total R&D spending by OECD countries and of OECD GDP. For most countries, applied research and experimental development account for the bulk of government sector R&D, but there are differences across countries in focal research fields and the amounts of expenditure attributed to them. Re-tabulating national-level data to the project definition changed the picture of the PRI sector. The data typically showed more business funding, more applied research, more engineering and technology and more industrial production than in the Frascati-defined government sector. However, any future statistical exercise would require greater consistency in the treatment of certain entities.

Country-level evidence highlighted the strong focus on applied research

The evidence collected from countries via the country context notes, case studies and survey painted a picture of diversity and ongoing change, along with some common trends in response to shared challenges. It revealed that countries' conceptions of "what is a PRI" differ, and countries took varying approaches to the inclusion of institutes with a strong cultural focus (e.g. museums), with important public service goals (e.g. hospitals) and with defence missions. Civil society institutes were also viewed as a grey area. Any future analysis would benefit from strong agreement on the desired approach to these entities.

The country-level information showed that the targets and focus of many PRIs have evolved in recent years. Changing activities, new policy challenges and wider economic and political developments have driven change in missions and mandates, and "excellence" and linkages have become focal points for many. Surveyed PRIs suggested applied research and dissemination of research results to the public had increased in the past decade. Fields of research remained relatively stable, although increases in "trans- and multi-disciplinary sciences" were identified. Broader public-oriented missions appeared more common than industry-oriented ones, with PRIs focused on particular sectors, fields or tasks. Applied research was a key activity, although PRIs often had multiple goals and undertook a number of other tasks (e.g. training researchers). The basic rationale for PRIs varied, but most often related to supporting the growth and productivity of industry, conducting research of benefit to society and conducting policy-relevant research.

PRI structures and governance have evolved to engage more stakeholders

PRIs' organisational arrangements have undergone active change. The survey suggested organisational structure had been the most significant area of change in institutes in the past decade, with growth in institutes and the size of research groups common. Numerous examples of structural changes were detailed, including the introduction of institutes with more business-like operational models and public-private partnerships. Changing goals and rationales may have been a key driver, alongside the trend towards increased openness, a move towards increased market responsiveness, budget pressures and effects to increase clarity over research roles.

Governance arrangements also evolved, partly in response to PRIs' structural changes, and now exhibit notable cross- and within-country diversity. High-level strategic directions played an important role in driving PRI activities, and were delivered in a variety of ways, including government plans and high-level advisory bodies. Oversight arrangements ranged from tight government control through to fully independent entities. The country-level evidence showed PRIs often pursue multi-faceted missions and rationales, and that decision-making across a range of issues is predominantly considered the domain of internal management rather than public authorities. While governments continue to express their desired directions for PRIs via funding, regulations and senior appointments, if not direct management and ownership, there is a question as to how clear this direction is and how closely it can be followed, especially when PRIs have numerous other interests to satisfy.

Funding has become increasingly competitive

PRIs' sources of income are diverse, as is the manner in which funding is delivered, although there was a trend towards competitive channels. Increased industry involvement was highlighted, and income from abroad has also increased. The core institutional (or "block") component of public funding is evolving, with some countries introducing performance-based elements or moving towards more contractual arrangements. There were strong increases in public competitive funding and private contract income for PRIs participating in the survey. Competitive funding had raised issues for some countries, and revisions to funding and governance structures were foreseen.

Human resources remain a major input, although PRIs exhibit considerable diversity in staff sizes and employment structures. Countries have seen a rebalancing of R&D personnel towards a greater share of researchers, and many institutes play a role in researcher development. Some PRIs have experienced recruitment difficulties, related to specific groups or skills, while others faced difficulties due to wider labour market regulations. Institutes are also challenged in their recruitment of foreign staff. Internally, establishing systems of staff motivation and reward that support the research outputs foreseen by PRIs missions may be a challenge for some institutes.

Linkages and internationalisation have increased and relationships are frequently collaborative

PRIs rarely operate in isolation and there has been a clear increase in the importance of their relationships with most other players. Surveyed institutes particularly increased their country links, joint research projects and participation in international committees. Institute design, changes to legislation, co-ordination mechanisms and various policy initiatives helped drive linkages and internationalisation; so too did PRIs' need to access knowledge and the globalised organisation of R&D. Methods of linking are varied and depend on the partner; options ranged from informal exchange and researcher interaction on projects, to collaborative centres. The survey results highlighted the importance of personal interactions, showing that joint positions and regular meetings were the top linkage method between PRIs and universities; they were also important linkage methods with firms, alongside joint projects and training. Collaborative relationships appeared to dominate for the majority of institutes.

Countries expressed some concerns about the strength of PRI linkages and internationalisation. Industry funding of government sector R&D is low on average in the OECD and a low percentage of innovative firms collaborate with PRIs. The survey results revealed that PRIs are interested in pursuing knowledge transfer and dissemination, yet linkages are driven more by knowledge acquisition than knowledge exploitation. However, expectations cannot be uniform across PRIs; for instance, large entities, those with multiple research areas, and those with more intensive academic orientations tended to have more diverse international linkages. Also, geographically proximate countries appear to be the main partners for PRIs and case study evidence underlined how such linkages develop over a long time.

PRI evaluations are often positive but entities are seeking to increase their scientific impact

Evaluations of PRI performance are often positive overall. Nevertheless, they highlight several reoccurring issues, particularly the difficulties in establishing governance and funding structures that can cope well with multiple stakeholders and funders and complex environments, the challenges in establishing and maintaining industry links, and the ongoing need for clear missions. These themes were echoed in the survey and case studies. Surveyed PRIs identified “increasing scientific impact”, “increasing the degree of internationalisation”, “recruitment and retention of highly qualified personnel” and “increasing contract research” as their main challenges in the next five years. Similar issues were identified in the case studies, with PRIs especially expecting changes in their activities, international linkages and funding arrangements.

Ongoing changes in the form and function of PRIs are thus to be expected. The information and evidence points to a policy agenda for PRIs centred on ensuring the relevance of PRI activities, shaping government funding to support PRI goals, enabling linkages and bolstering human resources. These issues are not self-contained and it is important to embed focused slices of policy analysis within a “bigger picture” of PRI systems as a whole.

Testing and assessing different methods of steering and governance is a key task for policy makers

Effective steering and governance is essential to ensuring PRIs’ relevance, and learning lessons from existing models and changes via evaluation should be given high priority. This should include scheduling evaluations and assessments of performance that explicitly attempt to trace the effects of structural and management changes on outcomes and compare these to *ex-ante* goals, as well as evaluating the increasing number of PRIs with business-like operational models against their stated goals of increased autonomy, collaboration and responsiveness to stakeholders. Testing and evaluating different methods of gathering, co-ordinating and operationalising key stakeholders’ inputs to target-setting would also yield important information for policy making, as would assessments of the effectiveness of the performance agreements and contracts that some countries have established with their PRIs. At the same time, governments need to recognise the trade-offs often inherent in their visions for PRIs; pursuing greater collaboration with industry, for instance, necessarily reduces the control of governments over PRIs and their research priorities.

PRIs' funding issues demand instruments which balance short- and long-term goals and the requirements of different users, uphold research quality and ensure the sustainability of PRI activities. Analysing how different government funding instruments impact on PRI behaviour and performance, especially in research and service provision, but also regarding their longer-term investments in infrastructure and equipment, should continue. A number of governments still make strong use of institutional (or “block”) funding, raising questions over how allocation of institutional funding can be used to shape PRI behaviour. Some work has been done on performance-based funding in tertiary education institutions, and the OECD's RIHR group will continue to examine different public funding tools at the cross-country level. Examining the impacts of competitive project funding on PRIIs would also be informative.

The role for policy in further stimulating linkages is not clear. Given the wide variety of linking methods and the differences across countries and PRI partners, as well as the evolutionary nature of collaboration, there is a question of what policy can do to improve the situation. Action on linkages and internationalisation might best focus on how steering and funding arrangements impact on PRIIs' incentives for collaboration and competition with other entities.

Finally, human resources, as a key input to PRI activities, may also require policy attention. Analysis on human resource issues could focus on the role of policy in supporting researcher training efforts, analysing the effects of internal incentive systems on research outputs, and assessing the scope for change in wider labour market regulations.

Chapter 1

Public research institutions in national innovation systems

Public research institutions (PRIs) are one of the two main actors in the public research system, and continue to play numerous roles in innovation systems. Their structures, function and performance are diverse and their activities vary widely according to their mission and type. This report will present new data and evidence on PRIs, drawing on extensive material supplied by OECD member and observer countries. It aims to enhance the level of policy debate and provide input into future policy making.

Government plays an essential role in research and innovation via the public research system, and many of today's innovations are based on knowledge generated in this sector (Ruttan, 2001; Faulkner and Senker, 1995). The two main actors in the public research system are universities and public research institutions (PRIs), where PRIs include government research laboratories and establishments engaged in activities such as administration, health, defence and cultural services, public hospitals and clinics, technology centres and science parks.

National public research systems differ greatly in their ability turn funding into research outcomes, and many countries are working to reform their public research system to increase its efficiency and responsiveness to social needs. This is particularly relevant in a context of severely constrained public finances. PRIs are increasingly faced with the challenges of globalisation, competition, and greater demand for quality and relevance. Adjusting to these pressures has led to changes in governance structures, priority-setting processes and funding allocation mechanisms (OECD, 2010a; 2010b).

However, in terms of analyses, universities have attracted more attention than PRIs (European Commission, 2009; OECD, 1989; PREST, 2002; OECD, 2009). In addition, previous efforts to study PRIs have been mainly undertaken at the national or institutional level, with cross-country analyses much sparser. One example of work at the international level is the Eurolab project carried out in 2002. This effort spanned fifteen European countries and demonstrated the feasibility of extended data and information collection in the area of PRIs (PREST, 2002). Another example is the 2003 report by the OECD ad hoc Working Group on the Steering and Funding of Research Institutions (SFRI) on the *Governance of Public Research: Toward Better Practices* (OECD, 2003), which reviewed the changes in the governance of OECD countries' science systems as well as highlighting the policy responses in these countries.¹ An older example is the 1989 report on *The Changing Role of Government Research Laboratories* (OECD, 1989), which focused on the contribution of PRIs to innovation and technological development. To enhance the level of policy debate and provide input into future policy making, it is necessary to build on existing cross-country work and continue to analyse PRIs and associated government strategies.

In an attempt to bring new data and evidence to bear on PRI policy issues, the OECD's Working Party on Research Institutions and Human Resources (RIHR) launched a project on "the Transformation of Public Research Institutions". The focus of the project was on public and semi-public research entities, regardless of their statistically-defined sector (*i.e.* the *Frascati Manual* categories of government, higher education, business and private non-profit – see OECD, 2002). As such, it aimed to capture new types of public or not-for-profit research institutes serving public objectives or providing "public goods". Such institutes have emerged or grown in many countries, but relatively little is known in a systematic and comparable way about their structure, missions, functioning, science and innovation performance and degree of internationalisation.

This report is the outcome of the RIHR project on PRIs in OECD countries and selected non-member economies. As well as providing a detailed statistical picture of the PRI sector, it builds an overall "map" or picture of the different types of institutes, the organisation of "public" non-university research systems, including their governance, funding and linkages, and the changes that this sector has seen in recent years.

The report draws heavily on material contributed by countries participating in the RIHR group. Submissions included a "country context" note, which gave country-level information on the missions and orientations of PRIs, their linkages, major institutional

changes, and governance and regulatory arrangements in the sector. Fifteen countries participated in the initial questionnaire round, with a further five contributing material during the course of the project. Participants in this part of the study were: Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, Germany, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Russia, Spain, the United Kingdom and the European Union. There were also 12 institutional case studies (provided by Austria, Finland, Korea, Italy, Norway, Poland, Spain and Russia), and 449 institute-level survey results from Austria, Italy, Norway, Poland and Slovenia. The project benefited from collaboration with the OECD's Working Party of National Experts on Science and Technology Indicators (NESTI), which used the detailed lists of PRIs provided by selected countries in their country context notes to build a new statistical snapshot of the PRI sector.

The role of PRIs in national innovation systems

PRIs have always been important actors in innovation systems and have been in existence for centuries in various forms. Examples of early institutes include the Castle of Uraniborg observatory (built at the end of the 16th century) in Denmark, the *Museum d'Histoire Naturelle* (1626) in France and the Coast Survey (1807) in the United States. From 1835 to 1945 the establishment of PRIs largely followed national strategic areas and priorities as well as changing industrial needs such as the exploration of mineral resources, agriculture, industrial development, health and military R&D (for more information see OECD, 1989). Following World War II, the number and variety of institutes established for civil and military applications expanded rapidly in many OECD countries and covered nearly all areas of government activity including economic and social areas.² Their growth largely continued through the 1960s.

However, the growth of PRIs began to slow down and fade in the 1970s, and by the 1980s, the role of PRIs in terms of their contribution to innovation and technological development was questioned in many countries. This was partly a result of measures to reduce public expenditure in the government sector as well as the desire to build R&D capacity in the business enterprise sector. Perceptions about the relative quality of research in PRIs and universities also changed once scientific results in universities began to improve (OECD, 1989). (Chapter 2 shows the switch over time in public R&D performers and the relative decline of government as an R&D performing sector.)

Opinion about the rationales for supporting public science (performed in both PRIs and universities) has also evolved, leading to changing approaches to the funding and governance of public research. While scientific research continues to be considered central to supporting social needs, generating knowledge to support domestic industrial competitiveness and providing advanced scientific training, it is no longer considered independent from application and users, or able to function without external governance and resource oversight (Geuna *et al.*, 2003, pp. xv-xvii). Advances in the understanding of innovation systems have also given rise to the notion of systemic failures, which reduce the efficiency of overall R&D and innovation efforts and pose issues for governments shaping PRI policy (OECD, 2010c, p. 192). PRIs have also been buffeted by factors such as trends to more open innovation, ongoing globalisation, and changing boundaries between basic and applied research, technologies, and users and producers of research (Leijten, 2007).

Nevertheless, PRIs remain critical for innovation through their role in creating, discovering, using and diffusing knowledge. Crow and Bozeman (1998, p. 24) highlighted that PRIs can be “focused on the production of public knowledge, or they can be designed

to produce knowledge for the consumption of a single firm, sector or industry”. The emphasis on knowledge puts PRIs in an important position within economies – knowledge creation and application are crucial for spurring productivity, economic growth and employment. Knowledge is a source of future and sustained growth that cannot be exhausted and is often non-rival. Unlike any other factor of production, knowledge can be used by many firms and countries at the same time to foster sustainable economic growth (OECD, 2010c, p. 145).

PRIs’ structures, functions and performance are diverse across countries, and their activities vary widely according to their mission and type. Some perform “blue sky” science or basic research that often has a long time horizon and carries high risks with uncertain returns, while others focus on more short term market-oriented research, development work, problem solving and technical assistance. Some PRIs specialise in mission-oriented research such as biotechnology or telecommunications, while others cross the scientific spectrum. Other roles include providing technology services, education and training activities (*e.g.* supervision of PhD candidates and hosting post-doctorate researchers, skills development and on-the-job learning), technology transfer (*e.g.* physical transfer of technology, prototypes and process and or “know-how”), the development of new instrumentation or laws and regulations (*e.g.* environment, health, safety, etc.), the preservation, storage and access to knowledge and scientific collections through libraries, databases and repositories³ and the provision of major scientific infrastructure and facilities (*e.g.* nuclear reactors, satellites, large telescopes, oceanographic vessels *etc.*).

The combination of these roles suggests PRIs can create important expertise for solving societal grand challenges. EURAB (2005, p. 7), for example, highlighted the typical functions of research and technology organisations (RTOs⁴) in providing fundamental research in strategically important areas (*e.g.* nuclear research or public health), supporting public policy through precautionary research (*e.g.* into sustainable development or food safety), policy design and monitoring, supporting the building of technical norms or standards, and constructing, maintaining and operating key facilities.

Over time, PRIs have become more tightly linked to other entities in the innovation system, playing an important role in their performance. There is increased inter-organisational collaboration and exchange, as well as a growing application of scientific research in industry and society. This has occurred as scientific disciplines have converged, computing advances have increased opportunities for knowledge “hybridisation”, and international communication capacity has diffused methods and results (Geuna *et al.*, 2003, p. 394). One result is that PRIs’ activities strongly support innovation, through certification, testing, monitoring and measurement, finding new uses of existing knowledge, creating links between scientific fields and establishing multidisciplinary knowledge bases (such as gene banks and quality-assured scientific collections). Using data from the United States, Cohen *et al.* (2003, p. 110) found that public research is important for a wide range of industries in the manufacturing sector and has a particularly large impact on industrial R&D in selected industries, such as pharmaceuticals. The research is used both to address existing problems and needs and to suggest new research efforts in industry.

Country-level studies have shown how PRIs can support innovation. An analysis of industrial research institutes in Sweden found that they assisted companies to move “one step beyond” their existing capabilities and reduced the risks associated with innovation (Arnold *et al.*, 2007). In the United Kingdom, entities in the intermediate research and technology sector⁵ were considered to provide “one-to-many” channels for spreading innovation to business and industry and to generate R&D spillovers for the economy

(Oxford Economics, 2008). Firms gained access to a network of organisations and a wider range of research than would be possible in-house, and in many instances the sector offered resources on a cost- and risk-sharing, industry-wide, basis. Oxford Economics suggested that the sector's work allowed companies to commercially exploit technological advances cost effectively, where otherwise the cost and risk of acquiring the necessary expertise would be too high for individual companies. It noted that the sector often assisted small firms that did not have sufficient research expertise or contacts with academia. Analysing Norwegian data, Nedrum and Gulbrandsen (2009) highlighted a number of motives for firms to purchase R&D from PRIs, such as to increase inadequate in-house knowledge and skills, to access equipment or test facilities and to boost in-house capacity, particularly during busy periods. The firms revealed that this R&D was important for developing new or improved processes and products, work methods and tools, production quality and reliability and identifying user needs and markets.

In their roles within innovation systems, PRIs also have impacts on universities, and on wider geographic areas. PRIs can act as an intermediary between firms and universities, by interpreting the technical needs of firm and passing this information to universities, and provide skilled labour for firms (Nedrum and Gulbrandsen, 2009). These roles and functions are often highly interdependent. PRIs can also shape a region's capacity to innovate by attracting R&D-intensive firms or the R&D facilities of multinational enterprises (MNEs).

The multi-faceted roles and activities of PRIs, and their position within research and innovation systems, underline the importance of analysing the sector to provide better information for policy making. PRIs continue to be heavily involved in knowledge creation and innovation processes, and maintaining a policy environment that supports their scientific and related endeavours will contribute to improved economic outcomes overall.

Structure of the report

The remainder of the report presents the results of the RIHR project on the transformation of PRIs:

- Chapter 2 provides a statistical overview of PRIs, beginning with an examination of the sector as it has been traditionally defined using R&D data and other indicators. It then presents the results of the NESTI statistical work, which looked more closely at the target population defined for the project in selected countries.
- Chapters 3, 4 and 5 present the findings from the country context notes, case studies and survey results submitted by participating countries. This more descriptive information complements the data presented in Chapter 2 and can help to further highlight patterns and trends. Chapter 3 presents the methodology for the RIHR's information collection and describes the main features of the PRI sector, particularly its missions and research orientations. Chapter 4 focuses on the operational features of the sector, namely its organisational arrangements, human resources, governance, and funding. Chapter 5 discusses PRI linkages and the internationalisation of the sector.
- The report concludes with Chapter 6, which discusses the implications of change in the PRI sector. Based on the challenges ahead, it outlines a possible future policy agenda.

Notes

1. This work was based on case studies of science systems in six OECD countries and was supplemented by additional material provided by participating countries or collected through literature surveys.
2. In some instances, PRIs were established to support and conduct R&D for actors who were unable to carry it out themselves, such as farmers or small- and medium-sized enterprises (SMEs).
3. Scientific collections include plants, animals, microbes, biomedical samples, rocks, minerals, ice cores, fossils and so on. They are an integral part of the infrastructure of all countries with strong research enterprises (OECD, 2008b).
4. The European Association of Research and Technology Organisations defines RTOs as organisations “which as their predominant activity provide research and development, technology and innovation services to enterprises, governments and other clients...”. This definition distinguishes RTOs from universities, the predominant activity of which is education, and from enterprises, the predominant activity of which is the production and sale of goods and services (EURAB, 2005, p. 3).
5. The intermediate research and technology sector was defined as “positioned between academia and corporate and governmental end-users of technology. It comprises a range of companies and organisations whose activities are aimed at enhancing the development of new technologies and increasing the rate of adoption of technological innovation” (Oxford Economics, 2008, p. 5).

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Chapter 2

A statistical view of public research institutions

National-level data on PRIs provide a “big picture” view of how these entities have transformed over time. This chapter presents data related to the Frascati Manual-defined government sector, as well as the results of a data re-tabulation that included PRI-like entities from other sectors. The data show the government sector has shrunk relative to other sectors in terms of expenditures and personnel. Initial results from the re-tabulation point to a bigger role for industry funding and a greater emphasis on applied R&D in PRIs than is suggested by Frascati data.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

National-level data on public research institutions (PRIs) can provide important insights into how these entities have transformed over time. Typically, in analyses of PRIs, data related to the Frascati government sector are used. Here, for R&D statistical collection purposes, R&D-performing institutions are classified according to their principal (economic) activity (Box 2.1). All non-market non-profit institutions controlled by government are included in the government sector, with the exception of those administered by the higher education sector (OECD, 2002).

However, the evolution of PRIs raises some important statistical issues. There are “borderline” research institutes whose classification in the university, government, business or non-profit sectors varies by country. Furthermore, these classifications have become increasingly blurred as PRIs have transformed over time, and it is difficult to monitor changes using the traditional R&D statistics approach. In fact, as pointed out by Cruz-Castro and Sanz-Menéndez (2003, p. 28) “these statistics hide some of the most interesting organisational phenomena: the changing nature of public research organizations and the transformation of the boundaries between the public and the private sector.”

Box 2.1. Classifying R&D performers – the Frascati approach

The *Frascati Manual* (OECD, 2002) presents four sectors at a national level:

- *Government.* All departments, offices and other bodies which furnish, but normally do not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the economic and social policy of the community (public enterprises are included in the business enterprise sector); and NPIs controlled and mainly financed by government but not administered by the higher education sector.
- *Higher education.* All universities, colleges of technology and other institutions of post-secondary education, whatever their source of finance or legal status; and all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education institutions.
- *Business.* All firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price; and the private non-profit institutions mainly serving them.
- *Private, non-profit.* Non-market, private non-profit institutions serving households (*i.e.* the general public); and private individuals or households.

However, there are “borderline” research institutes whose classification in these categories will vary by country. In addition, with the emergence of public-private partnerships in research, these classifications become increasingly blurred.

Source: OECD (2002).

To better capture the diversity of PRIs and their evolution, a specific definition of PRIs was developed for this project. It focuses on “public” and semi-public research institutions (excluding pure university institutes¹), regardless of their statistically-defined sector (government, higher education, business or private non-profit). Specifically, the target of the analysis is:

National entities, irrespective of their legal status (organised under public or private law):

- Whose primary goals are to conduct fundamental research, industrial research, experimental development, training, consulting and service provision, and to disseminate their results by way of training, publication and technology transfer.

- Whose profits (if any) are reinvested in these activities, the dissemination of their results, or training.
- Which are either totally or to a substantial share publicly owned, and/or are funded primarily from public sources via base funding (block grants) or through contract-based research, and/or are regulated, so as to achieve primarily public missions.

This definition was used as the basis for the project's new data and evidence collection. Each participating country was requested to provide a list of entities that it considered fitted the project definition. Descriptive evidence for these entities was provided in a “country context note”, which was supplemented by institutional case studies and institute-level survey results for selected countries (see Chapters 3-5 for the results). Selected countries also took part in a statistical exercise using existing national R&D data collections that sought to provide a quantitative snapshot of this target population. This exercise was conducted by the OECD Working Party of National Experts on Science and Technology Indicators (NESTI).

The following sections in this chapter set out the statistical evidence on PRIs, to provide a picture of the sector's size and weight in countries' research systems and how this has changed over time. First, the traditional definition of PRIs is followed, *i.e.* the Frascati “government” sector. While this is only a proxy for the study's target population described above, it allows a time series view of the sector, as well as a more detailed breakdown of expenditures, personnel and other variables at a national level. Second, the results of the NESTI statistical exercise are presented. This gives an initial indication of potential gaps and misalignments between the Frascati classification of PRIs and the contemporary view of PRIs as set out in the RIHR project definition.

The government research sector as traditionally defined

Investment in government R&D is one indicator of the efforts that countries are putting into achieving scientific and technological progress. Some key expenditure data that describe the size and shape of investment in PRIs are:

- The monetary value of national investments in R&D in the government sector.
- The relative size of these investments, as compared to GDP.
- The share of government R&D within total national R&D efforts.

Data on these and other expenditure variables are presented here.² They are followed by selected data on research personnel, R&D orientations, outputs and collaboration. Not all figures present all OECD, OECD accession and OECD enhanced engagement countries, due to data constraints. Averages (and/or medians) will be specified as OECD averages where this is the case; otherwise they represent averages or medians for the available group of OECD countries.³

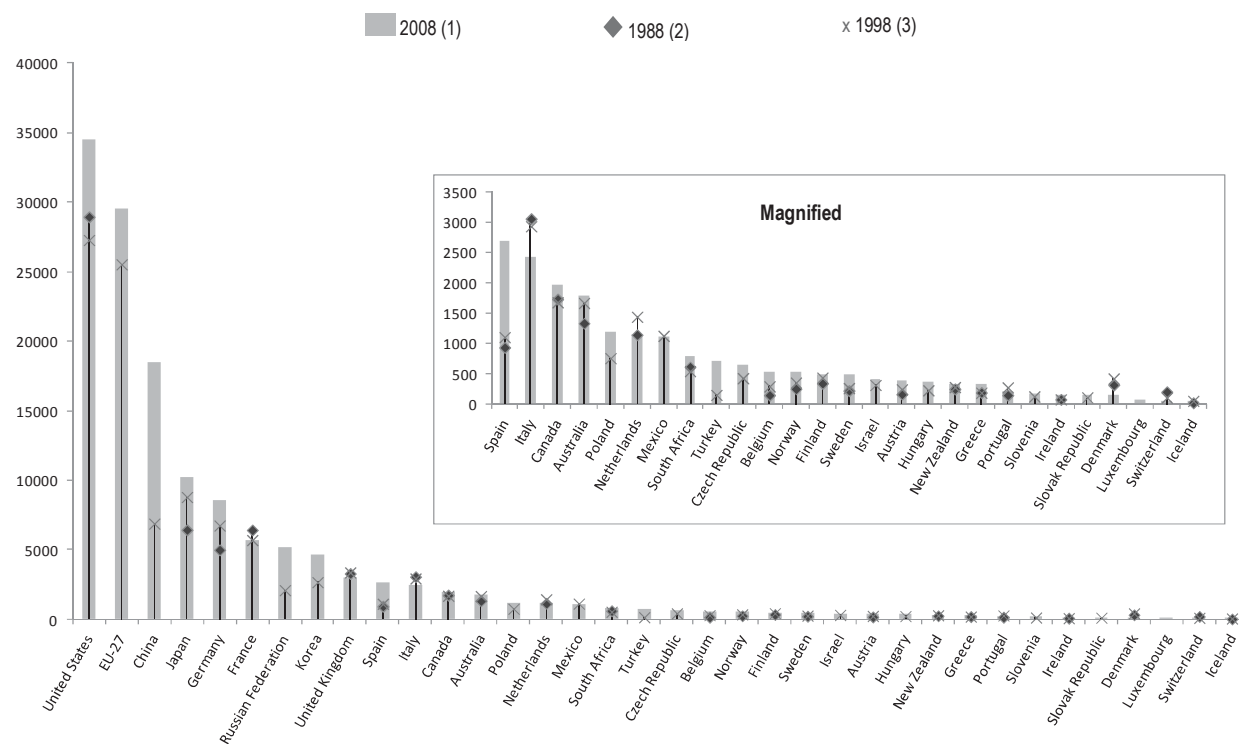
Expenditure data

Absolute real expenditure on R&D⁴ in the government sector rose from USD 69.1 billion in 1998 to USD 84.3 billion in 2008 for the OECD area – equivalent to a compound annual growth rate of 2%. At the country level, government intramural expenditure on R&D (GOVERD⁵) has increased in most countries over the past decade, with only nine countries experiencing a decline in spending (Denmark, France, Iceland, Italy, the Netherlands, Mexico, Portugal, Switzerland and the United Kingdom) (Figure

2.1). The strongest growth over 1998-2008 was in Spain and Turkey (with compound annual growth of over 9% and 16%, respectively). China's GOVERD grew at a compound rate of 10% over the same period.

Figure 2.1. Government expenditure on R&D

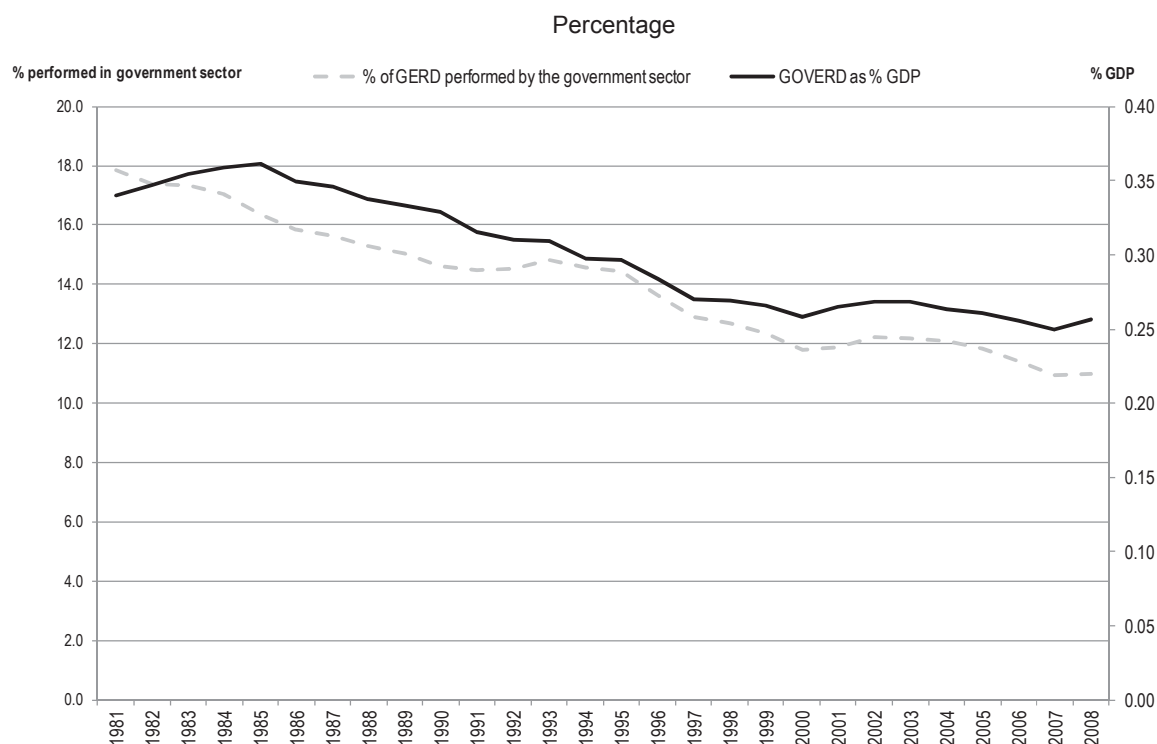
Year 2000 USD millions, constant prices and PPP



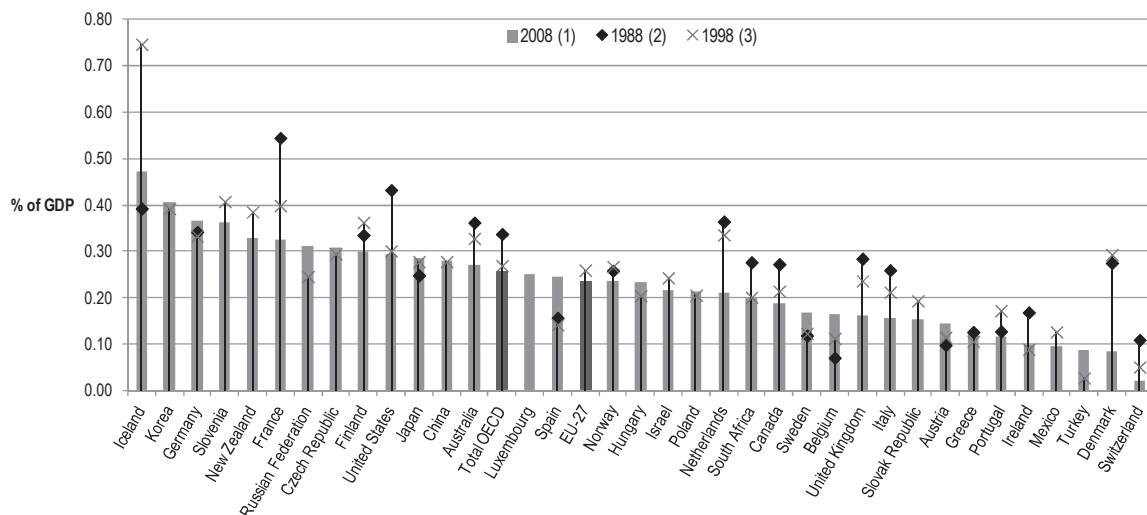
1. Australia 2006; Greece 2007; Mexico 2007; New Zealand 2007; South Africa 2007.
2. Austria 1989; Iceland 1987; New Zealand 1989; Norway 1987; Sweden 1987; South Africa 1987.
3. Greece 1997; New Zealand 1997; Norway 1997; Sweden 1997; South Africa 1997.

Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

However, since the early 1980s, OECD GOVERD as a share of GDP has fallen – from 0.34% in 1981 to 0.26% in 2008 (Figure 2.2). The share of R&D performed in the government sector has also steadily declined. In the OECD area, the share of gross domestic expenditure on research and development (GERD) performed by the government sector was 17.9% in 1981 and 11% in 2008. This contrasts with the relatively strong growth in OECD R&D spending in the higher education and business sectors, with such spending increasing as a share of GDP (OECD, 2010b).

Figure 2.2. R&D in the government sector, total OECD, 1981-2008

Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

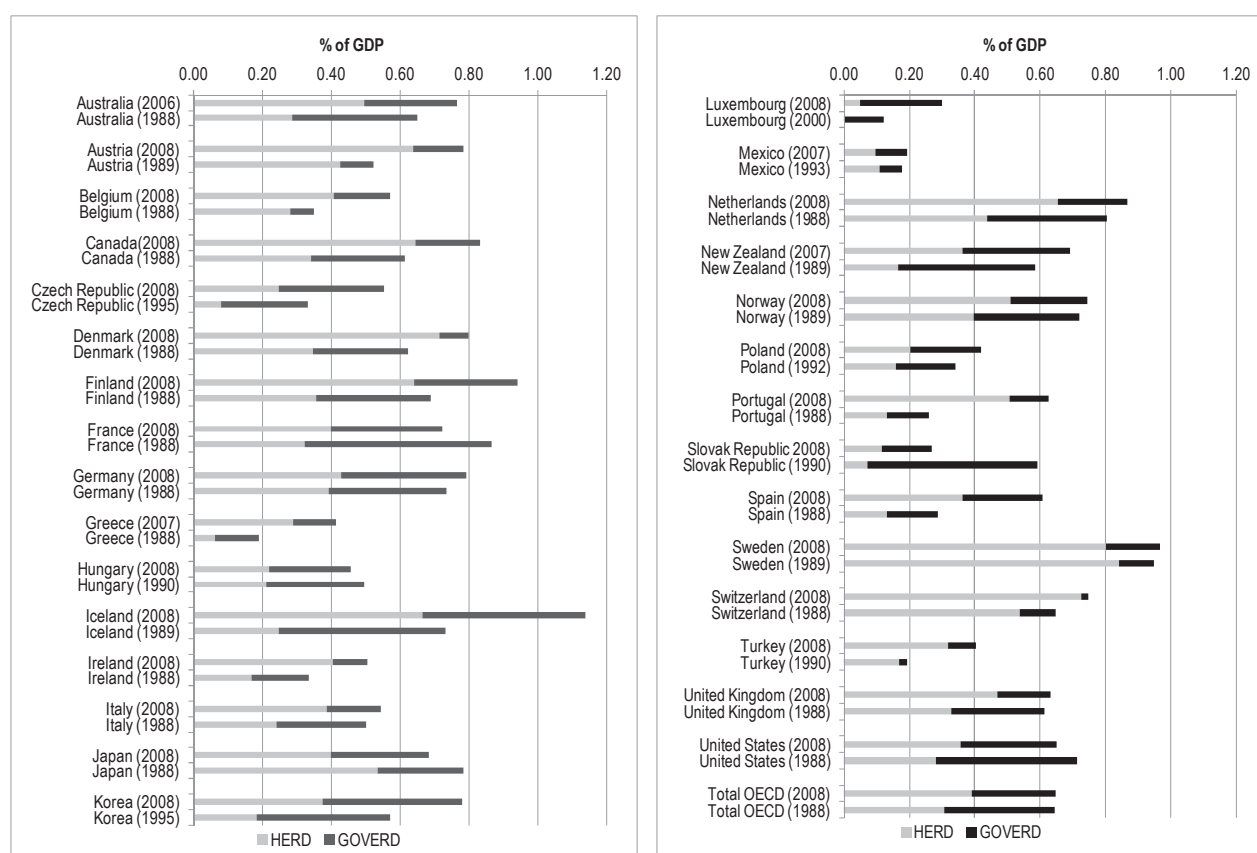
Figure 2.3. GOVERD as a share of GDP

1. Australia 2006; Greece 2007; Mexico 2007; New Zealand 2007; South Africa 2007.
2. Austria 1989; Iceland 1987; Norway 1987; Sweden 1987; South Africa 1987.
3. Greece 1997; New Zealand 1997; Norway 1997; Sweden 1997; South Africa 1997.

Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

Country-level data on GOVERD as a share of GDP reveal diversity in the R&D effort that is channelled through PRIs (Figure 2.3). Iceland had the highest GOVERD intensity in 2008, at 0.47%, while Switzerland had the lowest (0.02%). Iceland and Denmark experienced the largest falls in GOVERD intensity over the past decade; Iceland's GOVERD intensity has returned close to its 1988 level after a spike in the late 1990s and early 2000s, while the changes in Denmark were predominantly due to sectoral reorganisation in 2007, whereby government research institutions and universities were integrated (see Chapter 4 for further discussion). In other countries, increases and decreases in GOVERD intensity since 1998 have generally been relatively small. For the OECD group, the fall in GOVERD intensity was larger from 1988-1998 – a drop of 7 percentage points, compared to a drop of 1 percentage point in the most recent decade.

Figure 2.4. Total funding of R&D performed in the government and higher education sectors, 1988 and 2008
GOVERD and HERD as a percentage of GDP



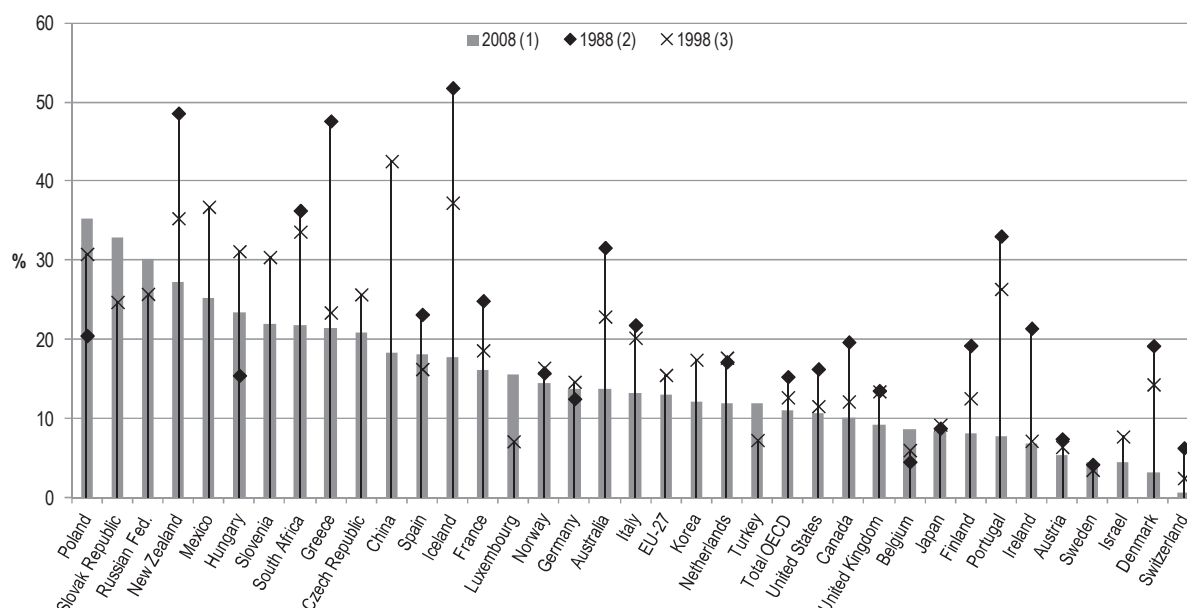
Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

Figure 2.4 shows R&D intensity in the government and higher education sectors over the past two decades (*i.e.* 1988-2008). The striking feature is the strong rise in R&D expenditure in the higher education sector (HERD) as a percentage of GDP, signalling a switch over time in performers. For the OECD area, a drop of eight percentage points in GOVERD intensity was matched by an increase of eight percentage points in HERD intensity between 1988 and 2008, demonstrating a clear shift away from the government sector and towards the higher education sector. HERD intensity rose in 27 countries, with Canada, Denmark, Iceland and Portugal experiencing a rise of 0.3 percentage points or

more, and Australia, Austria, Finland, Greece, Ireland, the Netherlands, New Zealand and Spain each experiencing a rise of between 0.2 and 0.3 percentage points. In contrast, GOVERD intensity fell in 18 countries, with France and the Slovak Republic experiencing falls of more than 0.2 percentage points. In terms of funding, the OECD share of GOVERD financed by government has been relatively stable at 96% in 1988 and 93% in 2008, whereas the share of HERD financed by government fell from 76% in 1998 to 71% in 2008.

The drop in the share of OECD GERD performed in the government sector that was depicted in Figure 2.2 is mirrored in individual country data. Figure 2.5 shows that many countries have seen a fall in the share of government-performed GERD in the last two decades – of 24 countries with data since the late 1980s, 20 had a declining share of GERD performed by government. Australia, Greece, Iceland and Ireland had the biggest declines in the first decade (*e.g.* a drop in the government sector's share from 47% to 23% for Greece), while Portugal stood out in the second decade with a fall of around 18 percentage points (from 26.4% to 7.7%). For the OECD as a whole, the share of GERD performed in the government sector dropped more in the first decade than the second – a drop of 2.6 percentage points from 1988 to 1998, then a drop of 1.7 percentage points to 2008. In non-member economies, China also experienced a decline in the share of government-performed GERD (from around 42% in 1998 to 18% in 2008), largely due to government reforms and the transformation of state-owned research institutes into enterprises (OECD, 2008a).

Figure 2.5. Share of gross expenditure on R&D performed by the government sector



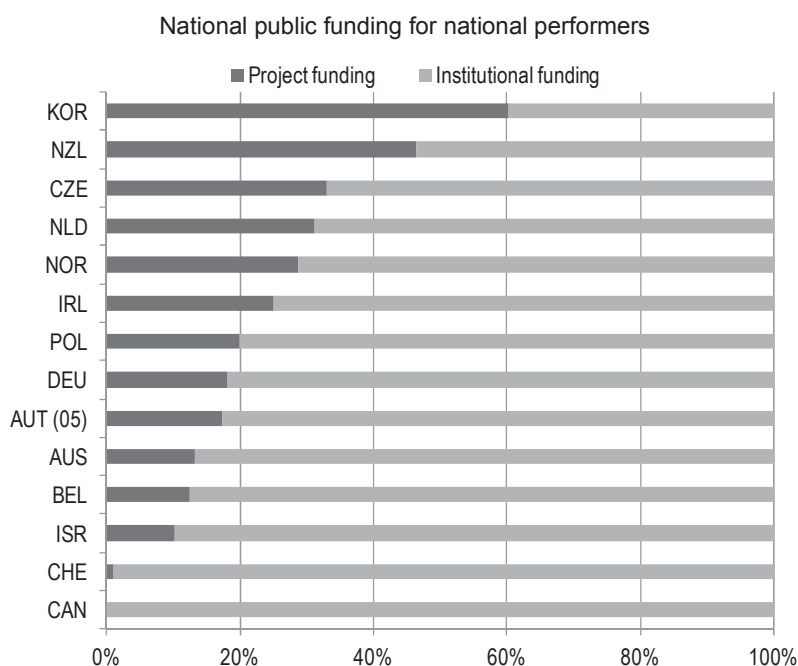
1. Australia 2006; Greece 2007; Mexico 2007; New Zealand 2007; South Africa 2007.
2. Austria 1989; Iceland 1987; New Zealand 1989; Norway 1987; Sweden 1987; Switzerland 1986; South Africa 1987.
3. Greece 1997; Luxembourg 2000; New Zealand 1997; Norway 1997; Sweden 1997; Switzerland 1996; South Africa 1997.

Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

At the same time, Figure 2.5 reinforces the diversity of R&D performance across countries. In Poland and the Slovak Republic, more than 30% of GERD is still performed in the government sector, whereas in Denmark, Israel, Sweden and Switzerland, the figure is less than 5%. The relatively high shares in some countries may partly be an ongoing legacy from former economic regimes, where business-performed R&D played a much smaller role than that performed by government.

Disaggregated expenditure data for the government sector highlight some interesting detail. Figure 2.6 draws on preliminary data to show that a number of governments made strong use of institutional or “block” funds in their funding of the government sector in 2008. This type of funding stream is usually attributed to institutions with no direct selection of projects or programmes to be performed. Rather, it tends to be focused on maintaining a stable research infrastructure and underpinning basic research.⁶ In contrast, project funding consists of funds attributed to groups or individuals to perform particular R&D activities, normally on the basis of a project proposal (Lepori *et al.*, 2007). The focus on institutional funding has implications for the governance and steering of PRIs and could suggest more reliance on missions and priority-setting mechanisms. At the same time, there is some evidence of increased use of project funding. Preliminary data from the OECD NESTI project on public R&D funding showed that both Australia and the Netherlands had increased shares of public project funding to national performers; from around 10% in 1975 to over 30% in 2009 in the Netherlands’ case (Steen, 2010). Funding is discussed again in Chapter 4.

Figure 2.6. Institutional and project funding in the government sector, 2008

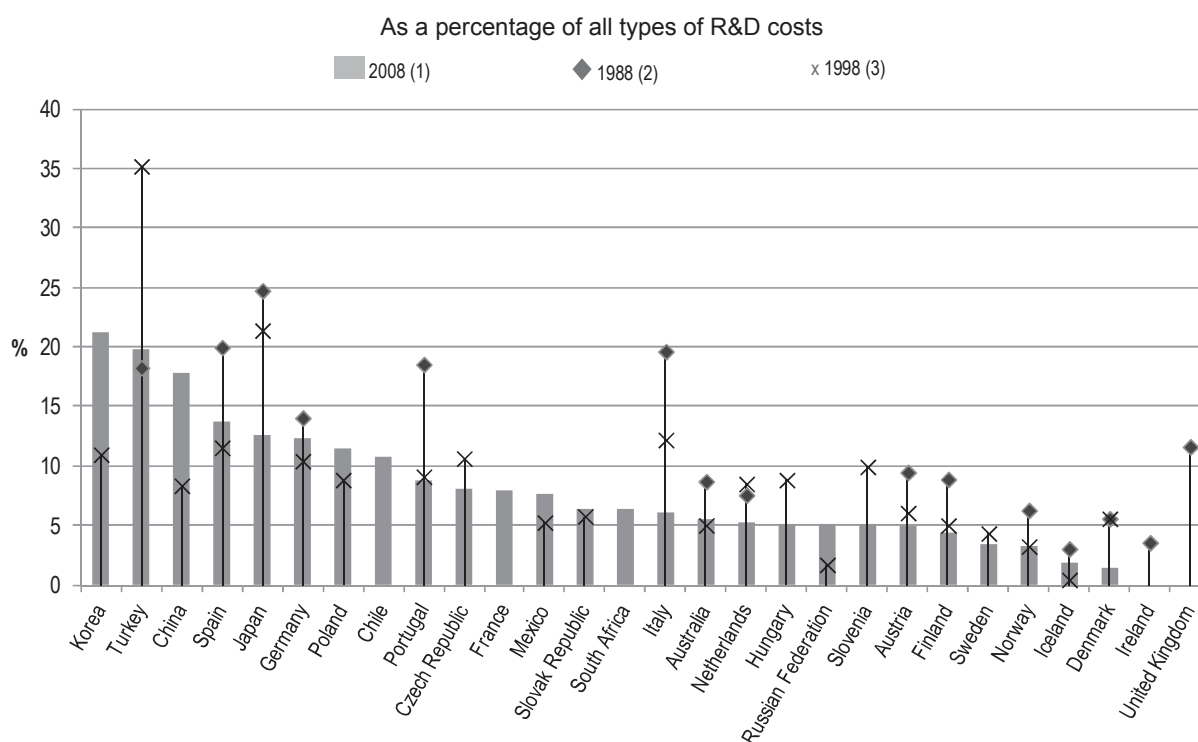


Note: For Canada: Government funding for the government sector is assumed to be 100% institutional (as it was not possible to provide a satisfactory breakdown by type of funding).

Source: OECD, based on preliminary data from the NESTI project on public R&D funding, September 2010.

Figure 2.7 suggests that R&D instruments and equipment are making up a declining share of government sector R&D costs for a number of countries. Just over half of the countries with data for both 1998 and 2008 (or the nearest years) experienced falls in the share of this type of R&D expenditure. Turkey had the biggest fall, of 15 percentage points, although this may not be unexpected as the share of instruments in total costs had been relatively high at the start of the period (35% in 1996). Nevertheless, for most of the countries in question decreasing shares of instrument costs were not a case of “moving towards the average”, as many already had instrument cost shares below the sample median in 1998. One driver of falling shares could be secular decreases in the cost of instruments and equipment relative to other costs such as staff salaries, other current costs (*e.g.* utilities, subscriptions to libraries, administrative costs, *etc.*) and land and buildings. Equally, there may be falling real expenditure in this area, perhaps due to changes in the research mix. Changing funding practices might also have an impact on instrument investment by PRIs (funding is discussed further in Chapter 4). Notably, with ICT infrastructure and other similar investments appearing in the stimulus packages of a number of OECD countries (OECD, 2010b, p. 121), there may be an increase in R&D instrument and equipment expenditure in future years.

Figure 2.7. Expenditure on R&D instruments and equipment in the government sector



1. Australia 2006; Austria 2007; Denmark 2007; France 2007; Germany 2007; Italy 2007; Mexico 2003; Netherlands 2007; Portugal 2007; Spain 2007; Sweden 2005; South Africa 2007.

2. Austria 1989; Finland 1989; Germany 1989; Iceland 1989; Norway 1989; Turkey 1990.

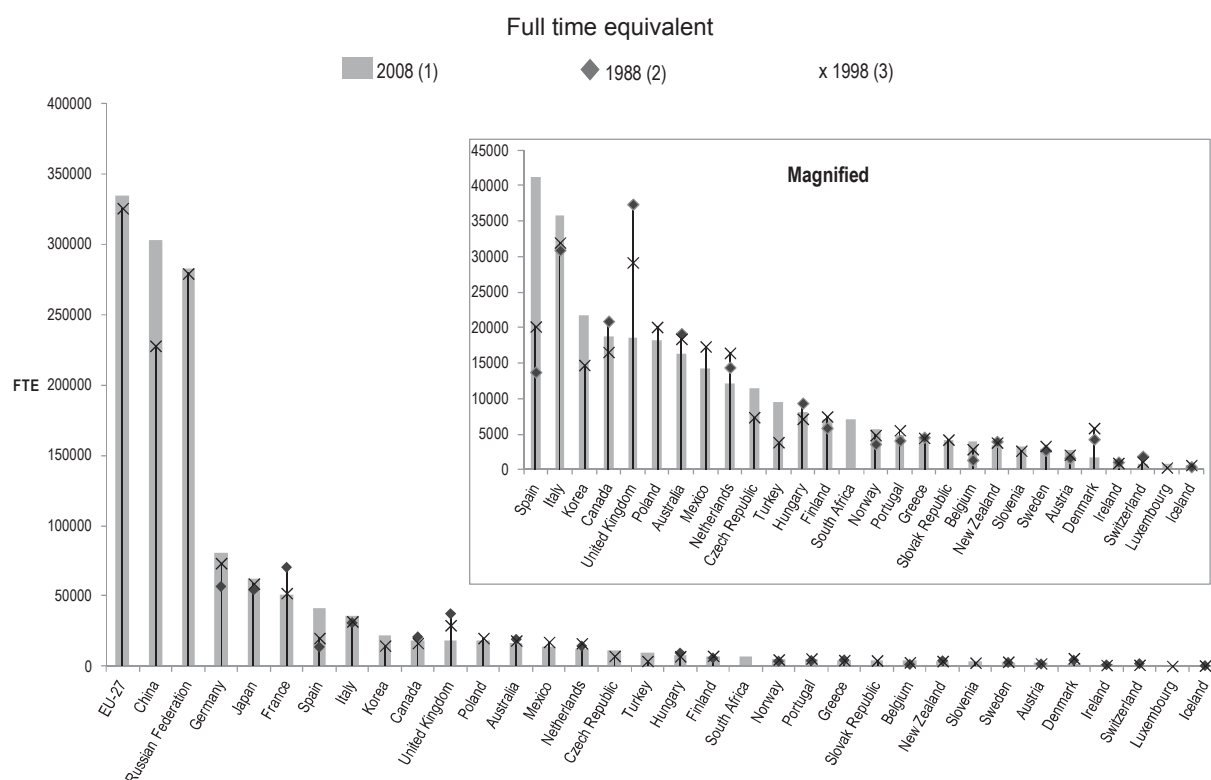
3. Denmark 1999; Hungary 1997; Iceland 1999; Mexico 1997; Norway 1999; Sweden 1997; Turkey 1996.

Source: OECD, Research and Development database, June 2010.

R&D personnel

Data on R&D personnel include all persons employed directly in R&D activities and therefore cover technicians and support staff, such as R&D managers, administrators and clerical staff, as well as researchers. Trends in R&D personnel typically follow patterns of R&D spending since salaries represent a sizeable share of R&D expenditure, although some sectors' (e.g. the business sector) R&D may have a stronger relationship between expenditure and staff growth than others (OECD, 2010b, p. 68). For the 30 OECD countries depicted in Figure 2.8, 17 had increases in the number of full-time-equivalent R&D personnel in the government sector from 1998 to 2008. The biggest increases were in Luxembourg, Spain and Turkey, with compound annual growth of 13%, 7% and 10%, respectively. Notably, Spain and Turkey were also the countries with the strongest increase in government sector R&D spending (Figure 2.2).

Figure 2.8. Total R&D personnel in the government sector



1. Australia 2006; Canada 2007; France 2007; Greece 2007; Mexico 2007; New Zealand 2007; Turkey 2007; South Africa 2007.

2. Austria 1989; Finland 1987; Germany 1987; Greece 1987; Iceland 1987; New Zealand 1989; Norway 1987; Sweden 1987.

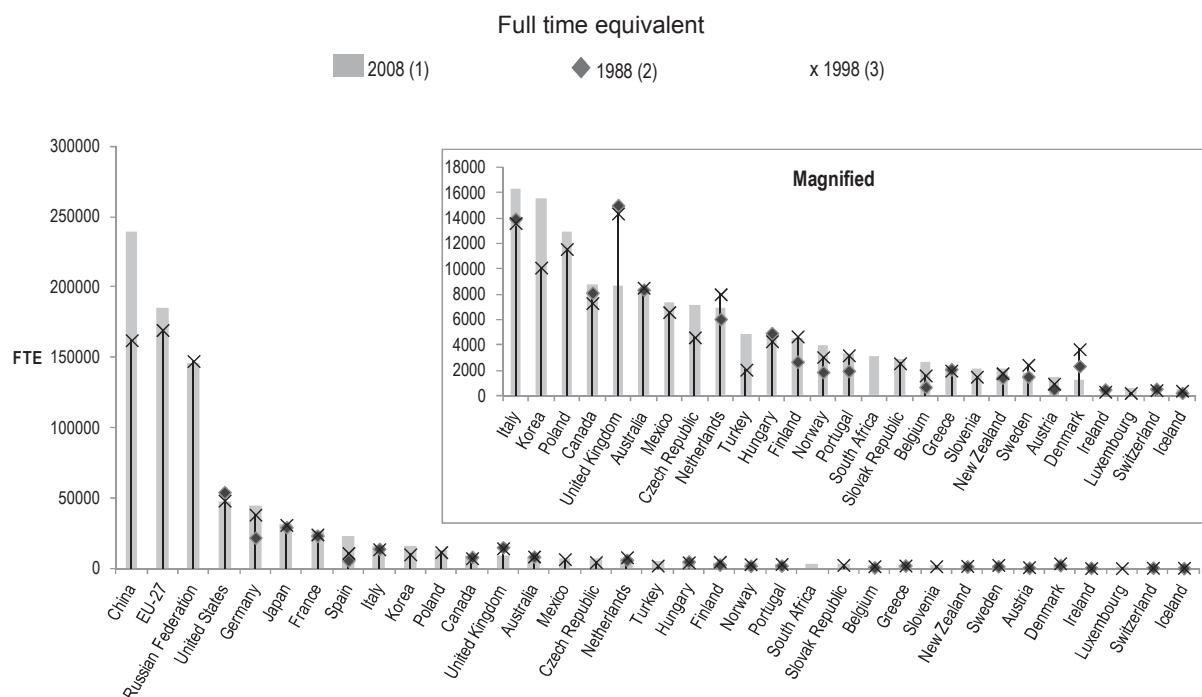
3. Greece 1997; Luxembourg 2000; New Zealand 1997; Norway 1997; Sweden 1997.

Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

Thirteen countries had decreases in R&D personnel numbers over the past decade. These were generally small, with the exception of the Netherlands, Switzerland and the United Kingdom, which had compound annual declines in personnel numbers of 3-4%. (Note that Denmark's data are influenced by the recent restructuring of the sector.) These

three countries also had declines in government sector spending over the 1998-2008 period. In non-member countries, both China and Russia had strongly growing expenditure in the government sector over 1998-2008 (Figure 2.2) but relatively slow annual growth in the number of personnel over the same period. In the earlier decade, 1988-1998, France experienced the largest absolute drop in personnel numbers (a decline of almost 20 000 FTE), while Switzerland experienced the largest percentage fall (-5% in compound annual terms). Belgium strongly expanded R&D personnel numbers in this earlier decade (7.5% in compound annual terms).

Figure 2.9. Researchers in the government sector



1. Australia 2006; Canada 2007; France 2007; Greece 2007; Mexico 2007; New Zealand 2007; Turkey 2007; United States 2002; South Africa 2007.

2. Austria 1989; Finland 1987; Germany 1987; Greece 1987; Iceland 1987; Netherlands 1987; New Zealand 1989; Norway 1987; Sweden 1987.

3. Denmark 1997; Greece 1997; Luxembourg 2000; New Zealand 1997; Norway 1997; Sweden 1997.

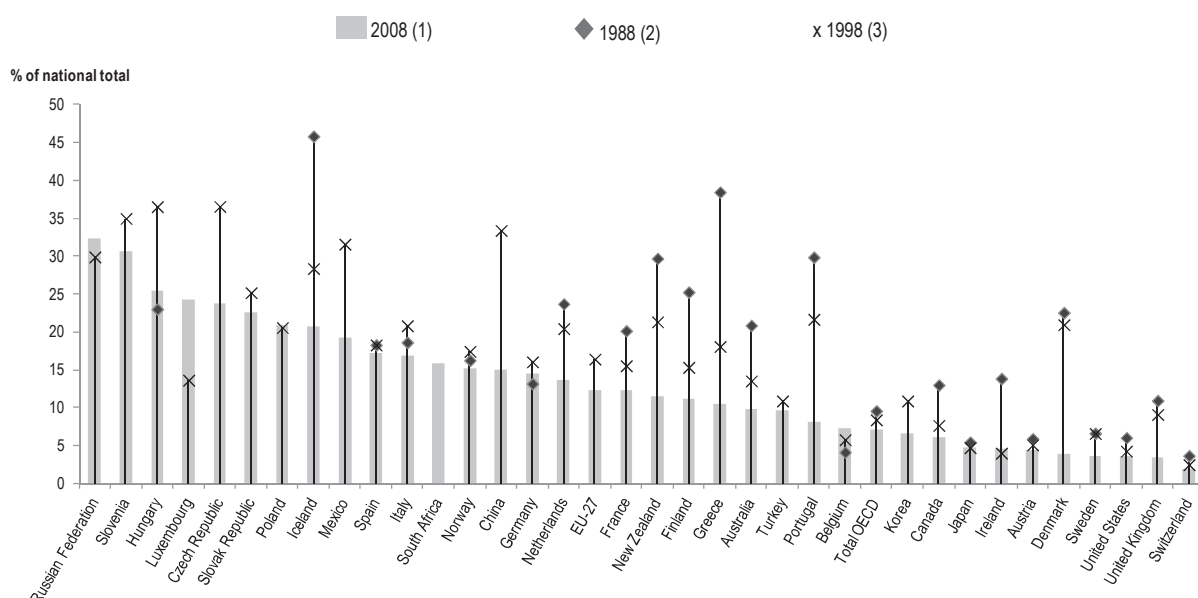
Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

Figure 2.9 looks at an important subgroup of R&D personnel – that of researchers. Researchers are defined as “professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and in the management of the projects concerned” (OECD, 2002, pp. 92-93). Thirty-one OECD countries had data for 1998 and 2008; of these, 24 had an increase in researcher numbers (expressed as full-time-equivalents) over the period, with 10 of these countries experiencing compound annual growth of more than 2%. This is a stronger picture of growth than that depicted for R&D personnel in the previous figure, suggesting a rebalancing of staff between researchers and support personnel. Ireland, Luxembourg, Spain and Turkey had the biggest increases in researcher numbers, (of 7-11% annually). Seven countries had declines in researcher numbers, the largest (excepting Denmark) occurring in the United

Kingdom (-4.8% in compound annual terms), similar to its experience for R&D personnel. China had stronger compound annual growth in researchers than in R&D personnel (3.9% versus 2.9%), while Russia experienced declining numbers. The data for France for the earlier decade, 1988-1998, shows that the drop in R&D personnel was attributable to declines in technicians and support staff, as researcher numbers grew over that period.

Figure 2.10 shows that government sector researchers have fallen as a share of total researchers in most countries, which is consistent with the fall in the share of government sector-performed research shown in Figure 2.5. For the OECD, the share of government researchers in total researcher numbers fell 1.2 percentage points from 1998 to 2008, to reach 7.2%. Twenty-six of thirty-one OECD countries with data for 1998-2008 (or nearest years) experienced decreases in the share of government researchers, with the biggest decreases (aside from Denmark) appearing in the Czech Republic, Hungary, Mexico and Portugal (falls of 11-13 percentage points). China also experienced a drop in the share of government researchers, of 18 percentage points, while Russia was one of the few countries with an increase (along with OECD members Belgium, Ireland, Luxembourg and Poland). The figure also highlights the ongoing diversity across countries; in Russia, one in three researchers work in the government sector, while in countries such as Japan, Sweden and the United Kingdom the figure is less than one in twenty.

Figure 2.10. Government researchers as a share of total national researchers



1. Australia 2006; Canada 2007; France 2007; Greece 2007; Mexico 2007; New Zealand 2007; Turkey 2007; United States 2002; total OECD 2007; South Africa 2007.

2. Austria 1989; Finland 1987; Germany 1987; Greece 1989; Iceland 1987; Netherlands 1987; New Zealand 1989; Norway 1987; Sweden 1987; Switzerland 1989; United States 1987.

3. Denmark 1997; Greece 1997; Luxembourg 2000; New Zealand 1997; Norway 1997; Sweden 1997; Switzerland 1996; United States 1997.

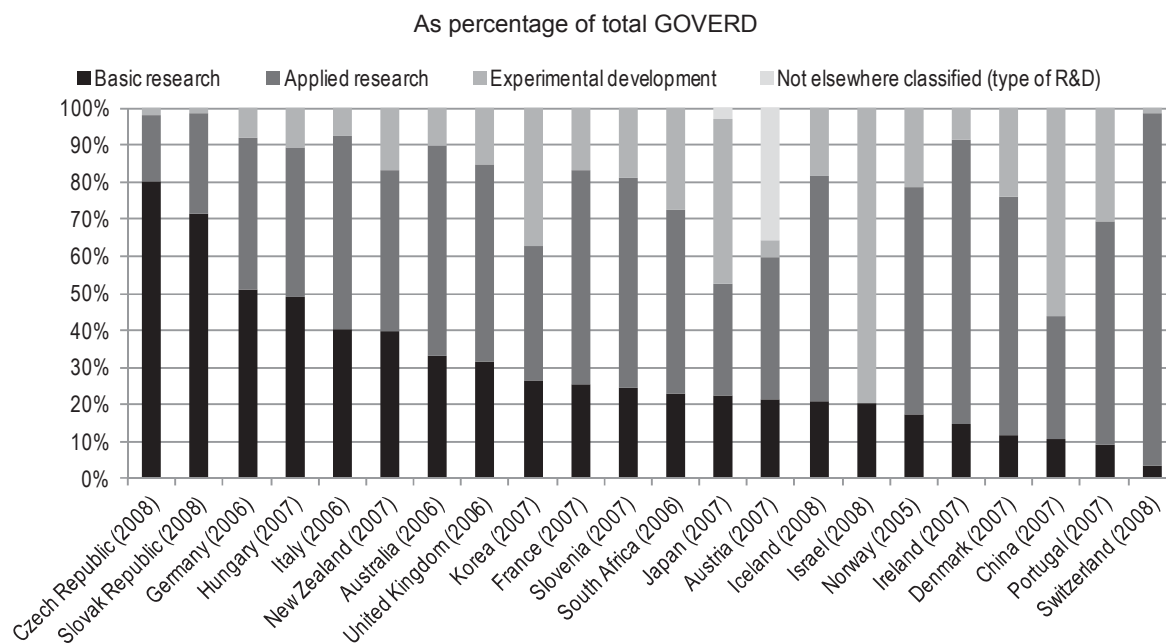
Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

Type of research

R&D data also provide information on the type of research undertaken in countries. Although the statistical categories differ slightly across countries, R&D data are usually presented in terms of three main types: basic research, applied research, and experimental development. It is important to note that there are conceptual and operational problems associated with these categories, since they seem to imply a sequence and a separation which rarely exist in reality (OECD, 2002). Nevertheless, they provide one useful indication of the variety of research performed and the differences between countries.

Figure 2.11 shows the mix of research types undertaken in the government sector in the most recent data year available (generally 2007 or 2008). The share of basic research ranged from 80% in the Czech Republic to 3% in Switzerland. For the majority of countries, applied research and experimental development accounted for more than 50% of GOVERD activity. Applied research is original investigation undertaken in order to acquire new knowledge, directed primarily towards a specific practical aim or objective, while experimental development is systematic work, drawing on knowledge from research and practical experience, that is directed to producing new materials, products and devices, to installing new processes, systems and services or to improving substantially those already produced or installed. After Switzerland, with 95% of research activity on the applied side, Denmark, with 95% of research activity on the applied side, Denmark, Iceland, Ireland, Norway and Portugal had shares of applied research above 60%. Israel had the highest share of experimental development, at almost 80%, while Japan had the next highest share (44%). China conducted the bulk of its GOVERD activity (55%) in experimental development in 2007.

Figure 2.11. GOVERD by type of R&D, latest available year



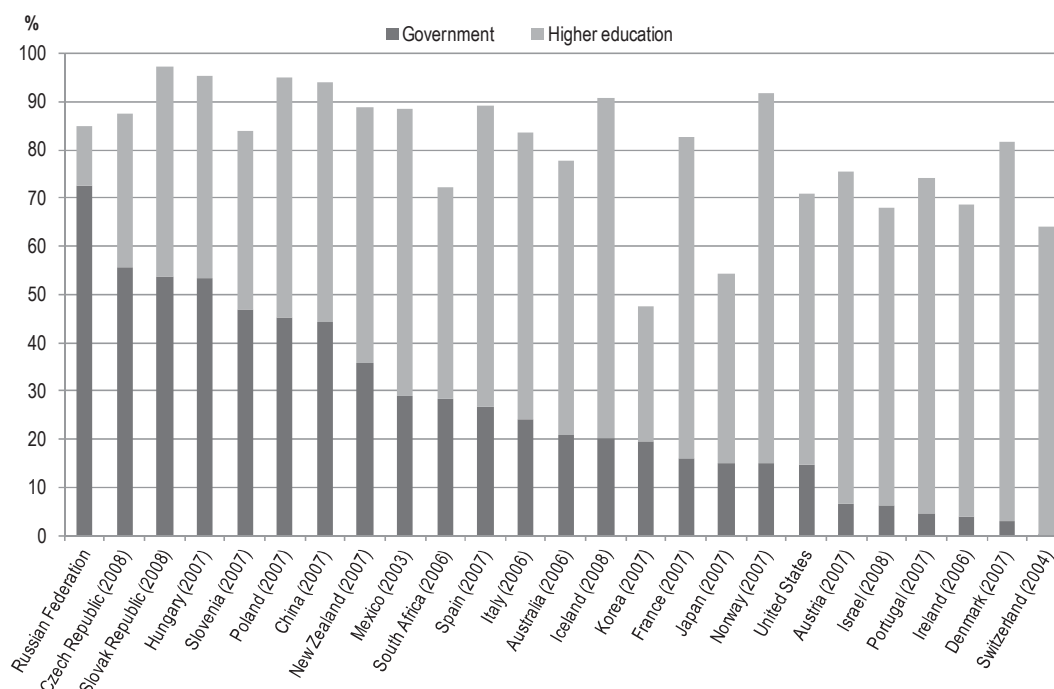
Source: OECD, Research and Development statistics, February 2010.

For some countries it is possible to look at the data on research types over a longer time period, which reveals the changing focus in PRIs over time. For example, in Australia, basic research has risen as a share of total GOVERD, from 24% in 1988 to 29% in 1998, then 33% in 2006. In France, while over 50% of GOVERD activity was in applied research in 1988, the three research categories had almost equal shares in 1998, before applied research again became dominant in 2007 (58%). However, basic research now accounts for a bigger share of activity than it did in 1988 (25% *versus* 16%). In contrast, Italy has reduced its basic research activity in the government sector; it fell from 46% in 1998 to 40% in 2006. These results highlight that the focus on R&D in PRIs is not static and may be linked to wider industrial, social or national priorities. Research priorities are discussed in more detail in the next chapter.

Figure 2.12 provides additional detail about basic research undertaken in the public sector, broadly defined. It shows that those countries with a particularly low share of basic research in GOVERD (*e.g.* Denmark, Ireland, Portugal and Switzerland) undertake the bulk of their public basic research in the higher education sector (over 60%), with a further 20% or more also conducted in entities outside the government and higher education sectors. For most of the countries for which data is available, university basic research accounts for 40% to 70% of all basic research performed in the country. In contrast, in Russia, more than 70% of basic research is performed in the government sector. China had 44% of basic research conducted in the government sector, with a further 49% conducted in the higher education sector.

Figure 2.12. Basic research performed in the public sector

As a percentage of national basic research



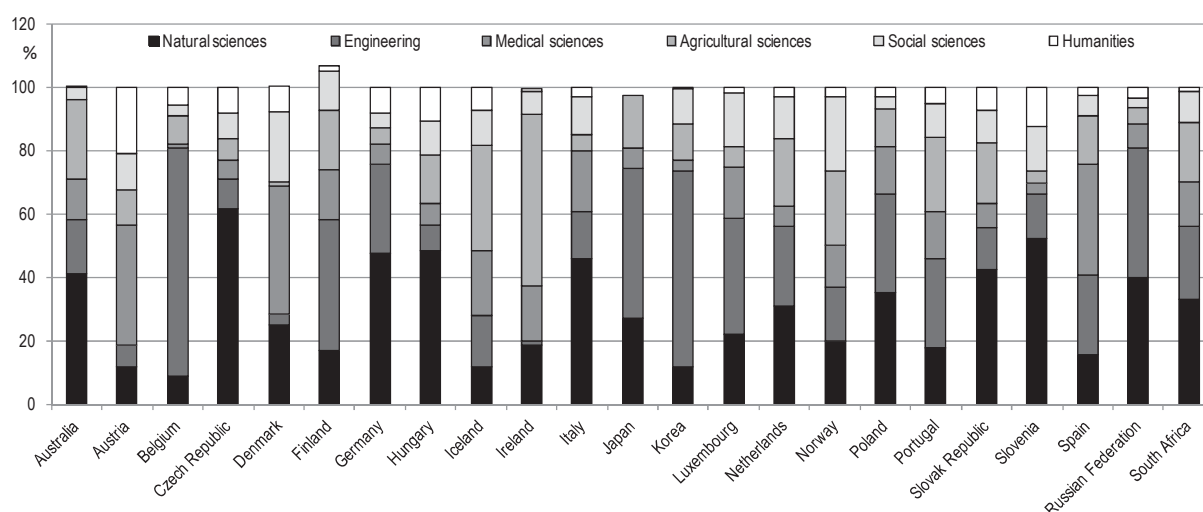
Notes: Total cost (current and capital) included for all countries except Norway, Poland, Spain, the United States and the Russian Federation, for which only current costs are included. Austria's government expenditure is underestimated. Israel: government expenditure excludes defence; higher education expenditure excludes social sciences and humanities. Switzerland: government expenditure for federal/central government only.

Source: OECD, Research and Development database, February 2010.

R&D data for the government sector can also be presented by field of study. There are large differences across countries, likely linked to the specialisations within the national innovation systems as well as the research priorities of governments (since business funds only a small share of government-sector R&D). Figure 2.13 shows the share of GOVERD by field of science for 2007 (or the latest available year). Natural sciences were strong in the Czech Republic, Hungary and Slovenia, with more than 48% of government sector R&D expenditure occurring in this area. Belgium had the lowest share devoted to natural sciences (9%). Belgium and Korea allocated more than 60% of government research expenditure to engineering; in contrast, Ireland and Denmark spent less than 3% in this area. Denmark had the highest share of spending in medical sciences (40%), while Spain and Austria also devoted more than 30% of GOVERD to this field. Belgium, Korea and Slovenia spent less than 5% of GOVERD in medical sciences. Ireland had by far the biggest share of spending directed to agriculture, at 50%, followed by Iceland with a 33% share. Social sciences were relatively strong in Denmark and Norway (21-23% of expenditure), while Austria had the highest share in humanities (21%). In non-member economies, Russia spent the bulk of its GOVERD in the natural science and engineering fields (40% in each). South Africa had a more even spread; the biggest share (32%) was in natural sciences, followed by engineering (23%), and agricultural sciences (18%).

Figure 2.13. GOVERD by field of science, 2007

As a percentage of total GOVERD



Notes: Australia 2006; Czech Republic 2008; Italy 2006; Luxembourg 2005; Slovak Republic 2008; Russia 2008; South Africa 2006. Finland's expenditures sum to more than the total, as the sub-categories include other classes.

Source: OECD, Research and Development statistics, February 2010.

In terms of absolute expenditure in the government sector in different fields of science, there are also large variations between countries, reflecting overall R&D budgets and country size. For instance, Ireland's 50% share of expenditure on agriculture, shown above, was equivalent to USD 95 million (PPP current prices), while Australia's expenditure in the same field, at 25% of GOVERD, was USD 525 million. Similarly, Belgium's high share of spending in the engineering field (71%) equated to USD 413 million, while Russia's 40% share equated to USD 2 885 million. This raises interesting questions of scale and critical mass thresholds; in particular, whether there are

minimum absolute levels of expenditure for research in different fields, below which research becomes less efficient or effective.⁷ Table 2.1 below presents a different slice of the data in Figure 2.13, showing the “focus field” for each country (*i.e.* the GOVERD field receiving the highest share of expenditure), its share of expenditure, and the absolute level of spending in that field. It shows, for instance, that natural sciences are the focal field for ten of the twenty-three countries with data, with shares of government sector R&D expenditure of 31% to 61%. Absolute expenditure (in PPP, current prices) ranged from USD 77 million (Slovak Republic) to USD 4.7 billion (Germany). Clearly, government R&D is only one component of national R&D effort, and critical mass also depends on collaboration and international linkages. Nevertheless, the data provide a partial view of what field specialisation (whether explicitly driven by research priorities or not) means in practical monetary terms in different countries.

Table 2.1. GOVERD – focal fields
2007 (or latest available year¹)

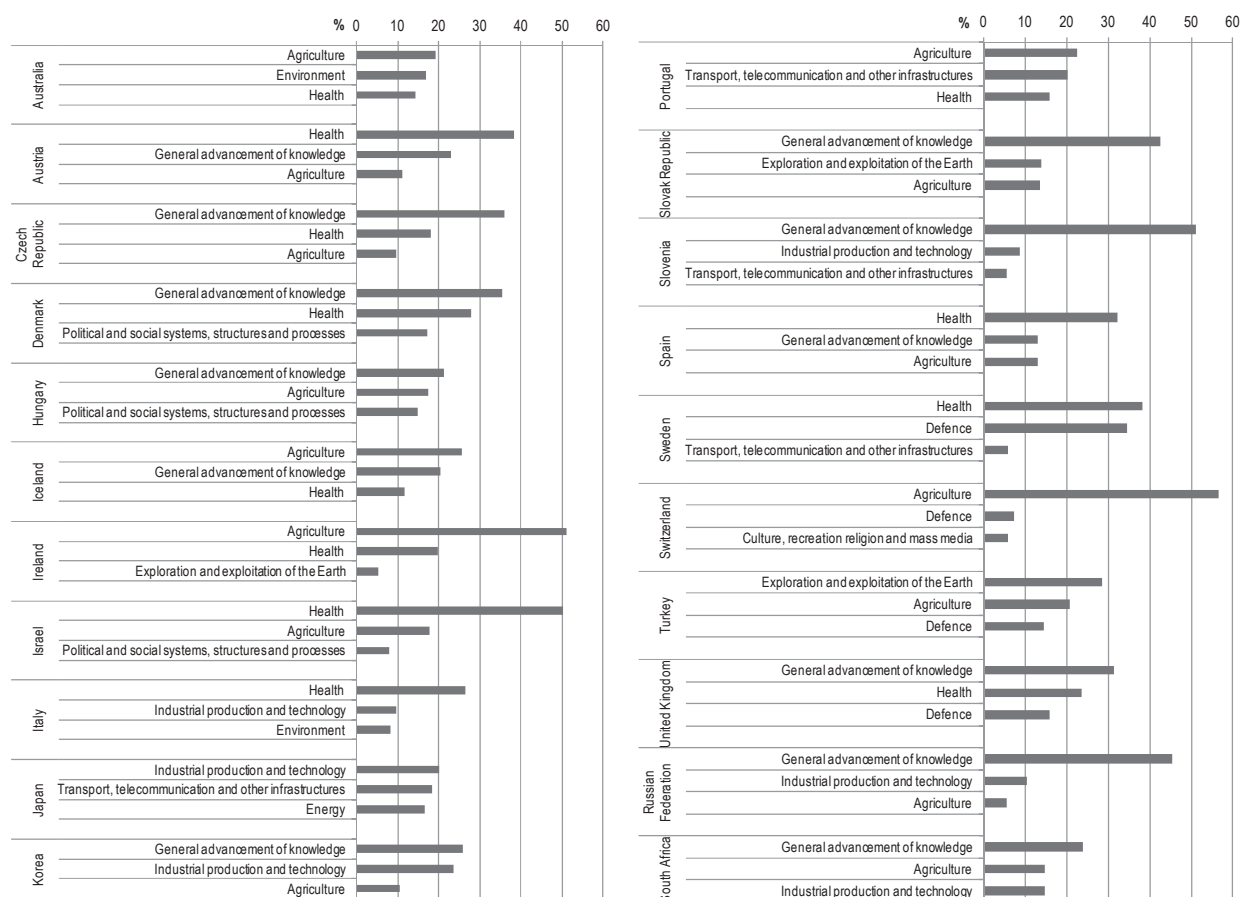
Country	Focus field	Share of GOVERD in focus field	GOVERD in focus field (USD millions, PPP, current prices)
Norway	Agricultural sciences	23.4	148.3
Iceland	Agricultural sciences	33.4	18.2
Ireland	Agricultural sciences	53.8	94.7
Portugal	Engineering	27.9	76.3
Luxembourg	Engineering	36.7	21.9
Russian Federation	Engineering	40.9	2 885.3
Finland	Engineering	41.2	222.2
Japan	Engineering	47.2	5 419.3
Korea	Engineering	61.9	3 011.1
Belgium	Engineering	71.8	413.6
Spain	Medical sciences	35.0	1 108.4
Austria	Medical sciences	37.7	157.6
Denmark	Medical sciences	40.7	67.1
Netherlands	Natural sciences	31.1	442.9
South Africa	Natural sciences	32.9	307.9
Poland	Natural sciences	35.4	437.3
Australia	Natural sciences	41.0	861.2
Slovak Republic	Natural sciences	42.4	78.0
Italy	Natural sciences	46.0	1 556.6
Germany	Natural sciences	47.5	4 733.6
Hungary	Natural sciences	48.3	212.6
Slovenia	Natural sciences	52.5	100.6
Czech Republic	Natural sciences	61.8	486.7

1. See Figure 2.13 for reference years.

Source: OECD, Research and Development statistics, February 2010.

Figure 2.14. Top three areas of GOVERD, by socio-economic objective, latest available year

As a percentage of GOVERD



Note: Iceland, Israel, Slovak Republic, Switzerland and Russian Federation: 2008. Austria, Denmark, Hungary, Ireland, Japan, Korea, Portugal, Slovenia, Spain, Sweden and Turkey: 2007. Australia, Czech Republic, Italy and South Africa: 2006. United Kingdom: 2005.

This data uses the NABS 2007 classification, *i.e.*: 1. Exploration and exploitation of the Earth; 2. Environment; 3. Exploration and exploitation of space; 4. Transport, telecommunication and other infrastructures; 5. Energy; 6. Industrial production and technology; 7. Health; 8. Agriculture; 9. Education; 10. Culture, recreation, religion and mass media; 11. Political and social systems, structures and processes; 12, 13. General advancement of knowledge; and 14. Defence.

In the NABS 2007 classification, the previously single objective of Social structures and relationships has been broken down into three socio-economic objectives – Education, culture, recreation, religion and mass media, and Political and social systems, structures and processes. At the time of this publication there is no breakdown of historical data into the three new SEOs. Another issue relating to the transition from NABS 1993 to NABS 2007 is that what was formerly Other civil research is now to be distributed among the other chapters. This distribution has not yet been done in this database. Until the countries are in a position to provide breakdowns according to the NABS 2007 classification, in some cases GERD by SEO is greater than the sum of its chapters.

Source: OECD, Research and Development statistics, February 2010.

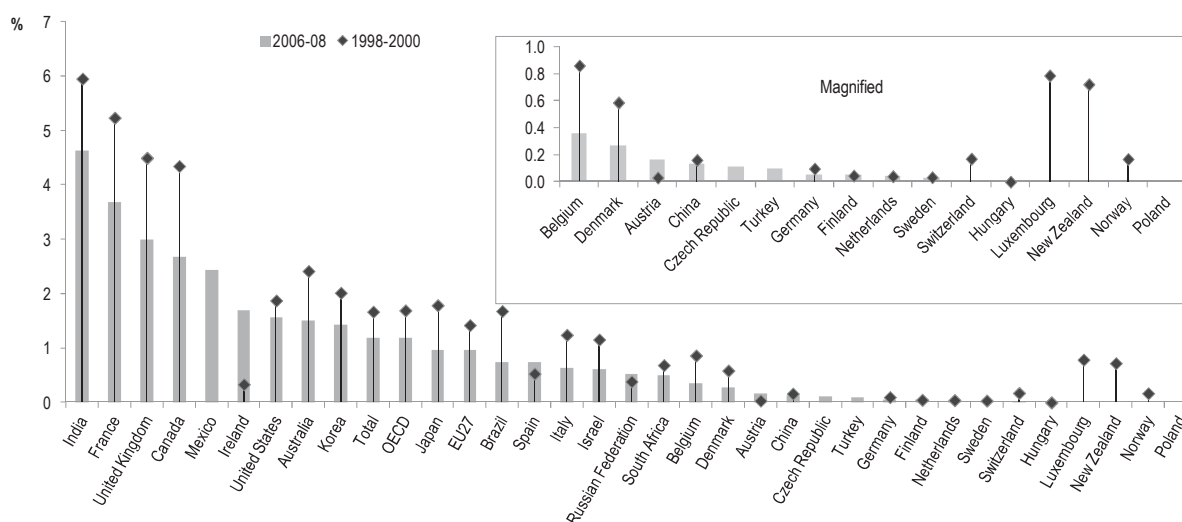
Figure 2.14 explores the issue of research specialisation and priorities further, by presenting the top 3 expenditure areas for government sector R&D as categorised by socio-economic objectives. This categorisation is reported retrospectively by R&D performers and data are not available for all countries. The figure presents the results for 19 OECD countries, plus Russia and South Africa. Agriculture appears most often in the top 3, listed by 15 of the countries. This is followed by Health and General advancement of knowledge, with 12 listings each. Interestingly, the objective of Environment appears in the top 3 only twice (Australia and Italy), while Energy appears once (Japan).

Exploration and exploitation of the Earth was the top objective for Turkey, while Denmark, Hungary and Israel each had Political and social systems, structures and processes in their top 3.

It will be interesting to see whether future breakdowns of GOVERD by socio-economic objectives reveal a greater emphasis on Environment and Energy research, given policy trends towards “greening” of national research and innovation strategies as countries raise environmental, climate change and energy higher on national agendas (OECD, 2010b, p. 72). Unfortunately, an early indicator of such changing priorities – government budget appropriation data (or GBAORD) – does not yet give details of socio-economic objectives at a sectoral level.⁸ This is a potential area for further development of the GBAORD data.

Patents and scientific publications

Figure 2.15. Share of patents owned by government institutions, 2006-08



Note: Patent counts are based on the priority date, the applicant's country of residence and use fractional counts on PCT filings at international phase (EPO designations). Patent applications are attributed to institutional sectors using an algorithm developed by Eurostat. Only countries/economies with more than 300 patents over the period are included in the graph.

Source: OECD, Patent Database, December 2010.

Patents provide a detailed source of information on inventive activity and can be used to assess inventive output. The majority of world patents are owned by private sector businesses, and OECD government institutions (excluding universities) owned only 1.2% of all international patents filed under the Patent Co-operation Treaty (PCT) between 2006 and 2008.⁹ This represented a fall from 1.7% between 1998 and 2000. This drop is noteworthy in the context of the rapid growth of patenting in other institutional sectors (OECD, 2008b) and the increased emphasis on patenting, licensing and commercialising public research results (Buenstorf, 2009). Figure 2.15 shows France, India and the United Kingdom had the highest share of patents owned by government institutions (although the data show Singapore outstrips these countries with 10% of filed patents owned by government institutions in 2006-08). In more than half the countries, the share owned by government was less than 1%. Ireland recorded the biggest increase in the share of government owned patents over the period (from 0.3% to 1.7%), while Canada experienced the biggest drop (from 4.5% to 3%). Nevertheless, the data can be volatile

from period to period, and it may be better to focus on general levels and shifts over longer time periods.

Table 2.2. Government patents by technology fields, 2006-08

As a share of countries patents filed in that field

	Biotechnology	ICT	Nanotechnology	Renewable energy
Australia	2.71	2.06	2.26	0.52
Austria	..	0.04	..	..
Belgium	..	0.82	..	..
Canada	10.60	2.01	10.86	..
Denmark	1.26	0.44	..	..
Finland	..	0.02	..	..
France	10.49	5.41	14.14	2.71
Germany	0.21	0.08	0.03	..
Ireland	6.32	2.31	10.00	..
Israel	1.73	0.66	1.45	0.38
Italy	3.68	0.96	7.76	..
Japan	5.53	0.93	6.55	0.69
Korea	4.96	0.79	9.70	0.58
Mexico	9.18	2.91	..	..
Netherlands	0.46	0.05	..	..
Spain	1.48	0.47	..	0.23
Sweden	..	0.01	..	..
Switzerland	..	0.05	..	..
United Kingdom	4.12	6.40	2.44	..
United States	4.97	1.30	4.45	0.75
EU27	2.68	1.73	2.78	0.25
OECD	4.26	1.28	4.61	0.45
Total	4.26	1.27	4.68	0.42
Brazil	0.86	1.27	..	..
China	0.73	0.11	..	..
India	11.94	4.47	6.74	..
Russian Federation	0.85	0.38	..	..
South Africa	6.39	0.20	..	..

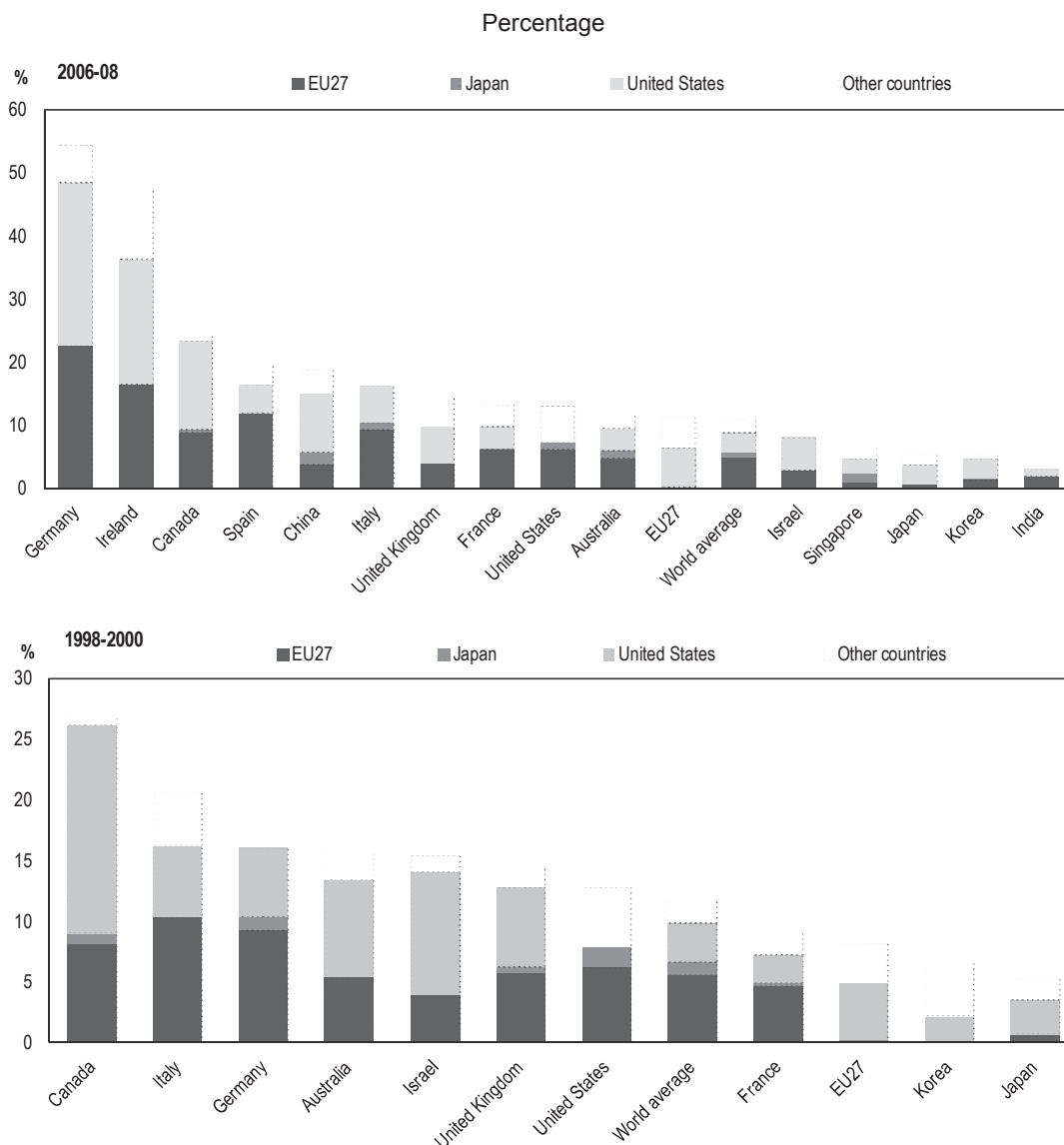
Note: Patent counts are based on the priority date, the applicant's country of residence and use fractional counts on PCT filings at international phase (EPO designations). Patent applications are attributed to institutional sectors using an algorithm developed by Eurostat. Only countries/economies with more than 300 patents over the period are included in the table.

Source: OECD, Patent Database, December 2010.

There is sizeable policy interest in a range of technologies that have potential growth opportunities or solutions to global social and economic problems. Common focal areas include biotechnology, ICT, nanotechnology and renewable energy. Table 2.2 shows government sector patent filings by technology field as a share of a country's patent filings in that field in 2006-08. The results reveal considerable diversity across countries and technology field. In the case of nanotechnology for example, the government sector

share ranged from 0.03% in Germany to 14% in France. Canada's government sector held a large share of patent filings in biotechnology, at over 10%, although India's government sector had an even greater share (of almost 12%). While it is important to interpret these results in the context of the small number of patents attributed to government institutions (Figure 2.15), the results point to some specialisation patterns within countries.

Figure 2.16. Domestic government ownership of inventions made abroad by partner countries



Patent counts are based on the priority date, the applicant's country (government sector only) and use simple counts on PCT at international phase (EPO Designations). Only countries with more than 50 patents owned by government are included in the graph. The EU is treated as one country; intra-EU co-operation is excluded.

Source: OECD, Patent Database, December 2010.

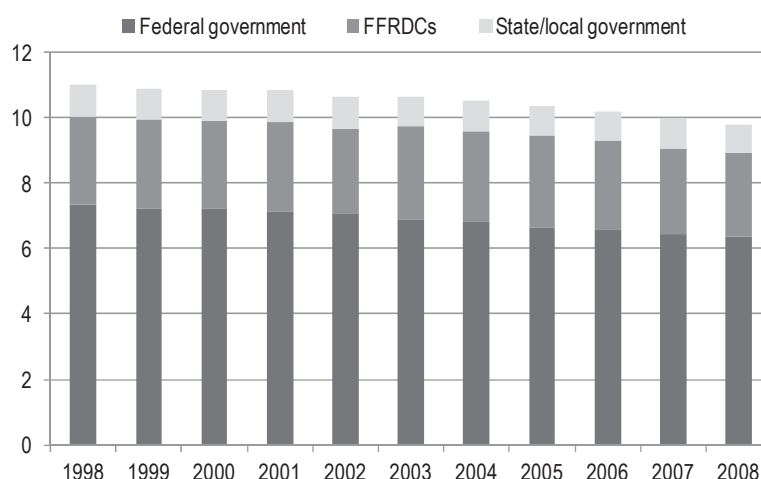
Patent data can be used to assess the internationalisation of science and technology activities. For example, the domestic ownership of inventions made abroad indicates the extent to which domestic firms or institutions control inventions made by residents of other countries (OECD, 2008b). Figure 2.16 shows the percentage of new patents that are owned by government institutions and were invented abroad. For instance, in 1998-2000

just over 25% of new patents owned by Canadian government research institutions were developed in countries abroad, notably the United States, but also in the EU27. The data was similar in 2006-08 for Canada; however, for some countries the data is quite volatile, reflecting the small numbers of patents involved. For example, 15% of the patents owned by Germany's government research institutions in 1998-2000 were developed abroad, compared to around 55% in 2006-08. The interesting point to note is the geographical spread of partner countries. European countries tend to partner more with other European countries, while Canada and Japan have strong links with the United States. The share of government inventions made abroad with Japan was low in most countries, perhaps reflecting cultural and linguistic barriers.

Data on scientific publications and citations can be used to measure the quantity and impact of scientific output. While these bibliometric indicators are imperfect¹⁰, the number of journal articles is an indicator of output and knowledge generation. In terms of institutional sectors, universities account for the bulk of scientific publications (OECD, 2008c). Figure 2.17 presents data from the United States that show the share of articles published by the government sector has been slowly falling over time, to less than 10% in 2008. This likely reflects the contraction of the sector. Further data on scientific publication outputs, drawn from RIHR country material, is presented in Chapter 6.

Figure 2.17. Scientific and engineering articles by the government sector, United States, 1998-2008

As a percentage of articles from all institutional sectors



Note: FFRDC = federally funded research and development center.

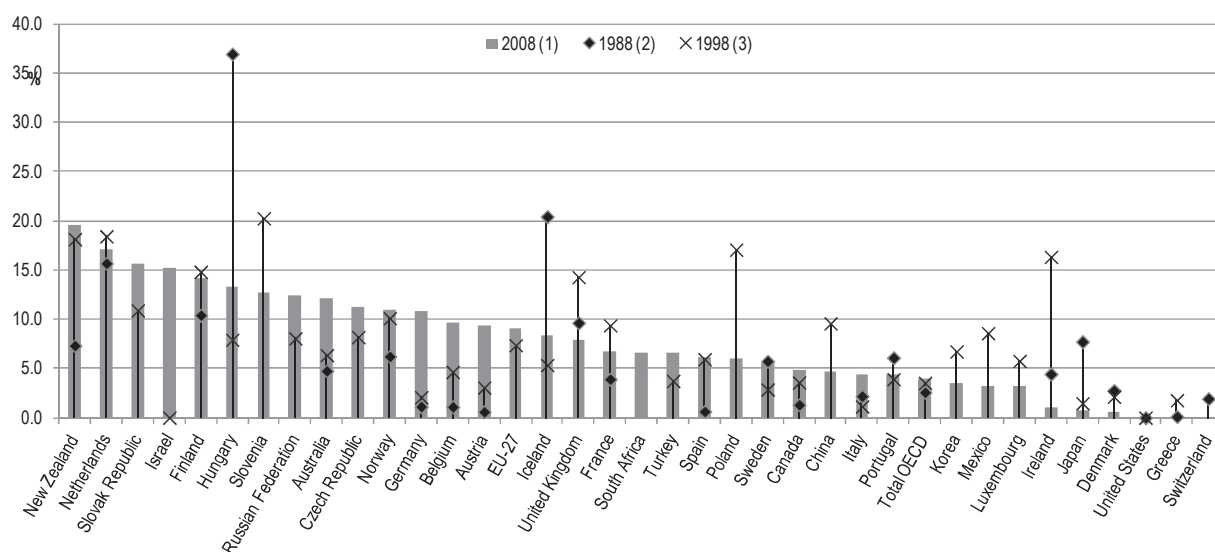
Article counts are from the set of journals covered by Science Citation Index (SCI) and Social Sciences Citation Index (SSCI). Articles are classified by the year they entered the database, rather than the year of publication, and are assigned to sectors on the basis of institutional address(es) listed on the article. Articles are on a fractional-count basis.

Source: National Science Foundation (2010), *Science and Engineering Indicators 2010*, Appendix table 5-42.

Collaboration and linkages

Collaboration between PRIs and industry is vital for generating technological spillovers, knowledge diffusion and innovation. Innovation surveys and more specific collaboration surveys have demonstrated that these linkages are much broader than R&D joint ventures, and often rest on informal relationships (OECD, 2001). Nevertheless, the share of GOVERD financed by industry provides an indicator of linkages between the two sectors. Figure 2.18 shows that for all OECD countries (except Chile and Estonia, for which data are unavailable), less than 20% of government sector R&D is financed by industry. The highest share was in New Zealand, where 19.5% of GOVERD was financed by industry in 2007. The lowest shares were in Denmark and Japan, with less than 1% financed by industry in 2008. Over time, the share has mildly increased; the OECD average in 1988 was 2.6%, rising to 3.5% in 1998 and 3.9% in 2007. Germany and Italy recorded the largest compound annual growth rates from 1998 to 2007, of 20% and 16%, respectively. Australia, Austria and Belgium also experienced solid growth in this indicator. Nevertheless, some countries experienced large falls in the share of GOVERD financed by industry in the last decade, such as Ireland (a compound annual rate of -23%), Mexico and Poland (-9%).

Figure 2.18. Share of government R&D expenditure financed by industry



1. Australia 2006; Austria 2007; Belgium 2007; Germany 2007; Italy 2007; Luxembourg 2007; Mexico 2007; Netherlands 2007; New Zealand 2007; Portugal 2007; Spain 2007; Sweden 2007; total OECD 2007; EU27 2007; Israel 2006; South Africa 2007.

2. Austria 1989; Finland 1987; Iceland 1987; New Zealand 1989; Norway 1987; Sweden 1987.

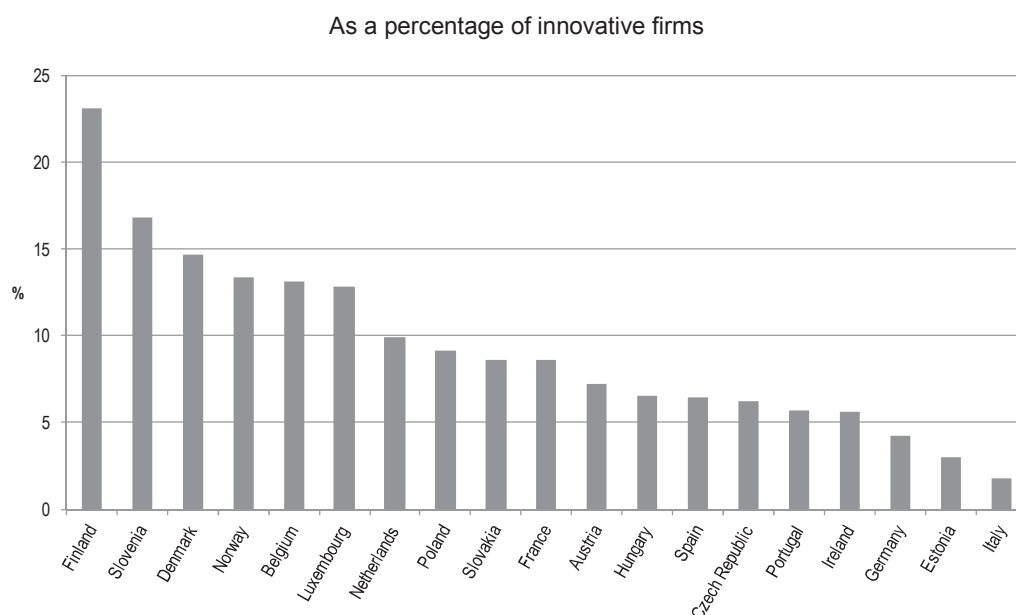
3. Denmark 1997; Greece 1997; Luxembourg 2000; Mexico 1997; New Zealand 1997; Norway 1997; Sweden 1997; China 2000.

Source: OECD, *Main Science and Technology Indicators (MSTI)*, 2010/1.

Results from innovation surveys are another useful data source that can be used to analyse linkages between PRIs and industry. Firms participating in the survey are asked if they have co-operated with a range of external partners during the innovation process. Collaboration with enterprises and institutions is widespread among innovating firms. Figure 2.19 shows the proportion of innovating firms collaborating with government institutions in the 2006-08 period. The results vary markedly, from more than 20% in

Finland to less than 5% in Estonia, Germany and Italy. A number of countries with data in Figure 2.19 also participated in the RIHR survey and case studies, and the results can be compared with the descriptive evidence on policies and outcomes on linkages (see Chapter 5).

Figure 2.19. Innovative firms collaborating with government or public research institutions, 2006-08



Note: Innovative firms are those with technological innovation (product, process, ongoing or abandoned), regardless organisational or marketing innovation. The sample covers firms in core NACE Rev 2 activities related to innovation activities. Denmark's data on firms collaborating with government or public research institutes is provisional.

Source: Eurostat, Community Innovation Survey (CIS) 2008.

An expanded view of PRIs

In an attempt to gather data about the specific target population of PRIs defined for this project, the OECD's NESTI group undertook a statistical re-tabulation exercise. This entailed performing a micro-data extraction from national R&D survey data, which drew out R&D expenditure data on the list of institutes that countries had identified as conforming to the RIHR definition of PRIs, set out earlier in this chapter. A first pilot was organised in Norway, with the help of NESTI delegates from NIFU. The exercise was then extended to other volunteer countries (Box 2.2). Results were reported for Austria, Poland and Russia.

Box 2.2. The statistical re-tabulation process

The first step in the statistical re-tabulation process was a pilot exercise conducted in Norway. This consisted of:

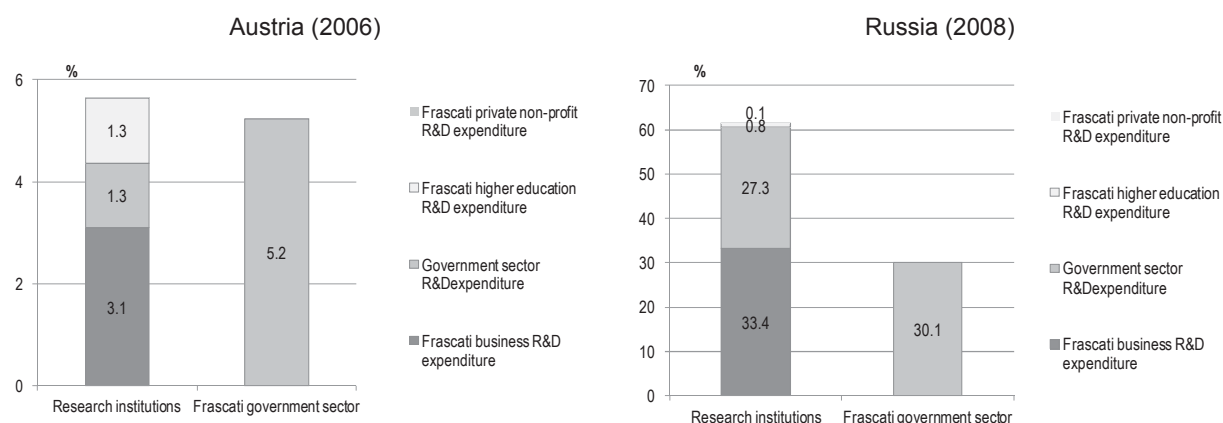
- Comparing the list of research institutes provided by the RIHR delegate according to the new definition with that of the Frascati Manual-compatible breakdown of institutions.
- Providing the total expenditure for the newly defined population broken down by sources of funds, types of cost, types of R&D, fields of science and socio-economic objectives as well as total R&D personnel by types of occupation.
- Showing the breakdown of the newly defined PRI population according to the original Frascati sectors.

Data requests were then sent in September 2009 to other countries participating in the exercise. Responses were received from Austria, Denmark, Finland, Luxembourg, Poland and Russia. Data were also received from Belgium, but for Flanders only; these data could therefore not be used in comparison with Frascati data that are for the entire country. The data for Denmark, Finland and Luxembourg also were not used for the analysis, since:

- In Denmark, the identified group of research institutes included the Approved Tech Service Institutions (classified with the Frascati business enterprise sector). However, the rapidly changing landscape, where a number of research institutes were merged with universities, made re-tabulation of the data impracticable.
- In Finland and Luxembourg, all identified research institutes belonged to the Frascati government sector.

Re-tabulating R&D expenditure according to the project defined population uncovered a PRI sector whose size compared to the Frascati-defined GOVERD varied from one country to another and reflected national differences in the organisation of the R&D system. The re-tabulated data included, on the one hand, research institutes under the umbrella of other Frascati sectors, predominantly the business enterprise sector, and excluded, on the other hand, government institutions whose primary goal was not R&D (*e.g.* various governmental agencies, hospitals, museums conducting research, etc.). The importance of Frascati business institutions in the new population had an impact on the distribution of expenditures in terms of sources of funds (*i.e.* more business funding), types of R&D (*i.e.* more applied R&D and development), scientific fields (*i.e.* more engineering and technology) and socio-economic objectives (*i.e.* more industrial production).

Figure 2.20 shows expenditure in the re-defined population of PRIs (denoted as research institutions) as a percentage of GERD, compared to Frascati-defined GOVERD as a percentage of GERD. For example, Austria's data showed a small increase in the overall share of government research institutions in GERD when the new PRI definition is used, since the inclusion of certain business-sector and Austrian Academy of Sciences entities is almost matched by the exclusion of around three-quarters of the GOVERD institutions, particularly regional hospitals, museums, libraries and other similar entities. However, the composition changes dramatically, with more than half of research institutes in the new sample coming from the Frascati business sector category. In Russia, the re-tabulation changed both the size and composition of the PRI sector. A large number of Frascati business sector entities entered the PRI category; one reason is that existing branch R&D institutes serving the market in Russia are attributed to the business enterprise sector for statistical purposes even though they remain publicly owned. Norway and Poland also showed increases in the size of the PRI sector under the new definition in addition to an increase in the share of business sector expenditure.

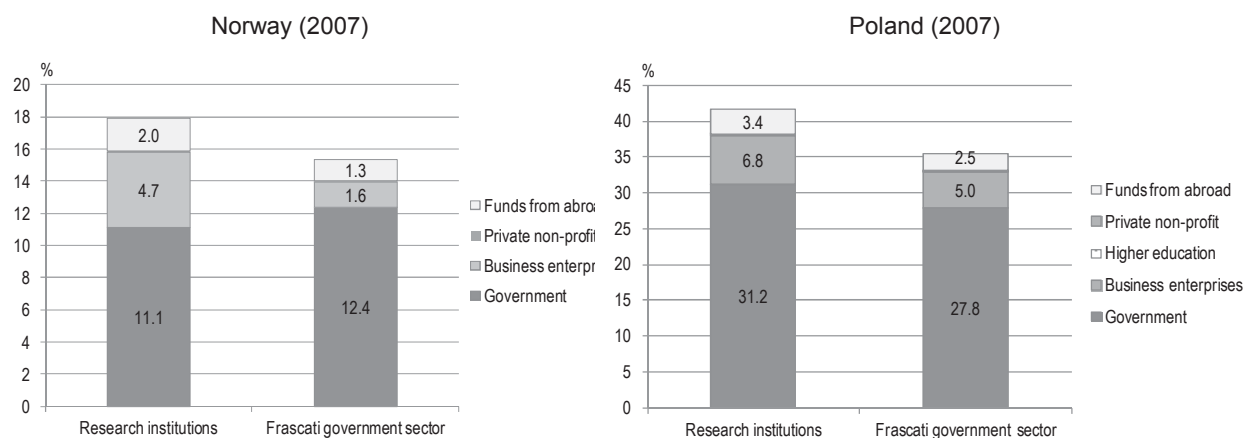
Figure 2.20. Research institutions expenditure and GOVERD as a percentage of GERD

Source: NESTI statistical re-tabulation.

Funding sources for the PRI sector also changed as a result of re-tabulation, with business funding and funds from abroad both showing notable increases. In Norway, for example, PRIs under the new definition attracted business funding equivalent to 4.7% of GERD, compared to 1.6% under the Frascati definition (Figure 2.21). Funds from abroad rose from 1.3% to 2% of GERD. In Poland, business enterprise funding for PRIs rose from 5% to 6.8% of GERD, while funds from abroad rose from 2.5% to 3.4% of GERD.

Figure 2.21. Research institutions expenditure and GOVERD, by sources of funds

As a percentage of GERD

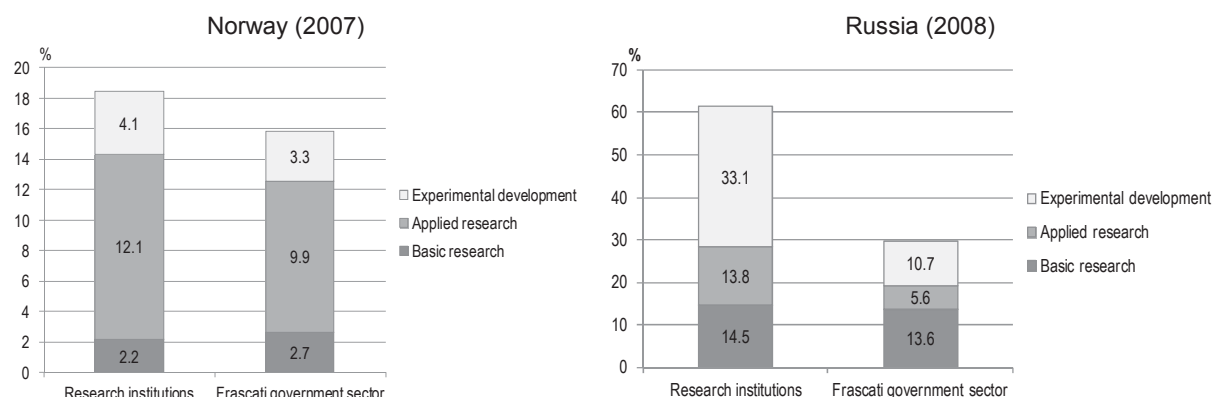


Source: NESTI statistical re-tabulation.

The split between basic research, applied research and experimental development differs according to the PRI definition used. In Austria, the composition changed to include higher levels of all three types of activity, accompanied by a fall in “not elsewhere classified”. In Norway, basic research fell as a share, but applied research and experimental development both increased (Figure 2.22). Russia saw a leap in PRI sector experimental development, from 10.7% to 33.1% of total R&D expenditure.

Figure 2.22. Research institutions and government current R&D expenditure by types of R&D

As a percentage of total current R&D expenditure

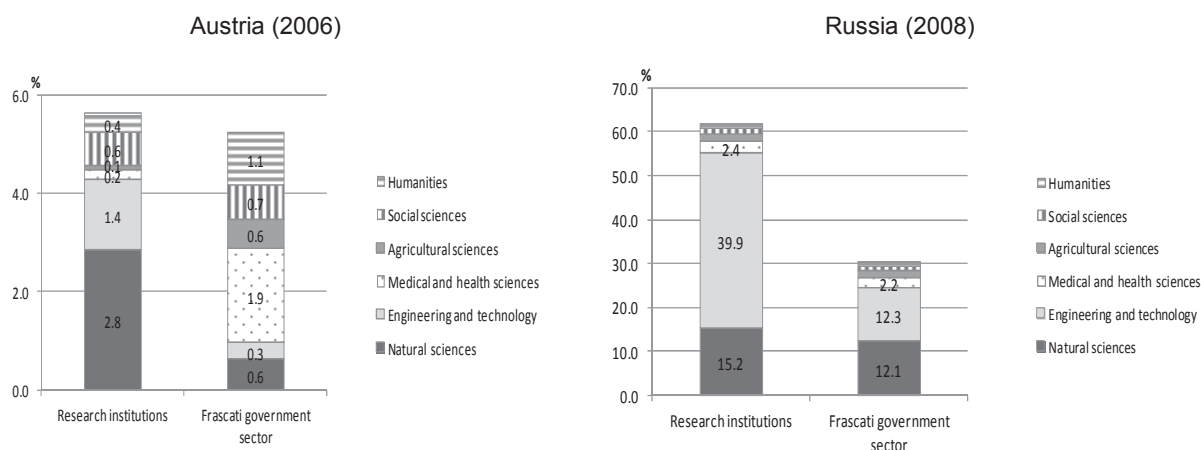


Source: NESTI statistical re-tabulation

Fields of research similarly shifted. For example, Austria's data showed a large jump in the share of natural sciences and a fall in medical and health sciences (Figure 2.23). In contrast, Norway's PRIs had the same share in natural sciences as in the Frascati-defined sector, but engineering and technology became much more prominent. Engineering and technology also increased in size in Russia.

Figure 2.23. Research institutions expenditure and GOVERD by fields of science

As a percentage of GERD



Source: NESTI statistical re-tabulation.

The data provided by Austria and Norway also allowed comparison of expenditure by socio-economic objective for the two government sector definitions. In Austria, the notable changes were in health research expenditures by PRIs (a fall in their share of GERD from 1.9% to 0.6%) and industrial production and technology expenditures (a rise from 0% to 2.9% of GERD). These two objectives also showed notable changes in Norway, in the same direction; in addition, Norway's data showed increases in the share of energy in PRI expenditures, as well as spending on transport, telecommunication and other infrastructure.

Notably, although the definition of PRIs set out for the project set some boundaries on the types of research institutes included, it still left scope for interpretation; different countries thus took different approaches. These tended to reflect the range and form of institutes situated in each country and judgements about the degree of “public mission” and importance of various institutes in national innovation systems. In practice, this means that some types of research institutes may not have been treated consistently across countries participating in the re-tabulation exercise. At the NESTI/RIHR expert meeting held in May 2010, participants agreed that the unit of analysis was difficult to define, that there would always be a grey zone and that it was not easy to apply strict classifications. The definition used in the RIHR project was seen as useful for analysing the grey zone and for statistically describing the characteristics and transformation of research institutes at a national level (the Russian case was noted in particular). However, further discussion about the appropriate approach to certain types of institution would be necessary to obtain consistent coverage in any larger data exercise. In addition, the definition may not be suitable as a basis for making international statistical comparisons of research institution sectors (*e.g.* comparing their sizes).

Summary

National-level data on PRIs can give important insights into how these entities have changed over recent years. Usually, such analyses of PRIs use data on the “government” sector, as defined by the Frascati Manual. However, the evolution of PRIs means that the government sector may not fully capture the group of institutes considered to be public research entities. For this project, a wider definition of PRIs was developed, which sought to include “public” and semi-public research institutions (but not pure university institutes) regardless of their statistically-defined sector. This chapter accordingly presented two levels of statistics: first, an analysis of the Frascati government sector to show how this sector’s size and weight has changed over time in countries’ research systems; and second, the results of a statistical exercise, using existing national R&D data, that aimed to provide a quantitative snapshot of the wider project-defined population of PRIs.

The data showed that absolute real expenditure on R&D in the Frascati-defined government sector has risen in the OECD over the last decade. At the same time, this spending now accounts for a smaller share of total R&D spending by OECD countries, with other sectors (*e.g.* higher education and business) accounting for an increasing share. Government-sector R&D also now accounts for a smaller share of OECD GDP; the higher education-sector has increased its share commensurately. Some cross-country differences exist underneath this aggregate picture. For instance, several countries (such as France, Italy and the United Kingdom) experienced real decreases in government R&D expenditure. There was also diversity in the share of R&D performed in the government sector; for some countries this is over 30%, while for others, the government sector accounts for less than 5% of R&D. Governments make strong use of institutional funding (*i.e.* not directly selecting projects or programmes) in their support of the government R&D sector, but there is some evidence of increasing use of project funding. Most countries experienced a decrease in expenditure on R&D instruments and equipment.

For most countries, applied research and experimental development account for the bulk of government sector R&D, but the exact shares and patterns over time differ across countries. Basic research tends to be undertaken in the higher education sector. There are large differences across countries in the fields of government sector research and the

amounts of expenditure attributed to them. These patterns are likely linked to specialisations within national innovation systems, and priority setting by governments. Natural sciences account for a large share of activity in some countries, while others are more focused on engineering, or on medical sciences, for instance. Data on the top three expenditure areas, categorised by socio-economic objective, reveal that “agriculture” and “health and general advancement of knowledge” most frequently appear as priority areas, while “environment” appears only infrequently.

Just over half of the OECD countries had increases in the number of government sector R&D personnel since 1998, but two-thirds experienced increases in the number of researchers, suggesting a rebalancing of staff between research and support personnel. Nevertheless, as a share of total researchers, government sector researchers have fallen in almost all OECD countries.

In terms of outputs, government institutions owned only a small fraction of international patents filed between 2006 and 2008. However, in some instances, these institutions owned significant shares of patents filed in particular fields (for example, biotechnology or nanotechnology), pointing to some areas of specialisation. Where government-owned patents were invented abroad, this was often in geographically-proximate countries; Canada had strong links with the United States, for instance. Collaboration between PRIs and industry is a source of technological spillovers and knowledge diffusion. Industry financing of government sector R&D is one indicator of such collaboration; in most cases, less than 20% of government-sector R&D was financed in this way, although the share had risen slightly over time. The proportion of innovating firms collaborating with government institutions varied across countries, ranging from below 5% to over 20%.

Taking national R&D data for Austria, Norway, Poland and Russia, and re-tabulating it according to the project definition of PRIs, changed the picture of the PRI sector to differing extents, depending on the country. Overall, the re-tabulated data tended to include research institutes from the business sector and exclude government-sector institutions whose primary goal was not R&D (*e.g.* museums). The size of the PRI sector enlarged significantly for some countries under the project definition, while for others the size was similar but the composition changed. The inclusion of the business-sector institutes typically had an impact on the distribution of expenditures in terms of sources of funds (more business funding), types of R&D (more applied research), scientific fields (more engineering and technology) and socio-economic objectives (more industrial production). However, given the scope for interpretation of the project definition of PRIs, some types of institutes may not have been treated consistently across countries, and any future data exercise would benefit from further discussion about the treatment of certain entities.

Notes

1. As will be discussed later and in Chapter 3, countries' interpretation of the study definition varied and future analysis would benefit from strong agreement on definitional issues.
2. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.
3. The OECD's Main Science and Technology Indicators (MSTI) database presents zone totals for the OECD and the EU27 for most series. The OECD zone includes all Member countries of the OECD except Chile, Estonia, Israel and Slovenia, *i.e.* Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. Further details may be found in OECD (2010a). The OECD generally attempts to provide the longest possible time series for each member country. Thus data are often presented for periods before a country became a member of the Organisation. Information on the precise membership dates of all OECD countries can be found on the OECD website www.oecd.org. Data for Russia (an OECD accession country) and Brazil, China, India, Indonesia and South Africa (OECD enhanced engagement countries) are included where possible.
4. Expressed in 2000 dollars (constant prices and PPP).
5. Government intramural expenditures on R&D are all expenditures for R&D performed within the government sector, whatever the source of funds.
6. Nevertheless, this is not to say that institutional funding comes with "no strings attached". Performance-based funding, where institutional or block funds are allocated with consideration of previous research performance, is of growing interest to many countries. See OECD (2010c) for a discussion of performance-based funding of public research in tertiary education institutions.
7. "Critical mass" depends on the goals to be achieved and the nature of the R&D field. It may be achieved in a single laboratory or project; equally it may necessitate new buildings, state-of-the art equipment and a large and diverse team of researchers and support staff (OECD 2010d, p. 133).
8. GBAORD identifies all budget items involving R&D, and measures or estimates their R&D content in terms of funding (OECD, 2002). These estimates are less accurate than performance-based data (such as GOVERD), but can give a direct indication of governments' policy priorities, as the budget data can be classified by objectives. They are also timelier than performer-reported data, which tend to become available only one to two years after the R&D has been carried out.
9. The patent data sourced from the OECD Patent Database and used in this sub-section includes all OECD member countries except Estonia in the OECD aggregate.
10. For example, bibliometric databases do not cover all disciplines equally well, citation practices vary by scientific field, non-English language journals are less well represented and the frequency of citation is not necessarily an indicator of quality.

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Chapter 3

The evolving public research institution sector – institutes and their orientations

The changing profile of the PRI sector, broadly defined, calls for additional country- and institute-level information to support policy making. This chapter begins to present the results of the RIHR project country context notes, institutional case studies and institute-level survey. It describes the types of entities considered to be PRIs and outlines the orientation of the sector. The evidence suggests the focus and targets of PRIs have undergone some significant changes in recent years. Excellence and openness are now focal points for many institutes. PRIs tend to focus on specific sectors, fields or tasks, with applied research generally a key activity. Supporting industry and conducting research of benefit to society are the main goals.

While the statistics presented in Chapter 2 give an aggregate view of the changes that have taken place in public research institutions (PRIs), there is a need for additional country- and institute-level information for policy making. In the Frascati-defined government sector (see OECD, 2002), the absolute level of spending in PRIs continues to grow, but these expenditures on research activity have declined as a share of GDP and as a share of total research spending. At the same time, there have been numerous changes to the organisation and governance of PRIs, and popular notions of “what is a PRI” now encompass institutes beyond the official government sector. A wider statistical view of PRIs that includes similar entities from other sectors can give a different impression of the size, composition and activities of PRIs, and highlights the importance of analysing more closely the institutes that feature in the public research space.

To complement the official data and illustrate the transformation of PRIs, the OECD Working Party on Research Institutions and Human Resources (RIHR) collected information from member and observer countries in three stages. First, countries were invited to contribute a “country context note” describing their PRI sector (as defined by the project definition). This had the aim of building an overall country-level picture of the number and different types of institutes, the organisation of “public” non-university research systems, and the changes in the sector. Countries were also requested to provide a list of their PRIs fitting within the project definition, on the basis of which further statistical work was conducted for selected countries (the results were discussed in Chapter 2). Second, countries were invited to participate in case studies of individual PRIs. Methodology and participation in these two initial stages is described in Box 3.1. Third, an institute-level survey of PRIs was launched by selected countries (methodology and participation in this stage is described in Box 3.2). Annex 3.A provides additional information on the survey data characteristics.

The project benefited enormously from the participation of countries in these three evidence collection stages; twenty delegations submitted information related to the country context note, while seven undertook case studies and five participated in the survey stage. The overall picture that emerged from this three-pronged evidence collection is one of diversity and ongoing change. Countries presented a wide variety of experiences, with their specific historical and institutional settings leading to unique collections of institutes and patterns of change. At the same time, some general trends could be observed, as a response to common challenges and concerns.

This chapter begins to present the findings from the country context notes, case studies and survey reports. It discusses the scope of the PRI population covered by the project, in particular the kinds of institutes that countries considered to be PRIs according to the RIHR project definition, and the commonalities and discrepancies that emerged in the classification process. It then describes the orientations of the PRI sector, particularly its missions and activities, looking at trends, drivers of change and current arrangements. A typology of PRIs is not proposed; countries grouped their PRIs in a variety of ways, and even where broad types of classifications could be identified, there remained an important level of institutional diversity. This highlighted the wide range of different PRIs that now exist in OECD member and non-member economies, and the difficulties of forming sharply defined, yet reasonably aggregated, groups of institutes for analytical purposes. Instead, the focus is on identifying commonalities and differences, and the various trends and challenges that countries are facing in their public research sectors.

Box 3.1. Country context notes and case studies – methodology and participation

Country context notes

The first stage of information collection for the PRI project comprised a “country context” questionnaire sent to all RIHR country representatives. This questionnaire sought country-level information on PRIs as defined by the RIHR project definition (which aimed to capture the full extent of public, semi-public or recently privatised entities). The questionnaire requested information on: *i*) the current position of PRIs, including their missions, divisions of labour and linkages, orientations and rationales; *ii*) the size of the sector, in terms of staff and R&D effort; *iii*) major institutional changes in the past 15 years; *iv*) general governance arrangements; and *v*) the general regulatory environment.

Country context notes were submitted by: Australia, Austria, Belgium (Flemish Community and Flemish Region), Canada, Chile, Denmark, Finland¹, Germany, Italy, Japan, Korea, Luxembourg, New Zealand, Norway, Poland, Russia, Spain and the United Kingdom. The European Union described its Joint Research Centre. The Netherlands provided information on its public research institutes (Steen, 2008).

Case studies

The second stage of information collection involved case studies of institutes. The aim of this stage was primarily to provide more in-depth knowledge about the diverse characteristics of PRIs before designing and performing institute-level surveys in volunteer countries. The cases also provided valuable examples of trends in individual institutes. The case studies covered five dimensions: *i*) the main missions and rationales of the PRI; *ii*) activities of the PRI and its role in the innovation system; *iii*) ownership and governance, including evaluation and human resources; *iv*) modes and channels of funding; and *v*) external linkages and internationalisation. The questions generally asked about current arrangements, recent changes (and their drivers), and views on the current arrangements and future prospects.

Seven countries (Austria, Finland, Korea, Italy, Norway, Poland, Russia and Spain) provided a total of 12 institutional case studies. Denmark provided its 2009 evaluation of Danish universities, which included a focus on the mergers and reorganisation in the university and research institute sectors (Ministry of Science, Technology and Innovation, 2009). While the cases may not build a statistically representative sample, they were a good mix of national systems, different institutional frameworks and diverse institutes that varied in their form, governance and activities. The cases comprised:

Austria – Christian Doppler Association (CDG)	Finland – National Institute for Health and Welfare (THL)	Italy – National Research Council (CNR)
Korea – Korea Institute of Science and Technology (KIST)	Korea – Korea Ocean Research and Development Institute (KORDI)	Korea – Korea Research Institute of Standards and Science (KRISS)
Norway – SINTEF	Poland – Polish Geological Institute (PGI)	Poland – Institute of High Pressure Physics of the Polish Academy of Sciences (IHPP)
Poland – Institute for Chemical Processing of Coal (ICPC)	Russia – National Research Nuclear University (NRNU MEPhI)	Spain – Spanish National Research Council (CSIC)

1. The information given in Finland’s country context note was based on a 2009 study, “The role of public research organizations in the change of the national innovation system in Finland” by Hyytinen *et al.*, see www.minedu.fi/export/sites/default/OPM/Tiede/setu/liitteet/Setu_6-2009.pdf.

Box 3.2. Institute-level survey – methodology and country participation

The third stage of information collection comprised a pilot survey of institutes, held in five volunteer countries. This had the aim of generating broader and more in-depth information, as well as some comparability (and hence, learning opportunities) across countries. In addition, the results could help inform any future development of a full survey and common set of indicators on PRIs. Austria (Joanneum Research) took the lead in designing the web-based survey questionnaire, drawing on the results of the country context notes and case studies, and incorporating parts of existing surveys. There were a total of 21 questions, covering 2 modules: the institute and its position in the research and innovation system; and organisation and management of the institute. Questions covered the rationales and missions of institutes (including key changes in the previous decade), activity areas, external linkages and internationalisation, funding structures and human resources, and governance and steering.

Austria, Italy, Norway, Poland and Slovenia participated in the survey. The samples are not necessarily representative of the overall country situations (see below) and strict comparability between countries is thus limited. Due to the small sample size, statistics for Slovenia were not reported; however, a qualitative report was supplied. Overall, the survey reports provided a valuable indication of trends and pressures in the PRI sector which, combined with the country context notes and case studies, yield a reasonably robust picture of the transformation of PRIs.

Country	Response rate (RR)	Comments on sample
Austria	176 responses (32% RR)	Possible bias due to higher response rate from Academy of Sciences institutes (basic research focus). Around 25% of responses were from temporarily implemented institutes.
Italy	113 responses (45% RR)	Sample mainly representative of CNR (National Research Council), a general purpose research institution (basic and applied research across many fields).
Norway	50 responses (88% RR)	Provides good quality information.
Poland	103 responses (47% RR)	Target population was Polish Academy of Sciences institutes, Research Institutes and those “other governmental institutes” extensively carrying out research.
Slovenia	7 responses (47% RR)	Responses may be influenced by current preparation of national strategies on higher education and research. Target population was Frascati-defined PRI sector.

Which institutes are “PRIs”?

As noted in Chapter 2, while the definition of public research institutions provided for the project set some boundaries on the types of PRIs included in the country context notes, scope for interpretation remained and different countries took different approaches. The exercise highlighted how the borders between different types of institutes can be blurry and the selection of entities reflected countries’ judgements about aspects of the PRI definition (such as public versus private missions, whether research is a “main task”, *etc.*). The information provided in the context notes was suitable for the purposes of this project, in describing broad patterns of change. However, any future data analysis would benefit from strong agreement on the desired approach to certain types of institutes, with a view to consistent institutional coverage and improved cross-country comparability.

The treatment of institutes with a strong cultural focus was one example of inconsistency in the PRI populations described in the country context notes. For instance, Denmark included entities such as museums and libraries, noting that although these have

a relatively strong emphasis on their service and information functions in contrast to their research functions, they are essential parts of the Danish research infrastructure. Austria also included such entities. In its context note, Poland noted a number of institutes operating under its Ministry of Culture and National Heritage that undertake research, although with a cultural not scientific mission, which were considered as borderline cases (*e.g.* the Polish Film Institute)¹. Other countries chose to exclude such institutes. The United Kingdom, for instance, noted that cultural institutions such as art galleries and museums were excluded as research represents a very small proportion of their activity. The United Kingdom considered that their classification as public sector research establishments (PSREs) in the UK science and innovation system was “based on historical and regulatory factors rather than an accurate description of their purpose”.

Some countries included entities that typically have strong public-service goals alongside research goals, such as hospitals. For example, Italy included its research-oriented hospitals, which operate through conventions between the Ministry of Health and regional governments, and which perform “research activities in biomedical fields or in the field of organization and management of health services”. Spain also included hospitals, noting that their mission is to support the health system and also provide support to the research activities of pharmaceutical companies. Norway noted that its health care institutions, including non-university hospitals, in total account for a substantial amount of research, even though each individually performs only a small amount of R&D activity.

In contrast, some other countries regarded medical research as a borderline case. For example, Denmark excluded medical and health research, which is primarily done at universities and in collaborations between Danish university hospitals and universities, from its note. This area of research was regarded as an essential part of the Danish national innovation system, but blurry institutional borders and the existence of researchers with multiple employers makes it difficult to categorise. Other examples of institutions with both public service and research goals that were included by some countries are statistical institutes (*e.g.* Italy’s National Institute of Statistics, Statistics Netherlands), central banks (*e.g.* Luxembourg’s Banque Centrale du Luxembourg) and institutes with strong links to central government agencies (*e.g.* Poland’s Economic Institute linked to the National Bank of Poland).

In a few instances, countries included institutes that may have strong similarities with “pure university institutes”, which were excluded from the RIHR definition of PRIs for the project. For example, Belgium included non-university higher education institutes, which “provide higher education and advanced vocational training outside universities and increasingly focus on scientific research and services to society, including cooperation and problem-solving for business”. Japan’s context note included inter-university research institute corporations, which focus on specific areas that require research from a national perspective and whose activities “contribute to the advancement of university research”. Austria’s Christian Doppler Association (CDG) might also be considered “borderline institute”, given the close relationship between CDG laboratories and universities (the CDG case is discussed in Box 4.2 in Chapter 4).

The criterion of a “predominantly public mission”, as suggested by the RIHR definition, also raised interesting issues and potential inconsistencies. While many PRIs have contact and linkages with industry, and thus have some degree of industry orientation, the point at which institutes cease to have a predominantly public mission is not clear. For example, Japan included technological research associations for mining and

manufacturing, which are collaborations of three or more corporations on field-specific R&D and which “occasionally receive government research funds”. Another example might be centres of excellence, which have been included by some countries (*e.g.* Belgium, Norway, Spain and the United Kingdom).

Similarly, Russia noted that the institutes included in its discussion of PRIs would differ according to whether “pattern of ownership” or “sector of performance” was chosen as a guide. Both classifications would include institutes under the academies of sciences and federal ministries; however, under an ownership criterion, research and production enterprises in which more than 50% of authorised capital (shares) is owned by the state would be included, while under a performance criterion, these enterprises would be excluded but budgetary science foundations would be added. For the country context note, Russia chose to focus on the institutes corresponding to the performance criterion, but it could be debated that relevant Russian research and production enterprises ought to be included in any further analysis.

Finally, several countries highlighted specific “border cases” that were excluded from the discussion but which showed some characteristics of the RIHR’s definition of PRIs. Civil society was one case mentioned. For example, Denmark pointed to private and non-governmental organisations that conduct research subsidised either by individual ministries or by research councils, that are outside direct public regulation but which represent a significant part of the Danish research and innovation system. An example was the Rehabilitation and Research Centre for Torture Victims, which is largely publicly funded and produces research of an international standard. Poland also regarded some civil society institutes as a grey area, particularly with the amount of funding coming from different sources (EU, government, business and international organisations) varying from one year to another. Finland noted a number of institutes that are supported from national lottery revenue, which are not included within the Statistics Finland definition of public research entities, but which undertake sectoral research (*e.g.* the Pellervo Economic Research Institute). Some of these institutes have links with universities and also receive funding from the Ministry of Education, for example, the Tampere Peace Research Institute.

Defence research was also considered a border case. It is an area of clear importance within some national innovation systems, but did not tend to feature in the country context notes, likely due to security and public interest concerns. Denmark noted that it had excluded research institutions operating under its Ministry of Defence, but acknowledged that defence and military research in some countries was essential for technological development and that some cases probably warranted inclusion in the analysis. Finland noted the important research work conducted by institutes such as the Finnish Defence Forces Technical Research Centre, which is not recognised under Statistics Finland’s public research entity category. Some countries did, however, list some defence-related institutes in their lists of entities. For example, Poland included several research institutes related to the military, such as the Military Institute of Armament Technology, while Canada included Defence Research and Development Canada, which encompasses seven research centres, and Norway included the Norwegian Defence Research Establishment.

Orientation of the PRI sector

The evidence collected from countries suggested that the focus and targets of many institutes have undergone change in recent years. As will be seen in Chapters 4 and 5, these changes have been important drivers of evolution in PRI structures, governance arrangements and interactions.

In the country context notes, some countries noted instances of explicit changes in missions and mandates of their PRIs. For example, Italy's reform efforts in 2003 included providing some of the large public research institutes (the National Research Council, the Italian Space Agency, the National Institute for Astrophysics and the National Institution of Energy and Environment) with precise missions closely related to the needs of the productive system. The European Union's Joint Research Centre (JRC) established its current overarching mission after a decade of ongoing changes in its activities, including development of work in existing areas (such as environmental impact and nuclear energy over the 1990s) and initiation of work in entirely new fields in response to new policy challenges and current events (*e.g.* the "mad cow" disease outbreak). At an institute-level, for example, an increased focus on energy policy development led to a change in the name and scientific priorities of the JRC's advanced materials-focused institute; this became the Institute for Energy and is now tasked with non-nuclear energy, energy safety and nuclear medicine. The case study of Norway's SINTEF Group noted that the "not-for-profit" aspect of the institute's mission has been made more explicit in the latest revisions of its statutes, as has its research mission (*e.g.* the primary research fields are listed, as well as the close collaboration with the Norwegian University of Science and Technology – NTNU). These revisions responded to issues with the Norwegian Tax Administration over the liability of research foundations to pay tax, and queries from the European Commission about its mission to promote technological and other industrially oriented research at the NTNU.

In some cases, changes in missions were part of a historical evolution in the PRIs' mandates and roles in response to wider economic and political developments. For example, Korea noted that the mission of its PRIs had evolved over time in step with its economic development. Institutes were first aimed at developing industrial technology for Korea's industrialisation, but are now aimed at providing a science and technology hub for Korea's future needs. Similarly, survey results from Slovenia suggested that changes in missions had been the most significant development for PRIs, driven by new strategic orientations and scientific developments, alongside overall economic and political development. The case of Spain's CSIC (Box 3.3) is illustrative of how institutes can be shaped by bigger forces, particularly when they are a central player in the country's national innovation system.

Box 3.3. Rationales, missions and political drivers – the case of Spain’s CSIC

Spain’s *Consejo Superior de Investigaciones Científicas* (CSIC – Spanish National Research Council) is the biggest research organisation in Spain. It employs around 13 000 people (of which around 3 000 are civil servant staff researchers), accounts for 25% of Spanish scientific publications registered in databases and is the main patenting organisation. It encompasses almost every scientific specialty, from physics to philosophy.

The origins of CSIC are in the *Junta para Ampliación de Estudios e Investigaciones Científicas* – JAE – created by ministerial decree in 1907. Its general goal was to forge links with European science and culture, thus ending Spanish isolation, and to train staff responsible for implementing reforms in science, culture and education. However, the JAE was closed down in 1938, in the middle of the Spanish Civil War. In 1939, the new political regime created CSIC, putting under its umbrella all centres belonging to the dissolved JAE as well as those created to reform the educational system. The ideological foundations of the new institution were different and the legal texts and management figures from CSIC’s conception reflected a renewed institution.

The founding act creating CSIC in 1939 specified that the PRI’s mission was to encourage, guide and co-ordinate national scientific research. The brevity of the formal mission allowed its interpretation according to trends, needs and capacities. The CSIC was under the trusteeship of the head of state and its president was the national education minister, thus the institution was heavily shaped by the principles of the new regime. In practice, this hindered research activity in certain fields, notably social sciences and the humanities. Initially, CSIC institutes were grouped under boards of trustees, which were further grouped under three sections, each governed autonomously but under a mission that was defined by the government’s views on the role of science in the country’s service. The mission in social science and humanities was to strengthen and promote Spanish culture, language and history, especially in certain historical periods. The mission for natural sciences was to cultivate and develop scientific capabilities and to shape nature for the country’s wellbeing. The mission of the technological branch was to promote the development of technology and to help the national productive sectors. One result of this is that CSIC came to encompass very different research centres and cultural institutions that in other countries tended to develop separately.

In 1975 the boards were abolished and the transition to democracy triggered the abandonment of the mission to provide technical support to industry. In 1986, the introduction of the Science Law saw more changes to the mission, and established CSIC’s distinctness from the university sector. At the same time, entry to the EU became another important motive to redefine CSIC’s mission.

The mission of CSIC now aims to achieve three main objectives: knowledge production of the best quality; its transfer to other agents; and its dissemination to society. It comprises several functions, including conducting research, providing scientific services to the General State Administration and training researchers and experts. “Side-missions” related to CSIC’s position in the research system include participating in international bodies and developing skills in managing science and technology. The formal mission is determined by the National Government, with non-binding contributions from other stakeholders. Nevertheless, the political and economic developments of the multi-level state (*i.e.* the EU and Autonomous Regions) have influenced the current missions, particularly given CSIC’s financing requirements.

Source: Case study report on CSIC (Spain) supplied to the OECD Secretariat.

A number of countries described changes to, or the establishment of, explicit priority areas for research activities. For example, Canada’s S&T Strategy sets out priority areas for funding, including environmental science and technology, natural resources and energy, information and communications technologies, and health and related life sciences. Chile also noted that priority areas had been identified, moving away from its historically neutral approach to the promotion of innovation, while Australia’s National Research Priorities guide investments in public research towards environment, health, frontier technologies and “safeguarding Australia”. Other examples include Germany, where the High-Tech Strategy 2020 focuses on priorities in areas where the state has special responsibilities and which are of particular societal relevance (*e.g.* climate

protection and security). Italy's National Research Plan sets out 11 strategic programmes, including new medical engineering, neurosciences and new systems of energy production and management. The Korean government wishes to maximise the efficiency of national R&D projects by reorienting them towards certain topics such as environment and energy.

More generally, “excellence” is now an explicit goal for many PRIs. Austria noted that its temporary research institutes now have a stronger orientation towards excellence, in addition to their original rationale of supporting industry-science linkages. Following an evaluation in 2000, the institutes funded by Austria's Ludwig Boltzmann Association transitioned to temporary institutes, in order to increase critical mass and foster excellence in research, while the competence centre programme was changed in 2008 to give excellence a greater role. In Finland, decisions about sectoral research have been strongly driven by a quality focus. A general model created in the early 1990s sought to evaluate the quality and relevance of sectoral research partly through its success on the competitive research market, while a government decision in 2005 stated that the relevance of sectoral research should be assessed according to the improvements in the economy, welfare and society. Germany's Joint Initiative also makes reference to a concentration on excellence. Reforms in Luxembourg since 1999 have also put scientific quality more to the fore, via changes to the method of funding (funding is discussed in Chapter 4).

Increased openness and linkages have also become a focal point for a number of PRI groups (Chapter 5 discusses linkages and internationalisation in greater depth). For instance, Denmark remarked that since 2001 it has been a government goal to create better links between education, research and innovation, which has led directly to substantial changes in the PRI sector. Germany's Joint Initiative for Research and Innovation also highlights strengthening co-operation and networking across organisations, with the aim of increasing the competitiveness of German research by making better use of existing potential. Belgium noted some modifications to the principles for aid for excellence centres, particularly putting more emphasis on collective research, non-technological aspects, and sub-regional innovation stimulation. In a related development, the United Kingdom's establishment of measures to increase knowledge transfer activities from publicly funded research (and related elaboration of metrics to assess this activity) is likely to have influenced the focus of institutes.

The survey data on trends in activities and fields of research further highlighted some of the changes in the focus and targets of the PRI sector. Applied research and dissemination of research results to the general public were the activities most frequently identified as having increased in volume in the last decade for Austrian, Italian and Norwegian PRIs.² They were also identified by Polish PRIs as being important areas of increased activity, although “other” (unspecified) areas of activity were noted to have increased more frequently. In Austria, Italy and Poland, the fields of “trans- and multi-disciplinary sciences” and “engineering and technology” were most frequently identified as having increased in volume in the last decade.³ Italy noted that this trend was consistent with a shift in its PRIs towards research of industrial interest. In Norway, “social sciences” and “trans- and multi-disciplinary sciences” were the fields most frequently noted to have increased. There were some notable country differences in the intensity of field growth. In particular, in Austria and Norway, the majority of responding institutes indicated that volumes of research undertaken in various fields had actually stayed the same over the past decade. In contrast, in Italy for example, a majority of institutes undertaking research in “trans- and multi-disciplinary sciences”, “engineering

and technology”, “medical and health sciences” and “natural sciences” noted that activity in these areas had increased. This may partly reflect the way in which the drivers of change in Italy have manifested themselves in comparison to the other countries.

Current orientation of the sector

The current orientation of the PRI sector can be revealed by the rationales, missions and activities of institutes. Table 3.1 sets out a summary of the PRI population for this study, as identified by countries, with institutes grouped in accordance with their presentation in the country context notes. It notes the mission orientation, specificity, type of activity and rationale/aims of the PRI groups. Within the table:

- The column on mission orientation aims to indicate where on the spectrum from strongly publicly-oriented to strongly industry-oriented a country’s PRIs sit. While PRIs as defined for this study all have predominantly public missions, most have some degree of interaction with industry and the activities of some PRIs will be heavily weighted towards assisting and working with business. For other PRIs, their activities will be skewed towards activities focused more on wider societal (or public) benefits.
- The column on specificity aims to indicate whether institutes are focused on more narrowly defined research fields or particular sectors, or whether they undertake research across a broad spectrum of areas. Multidisciplinary research may take place in either case.
- The column on type of activity aims to highlight whether institutes undertake basic research, applied research or development work. It also notes where institutes provide scientific infrastructure or undertake other tasks such as data collection.
- The column on rationale and aims provides some information on the goals of the PRIs.

From the table, it is clear that there is a multidimensional array of possible positions for PRIs and that no two countries are completely alike in their collection of institutes. As well as country-specific factors such as economic structure and government strategy, the different country profiles of PRIs may also partly be a function of timing. For example, Austria noted that the appearance of different types of PRIs was related to specific historical circumstances, under which certain organisational types were seen as the best fitting model for the times. In Austria’s case, permanent institutes were predominantly established in the decades around World War II, whereas temporary institutes are a more recent phenomenon. Both types of institute reflect the leading policy trends and paradigms that existed at the time of establishment.

Table 3.1. Missions and orientations – evidence from context notes

	PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Australia (46 institutes)	Government research organisations	Focus on research for the “public good”, but also aim to support industry.	Ranges from national institutes with diverse activities to agencies with mandates in specific fields.	Oriented to strategic basic research (rather than pure basic research) and applied research.	Contributing to Australia’s economic cultural and social wellbeing by undertaking research and contributing to debates on Australia-specific issues, and contributing to international projects. Delivering research capability in high-value areas where market provision is weaker.
	Private not-for-profit research institutes		Many medical research institutes. Focus on particular fields or certain community sectors.		
	Other institutions		Field/sector-specific.		
Austria (over 500 institutes ¹)	Permanent organisations	Almost all PRIs have some public mission, but many also show industry orientation.	Generally a more diverse functional role in NIS. Tend to provide cross-sectional applicable knowledge and technology.	Basic research (e.g. Academy of Sciences) Applied research and development activities (e.g. Austrian Research Centres) Providing research infrastructure	Supporting top-quality research Depending on the PRI: - Providing applied research and infrastructure for business; - Supporting regional innovation system; - Linking science and business; - Serving SMEs.
	Temporary organisations		Typically address a specific “gap” or function in NIS. Broad thematic variety as a group; individual PRIs tend to be focused.	Application-oriented basic research and applied research.	Enhancing bridges between universities and enterprises, and between science and industry. Some PRIs have SME, region or gender-related aims (e.g. Laura Bassi Centres of Expertise promote opportunities for women).

Note: In some countries, a number of institutes are grouped under an umbrella or parent research organisation. The notes accompanying this table specify some of the details of the counting procedure for different countries.

1. Austria: This separately counts institutes within their parent institution, e.g. the Christian Doppler Association (CDG) counts for 57 institutes.

Table 3.1. Missions and orientations – evidence from context notes (continued)

	PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Belgium² (48 institutes plus pilot programmes)	Flemish Strategic Research Centres (4)	Mixture of public and industry orientation	Focused on specific research fields	Basic, applied and development research. Reference laboratory. Inputs to public policy. Technology transfer and valorisation of research.	Providing internationally excellent research and supporting the technological economic texture of Flanders.
	Non-university HEIs ("Hogescholen") (22)	Predominantly public mission	Broad themes	Higher education and VET, plus scientific research and services to society	Providing education and training outside universities
	Flemish scientific institutes (4)	Public	Specific fields	Basic research Strong data collection role	
	Excellence Centres ("Excellentiepolen") (9)	Strong industry orientation	Industry-specific	Applied research	Co-operation among innovation actors with research and innovation relevance in specific industries
	Flemish Co-operative Innovation Networks ("Vlaamse Innovatiesamenwerkingsverbanden")	Industry orientation	Specific (?)	Collective research, technology advice.	Stimulating networks to support innovation in particular technologies or regions.
	Collective Research Centres (11)	Strong industry orientation	Sector-specific	Collective research	Stimulating technological innovation in specific industry sectors.
	Other major actors	Public	Field-specific	Knowledge-based research	
	Policy research centres ("Steunpunten") (13)	Public	Policy domain-specific	Basic research plus problem-driven research Knowledge transfer and provision of scientific services Data collection and analysis	Preparing policy-relevant research
2. Belgium: Flemish Community and Flemish Region.					

Table 3.1. Missions and orientations – evidence from context notes (continued)

PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Canada (88 research units ³)	Strong public orientation	Broad spectrum of subject areas as a group; individual PRIs focused on specific areas.	Basic and applied research.	To perform science in the context of policy development, decision making and regulatory issues. To support the growth, productivity and competitiveness of Canadian industry. Facilitating the science-business interface.
Chile (46 institutes)	Public and industry orientation, in the context of economic development	Field or sector-specific	Basic research (e.g. Millennium Scientific Institutes and Nucleuses) Applied research (e.g. Centres of Scientific and Technological Excellence) Knowledge/technology transfer (e.g. Foundation for Agricultural Innovation)	To strengthen and increase scientific activity and maximise its contribution to Chile's development. This includes a regional aspect, with 25% of the Innovation for Competitiveness Fund going to regions. Science-industry collaboration.
Denmark (16 government research institutions and 9 ATS institutes)	Public orientation	Field-specific	Basic and applied research Analysis, control and surveillance of a technical field Servicing national and international authorities. Evaluation Gathering and dissemination of knowledge or public service	Providing a knowledge base for policy decisions. Providing independent research for private and public customers. Linking to universities.
Government research institutions (Group 2: low degree of R&D)	Strong public orientation	General		Providing services and information to the public.
Approved Technological Service (ATS) Institutes	Industry orientation	Sector-specific	Applied research Provision of technological infrastructure (e.g. standardisation, testing, laboratories)	Support development and innovation in Danish enterprises, public authorities and institutions by disseminating new knowledge and technology. Linking science to industry.

3. Canada: This separately counts institutes within 10 umbrella organisations, e.g. Fisheries and Oceans Canada counts for 15 research centres.

Table 3.1. Missions and orientations – evidence from context notes (continued)

PRI groupings		Mission orientation	Specificity	Type of activity	Main rationale and aims
European Union (7 scientific institutes)	The Joint Research Centre (JRC)	Public focus	Institutes are theme-specific	Applied/policy-oriented research Measurement, testing and standard-setting Evaluation of policy options	To provide customer-driven scientific and technical support for conception, development, implementation and monitoring of EU policies.
Finland (19 institutes)	PROs as defined by Statistics Finland	Traditionally strong public focus, but more recently a greater client orientation.	Sector-specific, according to parent ministry.	Applied/policy-oriented research “Strategic research” Sector-specific functions (e.g. supervision, EU tasks)	Providing, producing and transferring knowledge for supporting strategic decision-making and developing society.
Germany (256 institutes ⁴)	Science and research organisations:	Strong industry orientation	Field-specific	Applied research	To carry out applied research of direct value to private and public enterprise and of wide benefit to society as a whole. Reinforcing the competitive strength of the economy in their region.
	Fraunhofer Society research institutes (80)	Public	Field-specific	Basic research	To perform basic research in the interest of the general public in the natural sciences, life sciences, social sciences and the humanities.
	Max Planck Society research institutes (79)	Public	Field-specific	Development and operation of large-scale research facilities and scientific infrastructure.	Contributing to solving major challenges facing society, science and industry in the fields of energy, earth & environment, health, key technologies, structure of matter and transport & space.
	Helmholtz Association research centres (15)	Public	Field-specific	Applied research	Carry out demand-oriented and interdisciplinary research, partnering with universities, business and government.
Leibniz Association institutes (82)		Serves public and industry goals	Field-specific		
Public and private research centres					

4. Germany: This separately counts institutes within four umbrella institutions, e.g. the Fraunhofer Society counts for 80 research units (including 57 Fraunhofer institutes). Other public and private research centres were not specified.

Table 3.1. Missions and orientations – evidence from context notes (continued)

PRI groupings		Mission orientation	Specificity	Type of activity	Main rationale and aims
Italy (250 institutions ⁵)	Institutions under supervision of:	Main institutions Minor institutions	Field-specific institutions, except for National Research Council	Predominantly basic research Provision of scientific infrastructure Measurement, surveillance and monitoring	Aims of institutions include: - Promoting innovation and competitiveness of the industrial system - Promoting internationalisation of research - Advising Government - Contributing to training of human resources
	Ministry for Education, University and Research	Public	Sector-specific	Applied research and development	Supporting Italy's competitiveness and sustainable development.
	Ministry of Economic Development	Public	Sector-specific	Applied research	Activities in the interest of public health
	Ministry of Labour, Health and Social Policies	Public	Sector-specific	Certification, inspection and monitoring Service delivery (hospitals)	
	Ministry for the Environment	Public	Sector-specific	Research	Scientific research and technical services concerning the environment
	Ministry for Agricultural, Food and Forestry Policies	Public focus	Sector-specific	Research Policy-relevant studies	Research related to the agricultural, fishery and forestry sector.
	President of the Council of Ministries	Public	Task-specific	Supplying official statistical information	Producing and disseminating information to describe the social, economic and demographic conditions of the country.

5. Italy: This counts institutes within their parent institution, e.g. the Italian National Research Council has 107 institutes, divided into centres and territorial sections.

Table 3.1. Missions and orientations – evidence from context notes (continued)

	PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Japan (107 institutions ⁶)	Independent administrative institutions that conduct R&D and National testing and research institutions (52)	Public	General purpose	Research (basic and applied) and development Provision of large-scale research facilities Standards Data collection	Contribute to solving policy challenges by undertaking R&D activities that are not implemented by other sectors and which require long-term or large investments. Linking to basic research in universities.
	Inter-university research institute corporations (4)	Public	Field-specific	Basic research	Promoting research that requires a national perspective
	Public service corporations that conduct R&D	Serve public interest but have stronger industry orientation than other institutions	General purpose	Where activities align with national policy issues, these corporations fulfil functions similar to independent administrative institutions.	Conducting research that facilitates the promotion of technology
	Technological research associations for mining and manufacturing	Industry orientation	Sector-specific	Applied research Testing and examination activities	Promoting collaborative research by firms
Korea (26 institutes)	Korea Research Council of Fundamental Science and Technology (supervised by the Ministry of Education, Science and Technology)	Institutes have both public and industry-oriented goals	Predominantly sector/field-specific	Applied research and initial development	Implement original research and mid-long-term R&D projects that: <ul style="list-style-type: none"> - create a new growth engine - enhance industry's high-tech capabilities - support SMEs and create new industries/jobs - resolve national issues and develop technologies to improve quality of life - resolve imminent issues e.g. national disasters
	Korea Research Council for Industrial Science and Technology (supervised by the Ministry of Knowledge and Economy)				

6. Japan: This counts institutes at the parent institution level. However, a number of institutions comprise multiple institutes or research sub-units e.g. the National Maritime Research Institute has 13 institutes/sub-units.

Table 3.1. Missions and orientations – evidence from context notes (*continued*)

	PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Luxembourg (9 institutions)	Principal actors in public research (4)	Centres created under law of 9 March 1987 (the <i>centres de recherche publiques</i>)	2 centres with public focus, 1 centre with stronger industry focus	Clear sector and field focal points	Strengthening economic and social tissue of Grand Duchy of Luxembourg. Creation of new technological skills and transfer of know-how to companies. Address societal medical challenges and promote public health.
				Basic and applied research, and development activities Pre-clinical and clinical research Certification/standards Training Data collection Policy advice to government	
		Centre created under law of 10 November 1989	Public	Applied research Data collection and analysis	Undertake economic and social science research.
	Minor actors (5)		Public	Basic and applied research Surveillance and certification activities Scientific infrastructure	
			More general purpose Field-specific		
Netherlands (over 110 research entities)	Research institutes of the Netherlands Organisation for Scientific Research (NWO) (9)	Public	Theme-specific	Basic and applied research Managing major national research facilities & gateway to international facilities for Dutch research Providing laboratories Developing new technology	To improve the quality of research and to initiate and encourage new developments in the field of research. Knowledge transfer for the benefit of society.
	Institutes of the Royal Netherlands Academy of Arts and Sciences (KNAW) (17)	Public	Theme/field-specific	Scientific research Collect and maintain scientific collections and make them available to others	To improve the quality of science to contribute to the cultural, social and economic development of society. Advocating the interests of the scientific community.
	Business units and centres of expertise of TNO (Netherlands Organisation for Applied Scientific Research) (49)	Public and industry-oriented goals	Theme-specific	Applied research	The application of scientific knowledge with a view to strengthening the innovative capacity of business and government.

Table 3.1. Missions and orientations – evidence from context notes (continued)

	PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Netherlands (continued)	Large Technological Institutes (GTIs) (4)	Public and industry-oriented goals	Theme-specific	Applied research Advisory tasks	To develop technologies for the business and public sectors.
	Agricultural research institutes under the DLO Foundation (8)	Public	Field-specific	Fundamental research Research for policy making	To conduct application-oriented and applied research commissioned by government, business life and non-profit organisations.
	Governmental institutes under various Ministries (13+)	Public	Policy-specific	Policy-relevant research Disseminating knowledge	Promote co-operation and collaboration between research institutes and business enterprises in areas of importance to the economy and society.
	Leading Technological Institutes (LTIs) and Leading Social Institutes (12)	Public and industry-oriented goals	Theme-specific	Applied research	Promote scientific excellence and engage companies in application of new knowledge.
Other institutes					
New Zealand (8 institutes)	Crown Research Institutes	Institutes have both public and industry-oriented goals	Sector-specific	Basic and applied research Supply of science-based public-good services to government (e.g. health surveillance) Informing public policy	Legally required to undertake high quality and ethical research for the benefit of New Zealand while running a sound business and exhibiting a sense of social responsibility. Other aims/functions include: <ul style="list-style-type: none"> - Conducting research near to areas of sector activity, via regional centres. - Improving conditions for transfer of knowledge at applied end of spectrum. - Serving as key repository of strategic scientific knowledge and skills. - Attracting and supporting human capital.

Table 3.1. Missions and orientations – evidence from context notes (*continued*)

PRI groupings		Mission orientation	Specificity	Type of activity	Main rationale and aims
Norway (127 institutes ⁷)	Government sector	Environment and development research institutes (7)	Sector and field specific	Predominantly applied research	Broadly, to meet specific needs for knowledge and to promote business and regional development. Other aims include: - Research for use in policy design - Contribution to research training - Knowledge transfer to industry
		Primary industry research institutes (12) Social science research institutes (24) Other R&D-performing institutions (68)			
Poland (221 institutes)	Business enterprise sector	Technical and industrial research institutes (including medical and health care research institutes) (16)	Sector specific	Predominantly applied research Testing and evaluation Importer of international technology	Broadly, to meet specific needs for knowledge and to promote business and regional development. Also: - Contribute to researcher training - Assist SMEs with low levels of R&D and small budgets
	Institutes of the Polish Academy of Sciences (77)	Currently a public focus	Predominantly general purpose	Mainly basic research	To carry out R&D, disseminate results and transfer to the economy. New legislation will allow institutes to be engaged in tertiary education and postgraduate training.
	Government R&D institutes with Ministry oversight: Research institutes (formerly "branch R&D" institutes) (130)	Currently an industry focus	Predominantly sector-specific	Development and applied research Laboratories for measurement and testing Provision of information services	To carry out R&D geared towards practical aims and practical implementation. New legislation will allow institutes to engage in other S&T activities such as measurement and standardisation, calibration and education.
	Other institutes subordinated to Ministries (14)	Public	Specific	Some research into cultural and social topics	

7. Norway: This counts institutes within their parent institution separately, e.g. SINTEF counts for several research institutes plus four limited companies. However, centres of excellence and centres of research-based innovation are counted within their parent institution and are not counted separately.

Table 3.1. Missions and orientations – evidence from context notes (continued)

	PRI groupings	Mission orientation	Specificity	Type of activity	Main rationale and aims
Russian Federation (over 1 400 institutes ⁸)	Institutes of the academies of sciences having state status	Predominantly public missions		Mainly basic research Applied research, including in area of state management	Ensuring the functions of state management and satisfying the needs of society, through research and research support.
	Research organisations subordinated to federal ministries and agencies			Basic and applied research Information and analytical support to activities of federal ministry/agency	Research institutes of state academies of sciences also contribute to training research staff.
	Budgetary science foundations			Funding Infrastructure provision	
Spain (more than 150 research centres plus 118 hospitals)	Research centres	Public and industry	Mono- and multi-disciplinary	Basic and applied research	To provide support for the development of national and regional R&D plans and programmes.
	Technological centres	Industry	Sector-specific, and often regional focus	Applied research	To support the research needs of industrial companies.
	Hospitals	Public	Sector-specific	Applied research	To support the health system and private companies related to it.
	Research foundations	Public and industry	Can be general or specific	Basic and applied research	To support research activities across a broad range of activities.
United Kingdom (142 institutions ⁹)	Departmental research bodies	Strong public orientation, although financial imperative is increasing the industry focus	Specific, according to parent department	Applied research and development Providing scientific input related to parent departments' policy, statutory, operational, regulatory and procurement responsibilities.	To provide advice, evidence and services to government and public bodies on policy issues and public services in a range of areas. Maintaining an in-house scientific capacity for emergency or national security reasons
	Research Council institutes		Field-specific	Basic and applied research Statutory obligations (e.g. monitoring)	To promote and support high-quality basic, strategic and applied research and related post graduate training.

8. Russia: This separately counts institutes within their parent institution, e.g. the Russian Academy of Agricultural Sciences counts for 312 institutes.

9. United Kingdom: This includes cultural institutions, such as the British Museum.

Source: Country context notes supplied to the OECD Secretariat.

It is difficult to precisely summarise the information provided by countries in their context notes so as to indicate the current predominant PRI mission orientation, level of field specificity, type of activity and rationale. Countries have presented these details for groups of institutes at different levels of aggregation, and a simple “count” of features overlooks the number and size of institutes within each group. For instance, fewer groups may have an industry orientation, but if these groups themselves have a larger number of (or bigger) institutes, then the weight of institutes with industry orientations may be larger than it appears.

Based on the information provided in the context notes, it appears that broader public-oriented missions may be more common than industry-oriented missions. Ten notes described a majority of institutes as having a strong public focus, while six described a majority as having a mixed public-industry orientation and one had a majority of industry-oriented PRIs. Some countries had a particularly strong public focus; Italy’s PRI groups, for instance, all had a public orientation, while Canada and Russia’s PRIs also appeared to have predominantly public missions. Other countries had particular PRI groups with a clear industry orientation, such as Belgium with its Excellence Centres, Innovation Networks and Collective Research Centres aimed at industry. The focus of PRI groups appeared overwhelmingly specific, that is, most institutes tend to concentrate on particular sectors/industries, research fields, policy domains or tasks, rather than undertaking research across diverse areas.

The survey results provided a snapshot of current research fields in Austria, Italy, Norway and Poland (Box 3.4). The data revealed that “engineering and technology” was frequently a “very important” activity within PRIs’ research portfolios, although the exact pattern of relative field importance differed between countries. The rise of “trans- and multi-disciplinary sciences” was also reflected in the results, with PRIs often regarding it as a very important activity. It is interesting to consider the findings in light of some of the trends and settings already described, in particular:

- Engineering and technology is often regarded as particularly industry-relevant; however, PRIs in both Italy and Norway had strongly publicly-oriented missions, and in Austria, the majority of PRIs had mixed public-industry-oriented missions.
 - While this does not necessarily point to a mismatch between the broad directions given to PRIs and their actual activities, it does highlight that many PRIs are under pressure to deliver research of interest to a wider range of stakeholders. This theme is echoed in Chapters 4 and 5 in discussions of governance, funding and linkages.
- The importance with which engineering and technology is regarded by PRIs does not fully align with the focal fields indicated in national R&D data, particularly government intramural expenditures on R&D (GOVERD). These focal fields were presented in Chapter 2, and give a broad indication of governments’ research priorities. To recall, Table 2.1 showed that medical sciences accounted for the largest share of GOVERD for Austria (almost 40%), natural sciences were the largest in Italy and Poland (46% and 35% of GOVERD, respectively) and agricultural sciences were largest for Norway (23% of GOVERD). Sorting the data by socio-economic objective (Figure 2.14), health accounted for the biggest share of GOVERD in Austria and Italy.
 - The differences in the sample population (*i.e.* the Frascati government sector *versus* the wider RIHR project-defined PRI sector) may partly explain the

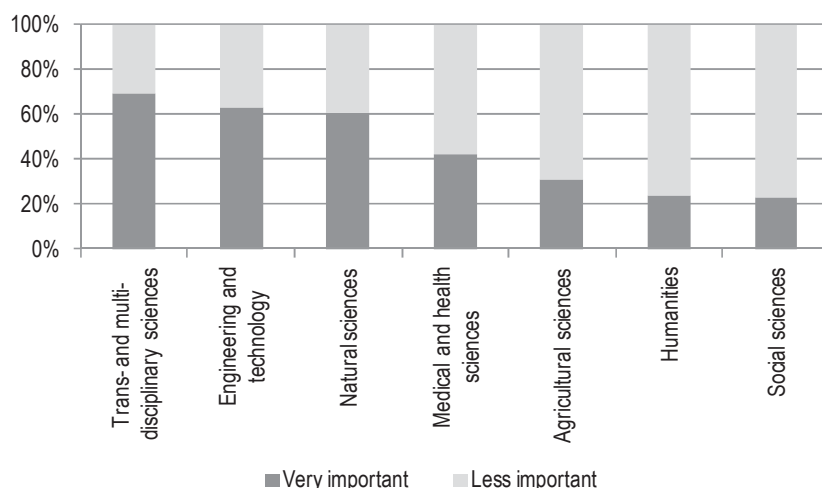
difference between the importance surveyed PRIs give to particular fields of activity and the overall weight of these fields in research activities (as revealed by national expenditures in the government sector). In Austria, for example, using the RIHR definition of PRIs raised the share of funding allocated to technical sciences (engineering and technology) to 42% in 2007, compared with 17% for human medicine (Federal Ministry of Science and Research *et al.*, 2010, p. 173). This accords with the general findings of the data re-tabulation shown in Chapter 2, and further underlines the importance of a clearer understanding of PRI activities for policy making purposes. Differences might also relate to the costs of undertaking research in certain fields (*e.g.* some fields require more expensive materials).

Box 3.4. Fields of science – survey evidence

Surveyed institutes were asked about the importance of the different fields of science that they addressed, focusing on those fields that represented at least 10% of an institute's personnel or financial resources. Responses from Austria, Italy, Norway and Poland showed that where institutes were engaged in the field of “engineering and technology”, this field was frequently noted as a “very important” activity (rather than a “less important” activity). “Natural sciences”, “social sciences” and “trans- and multi-disciplinary sciences” were also commonly considered as very important by institutes with these fields in their activity portfolio.

The exact pattern differed by country; for example, in Austria, “social sciences” and “humanities” were each noted as very important by 65% of institutes with activity in this area, followed by “engineering and technology”, where 63% of institutes considered their activities in the field very important. In Italy, 70% of institutes engaged in “trans- and multi-disciplinary sciences” considered this activity very important (see graph below) – this may reflect the influence of the National Research Council within the Italian sample, with its tradition of interdisciplinarity. Of those institutes with activity in “social sciences”, just over 20% regarded it as very important. In contrast, in Norway, “social sciences” were considered very important by 86% of institutes active in this area (although, if ranked in terms of R&D expenditure, this field would feature less notably). In Poland, “engineering and technology” was considered a very important activity by 82% of institutes active in this area, while “natural sciences” were considered very important by 68% of active institutes.

Italy: Activities in fields of science performed by Italian PRIs



Note: This draws on responses to question 6 (part a) of the survey. Response rates for this question: Austria: 93%; Italy: 71%; Norway: 90%; Poland: 98%. Statistics for Slovenia not supplied.

Source: Survey reports supplied to the OECD Secretariat.

Regarding the main types of activities undertaken by groups of PRIs, the country context notes suggested that applied research is a key activity, followed by basic research. Other activities mentioned in the notes included: standard setting, certification, surveillance and similar activities; infrastructure provision; development work; data collection; and public policy input. However, these activities are undertaken (or, at least, highlighted in the country notes) to a much lesser degree. This overall pattern was supported by the survey evidence (Box 3.5). Countries that appeared to task their PRIs with a particularly wide range of activities, for example, surveillance of certain sectors or provision of infrastructure as well as research activities, included Japan and Luxembourg. The European Union's JRC also undertakes a diverse range of activities through its seven institutes (and their composite research facilities and laboratories), in line with its mission to support a wide range of EU policy areas.

At the individual institute level, the case study evidence also pointed to the relative importance of applied research. However, each institute performed a mix of activities, within which some institutes suggested other activities such as consulting and training were just as important as applied research, while others suggested applied research and selected other activities were of a higher relevance than others (OECD, 2010). Diversity existed inside institutes also, between different sub-units. Often institutes appeared rather unique, either due to their combination of activities (*e.g.* Russia's NRNU MEPhI undertaking research and specific training – see Box 3.6), or their characterisation of them (*e.g.* some were described as highly risky, or as long-term, dangerous and extremely costly, while others were described as short-term and dependent on economic cycles).

Box 3.5. Goals and activities – survey evidence

Characteristics of institutes' main missions¹:

Evidence from the survey suggested that PRIs' missions often have multiple goals. In Austria, for example, around a quarter of institutes indicated their main mission had two characteristics, and almost 80% indicated their mission comprised two or more characteristics. Applied research appeared a common characteristic for most surveyed institutes, although its overall importance varied across countries. Providing education and training for researchers was also an important characteristic for some PRIs.

- In Austria, producing basic research was the most frequently noted goal (at 23% of total responses), and two-thirds of institutes indicated it formed part of their main mission. Researcher training received the next highest response. However, applied research-oriented areas together received a larger number of total responses (*e.g.* research oriented to strategic sectors, commissioned R&D for public administration plus commissioned R&D for firms received 31% of responses), indicating that applied research work is a key mission characteristic for the sector. The responses differed by sector; for example, basic research was relatively important for institutes in the Frascati-defined higher education sector, while those in the government and non-profit sectors indicated research to solve societal grand challenges was also an important goal.
- In Italy, basic research was also the most frequently noted goal (around 20% of total responses), but this was closely followed by research oriented to strategic sectors (19%). Adding this latter category to commissioned R&D for public administration and firms suggests applied research is a key mission characteristic for Italian PRIs. Providing education and training for researchers received 13% of responses. Similarly, in Poland, basic research was the most frequently noted goal (16% of total responses), with education and training of researchers in second place with 15%. Together, research for firms, public administration and strategic sectors accounted for 33% of Polish responses.
- In Norway, however, applied research was more clearly the main focus. Providing commissioned R&D for public administration accounted for 18% of total responses, and three-quarters of institutes indicated this was a main mission characteristic. This was followed closely by commissioned R&D for firms and research for strategic sectors.

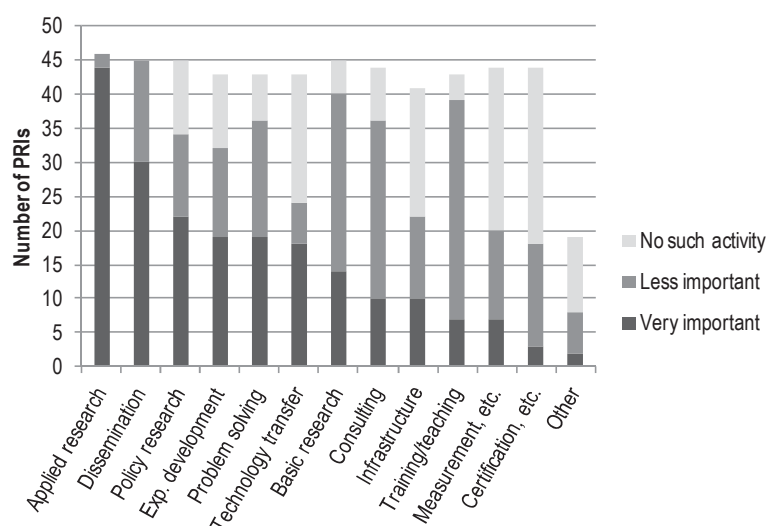
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Box 3.5. Goals and activities – survey evidence (continued)***Types of activities currently performed by institutes²:***

When asked about the importance of various activities currently performed, applied research was ranked highly by institutes in each survey country. For Austria, Italy, Norway and Poland, applied research was the activity most regarded as “very important”; it was also listed in all survey responses in Slovenia. Dissemination of research results to the general public was also a focal activity for many PRIs – it tied with applied research in Austria as the activity most frequently noted as “very important”, and was second in Norway and Poland (see Norway’s results in the figure below). In Italy, basic research and experimental research were frequently noted; dissemination of results was lower ranked, but had seen strong growth in the past decade. The importance of applied research and dissemination is consistent with the trends over the past decade, with increased activity in these areas in each participating country, as noted earlier. Activities frequently noted as “less important” by surveyed PRIs were consulting and training/teaching. A number of PRIs noted they had “no such activity” in the areas of certification and standards setting, provision of infrastructure, and measurement and instrumentation services.

Types of activities performed by Norwegian PRIs

Ranked by importance



Source: Norwegian survey report supplied to the OECD Secretariat.

1. This draws on aggregate country responses to question 2 of the survey. Institutes could choose multiple responses. Response rates for this question: Austria: 96%; Italy: 91%; Norway: 90%; Poland: 100%. Statistics for Slovenia not supplied.

2. This draws on aggregate country responses to question 4 (part a) of the survey. Response rates for this question: Austria: 94%; Italy: 73%; Norway: 92%; Poland: 100%. Statistics for Slovenia not supplied.

Source: Survey reports supplied to the OECD Secretariat.

Box 3.6. Activity mixes – the case of Russia’s NRNU MEPhI

Russia’s National Research Nuclear University – NRNU MEPhI – trains specialists in high-tech fields, particularly for the nuclear industry, and performs full-scale scientific research across various fields of science and technology. Its mission is to guarantee national safety and the scientific priorities of Russia in high technology fields. It was established in 1942 for professional training of personnel capable of working under the Atomic Project. Since 1952, MEPhI has trained personnel and carried out scientific research in the fields of peaceful use of atomic energy, fundamental science and other high-technology areas of the economy.

NRNU MEPhI aims to modernise the system of multi-level professional training and maintain a close integration of science, education and industry. Its most important activities are basic and applied research, experimental development, training and provision of infrastructure. These activities must meet high public requirements, be flexible in response to changing requirements, be delivered across a wide territorial space where university divisions are located, produce world-class performance across a wide spectrum of research areas and effectively integrate science and education. The activities are closely interconnected; training is integrated with the research process, scientific research provides income for the university, creating infrastructure provides a high level of both training and research activity, and research creates conditions for co-operation with other organisations.

Over time, the importance of obtaining world-class results in scientific research has grown, as has directing innovative activity towards realising technical products and technologies. Management of training quality is becoming more standardised and integration with the international education system is more important. A less than optimal structure of educational institutions preparing specialists for the nuclear sector was one driver of changes in MEPhI’s activities, as well as Russia’s economic requirements.

MEPhI’s current activities are carried out according to a Programme of Creation and Development of the university for 2009-17, approved by the Russian Government. This incorporates various indicators, according to which modifications to activities may be made if certain targets are not met.

Source: Case study report on MEPhI (Russia) supplied to the OECD Secretariat.

The basic rationale and aims of the groups of PRIs described in the context notes were many and varied. The exact wording differed from country to country, but general themes can be discerned. Goals around supporting the growth and productivity of industry were the most mentioned, followed by conducting research of benefit to society and conducting policy-relevant research and helping solve policy challenges. Supporting regions, enhancing links between science and industry, and promoting or transferring knowledge and technology were the next most commonly mentioned aims. Supporting top quality research and supporting human capital/education and training were explicit goals for a number of countries. Other rationales, such as assisting SMEs, promoting industry collaboration and networks, and promoting women’s participation in research, were noted by several countries including Austria, Belgium, Japan and Norway. New Zealand and the United Kingdom explicitly mentioned the need for PRIs to function as a repository of skills and knowledge, on which the government could draw in emergency situations or use in the context of national security issues. The European Union also noted the role of the JRC as a reference centre of science and technology for the Union.

Few countries commented on a rationale for their PRIs with respect to observed market failures or other issues. The United Kingdom noted that the roles of its PSREs are associated with a requirement to “deliver a strategic research capability required by the Government that is not readily provided by the market”. National investment in these institutes is justified in part by a market failure in the provision of scientific research. Australia stated that its PRIs deliver research capacity in high-value areas where it is not readily provided by the market. Norway commented that it too has a market failure rational for national investment in PRIs.

Summary

Changes in the organisation and governance of PRIs, and the appearance of PRI-like entities in the business, higher education and non-profit sectors, highlight the need for more country- and institute-level information to support policy making. As part of its project on the transformation of PRIs, the RIHR group compiled information from its member and observer countries via “country context” notes, institutional case studies and an institute-level survey. The resulting picture was one of diversity and ongoing change, along with some common trends in response to shared challenges. This chapter began the exploration of the results, presenting the kinds of institutes countries consider to be PRIs and describing their orientations.

While a project definition of PRIs was provided, countries interpreted this in different ways; treatment of similar entities was not always consistent, reflecting individual country judgements about private versus public missions and other PRI features. The types of institutes that were included by some countries but not others included institutions with a strong cultural focus (such as museums), institutions with important public-service goals (such as hospitals), institutions similar to “pure university research institutes”, and defence research institutions. Civil society institutes were seen as a grey area that could potentially be classed as PRIs. Any future data analysis would benefit from strong agreement on a desired approach to these entities.

The evidence collected from countries suggested that the focus and targets of many PRIs have undergone change in recent years. Some countries noted explicit changes in the missions and mandates of their PRIs, driven by changing activities, new policy challenges, and wider economic and political developments. Explicit priority areas for research activities were established in some countries while, more broadly, “excellence” is now a stated goal for many PRIs. Increased openness and linkages have also become a focal point in the activities of many PRIs. Survey evidence suggested applied research and dissemination of research results to the general public were important areas of increased activity for PRIs over the past decade. Fields of activity were relatively stable; where increases were identified, they were often in “trans- and multi-disciplinary sciences”.

The current orientation of the PRI sector is difficult to precisely summarise, as information was provided about groups of PRIs at different levels of aggregation in the context notes. On the basis of the information presented, it appears that broader public-oriented missions are more common than industry-oriented missions. The focus of PRI groups tends to be concentrated, either on particular sectors/industries, or certain fields or tasks. The survey suggested “engineering and technology” was frequently an important activity within research portfolios; this may reflect the wider range of PRIs captured within the RIHR definition. Underscoring the rise of trans- and multi-disciplinary sciences, this field was also commonly regarded as a very important activity. Applied

research in general seems a key activity; other tasks are undertaken (*e.g.* standards setting, provision of infrastructure and policy advice), but these appear to a much lesser degree. The survey suggested PRIs often have multiple goals, usually applied research plus, for example, training researchers. The basic rationale and aims of the PRIs were many and varied; most often goals were related to supporting the growth and productivity of industry, followed by conducting research of benefit to society and conducting policy-relevant research. Few countries commented on a “market failure” rationale for their PRIs.

Notes

1. These institutes were not included in Poland’s survey of PRIs.
2. This reflects responses to question 4 (part *b*) of the survey. Response rates for this question: Austria: 94%; Italy: 73%; Norway: 92%; Poland: 100%. Statistics for Slovenia not supplied. Note that response rates for individual questions, as reported here and elsewhere in the report, represent the percentage of institutes that responded to the survey that answered the question of interest (and not the overall response rate for the survey). Countries’ overall response rates for the survey are reported in Annex 3.A1.
3. This draws on responses to question 6 (part *b*) of the survey. Response rates for this question: Austria: 93%; Italy: 68%; Norway: 90%; Poland: 98%. Statistics for Slovenia not supplied.

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Annex 3.A

Characteristics of PRI survey data

	Austria	Italy	Norway	Poland	Slovenia
Timing	Oct.-Dec. 2010	Dec. 2010-Jan. 2011	Jan. 2011	Dec. 2010-Jan. 2011	Nov. 2010-Jan. 2011
Sample	560 institutes, following RIHR project definition ¹	250 institutes	57 institutes (within the Norwegian “research institute” sector ²)	216 institutes ³	15 institutes
Coverage of sample	100% of population discussed in the Austrian country context note	100% of population discussed in the Italian country context note	45% of population discussed in the Norwegian country context note (representing 80% of R&D in the sector)	Over 95% of population discussed in the Polish country context note	<i>(Country context notes were submitted prior to Slovenia becoming a member of the OECD)</i>
Mandatory	No	No	No	No	No
Who conducted the survey?	Joanneum Research, via on-line survey tool “Surveymonkey”	IRPPS-CNR (National Research Council)	NIFU	Ministry of Science and Higher Education	Ministry of Higher Education, Science and Technology
Response rate	32% (176 responses)	45% (113 responses)	88% (50 responses)	47% (103 responses)	47% (7 responses)
Extrapolation	No	No	No	No	No
Country comments	199 answers were received, but those answering no more than two questions were discarded. Possible bias due to higher response rate from Academy of Sciences institutes (basic research focus). Around 25% of responses were from temporary institutes.	Questionnaire was translated into Italian. Sample was mainly representative of CNR (National Research Council), a general purpose research institution (basic and applied research across many fields).	Considered to provide good quality information.	Target population was Polish Academy of Sciences institutes, Research Institutes and those “other governmental institutes” extensively carrying out research.	Responses may be influenced by current preparation of national strategies on higher education and research. Target population was Frascati-defined government sector.

1. The Austrian institutes included in the survey were drawn from all Frascati sectors.

2. The Norwegian statistical classifications differ from the Frascati classifications, with only three research-performing sectors (higher education, industrial, and research institute). The research institute sector includes institutes strictly oriented towards research as well as those conducting a lesser amount of research activity. The survey concentrated on those institutes within the research institute sector whose primary activity was research; these institutes are defined as those that are subject to the Norwegian guidelines for government core funding of research institutes.

3. Poland's non-university research institutes comprise five main groups: Polish Academy of Sciences Institutes; government R&D institutes subordinated to ministries (“research institutes” under the Act on Research Institutions); institutes acting as business firms and owned by the State Treasury; other government institutes acting exclusively on the basis of internal ministerial regulations; and non-profit institutes that receive a majority of funding from government. There are additionally two institutes that operate under state regulations (the National Bank of Poland's Institute of Economics, and the Institute of National Remembrance). The survey was sent to Academy of Sciences institutes, research institutes, and selected other government institutes.

Source: Survey reports supplied to the OECD Secretariat.

Chapter 4

Operational features of public research institutions – trends and arrangements

Organisational arrangements, governance arrangements, funding and human resources continue to evolve in response to changes in PRIs' goals, linkages and environments. The evidence described in this chapter points to numerous examples of structural changes to institutes, often including more industry involvement, and wide variance in PRIs' "distance" from government. Nevertheless, governments continue to exercise important influence, via high-level strategic direction, supervisory arrangements, funding and performance contracts. Funding is increasingly diverse, with more competitive channels. Human resources remain major inputs to PRI activity.

This chapter continues to present the findings from the OECD Working Party on Research Institutions and Human Resources' (RIHR) country context notes, case studies and survey (methodology and participation is described in Chapter 3). It focuses on four aspects of PRIs' "operational features", namely organisational arrangements, governance arrangements, funding and human resources. It describes changes that have taken place in recent years, identifies some of the drivers behind notable trends, and provides some examples of current arrangements. It also highlights challenges that were raised by countries in relation to PRIs' operational features.

Organisational arrangements

Countries have been very active in creating and modifying players in their PRI sectors. Numerous examples of structural changes to institutes were detailed in the country context notes, including mergers, reorganisations and changes in status, the establishment of new centres and the creation of new types of centres. Responses to the survey showed that organisational structure had been the most significant area of change in institutes in the past decade in Austria, Italy, Norway and Poland.¹ Growth in institutes, mergers and bigger research groups were common; few institutes in these countries indicated reductions in their size or scope. In Austria, for example, only 6-7% of institutes noted a reduction in the size of their research groups or the number of scientific fields covered, or a move to break up into several institutes. Similarly, in Italy, 12.7% of responses indicated larger research groups, while only 3.2% indicated smaller groups.

Changing goals and rationales in the PRI sector may have played a key role in driving organisational changes in institutes. In the survey, new strategic orientations were identified as the most significant driver of change by PRIs in Austria, Italy, Norway and Slovenia (although further institute-level data analysis would be required to explicitly link this driver to the identified change in organisational structures). The country context notes further highlight the link between PRI goals and organisational arrangements. Several countries noted that more emphasis is being placed on the quality and relevance of PRI research activities and their contribution to improving the innovative capacity of the country. Finland, for instance, has highlighted the importance of a stronger customer-based perspective, which has led to the creation of new centres of excellence whose funding is based more extensively on the basis of industrial needs.

Organisational change has also been spurred by a trend towards increased openness; PRIs are being encouraged to forge more linkages, notably with industry and across international borders (linkages and internationalisation are discussed in Chapter 5). In some instances, such co-operation might lead on to the creation of new entities. For example, Norway noted that many state university colleges and regional research institutes have established joint companies for commissioned research. Related to this, increasing responsiveness to market demands has also led to some changes in organisational characteristics (OECD, 2010a). Budget pressures can generate further change, as governments seek efficiencies; more generally, the influence of new public management approaches has encouraged greater autonomy and accountability for research agencies (OECD 2010b, p. 194).

In other instances, a lack of clarity about "who does what" has spurred organisational change. In their context notes, several countries commented that the divisions of labour between institutes have become less delineated and research entities are increasingly competing with each other, despite guidance from legislation, mandates and governance arrangements (Box 4.1). Changes in the PRI environment are effectively blurring the

boundaries between institutes. Funding arrangements (particularly, more competition) appeared to be the biggest driver, mentioned by several countries. This issue will be discussed further in the Funding section of this chapter. Other noted drivers of blurred boundaries were increased linkages and changes in the balance of research activity within the national innovation system. In Austria, for instance, the shareholding position (and associated participation) of permanent research organisations in temporary organisations (for example, the participation of Joanneum Research in competence centres) was thought to have lessened clarity. Korea noted that the increase in research activity at universities and in industry had led to discussions about the appropriate role of PRIs. However, not all countries were concerned; the United Kingdom noted that its Research Council Institutes aimed not to duplicate the research missions of higher education institutions or industry and sought to complement the skills and facilities provided in British universities.

Box 4.1. Division of labour between institutes – evidence from context notes

For some countries, the division of labour between PRIs is fluid, driven by PRI missions and functions and by research agendas. For instance, Russia noted that the division of labour between its PRIs (or state scientific organisations in Russian terminology) is first of all defined by their missions and their position within the framework of the managing institutions that fund R&D. In Spain, the national- and regional-level R&D&I Plans provide general divisions of labour for each type of public research institute in terms of theme, although funding flows may not maintain this clarity since most activities are supported by competitive calls.

Nevertheless, some countries appear to have an explicit division of labour set out in national legislation. In Italy, for example, Law 168/89 regulates the division of labour between public research agencies. This law subdivides the system into several categories, notably “non-instrumental institutions” which focus on research and “instrumental institutions” which have other specific tasks. Italy noted that the system is highly complex and is subject to an ongoing process of rationalisation. Finland also noted that its public research institutes have their roles based on law and that functions are defined during the foundation of individual organisations. For Finland, organisational divisions of labour are also implicitly guided by the system of establishing institutes on a sectoral basis to serve the sectoral needs of their parent Ministry. Luxembourg noted that the missions and domains of activity of its *Centre d’Etudes de Populations, de Pauvreté et de Politiques Socio-Economiques* were specified by law, since this centre was not created next to an existing organisation (in contrast to the *centres de recherche publics*) and there thus needed to be more explicit guidance on the exact role of the centre.

Other countries have particular governance arrangements that set out divisions of labour and functions of various players in the system. For example, in Chile, policy on innovation for competitiveness is drawn up by the Ministerial Committee for Innovation (*Comité de Ministros para la Innovación*), in line with recommendations from the National Council on Innovation for Competitiveness (*Consejo Nacional de Innovación para la Competitividad*). At the implementation level, the National Commission for Scientific and Technological Research (CONICYT – *Comisión Nacional de Investigación en Ciencia y Tecnología*) focuses on science and technology policies, while the Economic Development Agency (CORFO – *Corporación de Fomento de la Producción*) promotes business innovation and entrepreneurship. There is also the Millennium Scientific Initiative (ICM – *Iniciativa Milenio*), which finances research centres of excellence, and the Foundation for Agricultural Innovation (FIA – *Fundación para la Innovación Agraria*), which is responsible for promoting and developing a culture of innovation in the agricultural sector.

Source: Country context notes supplied to the OECD Secretariat.

As a result of ongoing changes, current PRI organisational arrangements are many and varied. Few issues were raised regarding future organisational arrangements and structures; in the survey, only Austria noted organisational development as a challenge for the next five years (see Chapter 6). Nevertheless, some challenges were noted in the case studies. For example, one PRI noted that having a large number of institutes could be an obstacle to efficiency if critical mass is low and institutes have difficulties in competing for projects, equipment and administrative support. A large number of institutes can also put pressures on central administrative bodies, with burdens falling both on institutes and the administrative units. In this case, there may be more urgent impetus for change to organisational structures. For most PRIs, however, it is likely that organisational structures will continue to evolve in response to changes in the environment.

The following sub-section discusses some of the main structural changes that have taken place in recent years, as described in the country context notes and case studies.

Structural changes in PRIs

It can be difficult to clearly delineate the types of changes to institutes, since in many instances multiple changes are occurring at the same time (for instance, a merger might create a new type of institute). The following discussion encompasses a variety of structural changes, including the appearance of new institutes, new types of institute, and mergers and reorganisations.

In their context notes, countries pointed out many examples of new institutes in their PRI sectors. For instance, Austria established a new permanent institute (ISTA) in 2006, aimed at high level basic research, with an intention to expand the institute to 50 research groups with more than 500 scientists by 2016. Belgium highlighted the creation of three large institutes, one of which was new (VIB) and two of which resulted from organisational change (IBBT and VITO). Canada pointed to the Canada Foundation for Innovation, initiated in 1997, which is an independent corporation created to fund research infrastructure, and Genome Canada, established in 2000, which is a non-profit organisation that is mandated to develop and implement a national strategy for supporting large-scale genomics and proteomics research projects. Italy highlighted the creation of new institutes such as the National Institute of Metrological Research and the Italian Technology Institute, which aimed at accelerating the growth of scientific and technological capacity and promoting collaboration among groups. The European Union noted the establishment of two new institutes within its JRC – the Institute for Health and Consumer Protection and the Institute for Prospective Technological Studies. This was in response to pressures to deal with new issues (such as dioxin contamination) and new policy challenges involving both scientific and socio-economic dimensions. Over time it has also created new laboratories and testing facilities.

Regarding new types of centres, there appeared to be more institutes with business-like operational models. For example, Austria highlighted the introduction of some new organisational forms within its permanent research institutes, notably some limited companies that had a more business-like organisation. It also noted a trend towards creating temporary institutes, which had resulted in a highly diverse group of institutes with a “fine-grained differentiation”. Japan noted the transition of its inter-university research institutes to corporate status, with a view to enhancing their independence and autonomy as well as revitalising their activities. Corporate status has also been made more attainable for Japan’s public service corporations. TNO in the Netherlands adjusted

its organisational structure into business units and centres of expertise, so as to enhance collaborative efforts and strengthen relationships with universities and companies. In Poland, legislative change regarding “branch R&D” institutes (now “research institutes”) has enabled restructuring of the sector and will allow institutes to establish capital holdings, acquire shares and bonds in entities in order to commercialise research results, and to conduct economic activities other than their statutory ones. The United Kingdom described moves to allow PSREs to obtain “trading fund” status, which is a change to their legal status that enables them to take more responsibility over their financial arrangements and sustainability and enables operations to resemble the private sector more closely than under pure government ownership.

Similarly, in Spain, a number of “foundations” have been created to support research activities. These entities have greater operational flexibility, lower administrative constraints and higher reactivity to technological challenges and social demands than public research centres. Most of Spain’s centres of excellence have been created as foundations, and the structure can be found in each of the broader categories of PRIs in Spain (research centres, technological centres and hospitals). In addition, in an effort to provide greater autonomy and administrative flexibility to national institutions undertaking research and other activities, Spain introduced a Law regulating the creation of national agencies. This has transformed the Spanish National Research Council (CSIC) into a research agency.

In terms of direct industry involvement, public-private partnerships (P-PPs) have emerged in some countries. In Austria, for example, the Christian Doppler Research Association changed its organisational form to a P-PP in 1995, thus opening its activities to all enterprises with R&D activities in Austria (Box 4.2). Technological or research consortia have also been created in several countries, for example, in Chile and New Zealand. Similarly, Norway’s Research Council established 14 centres for research-based innovation (SFI) in 2007, focused on long-term research conducted with research-intensive companies and funded for an 8-year period. Host institutions and industry partners are required to contribute a comparable amount of funding to the Research Council. The Netherlands introduced a new category of research institutes in the late 1990s, in the form of P-PPs – these Leading Technological Institutes were established to promote co-operation and collaboration between research institutes and businesses, and have recently expanded into the area of social priorities (in particular, urban research, ageing, and internationalisation of legal systems).

Box 4.2. Public-private partnerships – the case of Austria’s CDG

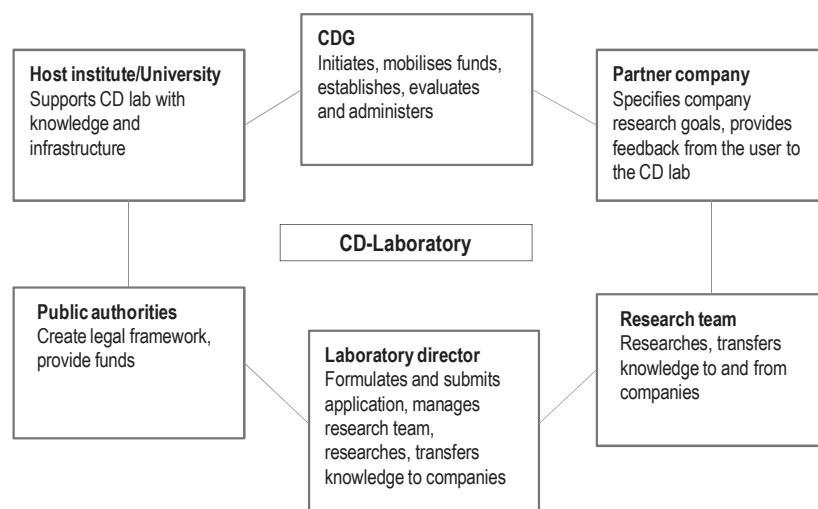
The Christian Doppler Forschungsgesellschaft (CDG) in Vienna, Austria, is a non-profit association aimed at promoting R&D in areas of natural science, technology and economics. It focuses on application-oriented basic research and aims to strengthen co-operation between science and industry. CDG’s history began in 1988, when the first CD laboratories were founded to bridge the gap between researchers performing basic research in academic environments and researchers in Austrian State-owned industries transferring basic research into application. At the time, the State-owned industries were seen as suffering from deficits in research and innovation activities that could result in new products and processes. CD labs were embedded in universities and funded by the State-owned industries, and were seen as a focal point within the academic world for basic research with potential application features.

.../...

Box 4.2. Public-private partnerships – the case of Austria’s CDG (continued)

Funding for CD labs became difficult in the early 1990s due to problems within the State-owned industry sector. At the same time, weaknesses in industry-science linkages were attracting government attention. Addressing both of these issues, in 1995 the federal government reorganised the CD labs as a public-private partnership (P-PP) for research collaboration, and made it possible for private companies to play a role in their creation and activity. This solution was considered of the right “size” (compared to an alternative “Fraunhofer model” based on German experience) and also suitably focused on detailed demand from industry. Setting up CD laboratories is now based on a “bottom-up” principle, such that any thematic field may be covered if there is a demand from industry for high-quality research and if it meets evaluation against scientific criteria. Industry funding (of 50%, or less for SMEs) provides an incentive for application-oriented research, while public funding allocations (a further 50%) on the basis of scientific excellence provide an incentive for frontier research. Labs are set up for seven years.

The incentive structure for CD labs demands a relatively complex organisation and governance structure (roles are depicted below). The Christian Doppler Association acts as the intermediary between funders and labs; it manages funding, and organises the establishment, evaluation and support of labs. Steering bodies within the Association have mixed private-public membership, for instance, at least eight of the 13-20 members of the General Assembly are elected by the partnering companies, while other representatives are nominated by the Ministry of Economy, Family and Youth, represent other government agencies, or represent research areas. CD labs are not legal entities in themselves, but use the hosting university’s legal status and infrastructure to perform administrative (e.g. payroll) and research functions. Once a lab is selected, the decisions about use of funding are in the hands of heads of laboratories, who prepare annual budget plans based on their research programme (itself based on industrial partners’ interests).



The P-PP model is seen within Austria as reasonably successful. Laboratory numbers have increased and the range of thematic research areas has broadened. Firms regard the model as a good opportunity for SMEs to participate in stable collaboration and access global state-of-the-art research, while government representatives consider the incentive structures, funding and scientific results to be adequate. Firms have the option of quitting the collaboration each year, and public funding is drawn on the basis of private contributions and evaluations of scientific excellence at the two- and five-year mark. The interests of scientists are considered, with a rule guaranteeing 30% research time for basic research and time allocated for scientific publication.

Source: Case study report on CDG (Austria) supplied to the OECD Secretariat.

Types of “excellence centres” also seem to have emerged strongly in recent years. For example, Belgium noted the introduction of excellence centres in 2001, and Finland’s Strategic Centres of Excellence for Science, Technology and Innovation were established in 2006. Chile’s Basal Financing Programme for Centres of Scientific and Technological Excellence (*Programa de Financiamiento Basal para Centros Científicos y Tecnológicos de Excelencia*) had allocated funding to finance eight centres of excellence by the end of 2007. As part of reform activities begun in 1999, Italy established centres of excellence with both public and private involvement in order to bring science and the market closer together. New Zealand established a Centres of Research Excellence Fund in 2001, to encourage the development of collaborative world-class research. The centres are hosted by universities and comprise a number of partner organisations including other universities and Crown Research Institutes (CRIs). Norway’s Research Council granted 13 “knowledge circles” status as centres of excellence in 2002, with 8 further centres established in 2007. These centres, focused on basic research, are hosted by research institutes, firms or universities and are funded for a 10-year period. In 2009, the Council also established eight centres for environmentally friendly energy research, which focus on long-term research conducted co-operatively with prominent research communities and users. Spain noted that several of the best centres of excellence had been created very recently, some with private partners or founders.

Countries have made use of mergers and reorganisations to better align their PRIs with their environment and tasks. In Finland, such reforms explicitly aimed to make the divisions of labour in the sector clearer, for example, the creation of the new National Institute for Health and Welfare (Box 4.3) and the split of the Finnish Institute of Marine Research. Other goals were to improve productivity and effectiveness and increasing the innovativeness of research. A notable reorganisation was undertaken by Denmark, which decided to integrate government research institutions into its universities. As of January 2007, 25 government research institutions and universities were reduced to a total of 11 institutions, and nine government research institutions were integrated into universities, in the form of faculties, departments or professional units (see Chapter 6 for details of an evaluation of this reform). Japan also described reasonably extensive consolidation and reorganisation of institutes, with a number of institutes transitioning from one type of entity to another. Part of this was spurred by reorganisation of government ministries, seeking to separate policy making from implementation activities. In this regard, Japan noted that in 2001, 57 national testing and research institutions were transitioned to independent administrative institutions, and were later consolidated to 34 institutions. It is planned to rationalise a further 16 independent administrative institutions into six, once laws concerning corporate establishments are revised. Further examples of mergers and other structural changes to PRIs are discussed in Box 4.4.

Box 4.3. Merging PRIs – the case of Finland’s THL

Finland’s National Institute for Health and Welfare (THL) is a R&D institute under the Finnish Ministry of Social Affairs and Health. It works to promote the well-being and health of the population, prevent diseases and social problems, and develop social and health services. It is also a statutory statistical authority in health and welfare and maintains and provides a large knowledge base within its field. THL was formed on 1 January 2009 through the merger of the National Public Health Institute (KTL) and the National Research and Development Centre for Welfare and Health (STAKES). The history of KTL began in 1911, when it was established as a laboratory to prevent the transmission of syphilis. Its role developed over time; its most recent mission was to survey and monitor the health of Finnish people as well as conduct research, plan and carry out actions contributing to the health of the population through disease prevention and health promotion. STAKES was formed in 1992 following the abolition of the National Agency for Welfare and Health. Its mission was to promote the welfare and health of the population and develop social and health services, as well as evaluate the outcomes of welfare policy and assess changes affecting welfare and health.

The merger between KTL and STAKES was based on the results of a 2007 administrative study. The aim of that study was first to evaluate the division of labour and the developmental needs of the public research entities and other public officials that were steered by the Ministry of Social Affairs and Health, and second to reorganise and rationalise the sectoral research conducted by the Ministry. The study considered that the operations of KTL and STAKES were partly overlapping – both had the key objective to serve municipalities in developing their health and social services through expert guidance and monitoring – and that customers, in particular, were unclear about the entities’ roles. The study also judged it ineffective to have information systems, national research data and register data in two separate organisations. By fusing the two entities, issues of division of labour and co-operation would be removed. In addition, aggregating the critical mass and interdisciplinary competencies in a bigger entity would contribute to improved productivity, effectiveness and innovativeness of research. This would help to create a nationally and internationally strong research centre in the field of welfare and health. Nevertheless, the arguments presented in the study have received some criticism from case study participants, for example, whether claims of unclear divisions of labour were accurate.

As part of the creation of the new entity, a group of experts scanned all THL activities to identify basic research-oriented competences, as these were seen as functions that should not be part of public research organisation activities. Based on the results, some competences were transferred to universities or other organisations, while others were closed down. Nevertheless, the division between basic and applied research is blurry in many THL departments, and basic research activities were viewed by case study participants as providing a good competence base and a source of research subjects. Under the THL mission, any basic research carried out at the institute must serve the needs of application-oriented research and the needs of a variety of customers.

THL emerged from the merger with nine strategic priority areas; however, there was only limited time to establish THL’s strategy. A systematic foresight process was carried out late 2009 and early 2010 to generate a vision of key areas where THL could make a difference. It has now established a vision for 2015, as follows:

- THL has considerable impact on improving welfare and health in Finland.
- THL is a key actor, a reliable expert and a valued partner in the protection and promotion of health and welfare.
- THL offers an inspiring, responsible and attractive work community.

Source: Case study report on THL (Finland) supplied to the OECD Secretariat. Finland notes that internal and external evaluations were carried out subsequent to the completion of the case study.

Box 4.4. Structural changes – further examples from country context notes

There are also some new centres in the private non-profit area. For example, Canada's consolidation of three leading forest sector research institutes has created the world's largest private non-profit forest research institute, which brings together stakeholders from the private and public sectors and academia.

Countries also described some examples of new organisational models. Canada highlighted its Chemical Biological Radiological Nuclear and Explosives (CBRNE) Research and Technology Initiative (CRTI) Program that was initiated in 2001 and brings together 21 federal government departments and agencies to enhance Canada's capability and capacity to respond to CBRNE threats to public security. Canada noted that this new model had provided new opportunities for knowledge sharing across organisations and disciplines. Similarly, Norway noted the establishment of the Oslo Centre for Interdisciplinary Environment and Social Science as an organisational framework for the co-ordination of R&D activities within nine research institutes and university departments.

Other examples of mergers and reorganisations were also presented by countries. The merger in 1997 of Austria's ARC with Arsenal Research created a large P-PP. Belgium commented that the new Better Administrative Regulation of the Flemish Government had led to adaptation in its scientific institutes, with mergers, splits and reorganisations taking place. Norway described the reorganisation of industry-oriented research in the area of agriculture and fisheries that took effect in January 2008 and which brought together all activities carried out by four former research institutes. The merger/reorganisation aimed to increase the competitiveness of the fishery and aquaculture industry and the land and sea-based food industry. New Zealand noted that only one merger had taken place in the past 15 years, namely a merger between the two CRIs involved in horticulture and cropping research. This was driven by increasing strategic synergies. Russia noted that there had been some restructuring of its network of research organisations between 2000 and 2006, led by the Interdepartmental Committee on optimisation, restructuring and increase of efficiency of scientific organisations. Reductions mainly affected research organisations subordinated to federal ministries and agencies.

Finland was the only country to particularly highlight privatisation of certain PRI activities. The privatisations were principally carried out in the sector of the Ministry of Labour and Employment and included, for example, the chemical analysis services of GTK.

Austria noted a strong trend towards regionalisation in the PRI sector, with several new institutes being established on a regional basis with funding streams coming from the federal states (Länder). The foundation of Salzburg Research in 1996, Carinthian Tech Research in 1997 and Upper Austrian Research in 2000, are examples of this trend. Spain suggested that the biggest change in the last 15 years in the Spanish R&D system has been the increasing participation of the Autonomous Communities (regions) in the system. Regional governments develop regional R&D plans, which set priorities and influence the organisation of the sector and its interactions, and play an important role in funding.

Source: Country context notes supplied to the OECD Secretariat.

In their context notes, a few countries commented on the change of weights of different entity types. Austria noted that the temporary institute sector has grown to almost the size of the permanent organisations classified in the business sector, in terms of public R&D expenditures. Poland noted that, since the mid 1990s, there has been a decline in the total number of institutes, with a decline in Polish Academy of Science institutes and a large decline in branch R&D units (now "research institutes", under recent legislation). In terms of share of the science budget, institutes of the Polish Academy of Sciences have stayed fairly static, while higher education institutes have increased their share at the expense of branch R&D units. Russia described an overall decline in the total number of R&D organisations from 2000 to 2006; at the sectoral level, the government sector saw an increase in institutes, the business enterprise sector

experienced a fall in the number of institutes, higher education institutes were essentially the same, and private non-profit institutes increased slightly in number. In the Netherlands, the number of institutes under the direct responsibility of Ministries has declined since the late 1980s, with some coming under the oversight of the Netherlands Organisation for Scientific Research (NWO) or the Royal Netherlands Academy of Arts and Sciences (KNAW) and some moving to universities. In contrast, the relative position of groups with an intermediary role between science, government and industry has strengthened.

Institutional arrangements

Similar to the variety of organisational forms adopted by PRIs, the country context notes revealed cross- and within-country diversity in PRI institutional/governance arrangements. Legal forms, lines of authority and internal structures came in many varieties, depending on the range of types of PRIs and their organisational forms. The case studies further highlighted this variety; internal organisational structures included divisions with sub-units, matrix arrangements, branches and departments, and networks, and legal arrangements included institutes with no independent legal status through to independent foundations (OECD, 2010a). Perhaps reflecting the views of many countries, the United Kingdom noted that given the breadth of activities in which its PRIs are involved and the heterogeneous nature of the sector, there can be no “one size fits all” governance arrangement.

For the most part, besides changes associated with the introduction of more business-like structures, changes in recent years have involved new decision-making bodies or revisions to supervisory arrangements. However, some countries experienced more systemic change (see the example of Poland in Box 4.5). Notable trends and current arrangements in the institutional/governance frameworks for PRI sectors are described in the sub-section below, with information around the themes of high-level direction, oversight and supervisory arrangements, and performance and steering mechanisms.

Few countries identified particular challenges for the future with respect to institutional arrangements. Rather, the focus in the coming years is likely to be a continuing search for optimal steering and governance arrangements that achieve goals (such as research excellence and supporting the growth of industry) within a constantly evolving environment. One issue that was raised in this regard was the complexity of setting direction within a multi-stakeholder environment. For instance, Finland discussed the challenge of implementing a system of horizontal and network-based governance that takes into account the cross-sectoral set of services provided by PRIs and the range of stakeholders that do (or should) have a voice. Within its advisory board for sectoral research, Finland has placed priority on developing mechanisms to enhance horizontal steering. The aim is to recognise societal research needs and to combine sectoral and horizontal target setting in the same strategy process to create common visions. Spain’s issues with duplication between national- and regional-level research activities (see the Funding section of this chapter), also highlight the challenges in setting priorities for steering and governance purposes in a multi-level environment. Another issue, raised in the case studies, was the challenge of effectively transmitting strategic directions from (often small) decision-making bodies to decentralised and dispersed research groups whose activities are influenced by project funding from external sources. As was seen in Chapter 3, while PRIs as a group often have predominantly public missions, they place high importance on industry-relevant areas of research.

Box 4.5. Institutional change in Poland

The Polish PRI sector has seen extensive institutional change, as Communist structures for research and development were unwound after 1989. The changes led to an increase in autonomy for institutions and a degree of competition for research funding. Paradoxically, the increase in scientific independence, peer-reviewing and competition for research grants reinforced existing choices and priorities, and the largest and most prestigious groups of researchers prior to 1989 remained influential. As well as a strengthening in “old boys’ networks”, changes also led to a drop in project funding and a shrinking share of applied research. Nevertheless, there were positive impacts, including a reallocation of funding from the Academy of Sciences and branch R&D institutes (now “research institutes”) to universities, the creation of business and innovation infrastructure, the strengthening of international contacts, and the development of co-operation between Academies of Sciences, ministerial departments and bodies and universities.

Restructuring of R&D units was also necessary, due to a decline in public spending and a fall in demand for domestic industry R&D. Coupled with the “survival strategy” mentality adopted by organisations, this resulted in the R&D system contributing minimally to economic growth. Changes took the form of cost reduction, rationalisation of organisational structures and management, and modification and expansion of production and services. In the last 10 years, restructuring and transformation has been ongoing. For instance, since 2001 there have been 22 major changes to Polish Academy of Sciences (PAS) institutes – in most cases, abolished institutes were incorporated in existing ones or opened under a new name and mission. As a result of mergers, the number of PAS institutes decreased by nine between 2001-09. Change was more intense in the government research institute sector (the former branch R&D units). For example, between 2002-10, the number of these institutes fell by 48 as a result of mergers, and between 2004-10, 20 institutes were transformed into limited liability firms or joint stock companies owned by the State Treasury. Of these 20 institutes, one has since been incorporated into a large Polish company, one has been privatised and transformed into an employee-owned company, and three have been listed for privatisation.

In recent years, the processes of “Europeanisation” (especially in the context of accession to the EU in 2004) and globalisation, and the spread of ICTs, have also had a strong influence. Policy now seeks to address the science-industry gap, support private business R&D, encourage flexibility and linkages, support international co-operation, enhance the economic and social orientation of the system, increase competitive project funding and increase evaluation activities. Poland noted that “learning by reading” and participation in various EU and OECD processes has helped to modify R&D policies and institutes and to promote legislative change. The research system has also become less inward-looking.

Source: Polish country context note supplied to the OECD Secretariat.

High-level direction

High-level strategic directions play an important role in directing the activities of PRIs. One obvious way that such directions manifest themselves is through initial government decisions on establishing research centres and setting their scope. Austria noted that, for its temporary institutes, ministry steering is first given via the initial decision to create a programme/institution. Similarly, in Denmark, the autonomous, not-for-profit ATS institutes are first given formal approval (the “A” in ATS) to carry out technological services. The approval is valid for three years at a time and depends on a number of requirements related to the institute’s financial, organisational and technical set-up. Technological research associations for mining and manufacturing in Japan are subject to initial accreditation from the minister-in-charge, although subsequent activities are at the discretion of the associations, within the bounds of their articles of incorporation. In Russia, research organisations subordinated to federal ministries and agencies are created, closed or reorganised under the initiative of the corresponding ministry or agency by order of the government.

High-level direction may also be given via objectives, goals and plans that are conceived by governments. For example:

- Chile's high-level direction set for its national innovation system aims to make government, companies, universities and technology centres serve as a dynamic source of growth and competitiveness for the Chilean economy.
- In Italy, the National Research Programme approved by the Interministerial Committee for Economic Programming assigns missions to the Italian scientific system and identifies strategic objectives. Growth and promotion of human capital, excellence and meritocracy in research, multidisciplinary and public-private collaboration are important goals.
- In Japan, the minister-in-charge establishes three- to five-year medium-term goals for independent administrative institutions; similarly, for inter-university research institute corporations, the minister sets a six-year medium-term goal.
- Poland's key steering mechanisms for PRIs are described in the Act of Law on the Financing of Science. They include the National Research Programme, which sets strategic R&D priorities, as well as rules related to funding and evaluation.
- In Spain, the national and regional governments develop National and Regional R&D&I Plans every four to five years, which identify and support scientific priorities, establish the governance framework and guide interactions with stakeholders. The approval of the Law/Act of Science that led to the first National R&D Plan in 1988 was seen as one of the biggest changes in Spanish R&D policy in the last 15 years.
- The EU's JRC has a multi-annual work programme, decided by the European Union Council, which clearly defines themes reflecting a coherent approach to user needs. In some instances, high-level direction has an explicit regional dimension.

High-level advisory bodies were noted by several countries in the context of providing direction to PRIs. For instance, Canada consolidated existing external advisory bodies into a Science, Technology and Innovation Council, whose task includes providing policy advice on S&T issues and producing regular national reports measuring Canada's S&T performance against international standards of excellence. Also, an Advisory Committee on the Canadian Space Agency was created to reinforce the direction of Canada's space programme, with strategic advice provided to the Minister of Industry on the priorities and overall direction of the Agency. Finland noted several bodies that have a role in defining future policies and visions, including the Research and Innovation Council (RIC – formerly the Science and Technology Policy Council of Finland), the centres of excellence, and the Finnish Funding Agency for Technology and Innovation (Tekes). The European Union's JRC is guided by its stakeholders via several routes, including consultations with the Directorates-General of the European Commission, a dedicated interface group with the European Parliament, and the Board of Governors which includes a high-level representative from each Member State. The Board of Governors assists and advises on the role and scientific, technical and financial management of the JRC.

Several countries highlighted the introduction of new governance bodies in their institutional frameworks for the PRI sector. Chile, for example, discussed the consolidation of the framework for promoting science, technology and innovation, with the creation of the National Council on Innovation for Competitiveness and the Ministerial Committee for Innovation. These bodies take decisions that directly influence the activities of Chile's PRIs. For example, the Ministerial Committee selected 11 priority clusters that will receive incremental resources. Italy highlighted some of the changes that have been made to the National Research System during recent reform efforts, that have the aim of establishing an improved organisational structure and improved performance of PRIs. For example, several new governance bodies were created, including the Committee of Experts for Research Policy and the Committee for the Evaluation of Research. Austria is currently reassessing the role and organisation of its two advisory councils (the Research, Technology and Innovation Council and the Science Council) in order to improve overall STI governance (OECD 2010c, p. 83).

At the same time, there are some increased efforts to incorporate “bottom up” direction from industry. In the Netherlands, a new system of “demand-driven steering” is based on the views of government, business enterprises and civil society on the societal needs that call for new knowledge. The “demand for knowledge” is grouped into 12 themes, and is expressed via institutional programmes and funding. Austria noted that the bottom-up principle in the selection of new research topics has been established in many programmes and temporary institutes, with the goals of ensuring excellence and ensuring results are able to be absorbed by industry. Denmark noted that its ATS institutes only develop the skills, services and products that the market demands, as the institutes sell services on commercial and competitive conditions in Denmark and abroad with no financial support from the Danish Government.

However, not all countries have moved to increase industry input. Luxembourg reduced industry involvement, with the creation of the Fonds National de la Recherche (FNR) in 1999. FNR calls for proposals in priority areas and conducts ex-ante evaluations. Prior to this, the dominating factor in choosing research projects had been the involvement of a third party (industry or other) who was willing to contribute money or time to the project. This was argued to indicate project quality and consistency with the national interest. However, this strategy was considered to have led to most projects contributing to the solution of short and medium-term problems, and to a wide spread of projects aimed at industry needs, which was not necessarily consistent with a strategic approach or the development of critical mass.

Oversight and supervisory arrangements

Several countries noted changes to oversight and supervision arrangements; most often this involved moving responsibility between ministries. In Denmark, for instance, the decision of the government to create better links between education, research and innovation led to the political administration of its ATS institutes moving from the Ministry of Economic and Business Affairs to the Ministry of Science, Technology and Innovation, which also administers the public research system and the universities. Following a recent reorganisation of Spanish ministries, the main public national research institutions are overseen by the Ministry of Science and Innovation, while regional public institutions are overseen by the corresponding regional council for education, science, industry or innovation (depending on the particular regional organisations).

Similarly, the supervision of New Zealand's CRIs has been influenced by several episodes of public sector science reform. In the early 1990s, a number of responsibilities were divided into separate organisations. The Ministry of Research, Science and Technology provided policy advice, and the Foundation for Research, Science and Technology became responsible for funding science outputs. The research institutes each had two shareholding Ministers: the Minister of Finance, to ensure appropriate consideration of economic and financial objectives; and the Minister for Research, Science and Technology. Shareholding Ministers received advice from the Crown Company Monitoring and Advisory Unit regarding institute performance, ownership issues (e.g. advising on investment and diversification options), and governance and appointments. Recently, the Ministry and Foundation were re-merged, and PRI policy and funding is again under one roof in the Ministry of Science and Innovation. This merger was designed to achieve greater strategic alignment and impact of government R&D investment.

Korea too has experienced several tranches of reform to its research sector. General restructuring of the public sector in the late 1990s led to the introduction of a "research circle" system (later "research councils"), where institutes were grouped according to their focus on basic, public or industrial technologies. Oversight was provided by the Office of the Prime Minister. A new law was enacted in 2004 after further restructuring, and supervision was passed to the Ministry of Science and Technology. The three research councils were then merged to form two research councils, with basic technology coming under the supervision of the Ministry of Education, Science and Technology (MEST) and industrial technology moving to the Ministry of Knowledge and Economy.

In some instances, changes to oversight arrangements also involved more independence for PRIs. In Luxembourg, the supervision of the Centre d'Études de Populations, de Pauvreté et de Politiques Socio-économiques was passed from the Minister of State to the Minister having public research within their remit. The Centre thus joined the *centres de recherche publics* under one supervising Minister. However, Luxembourg also noted that the *centres de recherche publics* ceased to be connected to their "parent" bodies in 2003 and are now independent entities. Norway noted that its agricultural research institutes became more independent from the Ministry of Agriculture in 1997, with core funding instead being channelled through the Research Council of Norway. This continued a trend that had begun earlier and which has allowed the Research Council to assume responsibility for allocating core funding to over 50 research institutes within the research institute sector.

Current arrangements

The status of some institutes means they are tightly bound to the public sector and its related legislation, regulations and processes. In Norway, public research institutes owned by the government are subject to government regulations and a government minister is constitutionally responsible for their activities and budget. These institutes are also subject to legislative requirements set out in, for example, the Norwegian Public Administration Act and the Civil Service Act. In the Netherlands, the Minister of Education, Culture and Science has overall responsibility for the long-term strategy of several groups of institutes, and also has decision-making power over their budgets, annual accounts and reports, and regulations governing organisational structures. In Poland, research institutes (former "branch R&D" units) depend both on the ministry responsible for science (as the main distributor of government funds for research) and

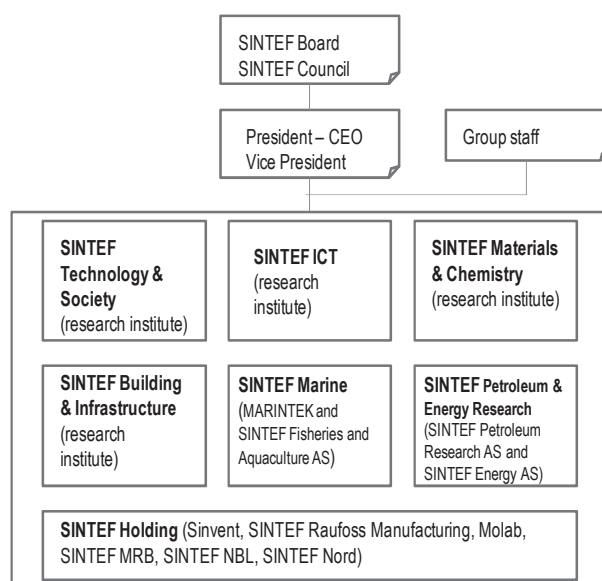
their relevant supervising ministry. They have some market freedom, but their financial and property decisions are limited by the commercial code and by an act of law on branch R&D units that, for example, requires the agreement of the supervising minister for every decision concerning property valued at more than EUR 50 thousand.

Clearly, the more “arms length” the institution is from government, the smaller is the apparent ability of government to influence PRIs and their governing bodies on a day-to-day basis. There is great variety in this government-institute distance, both within and across countries. For example:

- Australian PRIs experience different levels of government oversight, depending on the legislation under which they operate. Geoscience Australia, for instance, operates under the *Financial Management and Accountability Act 1997*, which gives financial autonomy but requires adherence to Australian Government financial management policies. Other entities operate under the *Commonwealth Authorities and Companies Act 1997* or the *Corporations Act 2001*, which give increased control over funds and governing bodies.
- Canada’s parliamentary system inherently provides oversight to its PRIs. As public institutions managing public monies, PRIs must adhere to Treasury Board guidelines, be answerable to Parliament (via the responsible Minister and/or Parliamentary Standing Committees) and be responsible to the Deputy Minister within the context of guiding legislation and departmental mandates.
- Norway noted that most of its research institutes are organised as separate legal entities with autonomy from the state. These institutes are not subject to government regulations, but instead conduct their activities within the general statutory framework and in accordance with legislation including the Limited Liability Companies Act and the Taxation Act. The case study of SINTEF is described as an example in Box 4.6.
- In Russia, research institutes of the academies of sciences are governed according to the charters of the academies and their own charters. However, the charter of the Russian Academy of Sciences is approved by the government, while the charter of the Russian Academy of Medical Sciences is approved by the general meeting of the academy.
- In the United Kingdom, each Research Council is funded by and reports to the Department for Business, Innovation and Skills (BIS).² However, their institutes are ultimately responsible to the parent council and have the power to develop their own strategy within the terms set out by the parent. Research Council institutes have heterogeneous governance arrangements; for example, institutes sponsored by the Biotechnology and Biological Sciences Research Council operate at “arms-length” from the council and are legally constituted as companies limited by guarantee and as registered charities. In contrast, the Medical Research Council operates a number of institutes and centres under its own name.

Box 4.6. Organisational autonomy and accountability – the case of Norway’s SINTEF

Norway’s SINTEF is the largest independent research organisation in Scandinavia. It was established in 1950 as a foundation to promote industrial and other technically oriented research at the former Norwegian Institute of Technology in Trondheim and to develop co-operation with the industrial/commercial sector at a national level, together with other research organisations. It is now a broad-based, multidisciplinary research entity with expertise in technology, medicine and the social sciences. It comprises the SINTEF Foundation, four non-commercial limited companies and SINTEF Holding (see below); the latter focuses on strategic ownership and establishing new companies, and was set up to separate SINTEF’s commercial activities from core research activities.

SINTEF’s organisational and governance structure**SINTEF Board**

Nine members: four from industry or the public sector; two from NTNU; plus three tenured employees of SINTEF (elected by the employees in accordance with the Foundations Act concerning employee representatives).

SINTEF Council

28 members: 25 appointed by the board of NTNU on the recommendations of stakeholders plus three elected from and by the employees of SINTEF. Of the board-appointed members: 11 from university faculties with which SINTEF has signed co-operative agreements; two recommended by the Faculty of Mathematics and Natural Sciences at the University of Oslo; nine recommended by four key organisations comprising the Confederation of Norwegian Business and Industry, the Norwegian Federation of Trade Unions, the Norwegian Society of Chartered Technical and Scientific Professionals, and the Research Council of Norway; plus three recommended by the SINTEF Board.

SINTEF has a high degree of organisational autonomy, institutionalised through the SINTEF Board and SINTEF Council (see above). Its overarching mission is set out in legislation and any decision to modify the statutes must be taken by the SINTEF Council following a proposal from the Board with a two-thirds majority; in practice, however, SINTEF’s internally-generated vision (“Technology for a better society”) is better-known within the organisation. SINTEF’s corporate management comprises the managing directors of the 6 research divisions, plus the president and vice president. This team is responsible for the day-to-day running of SINTEF, in close co-ordination with the management groups in the research divisions. It meets weekly to address advanced multidisciplinary challenges that no research division can manage alone, and to maintain communication and co-ordination between divisions. The SINTEF Board and group management (including the management groups of the research divisions) collaborate in strategy development. They also develop SINTEF’s IPR policies in accordance with Norwegian law and Research Council of Norway rules.

Source: Case study report on SINTEF (Norway) supplied to the OECD Secretariat and information from www.sintef.no.

The survey evidence suggested that PRIs' internal management plays a bigger role in decision-making than do public authorities, across a range of issues.³ Institutes were asked to select which actor (*e.g.* public authority, steering body, management, researchers, etc.) was responsible for decisions in a range of areas (*e.g.* missions, project selection, use of funds, infrastructure development, etc). The evidence is indicative only, as institutes were limited in their responses by the design of the question (one actor per decision area); additionally, institutes may have interpreted the terms used to describe actors and decision areas in different ways. Nevertheless, in each country, "top management of research organisation" and "management of institute" were consistently the most frequently-cited decision makers regarding research orientations, activity portfolios, use of public institutional funds, use of public targeted funds, use of other income, recruitment, employee development, and infrastructure investment. (Slovenia, in contrast, reported that steering bodies often played a central role in decision making in these areas.)

Internal management layers were also the most frequently noted decision makers regarding missions, strategic planning and project selection in Austria, Italy and Poland. In contrast, in Norway, steering bodies were cited by more than half of responding institutes for decisions on missions and planning, while project management was most frequently responsible for project selection. In all four countries, project management was cited alongside management in relation to decisions on use of public competitive funds and contracted funds.

Public authorities were less frequently cited as major decision-makers. In Norway and Poland they were the second-most cited decision maker on issues of mission (25-29% of responses) and in Italy they were the second-most cited decision maker on issues of activity portfolios (20% of responses). In Slovenia, public authorities often made decisions on PRI missions. Individual researchers were infrequently cited as decision makers; their biggest role was suggested in the selection of projects, where they were noted by 15-18% of responding institutes (Slovenia also noted their role in this area). In Italy, they also had some role in decisions about research orientation (noted by 17% of responding institutes); in addition, 15% of Polish PRIs noted their role in employee development decisions.

However, even if public authorities have no explicit role in decision-making, there are other methods of implicit steering that should be recognised. As noted by Italy in its survey report, despite the relatively minor apparent role of public authorities in decision-making, governments may exert control through appointments to upper management. In some cases, the top management of Italian PRIs is totally appointed by the supervising ministry; in this case, while the constitutional guarantee of freedom of research and institutional independence holds, there is effectively a strong role for government. Some examples of government and industry representation on boards, drawn from the country context notes, are given in Box 4.7. The case studies also noted that in most cases, some kind of government influence can be traced, even when institutes are independent and self governed (OECD, 2010a). Influence typically appeared via any kind of public funding decision, supervisory activities or via research councils and academies. The case of steering through performance agreements and funding is discussed in the sub-section below and in the Funding section of this Chapter. The question is how effective these channels for government steering are in practice.

Box 4.7. Government representation on boards – evidence from context notes

Government appointments and representation on governing bodies were a common example of a steering mechanism. Austria commented that ownership of institutes confers government influence, via selecting directors of the institutes, or by participating in supervisory boards or councils. Almost all of Austria's permanent institutes have 100% public ownership and this system implies an ongoing involvement of ministries, as owners and funders, in the development decisions of Austria's permanent research institutes. In Denmark, some government research institutions have independent boards, where board members are appointed by the relevant minister, while others are organised without a board and are subordinated to the relevant minister. In the former case, boards nominate a managing director to oversee daily management of the institution, who is then selected and recruited by the minister, while in the latter case, the managing director is recruited and selected directly by the minister. For Japan's independent administrative institutions, the minister-in-charge appoints the president and auditor of the institute. In the Netherlands, there is a range of organisational arrangements; for example, the NWO institutes operate as independent legal entities with their own managing boards and the Leading Institutes operate as P-PPs, while the boards of several institutes are appointed by Royal Decree. New Zealand's shareholding ministers appoint the boards that run each research institute, with boards then having the responsibility to meet the requirements of the Companies Act and to meet specific obligations set out in the Statements of Core Purpose and Statements of Corporate Intent. In Russia, directors of research organisations subordinated to federal ministries or agencies are appointed by the order of the corresponding ministry or agency. Appointments of the director, chairman and members of the council of the Russian Foundation for Basic Research are also government-ordered.

In some countries, government has a particularly strong presence in governing bodies. In Luxembourg, the *centres de recherche publics* each have an administrative council that provides direction. The councils include the minister charged with overseeing the particular centre, a representative of the Ministry of Economy and a representative of the Ministry of Finance, as well as other public and private sector representatives independent of the centre. In addition, each council includes a government commissioner, appointed by the Minister of Research, who provides consultation but also has the right to suspend any decisions of council that are considered to be contrary to laws or regulations and to refer these matters to the Minister of Research.

Source: Country context notes supplied to the OECD Secretariat.

In addition, even with higher levels of autonomy, PRIs' research activities can remain governed by certain government regulations related to, for instance, ethics and research freedom (Box 4.8). These reinforce any internal processes and steering groups that may exist (*e.g.* research ethics committees such as those found in Korea's KIST, KORDI and KRISS).

Box 4.8. Government regulations related to research – some examples from context notes

Requirements related to ethics and research integrity were noted by some countries in their context notes. For example, Canada noted that members of the federal S&T community are expected to uphold the public trust, as laid out in the 2003 Values and Ethics Code for the Public Service. They are also expected to adhere to core ethical principles governing the treatment of human research participants and animal welfare. Related to this, three Canadian research councils agreed on a policy statement known as the Tri-Council Policy on Research Involving Human Subjects, and will consider funding only individuals and institutions that certify they comply with this policy. In Australia, the health and medical research undertaken by private not-for-profit entities is affected by the Australian Government's *Privacy Act 1988*, State/Territory privacy legislation, privacy, confidentiality and secrecy obligations embedded in other legislation (e.g. freedom of information legislation), and legislation related to cloning and human embryos. Funding from the government is also subject to compliance with national ethical guidelines.

Some countries discussed rules relating to freedom of speech. Denmark noted that researchers employed outside universities are not protected by academic freedom provisions. Whistle-blowing is handled under the Danish constitution's protection of the freedom of speech and the guidelines for publicly employed persons' freedom of speech published by the Danish Ministry of Justice. Norwegian researchers employed outside the universities are similarly not protected by academic freedom provisions.

Freedom of research was also discussed. In Denmark, institutions that are regulated by the law on government research institutions have freedom of method and publication; indeed, the law requires results to be published, except when special considerations relating to the interests of companies or general conditions in society would not permit it. However, not all institutes have the freedom to define research areas or priorities. For ATS institutes, private laws apply to the regulation of research freedom. In Italy, researchers can carry out, within certain limits, professional and intellectual activities occasionally paid by external actors and parties and can co-operate with a university either as professors or for research. In Australia, a new framework for research independence and responsibility was launched in 2008, which entrenches rights and obligations of scientists and other researchers to participate in public research debates. Charters were signed with four major public research agencies, and included general principles that encourage open communication and dissemination of research findings, and independence and integrity of public research agencies in their research activities.

Source: Country context notes supplied to the OECD Secretariat.

Performance and steering mechanisms

A number of countries described their use of performance agreements in the context of PRI governance arrangements. Denmark's government research institutions with boards each have a performance contract with the relevant ministry, which sets out the strategy of research, tasks and working fields. Belgium concludes multi-annual management agreements with its strategic research centres, all policy-related research centres and its special institutes, and has short-term agreements (covenants) with its excellence centres. Similarly, in accordance with recent reforms, New Zealand's CRIs will each have Statements of Corporate Intent, which provide a framework for guiding operations and for monitoring and evaluating their performance. These Statements will show how CRIs will deliver against their Statement of Core Purpose over a five year period and what shareholders will receive for their investments. Luxembourg has recently begun piloting performance contracts between the government and research centres. Initial contracts covered 2008-10 and required centres to achieve certain objectives related to finance (e.g. obtaining funding from competitive research programmes), outputs (e.g. patents and publications) and structure (e.g. putting in place a system of full cost accounting).

For Finland, the introduction of a performance management model by the Ministry of Finance has significantly changed the framework for the steering and governance of public organisations. The focus is on socio-economic impact and the operational core of the model lies in the ability of parties to the performance agreements to find the right balance between the available resources and the results to be attained with them. As part of the model, basic performance criteria have been written into legislation. They comprise policy effectiveness (or societal impacts) and operational performance (particularly, operational efficiency, outputs and quality management, and management and development of human resources). Finland's PRIs have responded positively to these changes by developing tools and indicators to assess their impacts on customers and on society as a whole. However, as noted above, creating targets that take into account the views of all stakeholders is still a challenge.

In line with the use of performance agreements, several countries described in their context notes evaluation activities that influence the activities of PRIs. For example, Belgium evaluates the execution of institutes' performance agreements and their linked results every five years, using an external partner supported by an international panel of experts. Japan noted evaluation procedures for several of its PRI groups. Independent administrative institutions, for example, are required to submit their annual performance for each fiscal year to an evaluation committee, and their medium-term performance is evaluated by the evaluation committee at the conclusion of the medium-term goal period. At that point, the minister-in-charge reviews the overall scope of the institution and its operation, and takes measures in accordance with the results obtained in the evaluation. Luxembourg's performance contracts with research centres incorporate continuous monitoring and an evaluation at the end of the contract period. Korea noted that evaluation activities have taken place, most recently under a Research Performance Evaluation Law enacted in 2005; however, the system is considered to have some issues, including a lack of indices that can reflect unique characteristics of institutes and a focus on quantitative analysis.

In some instances, performance and evaluation results are explicitly linked to funding. For instance, Austria noted that efforts have been made to base institutional funding for its permanent organisations on performance agreements. This allows ministries to influence the research/strategic orientation of institutes by defining incentives, targets and performance indicators in agreements. Institutional basic funding is in almost all cases conditional on the performance of particular projects or on the supply of a particular service, defined either in the performance agreement or in defined research programmes of the institutes. In addition, Austria's temporary institutes receive some steering via changes to funding and support that is based on advice from evaluation activities, particularly from peer review processes. Belgium's performance agreements include results-oriented criteria (such as number of patents, spin-off companies and publications), for which institutes receive an annual financial grant. In the Netherlands, the NWO institutes receive a structural grant whose amount is based on a comprehensive review of their performance, development potential and financial status. Non-recurring grants are also awarded, which may be based on the results of evaluations. Norway's use of systematic performance-based core funding for PRIs is discussed further in the Funding section.

However, the survey results suggested that the influence of evaluation still differs between countries and across PRIs, with funding, strategic orientations and development plans affected to varying degrees by performance assessments (Box 4.9).

Box 4.9. Evaluation of PRIs – survey evidence

The survey results suggested that evaluation activities often incorporate both self-evaluation and external evaluation, and tend to rely on qualitative methods. In Austria, 54% of responses indicated that both types of evaluation were used, while 25% of responses indicated external evaluation only. Similarly, 67% of Italian responses indicated self-evaluation and external evaluation were used (with 31% noting only external), while 76% of Polish responses indicated both types of evaluation (with 19% noting only external). In contrast, however, Norwegian responses indicated a higher use of self-evaluation, with 22% of responses selecting this option and 72% noting both types of evaluation are used.

Evaluations were said to be mainly qualitative in Austria, Italy and Norway, receiving 53-73% of responses. In Poland, however, just over 50% of responses said that evaluation processes were mainly quantitative. Italy noted that the methods of research evaluation in Italy are rapidly evolving, with the creation of an independent agency for university and research evaluation (expected to become operational in 2011).

Institutes were also asked whether the evaluation influenced institutional funding, strategic orientation of activities or development plans. Multiple responses were possible. The weight of responses (38-43%) suggested that strategic orientation was most influenced by evaluation in Austria, Italy and Norway; in Poland, however, funding was most frequently noted, with 37% of responses. Only 20% of responses in Norway noted the influence on funding, compared with 27% in Austria and 32% in Italy. Given the recent introduction of a new core funding system partly based on performance, the influence of evaluation on funding could be expected to rise.

Note: This draws on responses to survey question 20. Response rates were: Austria: 74%; Italy: 43% (component on types of evaluation), 40% (component on quantitative/qualitative nature), 35% (component on influences); Norway: 92% (component on types of evaluation), 82% (component on quantitative/qualitative nature), 86% (component on influences); Poland: 98%. Statistics for Slovenia not supplied.

Source: Survey reports supplied to the OECD Secretariat.

Funding

The funding of PRIs can be a crucial parameter in determining their direction, activities and linkages with other players. Current arrangements reflect ongoing changes in governments' budgetary approaches as well as the wider environment for R&D. The overall trend appears to be increasing levels of competitive funding, both through public channels and private sources. Yet diversity remains within and between countries in the sources of income for PRIs and the manner in which funding is delivered. The case studies, for example, showed that some PRIs are still heavily dependent on public institutional funding (OECD, 2010a).

Increased industry involvement in funding was highlighted in a number of country context notes. Changes in Austria's PRIs show the increasing emphasis put on industry involvement in research, via funding streams and guidance to research selection. Efforts were made to increase the private commitments for almost all P-PP agreements and to base institutional funding for permanent organisations on performance agreements, increasing the pressure for more competitive funding (while at the same time giving "excellence" a more prominent role). Chile has given priority to improving and strengthening collaboration between R&D centres and companies, and has made progress in establishing tax incentives for such collaboration. One of the major changes in New Zealand in the past 15 years has been the diversification of the CRIs' revenue base, driven by changes in the funding environment and the tertiary education sector. The opening up of the Public Good Science Fund to all research organisations, its split into mission-oriented funds, and the creation of new funding lines, accompanied by the

increased capacity of the tertiary sector to do research, has increased competition for research funding and has necessitated more engagement with industry. In the United Kingdom, PSREs are increasingly encouraged to generate income privately as part of a wider aim to establish financial sustainability in the sector. Thus many are branching out into commercial work.

Income from abroad has also increased for a number of institutes, although for many this increase may be from a low base. The survey results found that the share of funding from abroad had increased for more than half of responding institutes in each country.⁴ In Austria, 56% of institutes had increased foreign funding; this figure was 62% for Norway, 69% for Italy and 72% for Poland. Nevertheless, the case study evidence suggested that the share of income from abroad may still be relatively low for many PRIs – it ranged from below 1% to more than 10% in the case study sample (OECD, 2010a). This may indicate that, even when PRIs intend to intensify their level of internationalisation, it is difficult to source funds from abroad. The institutes with the highest level of foreign income in the case studies were those that had research with a global dimension, such as relating to health or to energy.

Box 4.10. PRIs and the EU – the case of Poland’s ICPC

Poland’s Institute for Chemical Processing of Coal (ICPC) was founded in 1955. Its general scope is the development of technology in the areas of conversion of coal, biomass and waste into energy, enhanced fuels, and chemicals. It works with both large industrial organisations as well as small and medium-sized enterprises, and provides knowledge and know-how to the state administration and local governments.

The introduction of a free market economy in Poland in 1991 precipitated both structural transformations in the ICPC and changes to its governance and budget arrangements. From that point, the ICPC had to obtain significant funding from the market and direct research towards customers’ expectations. However, following Poland’s entry as a full member of the European Union in 2004, there have been more opportunities to apply for funding from EU sources. In recent years, expenditure on projects financed from commercial sources has fallen, while expenditure on projects financed from EU Structural Funds has risen. In 2008, unconditional public core funding (a block grant) made up 25% of the PRI’s budget, while conditional or competitive public funding made up an additional 20%. More than 50% was then obtained from contract income, essentially from commercial sources or from EU funds. EU accession also accelerated changes in the ICPC’s activities, as a result of Poland’s political undertakings. For instance, Poland now has obligations to increase generation of power using renewable resources and has introduced a directive on waste utilisation.

The ICPC has participated in many international projects financed within the framework of EU programmes. Since 2002, it has executed several projects each year, the biggest being the Centre of Excellence on “Thermochemical Conversion of Solid Fuels: Processes of Pyrolysis, Gasification and Combustion of Biomass and Wastes – CONBIOT” in the years 2002-06. The Institute has been participating actively in the work of the European Coke Committee, and presided over the body from 2002-04. In addition, the ICPC is participating with other Polish actors to win European-supported projects, such as the recent European Institute of Innovation and Technology (EIT) funded co-location centre in Krakow for sustainable energy, where clean coal energy will be researched.

Nevertheless, EU funding is not always straightforward. The ICPC successfully implemented some EU projects financed from Structural Funds in the 2004-06 programming period. However, the execution of these projects required up-front expenditures which were then refunded on the basis of documentation. This procedure was seen as an obstacle for many research institutes in Poland in implementing this type of project.

Source: Case study report on ICPC (Poland) supplied to the OECD Secretariat; Zawada (2010).

Examples of foreign funding were also raised in the country context notes. For instance, Denmark remarked on an increase in international income for its Approved Technological Service institutes over the past decade. In 2007, around 50% of the revenue from commercial sales came from abroad and 42% of turnover came from exports. Several institutes are represented overseas, while another is engaged in development activities abroad. European Union funding is also an important source of international income, given the participation of Danish institutes in EU research. This may be the case for many European PRIs – Box 4.10 describes the case of Poland's Institute for Chemical Processing of Coal, for instance. The Netherlands experienced steady growth in funding of foreign origin for its research institute sector, from around 2% in the early 1990s to more than 10% in 2003.

The core or “block” funding tranche of PRI's government income is also an area of change. For instance, the United Kingdom has been phasing out block grants, with payment on a contractual basis becoming more common. This aims to increase PSREs' autonomy and encourage them to source income from a variety of public and private sources. In contrast, Korea plans to increase the ratio of PRIs' government funding, to strengthen their autonomy and independence and create a stable research environment. It also plans to build a performance-oriented system which reflects evaluation results of government-funded institutes and projects. In Norway, a new core funding system that is partly performance-based was introduced for the research institute sector in January 2009. Under the scheme, the basic funding component comprises a permanent allocation and a fluctuating allocation of around 10%, which is allocated on the basis of institutes' performance on scientific publications, co-operation with the higher education sector, income from the Research Council of Norway, income from abroad, and income from national research commissions. The participating institutes are divided into groups to ensure that relatively similar research institutes compete for core funding on similar terms.

Some countries highlighted changes in the amount of funding going to the PRI sector. Reinforcing the science base remains an important element of national innovation strategies and for some countries it is of the highest priority (*e.g.* Hungary, Japan, Norway and Sweden). Some also plan to increase public funding for R&D (*e.g.* Canada, Germany, Norway, Spain and Sweden) (OECD 2010c, p. 90). In its country context note, Chile noted that it had increased resources for science, technology and innovation, and that its public investment was on track to reach the level of OECD countries by 2025. Germany described its Joint Initiative for Research and Innovation, which increased funding for the major science and research organisations that are co-financed by the Federal Government and the *Länder*. The funding commitment aimed to provide institutions with financial planning security and to increase annual grants by at least 3% p.a. until 2010. In return, the institutions committed themselves to increasing the quality, efficiency and performance of their R&D work. There are plans to increase contributions by 5% annually between 2011 and 2015 (OECD 2010c, p. 92).

Also influencing the amount of funding going to PRIs is the increasing use of full economic costing. For instance, in the United Kingdom, the amount of funding is now influenced by a focus on financial sustainability. This entails trying to recover the full economic costs of research activities and investing in infrastructure at an adequate rate to maintain future capability, along with establishing a strategic plan against which future needs can be identified and performance measured. Full economic costing requires that capital and infrastructure costs associated with each piece of research commissioned from public research establishments are included in the final price. This is a major change in

the business model of PSREs and represents a step towards establishing internal and external market pricing. Full economic costing is an approach being picked up in several countries, including Canada, Finland and Sweden (OECD 2010c, p. 96).

The survey evidence corroborates many of these funding trends (although it is indicative only⁵). Institutes were asked to indicate whether shares of particular types of funding had increased, decreased or stayed the same over the past decade.⁶ All countries showed strong increases in public competitive funding (*e.g.* won under competition with other PRIs, universities and/or firms, funding from research councils, tenders, EU Commission). In Italy, 76% of responding institutes noted this source of income had risen; the figure was 75% for Poland, 70% for Norway and 60% for Austria. Another area of relative commonality was in private contract income (*e.g.* from firms for R&D, including foreign firms), which showed clear increases for institutes in Austria, Italy and Poland (more than 50% of responding institutes indicated this source of income had increased). Shares of public institutional funding (defined as unconditional fixed/core block grants, *i.e.* not directed towards particular projects or programmes) were overwhelmingly constant or falling, except in Poland. Only 9-25% of responding institutes in Austria, Italy and Norway had experienced increases in this type of funding, while in Poland the share was 37%.

As a result of all these changes, funding sources for the PRI sector as a whole and across different institutes are now quite diverse. In its context note, Italy, for instance, noted the national, regional and international sources of funds for its PRIs. There are three principal public funds, managed by the Ministry for Education, University and Research, with funding also sourced from regions, where regional bodies implement strategies to innovate local productive systems. A further important source of funding comes via the European Commission's Framework Programme and Structural Funds. In the Netherlands, there is a spectrum of funding arrangements with different institutes tapping into varying ranges of funding channels. At one extreme, government institutes are run as part of the relevant Ministry. At the other extreme, the Leading Institutes receive funding from Ministries, companies, universities and public research institutes. TNO also receives government funding from various ministries and acquires a large share of its funding from the open market (this is also the case for the Large Technological Institutes). The United Kingdom, too, pointed out the diverse funding sources of some of its Research Council institutes, including government departments, charities, the EU and industry.

Box 4.11 describes some of the funding arrangements currently in use; it highlights how diverse the approach can be, depending on the type of institutes and particular country contexts.

Box 4.11. Funding arrangements – examples from context notes

Countries' arrangements for PRI funding highlight the diversity of the “mechanics” involved in funding, and reflect country-specific settings and processes. A sample of some arrangements follows:

- Canada noted that federal S&T expenditures are allocated through normal departmental and agency budget processes, with no “separate” funding for S&T.
- Germany noted that its approximately 750 publicly funded research establishments are largely financed by the Federal Government and the Länder on the basis of an agreed formula.
- In Korea, there is a high level of private sector funding for the PRI sector, accompanied by a focus on applied and developmental research. Korea plans to allocate a portion of the R&D budget for government-funded research institutes to individual researchers, to promote their creativity and support discovery of seed technologies.
- In Norway, the Research Council of Norway has been delegated the responsibility for providing core institutional grants for most institutes.
- The employees and basic activities of public research institutions in Spain are mainly funded by the national and regional governments, but the main R&D activities are funded through competition in open calls by regional, national and international R&D programmes. Spain noted that a minor fraction of financial support for research activities in PRIs comes from private contracts.
- The European Parliament and Council jointly decide on the JRC's part of the Framework Programmes for Research and its relevant budgets. This funding is for direct support to EU institutions; further income is generated through the JRC's participation in indirect actions, additional work for Commission services and contract work for third parties (such as regional authorities and industry). The JRC itself finances significant bodies of work through competitive contracts. This work, worth more than EUR 47 million in 2008, complements the tasks in the JRC's work programme and is seen as an essential tool for acquiring and transferring expertise and know-how.

Source: Country context notes supplied to the OECD Secretariat.

Potential funding issues

The increase in competitive funding for PRIs raised concerns for some countries. For example, as mentioned earlier, an increase in this type of funding may have driven increased competition and unwanted overlap between the activities of PRIs and other research entities. In their context notes, countries described several issues they had encountered with competitive funding:

- In Korea, the PBS (project based system) that pursues productivity improvements in research activities through competition has been in operation since 1986. However, while it has delivered some positive impacts, such as increasing transparency and accountability, Korea considers that it may also have led to an excessive focus on short-term projects, fragmentation, and weakened job security for researchers. Institutes may also have expanded into research areas beyond their expertise. Changes to the system are envisaged, to support more original research.
- In New Zealand, high levels of competition for research funding have meant that, over time, some CRIs have developed similar capabilities and increasingly compete with other CRIs and with universities. It was suggested that overlaps can give rise to tensions and inefficiencies, and potentially lead to research areas or

activities that are under-served by both types of organisation. Core funding for CRIs was recommended by New Zealand’s Crown Research Institute Taskforce (Crown Research Institute Taskforce, 2010) and from 1 July 2011 CRIs will receive a significant proportion of their government funding directly through core funding (in most cases, this will be about 60%).

- New Zealand CRIs are also sometimes perceived to be competing with New Zealand firms, rather than working with them to build their R&D capacity. CRI linkages with firms have been encouraged by low real growth in public sector funding, as well as legislative requirements to undertake R&D for the benefit of New Zealand and to promote and facilitate the application of R&D results, both of which imply linkages with R&D users. However, this issue may also partly be a function of the small average firm size in New Zealand, with most firms not undertaking R&D internally.
- In Spain, the concerns about competitive funding are related to efficiencies across different levels of government. There, this type of funding is considered to be driving a high degree of duplication and overlap between national-level and regional-level research activities, in spite of R&D plans at each level. The Spanish government is working on a new Science and Technology Act that will create a new framework for research funding; this aims to improve co-ordination between the General State Administration and regional administrations in order to develop national plans for R&D and innovation and to improve governance (OECD 2010c, p. 84).

One underlying consideration may be the appropriate extent of competitive project funding *versus* core institutional funding. Korea and New Zealand have relatively high levels of project funding in the government sector, as was described in Figure 2.6 in Chapter 2. Some revisions to funding structures, taking account of PRIs roles and activities, may be desirable (see also the OECD Innovation Reviews of Korea and New Zealand: OECD, 2009a; and OECD, 2007). Another underlying consideration is the framework within which competitive funding operates. PRIs that seek to offer services (e.g. research, infrastructure, etc) to other entities should be subject to similar competitive obligations as private enterprises, so that they do not have an unfair advantage in the marketplace. More generally, they should normally operate under “competitive neutrality”, that is, the overall legal and regulatory environment should present the same rules for PRIs as other entities in the market (for a discussion of competitive neutrality, see OECD, 2009b). Here, the use of full economic costing is a useful tool to increase the transparency of pricing of PRIs outputs. Setting up PRIs as more business-oriented entities, as some countries have done (see the discussion of Organisational arrangements, earlier in this Chapter), can also help alleviate competitive neutrality issues. The broader issue of collaboration and competition between different research entities is discussed further in the next Chapter on Linkages and Internationalisation.

Another related issue regarding funding is the ability of PRIs to finance their equipment and infrastructure needs. As noted, some countries have increased their use of full economic costing, which should allow for a contribution to PRIs’ infrastructure costs associated with individual projects. Nevertheless, as shown in Figure 2.7 in Chapter 2, many countries have experienced falls in overall expenditure on R&D instruments and equipment in recent years, at the same time as PRIs have faced pressure to increase funding from industry and abroad. In the case studies, several PRIs noted the importance of research infrastructures and high-tech equipment for their work; some also noted the

need for renewal of their laboratories, particularly where these had been running for some time. Ensuring that PRIs are able to plan for and fund the appropriate level of investment in infrastructure and equipment is an important precondition for their performance.

Human resources

The changes in PRIs' orientations and organisational arrangements have fed through to changes in the configuration of their human resources. The case studies clearly illustrated how structural changes flow through to staffing; staff increases and reductions were both experienced and could be partly attributed to organisational changes such as mergers and greater use of outsourcing (OECD, 2010a). Aspirations and evolving goals also lead to staff changes; one Korean case study noted that its aim to become an R&D institute with an international presence and recognition required it to build global research groups led by world-class researchers.

PRIs continue to depend heavily on human resources. Across the variety of institutes covered by the case studies, qualified human resources were consistently marked as a major input to PRIs' activities. There is considerable diversity in the current size of PRIs; employee numbers differ substantially, both within countries and between countries. For example, in the case study of Austria's CDG, the number of employees per laboratory ranged from 2-25, while in Poland, there were approximately 100 FTE in the Institute of High Pressure Physics (IHPP) and around 740 FTE at the Geological Institute. In some countries, staff are considered civil/public servants, and are governed by particular employment regulations. In others, general employment legislation applies (examples from the country context notes are shown in Box 4.12).

Box 4.12. Civil service and labour laws – evidence from context notes

For a number of countries, civil service status is not, or no longer, provided to PRI employees. Austria, for example, noted that only in a small number of federal institutes is civil service status held by employees, and these are often long-serving employees. New employees are not specified as civil servants. Denmark also began phasing out special employment conditions for civil servants from the mid-1990s and researchers are generally employed under normal regulations for Danish employees. Germany noted that its public research institutions receiving funding from the federal government are, as a rule, legal entities under private law and their staff are not civil servants. As New Zealand's research institutes are not part of the core public service, staff are not considered civil servants. However, staff can choose to join and be represented by the Public Service Association (a union), which also represents employees of government departments and ministries. In Poland and Russia, researchers do not have civil servant status.

Some countries do, however, provide civil service status to PRI employees. Canada, for instance, noted that the majority of employees of federal R&D institutions are public servants, and staff at most Australian government research bodies are classified as public servants (*i.e.* holding civil servant status) and are subject to additional workplace regulations. Finland's public research personnel generally have civil servant status and labour laws and other laws regarding civil servants are applicable. Italy's research institute staff have contracts similar to university staff, except for differences in salary adjustments. Contracts may be permanent or fixed term. Access to the profession is possible only after a national competition open to Italian and foreign competitors. Most of Spain's national and regional institutions provide civil service status to their employees, although some public centres also use private labour contracts, while foundations are based on private contracts and specific regulatory rules. In the EU's JRC, the employment of statutory staff is governed by the EU Staff Regulations of Officials of the European Communities, or by the Conditions of Employment of other servants of the European Communities. However, there are also a variety of non-statutory contracts available for researchers, trainees and detached national experts, where employment is not governed by the Staff Regulations.

.../...

Box 4.12. Civil service and labour laws – evidence from context notes (*continued*)

The applicability of general employment laws was noted by several countries. In Canada, all federal government departments must comply with employment standards legislation and Treasury Board Secretariat guidelines with respect to rates of pay and collective agreements. Employees in Poland's public research institutes are liable to the Code of Labour and articles in relevant acts of law. Additionally, research institutes (former "branch R&D" units) might have "common agreements" that decide some labour issues. Germany's research institutions are subject, as are other German employers, to applicable labour and collective bargaining laws. One interesting case was described, with respect to a ban on research institutions treating their employees more favourably than comparable Federal Government employees. Germany noted that there were able to be exceptions to this rule, such as paying senior scientists in the same manner as university professors, with the possibility of awarding merit pay. Some staff could also be eligible to special payments on top of their fixed salaries to reward their scientific achievements.

Source: Country context notes supplied to the OECD Secretariat.

Depending on the size, mission and activities of PRIs, different internal employment structures were observed, with different shares of scientists, technicians and administrative personnel (OECD, 2010a). The country context notes provided evidence at the country level; in Australia, for instance, just over 50% of human resources devoted to R&D in the government sector were researchers (measured in person-years of effort). Denmark noted the share of staff with a research training background in its government research institutions was around 18.5% in 2007, while that in the Approved Technological Service Institutes was around 10% (44% of staff were university graduates). Figures on permanent staff and those with fixed-period contracts for Italy suggested that around 46% of staff were researchers in 2006. Researchers and student researchers in Luxembourg's government research sector accounted for 68% of staff in 2006. In Spain, 60% of people involved in R&D activities in 2006 were researchers. The EU noted that the JRC's policy of attracting bright and able scientists ensures a rich resource pool, and it offers a variety of temporary and permanent work opportunities and training for scientific and technical staff.

In terms of changes in employee categories, institutes responding to the survey most frequently indicated that the share of researchers had gone up over the past decade; this was the case for 49% of responding institutes in Italy through to 80% of responding institutes in Norway.⁷ (However, Norway noted that when data on full-time-equivalent numbers of researchers were examined, these showed shares of researchers had been fairly stable in recent years.) Shares of technicians and administrative personnel tended to stay static or drop for most responding institutes. This accords with the data presented in Chapter 2.

In addition to researchers' own sense of personal development and achievement, PRIs motivate their researchers in a variety of ways. The case studies highlighted a number of examples of incentives that drive researchers' activities, such as allocating free research time and resources for application-oriented basic research, providing the opportunity to lead laboratories, and determining career progression on the basis of publications and other outputs. Commercialisation of research outputs was also mentioned as a motivation for researchers. Stable provision of research funding and prioritised allocation of new staff to encourage the formation of excellent research teams also served as a stimulus for research activities in some cases. The case of Korea's KRISS is described in Box 4.13.

Box 4.13. Incentivising researchers – the case of Korea’s KRISS

The Korea Research Institute of Standards and Science (KRISS) is the national metrology institute of Korea. It works on providing measurement and standards services to customers at home and abroad, and carrying out R&D activities on developing advanced measurement science and technology in the areas of physical metrology, metrology for quality of life, industrial metrology and convergence technology. Human resources are of top priority and research scientists account for around 60% of KRISS’ permanent employees. More than 90% of the research scientists have doctoral degrees in the relevant areas of their professional activities.

The programmes of incentives that KRISS provides to encourage researchers include:

- Provision of and increases in research funding.
- Cash incentives after completing projects.
- Offering opportunities to lead new and important R&D projects.
- Awarding honours (with financial rewards) for excellent research achievements.
- Special R&D funds for selected researchers with outstanding achievements.
- Awarding extra credits in performance evaluations.
- Naming KRISS Fellows, whose service until retirement is secure (*i.e.* no periodic contract renewal).
- Allowing opportunities to teach students.
- Allowing opportunities to join KRISS projects, even after retirement, as a guest researcher.
- Offering paid leave for those serving KRISS for 10, 20 and 30 years, with some financial support.
- Offering opportunities for social events.
- Regular health checks in advanced hospitals.

Source: Case study report on KRISS (Korea) supplied to the OECD Secretariat.

Many institutes play a role in researcher development. In some instances, this takes place through their co-operation with universities; this is discussed in Chapter 5 in the context of linkages between PRIs and other actors. In others, there may be internal programmes; the case study of Italy’s CNR, for instance, described CNR’s own programmes of research fellowships, training activity in PhD courses, advanced post-graduate specialised courses, and various training activities. Norway’s SINTEF case study described how junior personnel are given introductory courses in project management, as this is considered a key competence. It noted that co-ordinating EU research projects with the Framework Programmes required specialised skills in research administration. More broadly, in their context notes, some countries drew attention to their PRIs’ human resource development plans. For example, Canada’s federal Department of Fisheries and Oceans (DFO) has developed a National Human Resources Strategy whose vision is to develop and maintain a highly skilled workforce focused on scientific excellence within a culture in line with DFO- and government-wide priorities. The strategy drew on an assessment of business requirements and HR gaps, to ensure that the science sector will have people with appropriate skill sets to deliver on science programmes.

The role of human resources in connecting PRIs with the rest of national innovation systems and entities abroad is discussed in Chapter 5.

Challenges

Challenges in the area of human resources mainly related to recruitment. A number of case studies, but not all, recorded difficulties in hiring employees; this affected all staff groups – young researchers, scientists and engineers, researchers with particular experience or specialities, and other personnel. Other cases experienced difficulties in hiring foreign scientists, partly due to issues with cultural adjustment, communication, family settlement, education for children, etc. and partly due to research-related reasons. (Survey evidence on foreign staff is presented in Chapter 5 on linkages and internationalisation.)

However, Spain also drew attention to wider labour market issues in the R&D arena. In its context note, it commented that one of the main achievements of the Spanish R&D system in recent years has been the formation of a large number of highly qualified young researchers, with many instruments to facilitate the development of researchers at different pre- and post-doctoral levels. However, it has concerns about how to best integrate these young researchers into the staff of public institutes. The case study of Spain's CSIC provided further comment, noting that recruitment is highly regulated for tenured personnel, and the demand for these positions vastly outstrips supply. Hiring is more flexible for new fellowships and temporary contracts mainly based on funded research projects, but these too are heavily oversubscribed.

OECD countries in general have given high priority to developing human resources for science and technology, and have often included specific goals in their national R&D or innovation strategies (see OECD, 2010c, pp. 136-148 for recent policy trends). With ongoing increases in tertiary attainment and the numbers of research personnel in OECD countries, specific recruitment problems may be an issue of matching skills to jobs, rather than an absolute deficit of skilled people (OECD, 2010c, p. 45). In this case, training and mobility of R&D workers may be the best ways of meeting PRIs human resource needs. However, some countries may need to look at wider labour market regulation issues, so as to fully utilise their R&D personnel. Addressing gender issues, so that women researchers may fully participate in the PRI labour force, may also be an area for attention (OECD, 2011).

Summary

The evidence presented by countries in the context notes, case studies and survey results show that PRIs' organisational arrangements have undergone active change in recent years. In fact, the survey suggested organisational structure had been the most significant area of change in institutes in the past decade, with growth in institutes, sometimes via mergers, and growth in the size of research groups common. Changing goals and rationales in the PRI sector may have played a key role in driving organisational change. Other possible drivers include the trend towards increased openness, a move towards increased market responsiveness, budget pressures, and efforts to improve clarity over the division of labour between research entities.

Numerous examples of structural changes were detailed, including mergers, reorganisations and changes in status, the establishment of new centres, and the creation of new types of centres. Institutes with more business-like operational models were introduced by a number of countries, to enhance independence, autonomy and flexibility. In terms of direct industry involvement, public-private partnerships (P-PPs) emerged in

several countries; excellence centres that drew in private partners were also introduced. Some countries have used mergers and reorganisations to better align PRIs with their tasks and environments, but privatisation was rarely mentioned. As a result of ongoing changes, current organisational arrangements are varied. Few countries identified issues regarding potential future changes.

There is notable cross- and within-country diversity in PRIs' institutional/governance arrangements. Legal forms, lines of authority and internal structures come in many varieties, depending on the range of PRIs and their organisational forms. High-level strategic directions played an important role in driving PRIs' activities. These directions were delivered in a variety of ways, including: initial government decisions on setting up institutes and their scope; overarching government-devised objectives, goals and plans; and recommendations of high-level advisory bodies. Oversight and supervisory arrangements ranged from tight government control through to fully independent entities. The survey evidence suggested that PRIs' internal management play a bigger role in decision-making than do public authorities, across a wide range of issues, including research orientations and use of funds. Nevertheless, government representation on boards, appointments to upper management, public funding decisions and supervisory arrangements channel government influence, even to institutes that are independent and self-governed. The question is how effective these channels are in practice. Several countries also described performance contracts and evaluation schemes, sometimes linked to funding, that provided further steering to PRIs.

With respect to institutional/governance arrangements, in addition to changes associated with the introduction of business-like structures, change for the most part involved the introduction of new decision-making bodies or revisions to supervisory arrangements. Some countries made efforts to incorporate more "bottom up" direction from industry. Looking ahead, no particular changes were signalled; rather, the focus may be on continuing to search for optimal steering arrangements that can help achieve goals such as excellence while at the same time keeping up with a changing environment. Effectively incorporating the views and input of multiple stakeholders across multiple levels is one challenge in this.

Funding can be a crucial parameter in determining the direction and activities of PRIs. The overall trend appears to be towards increased levels of competitive funding, although PRIs remain diverse in their sources of income and the manner in which funding is delivered. Increased industry involvement in funding was highlighted in a number of country context notes, and income from abroad has also increased (although from a low base). The core institutional or "block" tranche of public funding is undergoing change, with some countries introducing performance-based elements or moving towards more contractual arrangements. The survey evidence corroborates many of these trends, with institutes experiencing increases in public competitive funding and private contract income, and decreases or constant shares in public institutional funding. Nevertheless, as part of reinforcing their science base, some countries have highlighted increased funding for their PRI sectors. Competitive funding raises issues for some countries, with concerns over non-productive competition between entities, a focus on shorter-term projects and co-ordination difficulties across levels of government. The ability to finance equipment and infrastructure was also raised. Revisions to funding and governance structures were foreseen in some countries.

Human resources remain a major input to PRIs' activities. There is considerable diversity in staff sizes and employment structures; for instance, researchers' shares of the workforce were less than 50% in some cases, and over 50% in others. Changes in PRIs' orientations and structures have fed through to changes in human resources – some institutes grew in size while others shrank. Most institutes in the survey indicated researcher shares had risen, while those of technicians and administrative personnel were static. PRIs motivated their staff in a variety of ways, often incorporating funding, research opportunities and career progression. Some PRIs were experiencing recruitment difficulties, while for others, general labour market regulation was causing issues for employing young researchers. OECD countries in general have given high priority to developing human resources for science and technology; training, mobility and labour market reform may hold the keys to recruitment issues.

Notes

1. This draws on question 3 of the survey. Response rates were: Austria: 84%; Italy: 74%; Norway: 88%; Poland: 88%. Statistics for Slovenia not supplied.
2. Until June 2009, Research Councils reported to the Department for Innovation, Universities and Skills. At this time, the Department was merged with the Department for Business, Enterprise and Regulatory Reform to form the Department for Business, Innovation and Skills (BIS).
3. This draws on responses to survey question 19. Response rates were: Austria: 73%; Italy: 43%; Norway: 90%; Poland: 99%. Statistics for Slovenia not supplied.
4. This draws on responses to survey question 12. Institutes were asked to indicate if the share of funding from abroad had increased, decreased or stayed the same over the past decade. Response rates were: Austria: 78%; Italy: 54%; Norway: 90%; Poland: 83%. Data for Slovenia not supplied.
5. While the survey data are consistent with the funding trends seen in the context notes, they should be interpreted as indications only. The data are not weighted for the actual volumes of different types of funding for PRIs; the aggregate trends may look different if absolute monetary values were used. Also, institutes may have experienced many changes in funding sources over the past decade, but the sequencing and size of these changes were not able to be detailed in the response. Additionally, Poland noted that the response options may not have reflected Polish circumstances.
6. This draws on responses to question 14 of the survey. Response rates were: Austria: 67%; Italy: 40%; Norway: 90%; Poland: 87%.
7. This draws on responses to a component of survey question 15. Response rates for question 15 were: Austria: 74%; Italy: 43% (for this component); Norway: 92% (for this component); Poland: 97%.

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Chapter 5

Public research institution linkages and internationalisation

National and international linkages are an important facet of public research institutions' operations. This chapter presents evidence showing that the importance of linkages has increased for many institutes in recent years. Methods of linking are varied, and differ by partner and by country. Most linkages are collaborative, and purely competitive relationships appear to be limited. Some countries identified scope to increase the linkages of their PRIs; however, this may need to be tempered by considerations of PRI size.

This chapter draws on the evidence provided by members and observers of the OECD Working Party on Research Institutions and Human Resources (RIHR) in country context notes, case studies and survey reports, to discuss public research institutions' (PRIs') linkages within national innovation systems and connections abroad. It presents recent trends and describes some of the main drivers of change in linkages and internationalisation. It then discusses various methods used by PRIs to link to other entities, and presents evidence on the extent of collaboration versus competition. Finally, it notes some views on the strength of linkages and areas for improvement.

Links to and collaboration with other players in the national innovation system and abroad are an important facet of PRIs' operations. It is reasonably uncommon for PRIs to operate in isolation; survey evidence from Austria, Italy, Norway and Poland found that a status of "no relationship" was most often recorded between PRIs and foreign firms and foreign public administrations.¹ The vast majority of PRIs surveyed indicated they had relationships with domestic and foreign universities. Domestic and foreign PRIs and domestic public administration (*e.g.* ministries, etc) were also common partners for surveyed institutes; at most, 12-16% of PRIs indicated they did not have a relationship with these players.

Clearly, the exact nature of linkages depends on the individual PRI and its research profile. Potential partners are wide-ranging and could include other PRIs, government ministries/agencies, universities and other higher education institutions, industry and independent research groups, both national and international. As an illustration, Norway noted that some of its social science research institutes work closely with universities, while others work closely with government and industry, with the approach depending on whether the institutes are basic research- or applied research-focused. Linkages can also take many forms; Australia's Defence Science and Technology Organisation (DSTO), for instance, is involved in a variety of industry alliances, collaborative agreements, research agreements and technology licensing agreements, and participates in various Co-operative Research Centres as well as Centres of Expertise in universities.

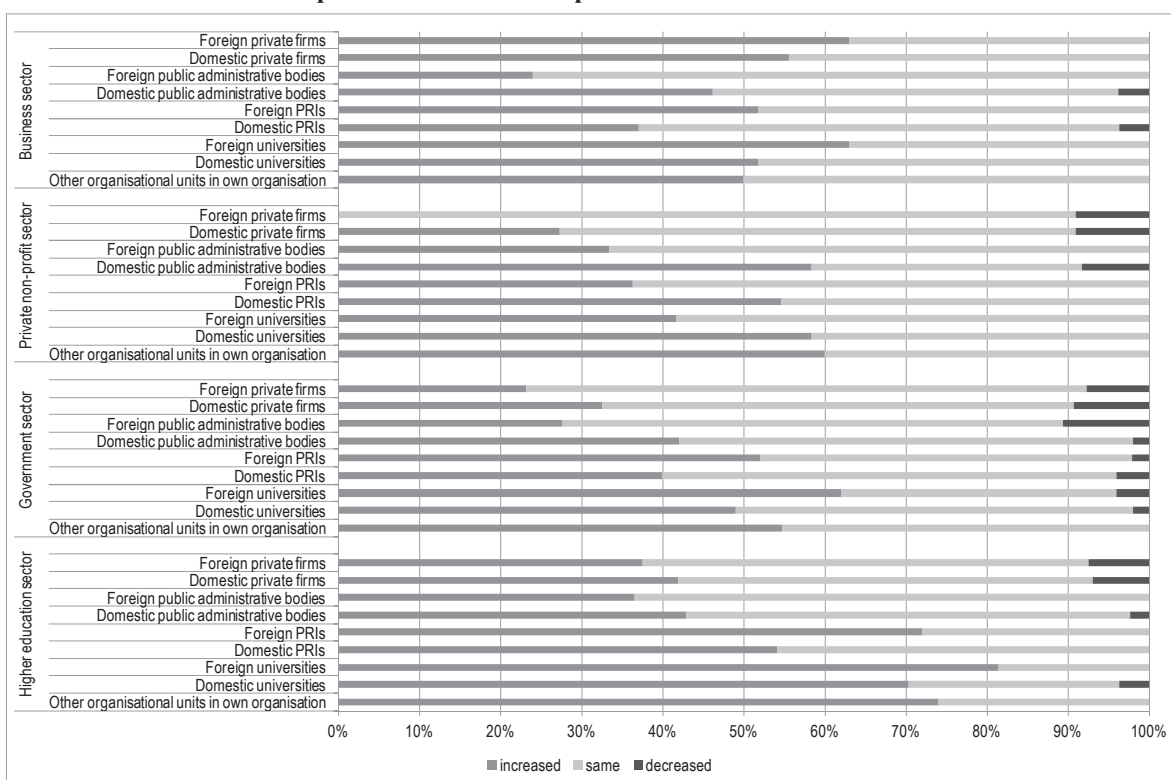
Recent trends

At a general level, the survey evidence pointed to a reasonably clear increase in the importance of PRIs' relationships with other players in research and innovation systems.² In Italy and Norway, more than half of responding institutes indicated that their relationships had become more important with all actors except foreign firms and foreign public administrations. In Poland, the pattern was similar, although less than half thought relationships with domestic PRIs had become more important. The results for Austria were slightly different; more than half of responding PRIs considered their relationships with domestic and foreign universities, foreign PRIs and units within their own organisation had become more important, but relationships with other players were more likely to have been considered to maintain or decrease their level of importance (Box 5.1 describes the Austrian data at a more disaggregated level). In Austria, Italy and Norway, the biggest increase in importance was recorded for relationships with foreign universities; Italy's PRIs also noted stronger relations with units in their own organisation, while Norwegian PRIs also noted strengthening links with domestic universities. In Poland, the biggest increase in importance was seen in relationships with foreign PRIs and domestic firms, perhaps reflecting the ongoing evolution of the PRI sector following Poland's economic opening.

Box 5.1. Austrian PRIs – trends in the importance of relationships – survey evidence

The figure below shows the Austrian responses broken down by the Frascati sectors (OECD, 2002) in which PRIs appear: higher education, government, private non-profit and business. The data showed that the strengthening of PRI relationships with foreign universities took place across most different types of PRI. It also shows that PRIs in the higher education sector in particular regard their relationships with a number of other actors to have increased in the last decade. A partial reason is the responses from temporarily implemented institutes, which typically are hosted by universities. More generally, it may partly be due to the overall increase in the higher education sector's R&D profile in recent years. Those operating in the business sector also saw important strengthening in relationships with foreign firms.

Trends in the importance of relationships between Austrian PRIs and other actors



Note: This breakdown by sector was calculated by Joanneum Research on the basis of responses to question 9 of the survey.

Source: Austrian survey report supplied to the OECD Secretariat.

Box 5.2. Foreign staff in PRIs – survey evidence

The survey results indicated that the share of staff with foreign nationality has remained the same over the last decade for many institutes in Italy and Poland. In Poland, 68% of respondents said the share of foreign staff had remained the same, while in Italy, this share was 57%. The results were more even in Austria, where almost half of the responses indicated that this facet of internationalisation had remained static, while half pointed to an increase. In Norway, in contrast, this aspect of internationalisation has clearly strengthened, with 70% of responding institutes indicating an increase in foreign staff.

Note: This draws on responses to survey question 12. Institutes were asked to indicate whether the share of staff with foreign nationality had increased, decreased or stayed the same in the past decade. Response rates: Austria: 78%; Italy: 54%; Norway: 90%; Poland: 96%. Statistics for Slovenia not reported.

Source: Survey reports supplied to the OECD Secretariat.

When asked specifically about their degree of internationalisation, surveyed institutes indicated that this had increased across a number of facets.³ For all countries, more than 80% of responding institutes had increased the number of international partners over the past decade. Eighty or more per cent of responding institutes in Austria, Italy and Norway had also increased the number of countries with which they had established relations (the share in Poland was 72%). The share of responding institutes that indicated an increase in the share of international joint research projects ranged from 67% in Austria to 80% in Norway, while participation in international committees had increased for 56% to 73% of responding institutes (in Poland and Italy, respectively). Funding from abroad had a similar profile (as was discussed in Chapter 4). The share of staff with foreign nationality was one of the weaker performing facets of internationalisation overall, with only Norway recording a strong increase in this indicator (Box 5.2). (The case studies also noted that employment of staff with foreign nationalities was low – this was suggested to be a result of labour market regulations, language difficulties, and perhaps institute-specific factors⁴ (OECD, 2010a)). Slovenia noted that the trend was towards increasing internationalisation among its PRIs, mainly via growing co-operation with foreign universities and PRIs.

Some drivers of linkages and internationalisation

Governments play an important role in shaping the pattern of PRI linkages. For instance, the country context notes showed that in some countries, certain institutes are explicitly designed to link as part of their main functions. As an example, the Flemish Government's Excellence Centres (*Excellentiepolen*) are primarily oriented towards co-operation among innovation actors with research and innovation relevance on a Flemish scale in different industries – automotives, logistics, innovative foods and geographic information, to name a few. Spain's technological centres are created specifically to support companies; in some cases, the centres are created by the companies in co-operation with regional governments. In addition, the national government has created an entity (*Centro para el Desarrollo Tecnológico Industrial*) to help guide firms in their participation in national and international R&D programmes. The TNO centres of expertise in the Netherlands link to universities and businesses, with the aim of strengthening the relationship between TNO and the SME sector. Denmark's Approved Technological Service (ATS) institutes are bridge-building institutions that link science and research with high-tech industry and aim to enhance knowledge transfer from the public research system to business. The working fields of the nine ATS institutes include food and agriculture, pervasive computing and metrological measuring equipment. In terms of explicitly linking to universities, Denmark's Centre for Suicide Research is an example of an institute with a contractual aim to develop strong links with university research environments.

Other PRIs may receive less explicit encouragement to link with other players. One example comes from Poland's context note, which noted that recent changes in legislation enable and strengthen co-operation between Polish Academy of Science institutes and public institutes, and between these groups and universities and firms. Poland noted that its policy has increasingly sought to address the science-industry gap and to support a more outward-looking public research system by encouraging increased co-operation between public research bodies and industry. Similarly, Italy highlighted an important legal change (Law 297/99), which aims to create a favourable context for industrial investments in research and to increase the involvement of SMEs. In Australia, the *Powering Ideas* agenda sets an ambition to double the level of collaboration between Australian businesses, universities and publicly-funded research agencies by 2020.

The push from governments for PRIs to create and maintain linkages with other players in the system can be underpinned by certain governance arrangements, such as co-ordination mechanisms. For instance, Canada noted that its federal S&T Strategy makes a commitment to enhancing collaboration among government research institutions, universities, industry and the non-profit sector. To this end, there is deliberate horizontal S&T policy co-ordination across the federal government, overseen by the Minister of Industry, and federal departments work with other players to conduct their research activities. Natural Resources Canada (NRCan) was highlighted as an example, with over 1 000 collaborative arrangements that leverage over CAD 300 million each year in addition to the department's budget. In areas of shared federal-provincial jurisdiction there are also co-ordination mechanisms in place. For example, there is a national agricultural policy framework and agreement which details joint initiatives that involve other levels of government, the agriculture sector and academia. In Chile, the Ministerial Committee for Innovation is responsible for co-ordinating the different public agencies that form the National System of Innovation for Competitiveness (SNIC – *Sistema Nacional de Innovación para la Competitividad*). The committee is chaired by the Economy Minister and has the Ministers for Education, Finance, Foreign Relations, Agriculture, Public Works, and Transport and Telecommunications as its members, thus institutionalising the linkages. Further reinforcement can come from stakeholder involvement in top level management. For example, Austria's Christian Doppler Research Association (CDG) has its partners from science and industry represented on an equal level within the Executive Board (*Kuratorium*) and Scientific Board (*Senat*), alongside the representatives of the public interest (Federal Ministry of Economy, Family and Youth).

Nevertheless, a number of institutes link with others in the course of their research and other activities but do not receive explicit government direction on these interactions. For example, the Flemish Strategic Research Centres have a mission to strive towards international excellence in their fields of research and to support the technological economic texture of Flanders. In the course of meeting this mission, and depending on the individual case and specific task, the institutes co-operate with universities, other educational institutions, international institutes and other sector-specific actors.

Links at the international level can also be pushed strongly by governments. A range of policy initiatives have been introduced in various countries and at EU level, involving funding streams and support for foreign affiliates (see OECD 2010b, p. 129). In its context note, Canada noted that the federal government actively participates in the facilitation of international partnerships among researchers, industries and other stakeholders to improve the speed with which advanced knowledge is generated and applied. Space exploration was highlighted as a notable success, with the Canadian space industry well integrated with both the US and European space communities, and many Canadian programmes including US partners. Similarly, Italy highlighted the international linkages developed by the Italian Space Agency, noting that it has a key role at the European level and has a close working relationship with NASA and other national space agencies. Italy also noted that the National Institute for Oceanography and Experimental Geophysics co-operated with international institutions in its studies and research. In a similar example, the European Union has developed a strategic approach to the role of its JRC as a partner, and has set up several high level agreements with large scientific and industrial communities on new networks and research collaboration. International links are supported in this case by high-level representation from each Member State on the JRC's Board of Governors, in addition to the logical incentives to link with other players in EU Member States, as the JRC delivers policy-relevant research and advice.

Table 5.1. Reasons for changes in the degree of internationalisation: survey evidence

Most frequently selected drivers

	Reasons for changes						
	Access to knowledge	Exploitation of knowledge	Globalised organisation of R&D	Economic needs	Strategic considerations	Political will	Other
Number of international partners	Austria (34%) Poland (25%)		Italy (43%) Norway (40%)				
Numbers of countries with established relations	Poland (25%)		Italy (41%)		Austria (31%) Norway (43%)		
Share of international joint research projects	Austria (27%) Poland (25%)		Italy (47%)		Norway (26%)		
Share of funding from abroad			Poland (23%)	Austria (35%) Italy (44%) Norway (36%)			
Share of staff with foreign nationality	Norway (57%)		Poland (25%)				Austria (23%) Italy (29%)
Participation in international committees		Italy (32%)	Poland (26%)		Austria (43%) Norway (39%)		

Notes: This draws on responses to question 12 of the survey. Response rates: Austria: 78%; Italy: 52%; Norway: 90%; Poland: 83%.

Source: Survey reports supplied to the OECD Secretariat.

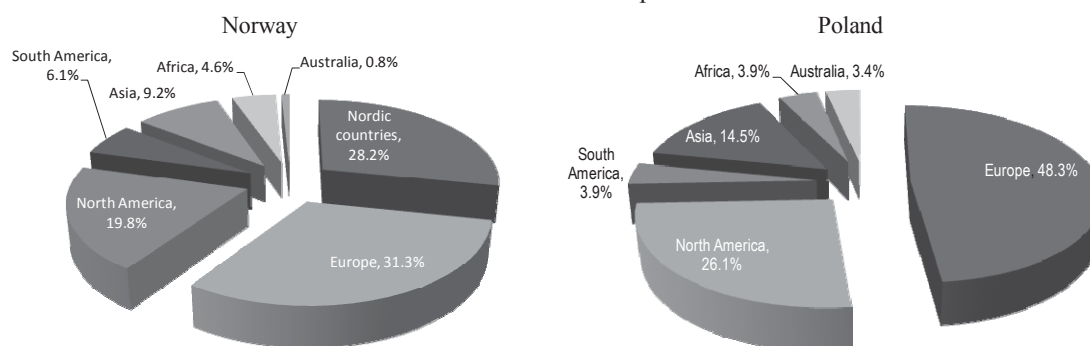
The survey responses provided additional information about the drivers of international links. Institutes were asked to note the factors behind changes in various internationalisation indicators, such as participation in international committees (with a caveat that the design of the question may have restricted institutes' responses⁵). Access to knowledge and the globalised organisation of R&D were the most common considerations overall, although there were differences between the countries and across the different facets of internationalisation (Table 5.1). For instance, in Norway, changes in the share of foreign staff were strongly driven by knowledge access considerations (57%), while in Austria and Italy such changes were driven by "other" factors, and in Poland they were driven by the globalised organisation of R&D. Polish PRIs also indicated the importance of globalised R&D for changes in the share of foreign funding and participation in international committees, perhaps reflecting their participation in EU-level activities (see Boxes 4.5 and 4.10 in Chapter 4). Strategic considerations loomed larger for Austrian and Norwegian PRIs; this may partly reflect their smaller size and subsequent need to clearly plan and leverage opportunities abroad. Interestingly, exploitation of knowledge did not feature very strongly, generally ranking in third or fourth place as a driver of change in internationalisation indicators (although in second place for Italy and Poland with respect to foreign staff). This might suggest that PRIs have a predominant focus on knowledge creation, with less emphasis on its ultimate utilisation, and contrasts with other survey results that stressed knowledge transfer aspects of their activities (*e.g.* the importance of disseminating results to the public and supporting the growth and productivity of industry). Equally, it may be a question of interpretation of what "exploitation of knowledge" represents.

Box 5.3. Foreign locations of PRI partners – survey evidence

As part of the series of survey questions on internationalisation, institutes were asked to identify the main foreign locations and/or partners in their international linkages.¹ In all countries, PRIs had strong connections to other European countries and to North America, consistent with a long history of scientific relations with these countries. Neighbouring countries were also important for some – for instance, over 80% of responding Norwegian institutes indicated that other Nordic countries were a main foreign location for linkages. Asia was more important for PRIs in Italy and Poland than Austria and Norway, while Australia was a minor partner for all countries. Slovenia noted that foreign partners were mainly in Europe, but also in North America and Asia. The figures below detail the international partners of Norway and Poland. They indicate the “weight” of different locations in overall PRI linkages, with the shares of locations taken as a share of total responses (institutes were able to choose multiple answers).

Main foreign locations and/or partners

As a share of total responses



1. This draws on responses to question 11 of the survey. Multiple answers were possible. Responses rates were: Austria: 78%; Italy: 55%; Norway: 90%; Poland: 97%. Statistics for Slovenia not reported.

Source: Survey reports supplied to the OECD Secretariat.

Box 5.4. Development of international links – the case of Korea's KIST

The Korea Institute of Science and Technology (KIST) was established with the assistance of the Battelle Memorial Institute in the United States in 1966. Since its establishment, it has played an important role in Korea's economic development and has given birth to a number of new institutes, such as the Korea Institute of Machinery and Materials and the Korea Research Institute of Bioscience and Biotechnology.

KIST has expanded its global network over time, with a view to becoming a world-class research institute. From the 1960s through to the early 1990s, KIST focused on relations with the United States and Japan. Relations with Germany increased with the establishment in 1996 of KIST Europe, in Saarbrücken. Collaboration with China and Russia also rose during this period and, since 2000, co-operative relations with developing countries such as India and Vietnam have increased. Relations continued to deepen with the United States, with research laboratories opening at MIT (in 2004) and Carnegie Mellon University (in 2007). It now has Memorandums of Understanding with 58 institutes in 24 countries, including France, Germany, Italy, Mongolia, Russia and the United States.

In addition to its research centres abroad, key activities in the internationalisation process include attracting foreign scientists, housing foreign research institutions on the KIST campus and organising workshops and symposiums. Collaborative research and hosting international students are also important. KIST has a graduate programme for foreign students, whose purpose is technology transfer towards developing countries. A full scholarship is offered, including tuition fees, stipends, housing and insurance. It also has its own programme for three-month technical training courses in foreign institutions.

Collaborative linkages are considered more important than ever, as technological development speeds up. Partnerships are seen to bring synergies and KIST intends to further internationalise by increasing collaborative research projects, recruiting more foreign scientists and establishing research bases abroad. Relations with developing countries are viewed as necessary, particularly in the fields of climate change and green technologies.

Source: Case study of KIST (Korea) supplied to the OECD Secretariat.

At an international level, proximity appears to be important for PRI linkages. The survey evidence suggested that other European countries were the main location of PRI partners, followed by North America (see Box 5.3). However, this may also be a function of the overall level of scientific development in these countries compared to other possible partner countries, and the resulting possibilities for interaction and collaboration. A breakdown of Austrian survey responses by sector indicated that business sector institutes are working more with Asia than are institutes from other sectors. This may suggest that the type of R&D work undertaken in the business sector institutes is more in line with the interests of emerging economies in Asia. It can also take time for linkages to develop – the case study of the Korea Institute of Science and Technology illustrates how links began with Japan and the United States, and have since spread (Box 5.4).

Methods of linking

For many institutes, linkages occur through researchers interacting with other players on particular research projects. This could take the form of formal and informal co-operation between researchers, operating within their individual institutes. In Australia, a number of mechanisms have been developed to encourage collaboration between PRIs on the one hand and universities and industry on the other. The initiatives provide support to build teams, pool expertise and share facilities, with the aim of transferring technology to industry, government and the community. The CSIRO National Research Flagships programme, for example, brings together government agencies and many large companies in areas such as mining, energy and infrastructure management.

At a regional level, Austria's Josef Ressel Centres aim to support links between innovative SMEs and the research capacities of Universities of Applied Sciences, with a view to strengthening regional R&D activities. Austria also observed that Joanneum Research has close co-operation with universities in the federal state of Styria, which allows it to concentrate on applied research and technological development activities designed at providing companies with a competitive edge. Germany also noted regional-level collaboration, with some 130 networks of excellence having been developed in 32 German regions. Innovation-friendly frameworks enable the networks to help the regions to develop their particular strengths. Notably, the geographic location of PRIs can also stimulate linkages to the wider public. Australia noted that a number of its PRIs have facilities around the country, which provide support and connection to regional communities. For instance, the Bureau of Meteorology maintains a network of field offices across the Australian continent, on neighbouring islands, and in Antarctica, staffed by scientific officers and delivering services directly to the local community. The facilities undertake research of direct relevance to the area and bring social, educational, economic and cultural benefits to the community.

At the pan-EU level, the JRC works closely with other stakeholders in EU policies; the centre collaborates with over 1 000 different research and other organisations, both public and private, to achieve its goals and offers possibilities for both short- and long-term collaboration. Its independence from national and private interests means it is often called on to exercise the role of an external reference and mediator. It also collaborates closely with other European-level entities; for instance, the JRC's Community Reference Laboratory for genetically modified organisms (GMOs) in food and feed works with the European Food Safety Authority to support the authorisation process of GMOs in the EU. It also provides services directly in support of EU legislation and policy, through entities such

as the Major Accident Hazards Bureau and the European IPPC Bureau (Integrated Pollution Prevention Control).

Linkages may also manifest themselves through staff mobility. For instance, Australia noted its Researchers in Business scheme that supports placement of researchers from public research agencies (and universities) into businesses, in order to help develop and implement a new idea with commercial potential. The case studies suggested that joint positions, especially with universities, were not a general characteristic of employment structures (OECD, 2010a). However, the survey provided some evidence on the links between PRIs and universities, showing that there is a non-negligible (and often increasing) share of PRI staff that teaches part-time at universities.⁶ Norway reported that, on average, 10% of staff at responding institutes worked part-time at universities in a teaching role, with half of the institutes experiencing an increase in this share over the past decade. Similarly, in Austria, the average share of staff with such commitments was 25% for responding institutes (mainly due to the activities of institutes in the higher education sector), and 47% had seen an increase in this share over the past decade. In Italy, 65% of institutes had between 1-15% of their staff working part-time at universities; this share had remained steady for most institutes. Italy noted that part-time work options for researchers are usually limited and used for short periods only (for example, for women returning to work after maternity leave). Seventy-seven per cent of responding Polish PRIs had between 1-15% of staff working part-time at universities, and 65% had experienced an increase in this share. Slovenia noted that the share of PRI staff with part-time teaching roles differed substantially by entity, ranging from 4-40%. In its context note, the Netherlands showed a number of TNO's employees work as part-time professors at a number of universities, and there are also TNO lecturers working in higher vocational education.

Some institutes have strong links with universities due to their role in researcher training. For example, most PRI groups in Norway have interactions with universities via their activities in supervising master's degree students and providing workspace and partial funding for doctoral research fellows. In Russia, research institutes of the state academies of sciences make significant efforts to train research staff, providing a research base for tertiary education students. More generally, the EU's JRC is keen to provide access to its facilities for research and training, and welcomes researchers from new Member States and applicant countries to work on a temporary basis. The survey results reinforced the importance of the training link (see Box 5.5).

Box 5.5. Employment of post-graduate students – survey evidence

Over the past decade, more than half of responding institutes in each survey country had increased the number of post-graduate students (including pre-doctoral fellows) employed or hosted. The figures ranged from 53% of responding Austrian PRIs that had increased numbers of these workers, up to 65% of Polish PRIs. Italy commented that the increase in the number of post-graduate students in Italian PRIs may form part of the trend to replace permanent staff with post-doctoral graduates. Slovenia noted that post-graduate students had also been increasing at its PRIs.

The majority of PRIs now employs or hosts post-graduate students, ranging from 69% of responding institutes in Austria to 96% in Italy. Slovenia noted that all its PRIs employed post-graduate students. In a breakdown of responses by institute sector, Austria found that the share of institutes employing post-graduate students was higher for institutes in the higher education and business sectors; this may be partly due to the inclusion of competence centres, which are temporarily implemented institutes within the business sector that employ high shares of researchers in post-graduate positions.

Note: This draws on responses to a component of survey question 15. Norway's response rate for this component was 94%.

Source: Survey reports supplied to the OECD Secretariat.

Provision of infrastructure and other shared resources were noted avenues for interaction between national innovation system players. Japan pointed to its independent administrative institutions and national testing and research institutions fulfilling an important “backbone” role in the system through their provision of large-scale research facilities, measuring standards, and high value-added information infrastructure such as life-science databases. These resources are used by industry, academia and government. In Spain, technological and scientific parks are a new R&D instrument that aims to increase interaction and technology transfer between the public and private sectors; the parks are considered to have supported the increased number of technological centres and spin-off companies derived from public centres. Co-location was mentioned by other countries also; in Australia, for example, many of the private not-for-profit medical research institutes are situated within the grounds of, or allied with, a university, and their work often complements the skills and facilities provided in the allied universities. Similarly, Austria’s Christian Doppler laboratories and Ludwig Boltzmann institutes are established within the infrastructure of the host institutions (universities or non-university research institutions), which theoretically should support interaction between these actors.

Large infrastructure can also play a role in international linkages. Germany’s large science and research organisations attract researchers from many countries and the Helmholtz Association in particular develops and operates large-scale research facilities and scientific infrastructure that is available to international as well as national research teams. Italy, too, highlighted the importance of infrastructure as a driver of international linkages, noting that its National Institute of Nuclear Physics participated in research into the construction and use of accelerators at CERN in Geneva. In Norway, the Institute for Energy Technology (IFE) runs the Halden Reactor programme, which is a jointly financed undertaking of national organisations in 18 countries under the auspices of the OECD Nuclear Energy Agency. The European Union’s JRC grants access to many of its facilities to scientists from partner organisations via its collaborative activities.

Funding and financial support is another common way in which institutes link with other players. For example, Japan noted that some of its independent administrative institutions provide research funds to support basic research efforts by universities. The administrative institutions often utilise results from basic research by universities in the course of their own research and frequently have co-operative agreements with them to facilitate this knowledge transfer. New Zealand noted that new funding approaches have been designed to create cross-organisational platforms of research that encourage collaboration and linkages between universities and CRIs. Spain’s PRIs are able to interact with stakeholders across the national and regional levels and may apply jointly to research calls; indeed, many calls for scientific programmes are open for public institutions and private companies that can develop co-ordinated projects or activities. All countries noted the funding received by PRIs from industry players, international bodies, charities and other entities. Countries variously highlighted contract arrangements and co-operation agreements as providing the basis for funding flows to PRIs from these players.

For eligible countries, central EU funding and co-ordination initiatives provide a clear opportunity for links with other entities. Belgium’s four large Flemish Strategic Research Centres both participate in and act as co-ordinators of EU-funded R&D projects through the EU Framework Programmes, the Competitiveness and Innovation Programme, and Structural Funds. In some cases, they also provide expertise and policy input for initiatives at EU level. For its part, Poland noted that after the collapse of the Communist system, public institutes have become increasingly interlinked by the multitude of international agencies, joint committees and projects at the EU and OECD level. Spain

considered the participation of its PRIs in the European Framework programmes to be one of the biggest changes in the Spanish R&D scene in the last 15 years. Most major public research institutions have created specific offices to support the participation of their research groups in European programmes.

The act of transferring intellectual property also creates links between PRIs and other players. The case studies found that technology transfer and the dissemination of know-how were among the most important activities in all institutes; this was organised in a variety of ways, from being a task of sub-unit through to explicit units within the organisation (OECD, 2010a). The context notes provided some examples also; in Spain, for instance, the national government has created a network to link the various Offices for Transferring Research Results that are located inside many public research entities, including universities. These offices guide and develop interactions between PRIs and firms and are also involved in the management and valorisation of know-how and patent portfolios of PRIs. Similarly, to boost the use of intellectual property created in government-funded research institutes, the Korean government is working to support the formation and operation of IPR units in institutes; the focus is currently on recruiting IPR experts, strengthening the outsourcing of certain activities such as registration, and building information technology systems for IPR management. It also plans to ease regulations on pre-consultation and approval related to technology transfer. Some general details of IPR arrangements in PRIs are discussed in Box 5.6.

Box 5.6. Intellectual property rights and PRIs – evidence from context notes

The RIHR country context note questionnaire asked about the general regulatory environment faced by public research institutions, including in the area of intellectual property rights (IPRs). A variety of arrangements are in place, with differences in the type of laws that govern IPRs and in where IPRs are vested. Some examples follow:

- In several countries, such as Austria, Finland and Norway, the regulatory environment for PRIs concerning intellectual property is no different to that of companies and other entities. Similarly, in Russia, IPRs created in a public research entity are regulated in accordance with Part 4 of the Civil Code of the Russian Federation.
- In other countries, however, some research institute-specific rules may apply. For instance, the Danish law on inventions in PRIs entails that those inventions done as part of work for government institutions belong to those institutions. For ATS institutes, however, the private law on intellectual property applies. In Chile, IPR associated with inventions coming from publicly funded R&D projects follow the general rules of the Industrial Property Act. However, in cases where the contracting party is a university or government agency, there is a special rule that concedes ownership to the latter of all (worthy) findings under contract.⁷
- For the EU's JRC, all intellectual property created by staff is the property of the European Communities, as the Staff Regulations contain an explicit article which states inventions and any writings or other works performed by staff belong to the employer.

Researchers may sometimes receive a share of the proceeds from their intellectual property developments:

- In Italy, patents based on research conducted by researchers are the commercial property of the institution, but the intellectual property of the researcher is recognised and in the case of commercialisation a special reward is given to the researcher. Spanish regulations provide the researchers of public institutions the opportunity to receive a fraction of patent royalties.
- In Poland, acts of law on copyright and industrial property rights leave decisions on how to divide profits stemming from IPR between inventors and organisations to internal regulations. This can cause problems, particularly when the Supreme Chamber of Commerce questions agreements from the public interest point of view.

.../...

Box 5.6. Intellectual property rights and PRIs – evidence from context notes (continued)

Sometimes, guidelines exist to help define property rights:

- In Australia, intellectual property is generally vested in the research organisation, but guidelines assist government departments to strike a balance in contract negotiations over intellectual property that keeps commercialisation opportunities alive without detriment to the national benefit. Similarly, in New Zealand, intellectual property is generally vested in the research organisation, but for contracts funded by government departments, guidelines exist to help departments strike a balance in contract negotiations that keeps commercialisation options alive without detriment to the national benefit. For contracts funded through the Ministry of Science and Innovation, the party best placed to commercialise the development would be expected to own the rights.

Source: Country context notes supplied to the OECD Secretariat.

The PRI survey provided further insights into linkage methods by showing the methods that are used with different partners. Institutes were asked to characterise their links with other (domestic and foreign) actors, with options ranging from “only informal exchange” to “collaborative centres – joint research labs”.⁸ The first notable result was that countries’ PRIs link in many different ways to their partners, suggesting there is no “one-size-fits-all” approach to relationships within innovation systems. Table 5.2 provides a snapshot of Poland’s PRIs’ linkages with their partners to illustrate this point. PRIs’ responses were aggregated for each type of partner entity. The results show, for instance, that PRI linkages with other PRIs take many forms, with regular meetings, collaborative centres – joint research labs and regular joint projects the most frequent links, but joint publications, shared infrastructure and PhD training programmes also notable activities.

Table 5.2. Linkages between Polish PRIs and other (domestic and foreign) actors

	Universities	Public research institutes (non-university)	Public administrative bodies (ministries, agencies, etc.)	Private firms	Others (e.g. associations, etc.)
Only informal exchange	3.3%	5.5%	12.4%	14.1%	13.7%
Regular meetings/workshops/conferences (at least quarterly)	12.8%	15.3%	24.4%	14.1%	20.0%
Head of institute and leaders of research groups/units also employed at ...	11.5%	6.5%	10.4%	2.7%	8.4%
Staff also employed at ...	14.2%	8.5%	7.5%	10.9%	9.5%
Regular (at least quarterly) personal exchange (based on programmes)	4.3%	3.3%	2.0%	2.7%	2.6%
Training programs for PhD from ...	10.9%	9.0%	3.0%	3.3%	5.8%
Training programs for ...	8.6%	8.3%	13.9%	15.2%	14.7%
Collaborative centres – joint research labs	9.7%	13.3%	3.0%	9.8%	7.4%
Sharing infrastructure with ...	5.4%	9.0%	6.0%	7.6%	3.2%
Regular (at least quarterly) joint publications (based on institutionalised co-operation)	9.1%	9.3%	5.5%	6.5%	6.3%
Regular (at least quarterly) joint projects (based on joint programming)	10.1%	12.0%	11.9%	13.0%	8.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

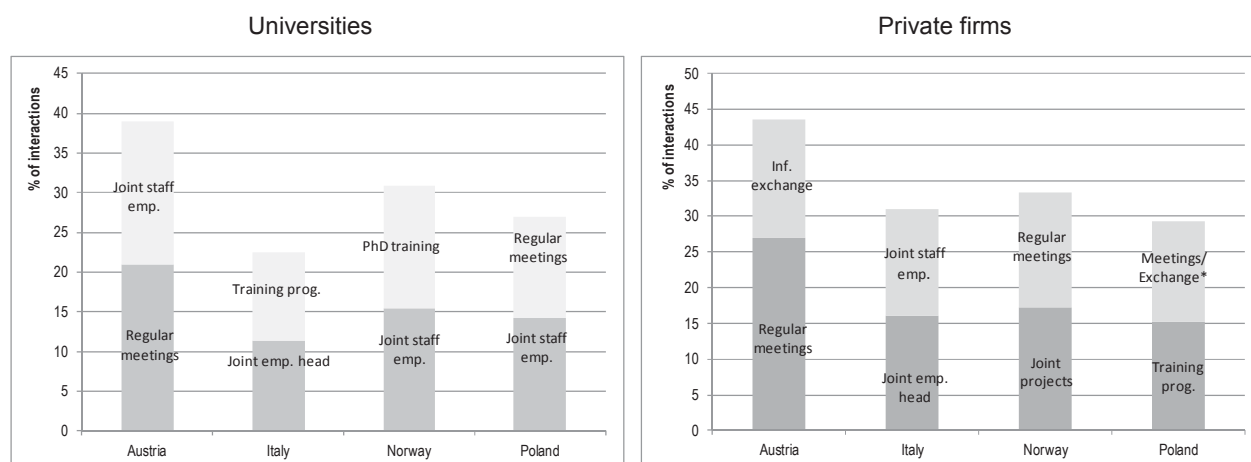
Source: Polish survey report supplied to the OECD Secretariat.

The second notable result was the diversity by country in the types of links used with different partners. In Italy, PRIs most commonly linked with all other actors via joint employment of institute heads and leaders of research groups/units, while in Austria, “regular meetings/workshops/conferences (at least quarterly)” were the most common link with all entities except “other”. In contrast, the most common links used by Norwegian and Polish PRIs differed more by partner entity – for example, joint staff employment was the most common link with universities, while with firms, Norwegian PRIs most often had “regular (at least quarterly) joint projects based on joint programming” (Polish PRIs most often had training programmes for firms). Figure 5.1 shows the two most common links used by PRIs with university and private firm partners, by country. It shows, for instance, that joint employment of various categories of employees was the most common linkage between Italian PRIs and private firms, accounting for just over 30% of institutes’ responses on links with private firms. Austria noted that the high share of joint staff employment with universities may partly result from the inclusion of temporarily implemented institutes in the survey, although the pattern can also be seen in Academy of Sciences institutes.

The case studies confirmed this diversity in linkages. In general, across the 12 case studies, all kinds of linking mechanisms were applied: informal exchanges, project-based co-operation, strategic alliances, personnel exchange, joint research centres, and others (OECD, 2010a). In their connections with universities, for example, the level of formality ranged widely, from informal knowledge exchange, close interaction on research projects, joint programmes and educational co-operation, secondment of researchers, through to embedded laboratories in universities.

Figure 5.1. Top two linkage methods between PRIs and selected partners

As a percentage of total interactions with selected partners



Notes: This figure is based on responses to question 10 of the survey.

Categories of interaction noted in the figure refer to the following question response options: “Inf. Exchange”: Only informal exchange; “Joint emp. head”: Head of institute and leaders of research groups/units also employed at (partner); “Joint projects”: Regular (at least quarterly) joint projects (based on joint programming); “Joint staff emp.”: Staff also employed at (partner); “PhD training”: Training programmes for PhDs; “Regular meetings”: Regular meetings/workshops/conferences (at least quarterly); “Training prog”: Training programmes for (partner).

* In Poland, regular meetings and informal exchange tied for the second most common linkage method with private firms.

Response rates to this question were: Austria: 91%; Italy: 58%; Norway: 90%; Poland: 97%. Statistics for Slovenia not reported.

Note that Norway did not include the category “Training programmes for (partner)” in its survey questionnaire.

Source: Survey reports supplied to the OECD Secretariat.

Collaboration and competition

One issue that was raised in some country context notes was the potential for linkages (and co-operation) with business to turn into a (real or perceived) competitive relationship. The results of the survey provide some evidence on the extent of PRIs' collaboration and competition with industry actors in the research and innovation system.⁹ For the majority of institutes, relationships with private domestic and foreign firms, where they existed, were of a pure collaborative nature, rather than competitive or a collaborative-competitive mix. Italy and Poland had the highest proportions of collaborative relationships between PRIs and firms. In Italy, 86% of relationships with private firms were collaborative, along with 76% of those with foreign firms. The figures for Poland were 70% for domestic firms and 74% for foreign firms. In Austria, 67% of relationships with domestic firms were collaborative (the figure was 65% for relationships with private foreign firms). Sixty-two per cent of relationships between Norway's PRIs and domestic firms were collaborative, compared to 70% of those with foreign firms. Outright competitive relationships with firms were rare; where relationships existed, these were competitive in 0-14% of cases with domestic firms, and 0-8% of cases with foreign firms. The case studies also suggested that relationships with firms are typically collaborative (OECD, 2010a). Altogether, this might suggest that while some intensely competitive relationships may exist between PRIs and firms, it is not the norm.

The survey results also described the nature of PRIs' relationships with other actors in the research and innovation system, ranging from units with the PRIs own organisation, through to foreign public administrative bodies. They showed that where linkages existed between PRIs and other players, collaboration was frequently the dominant type of relationship, *i.e.* accounting for more than 50% of relationships. In Austria, purely collaborative relationships were the majority in all cases. For Italy, collaboration accounted for more than 50% of relationships with all other players except other research units within the PRI's own organisation. For Poland, the exceptions were with domestic universities and PRIs, while for Norway's PRIs, collaborative relationships accounted for less than 50% of total relationships with domestic universities and domestic and foreign PRIs. Slovenia noted that numerous relationships with other actors in the research and innovation system were recorded, and were identified as collaborative in the majority of cases.

Overall, the share of pure collaboration was highest in relationships with public administrative bodies (ministries, agencies, etc.). For instance, collaborative relationships as a share of total relationship with domestic public administrative bodies ranged from 86% in Poland to 90% in Norway; similar results were reported for foreign bodies. Relationships with firms, as described above, were the next most purely collaborative types of linkages.

Linkages with other PRIs were a mixture of pure collaboration and collaborative-competitive relations. Norway recorded the lowest share of purely collaborative relationships between domestic PRIs, at 11% of total relationships; collaborative-competitive relationships accounted for a further 83%. At the other end of the scale, Italy's PRIs reported that 51% of their relationships with their local peers were collaborative, while a further 42% were collaborative-competitive. Norway also reported the lowest share of purely collaborative relationships with foreign PRIs, at 39%, while 66% of Poland's PRIs' links to foreign PRIs were collaborative. Again, the bulk of other relationships were a mix of collaboration and competition.

Collaborative relationships as a share of total relationships with domestic universities ranged from 26% in Norway to 56% in Italy; around 6-7% of reported relationships were purely competitive. It thus appears that domestic universities are more likely to compete with PRIs activities than domestic firms. This accords with the data presented in chapter 2, in that as R&D activity in universities has increased over time, there is more scope for overlap. It also accords with concerns raised in the context notes about blurring divisions of labour between entities in countries' innovation systems. With foreign universities, collaborative relationships were more common, accounting for 51% (Norway) to 68% (Italy) of PRIs' relationships. Slovenia also noted that relationships of a mixed collaborative-competitive nature appeared with domestic universities, while only collaborative links appeared with foreign universities.

The strength of linkages

There is no one “right way” to measure the strength of linkages. Poland's context note particularly noted the lack of “ready-made diagnosis” in this area, and suggested a variety of indicators to inform the debate. These included data on co-publications and co-patents, and information on research and innovation consortia (both formal and informal), provision of services for SMEs, linkages with multinational enterprises, linkages with world science, linkages with other institutions, linkages with business associations and policy links between funding ministries and institutes.

Nevertheless, some country context notes pointed to evidence that linkages could be stronger. In Poland, the sources of information for innovative activities in Polish industry and enterprises during the period 2004-06 were primarily “inside enterprise”, “clients/customers”, “conferences/fairs/exhibitions”, and “suppliers of equipment/software/components”. Public research institutes were rated low on the list, suggesting that either linkages are poor or PRIs are not providing the type of information firms need. Similarly, the United Kingdom's context note pointed out that the 2007 UK Innovation Survey revealed that few firms used government or PRIs as a source of information and suggested there was room for improvement in knowledge transfer between these players. Spain considered private sector interactions with its public research centres to still be below a satisfactory level and suggested this issue was one of the main concerns of the Spanish R&D system. These observations are supported by data on collaboration between innovative firms and government or public research institutions; Figure 2.19 in Chapter 2 showed that for most countries, less than 15% of innovative firms collaborated with PRIs in 2006-08, and for Poland and Spain the share was less than 10%.

Linkages via staff mobility were also considered weak in some countries. For instance, in Korea, government-funded research institutes are considered to have relatively low levels of “manpower exchange and talent outsourcing”. More flexible use of human resources may help institutes to face the challenge of creating a favourable environment and conditions for joint research. Similarly, in Japan, a 2007 report on the State of Independent Administrative Research and Development Institutions highlighted the issue of personnel mobility between research institutions, and recommended dismantling various obstacles and barriers, such as compensation or pension-related factors, to facilitate the flow of people between organisations.

For some countries, the strength of linkages depended heavily on the sector or field of research of the PRI. In New Zealand, for example, the most solid links between CRIs and the business sector are with primary sector players. CRIs have relationships with industry bodies, large processing and product development firms, and commodity levy

associations related to agriculture and primary production. There are also several research consortia in the primary sector area that formalise partnerships between firms, industry groups and research organisations to undertake longer-term research contracts. Linkages are less well developed in other areas, such as manufacturing. The context note suggested that this may be due to the features of manufacturing firms, including their smaller size, their spread across a diverse range of subsectors, and their need for quicker flow-through to marketable products and services than perhaps is provided by PRI projects.

While the strength of linkages may present scope for improvement in certain cases, there was also evidence that expectations should not be uniform across different PRIs. For instance, the case studies suggested that international linkages may also be a function of institutes' size. Larger institutes, those with multiple research areas and those with more intensive academic orientations tended to have linkages with a more diverse range of countries. For some of these larger entities, internationalisation may even be a statutory task (see Box 5.7 for the example of Italy's CNR).

Box 5.7. Size matters – internationalisation and Italy's CNR

Italy's National Research Council (CNR) is the largest Italian public research body and was established in 1923. Its mission, formally stated in law, is to “carry out, promote, spread, transfer and improve research activities in the main sectors of knowledge growth and of its applications for the scientific, technological, economic and social development of the country”. Within this, one of its goals is to promote the internationalisation of the research system. The CNR had more than 8 200 employees in 2010, including more than 4 000 researchers and 3 000 junior scientists completing their training. Its institutes cover a wide range of scientific fields, housed within 11 departments covering life sciences, agrifood, materials and devices, medicine, energy and transport, molecular design, earth and environment, cultural heritage, information and communication technologies, cultural identity and production systems.

Taking part in large research programmes and international organisations, and fostering collaboration with foreign research institutions, is one of CNR's main statutory tasks. It participates in the European Framework Programmes for Research and Technological Development and other EU initiatives, and is an active member of the European Heads of Research Councils association (EuroHORCs) and the European Science Foundation (ESF). CNR represents Italian science in more than 50 international non-governmental organisations, and ensures national participation in the management and use of large international scientific facilities. Researcher mobility is promoted within bilateral agreements that incorporate joint research projects of 2-3 year duration that consist of Italian and foreign scientists, individual visits and bilateral workshops. Bilateral agreements are in force with institutions in more than 25 countries, both large and small, developed and developing (*e.g.* Albania, Brazil, China, Egypt, Germany, Israel, Japan, and the United States). Mobility is also promoted via the Short-term Mobility Programme that is addressed to researchers at CNR, Italian universities and other Italian public research institutions, who wish to participate in research activities carried out in foreign scientific institutions or universities.

Each department has a vast array of international linkages, formed through the activities of their institutes. The international collaborations and partners of the Energy and Transport Department provide a small sample of the multitude of CNR linkages:

European Automotive Research Partners Association – EARPA (joining independent European research centres in the automotive sector)	European Atomic Energy Community – EURATOM / ITER project (for research on nuclear fusion)	European Joint Technology Initiative (JTI) on hydrogen
European Space Agency – ESA (for aerospace research activities)	French National Centre for Scientific Research – CNRS	Institut Français du Pétrole
Max-Planck Institut – Germany	Universities of Osaka, Cambridge, Leeds	Daimler Chrysler, Bosch, STM, General Motors

Source: Case study report on CNR (Italy) supplied to the OECD Secretariat.

Summary

Links to and collaboration with other players in the national innovation system and abroad are an important facet of PRIs' operations. The exact nature of linkages depends on individual PRIs and their research profiles; however, institutes rarely operate in isolation. The survey evidence pointed to a reasonably clear increase in the importance of PRIs' relationship with most other players, except foreign firms and foreign public administrations. Relationships with foreign universities recorded the biggest increase in importance in several survey countries. PRIs' degree of internationalisation had risen across several facets, including the number of international partners, countries with established links and joint research projects. The drive to link and internationalise in many cases came from government, through institute design, changes to legislation, co-ordination mechanisms and various policy initiatives. But equally, the survey responses pointed to "access to knowledge" and "globalised organisation of R&D" as key considerations for PRIs in their internationalisation activities.

Methods of linking were varied. For many institutes, researcher interaction on projects was important, including with firms and universities. Staff mobility was part of this, and part-time teaching roles for PRI staff at universities may be increasing. Some institutes have strong links with universities due to their role in researcher training, and the survey showed many institutes had increased the number of post-graduate students employed or hosted. Provision of infrastructure was another avenue for interaction, and large infrastructure certainly plays a role in some international linkages. Funding and financial support were clearly common channels through which institutes linked to other players, and EU funding is significant for some eligible institutes. Transferring IPR and knowledge provides a further channel. The survey showed that PRIs link to different partners in different and numerous ways, from informal exchange, to regular meetings and staff exchange, to joint publications and collaborative centres. Different countries displayed different patterns; some were more likely to link via joint employment of staff, while others made heavier use of regular meetings.

Some countries expressed concern that linkages could precipitate unhelpful competitive relationships between research entities. The survey showed, however, that for the majority of institutes, relationships with private domestic and foreign firms, where they existed, were of a purely collaborative nature and outright competitive relationships were rare. Pure collaborative relationships were frequently the dominant type of relationship with other entities as well, although the details varied by country. Linkages with other PRIs tended to be a mixture of pure collaborative and collaborative-competitive relations. Domestic universities were more likely to be a competitor than domestic firms.

While there is no one right way to measure the strength of linkages, some countries suggested there was room for improvement in their PRIs interactions with other actors. Limited use of PRIs as information sources, and low staff mobility, were viewed by some as indicators of weak links. However, the case studies suggested that links may be a function of institutes' size, with larger PRIs having a greater range of linkages, both national and international. Expectations of interaction levels may need to be calibrated accordingly.

Notes

1. Based on responses to a sub-component of survey question 9. Institutes were requested to characterise their relations with other actors as “competitive”, “collaborative”, “both” or “no relationship”. Response rates were: Austria: 85%; Italy: 58%; Norway: 90%; Poland: 98%. Statistics for Slovenia not reported.
2. This is based on responses to a sub-component of survey question 9. Institutes were asked to note whether, during the last 10 years, the importance of relationships with various actors had increased, stayed the same or decreased. Response rate was: Austria: 85%; Italy: 58%; Norway: 90%; Poland: 98%. Statistics for Slovenia not reported.
3. This draws on responses to question 12 of the survey. Institutes were asked to note whether certain indicators of internationalisation had increased, decreased or stayed the same over the past decade. Response rate: Austria: 78%; Italy: 54%; Norway: 90%; Poland: 96%. Statistics for Slovenia not reported.
4. Institute-specific factors were cited as one potential driver of differences in foreign staff employment levels in Finnish public research organisations (see Loikkanen *et al.*, 2010).
5. This draws on responses to question 12 (part *b*) of the survey. Only one pre-defined “reason” (*e.g.* access to knowledge) could be linked to each internationalisation indicator (*e.g.* number of international partners). Institutes were thus limited in their responses. In addition, the reasons given relate to all directions of change specified in the earlier part of the question (*i.e.* for each indicator, levels of internationalisation could have increased, decreased or stayed the same). The responses therefore indicate general determinants of change. Micro-level analysis would be required to draw specific links between internationalisation indicators, directions of change and underlying reasons. Response rates to this question were: Austria: 78%; Italy: 52%; Norway: 90%; Poland: 83%.
6. This draws on responses to a component of survey question 15. Response rates were: Austria: 74%; Italy: 30-33% (for this component); Norway: 92% (for this component); Poland: 97%.
7. In its context note, Chile highlighted that maintaining an adequate and balanced intellectual property system is a key issue for the Chilean economy. In 2008, Law 20.254 created a National Industrial Property Institute for the registration of patents. In addition, a new institutional framework for industrial property administration was enacted, with a reformed Industrial Property Office improving registration services for trademarks, geographic indications, patents, utility models, industrial designs and layout designs of integrated circuits. The government has also developed instruments to strengthen the protection of intellectual property, such as CONICYT’s Programme for the Promotion of Patenting. More broadly, the Chilean legal and institutional framework for IPR confers protection to all categories of intellectual property included in the TRIPS agreement and additionally confers protection to new plant varieties, appellations of origin and utility models. Protection of IPR is ensured at constitutional level and furthered in numerous laws. Chile has also become a party to numerous multilateral IP agreements, including via free trade agreements.
8. This discussion draws on responses to question 10 of the survey. This question took the form of a matrix where institutes were asked to tick if a type of linkage (*e.g.* training programmes for PhDs) applied with an actor (*e.g.* domestic or foreign university). Response rates were: Austria: 91%; Italy: 58%; Norway: 90%; Poland: 97%. Statistics for Slovenia not reported.
9. The discussion in this sub-section is drawn from responses to question 9 of the survey. Institutes were requested to characterise their relations with other actors as “competitive”, “collaborative”, “both” or “no relationship”. Response rates were: Austria: 85%; Italy: 58%; Norway: 90%; Poland: 98%. Statistics for Slovenia not reported.

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Chapter 6

Implications of change – public research institutions' performance and policy agenda

Public research institutions (PRIs) have undergone much change in recent years and are now a diverse set of institutes. This chapter highlights the evidence on their outputs and performance, drawing on the evidence from context notes, case studies and survey as well as evaluations. While assessments are often positive, they also highlight issues that require policy attention to boost PRIs' effectiveness in meeting their missions. The evidence points to a future policy agenda centred on ensuring the relevance of PRI activities, shaping government funding to support PRI goals, enabling linkages and bolstering human resources.

National-level R&D data, and evidence from the OECD Working Party on Research Institutions and Human Resources' (RIHR) country context notes, institutional case studies and institute-level survey, has painted a picture of a public research institution (PRI) sector in flux and with much diversity. While the Frascati-defined government sector has become a smaller share of total R&D activity in many OECD countries, the popular notion of what is a “public” institute has widened over time, to include entities from the business, higher education and non-profit sectors. As such, the role of “public” institutions remains crucial in overall national innovation systems. Over recent years, PRIs have undergone significant changes in their orientations, organisational structures, funding and linkages, driven by a variety of factors, including changing government priorities and operational environments. As a result, PRIs come in many different forms and sizes, with different methods of governance and diverse activities.

Results from RIHR's institute-level survey summed up PRIs' recent trends. The survey requested institutes' views on the most significant changes that had taken place in their development over the past decade (Box 6.1). The answers provide an interesting view of the main trends and pressures, as seen by the institutes themselves. Across countries, organisational structure clearly stood out as an important change, with PRIs in Austria, Italy, Norway and Poland most frequently identifying this as a significant change in their development. New strategic directions were often cited as a major driver of change, while expansion of PRIs was frequently the way in which changes were manifested.

Given this background of ongoing change in organisational structures, orientations, linkages, and more, it is important to take stock of the effects of these changes on PRIs' performance and to identify where challenges remain. Are PRIs achieving their goals, are new organisational and governance arrangements working well, are institutes on a sustainable trajectory to continue contributing to national research and innovation efforts, and where does further policy work need to be undertaken? This chapter examines evidence on the outputs and performance of PRIs, drawing on information from the country context notes, case studies and survey, as well as evaluations of institutes and policy changes. It then discusses some of the challenges PRIs see ahead, highlighting the key issues emerging from evidence presented in the report and drawing implications for a PRI policy agenda.

Box 6.1. Significant changes in institutes' development – survey evidence

The institute-level survey asked institutes to identify three significant changes in their development over the past decade, and specify for each one the causes and drivers of change and the manner in which change appeared. The table below aggregates, at country level, the information provided about the first significant change PRIs identified.¹ It sets out the three most frequently noted changes, drivers and manifestations of change for each participating country.

The data reveal that organisational structure was the most significant change identified in Austria, Italy, Norway and Poland; for Slovenia, changes in missions were the most significant change. Other frequently noted changes were in the portfolio of activities and in steering and management. For example, changes in organisational structure accounted for 38% of identified changes in Norway, with a further 17% of changes related to steering and management. Causes and drivers of change were most often new strategic orientations, scientific developments, public budget restrictions and political developments, although the importance of these differed by country. Changes manifested themselves clearly in growth of institutes, additional scientific fields, mergers and new management structures.

.../...

Box 6.1. Significant changes in institutes' development – survey evidence (*continued*)

As the data are simply aggregated at the country level, cause and effect relationships between the changes and the drivers and manifestations of change identified by PRIs, cannot be confirmed. Micro-level analysis of the results, taking into account complementary qualitative information, could provide additional insights into the relationships between the different variables in each country. It is also interesting to disaggregate the data by sector. Analysis by Austria showed some differences according to the Frascati sector to which Austrian institutes belonged; for example, PRIs in the higher education sector more frequently identified mission changes, while those in the government sector were more affected by public budget restrictions.

The three most frequent changes, drivers and manifestations of change – survey evidence

	Change of		Causes and drivers of change		Appearance of change in...	
Austria	Organisation structure	29%	New strategic orientation	29%	Growth of institute	18%
	Portfolio of activities	21%	Scientific development	25%	Additional scientific fields	16%
	Steering and management	19%	Public budget restrictions	15%	New management structures	12%
Italy	Organisation structure	38%	New strategic orientation	41%	Merger of institute	21%
	Steering and management	17%	Public budget restrictions	22%	New management structures	16%
	Mission	17%	Scientific development	13%	Growth of institute/ Additional scientific fields	15%
Norway	Organisation structure	38%	New strategic orientation	35%	Growth of institute	17%
	Steering and management	17%	Political development	26%	New management structures	14%
	Portfolio of activities	13%	Scientific development	14%	Increased internationalisation	12%
Poland	Organisation structure	24%	Scientific development	25%	Additional scientific fields	21%
	Portfolio of activities	18%	New strategic orientation	24%	Growth of institute	13%
	Relationships with other R&D actors	17%	Technological development	18%	Larger research groups	11%
Slovenia	Mission		New strategic orientation, scientific development, and overall economic development/Political development		Growth of institute	

Note: This table is based on responses to question 3b of the RIHR survey. Institutes were given a series of tick-box options (with the possibility to specify other answers or add comments). Institutes were able to tick multiple boxes. The results shown are drawn from an aggregation of institute responses in each country. Percentages are share of total responses (institutes could choose multiple answers for this question). Response rate for this question: Austria: 84%; Italy: 70% (sub-question on change), 63% (sub-question on causes), 68% (sub-question on appearance); Norway: 88% (sub-question on change), 84% (sub-question on causes), 80% (sub-question on appearance); Poland: 88%. Statistics for Slovenia were not supplied. See Annex 3.A for further details on characteristics of the survey data.

1. Following discussions with country experts at a project meeting in February 2011, only the first of the three significant changes described by institutes was noted in the survey reports sent to the Secretariat.

Source: Survey reports supplied to the OECD Secretariat.

PRIs' performance measured by outputs

Scientific publications are one important output of PRIs, alongside more industry-oriented outputs such as patents. Data in Chapter 2 showed that PRIs (as defined by the Frascati government sector) own only a small share of all international patent filings, although they have higher shares in some focal areas. Cross-country data on scientific publications in the government sector were not available for this study; however, data from the United States suggest a decreasing share of articles are published by PRIs, consistent with the sector's decreasing share of total research activity.

The institute-level survey showed that publications (both refereed scientific articles and other publications such as reports) and dissemination efforts (such as participation in fairs or presentations) were often noted to have increased over the last decade for PRIs in Austria, Italy, Norway and Poland (see Table 6.1 for key trends in outputs). However, more industry-related outputs, such as patents, prototypes, spin-offs and certification activities, tended to have stayed the same over recent years (and the data also suggested that fewer PRIs were involved in these activities). Italy commented that despite the greater efforts by Italian PRIs in applied research, it appeared that industry's interest in the research outputs had not substantially increased.

For Norway and Poland, scientific publications were the output for which the highest share of PRIs indicated an increasing trend (89% and 71% of responding institutes, respectively, experienced increases in this output). In Austria, it was "other" publications (77% of responding PRIs had increases), while in Italy it was dissemination activities (72% of responding PRIs had increases). Few PRIs recorded decreased outputs in any area. Highlighting the wide range of tasks undertaken by PRIs, Polish PRIs also recorded increased activity in unspecified "other" outputs. A breakdown of PRI responses by sector in Austria showed that business sector institutes most frequently experienced increases in prototypes and spin-offs, while higher education sector institutes most frequently had increases in all types of publications.

The case studies and country context notes generally confirmed PRIs' focus on scientific publications. The case study of Korea's Research Institute of Standards and Science (KRISS), for example, noted it produces more than 300 Science Citation Index (SCI) papers annually. Austria's case study of the Christian Doppler Research Association (CDG) found that between 2006 and 2008, the scientific publication output of laboratories was dominated by peer-reviewed scientific articles (over 350 each year). The laboratories also produced non-peer-reviewed scientific publications, monographs and publications for broader audiences, and oversaw the completion of academic diplomas, theses and habilitations. This study noted that aggregate outputs depended on the age structure of the laboratories – it takes time to develop ideas to the point of patenting, for example.

Table 6.1. Trends in outputs of PRIs – survey evidenceMajority responses¹, by country

	Austria	Italy	Norway	Poland
Number of scientific publications (refereed)	increased	increased	increased	increased
Number of theses/dissertations supervised and completed	49% increased/ 49% same	increased	increased	increased
Number of publications (all others, including reports)	increased	increased	increased	increased
Number of conferences/workshops organised	increased	increased	increased	same
Number of patent applications	same	same	same	44% increased/ 43% same
Number of patents granted	same	same	same	same
Dissemination efforts (e.g. participation in fairs, information events, presentations)	increased	increased	increased	increased
Days spent on consulting	same	same	same	increased
Days spent on lectures and teaching assignments at universities	increased	same	49% increased/ 43% same	increased
Days spent on seminars and training for customers	same	increased	same	same
Number of certifications/expertise given	same	same	same	increased
Number of prototypes	same	same	same	same
Number of spin-offs	same	same	same	same

1. For each type of output, the table notes whether 50% or more of responses indicated that, over the last 10 years, outputs had shown an increasing, decreasing or “same” trend.

Note: This table draws on responses to survey question 17. Institutes were asked to indicate the trend in various outputs over the last ten years, with the possible responses being “increased”, “same” and “decreased”. Not all institutes gave a response for each type of output. The overall response rate for the question was: Austria: 72%; Italy: 43%; Norway: 88%; Poland: 97%. Data for Slovenia not supplied.

Source: Survey reports supplied to the OECD Secretariat.

Spain's case study of CSIC described how its contribution to scientific publications had increased; in the Spanish context, its share increased from 14% in 1981-1985 to 19% in 1999-2003. In the same period, its share of European production rose from 0.4% to 1.6% and that of world production from 0.1% to 0.6%. CSIC's publication output compared well with some similar European institutions but not with others; the case study suggested differences could be due to numbers of staff and facilities in different institutions, and the output profiles of different disciplines. The CSIC was considered less efficient in fulfilling its missions related to technology transfer, training and dissemination. Patents, spin-offs and public communication of science were low compared to the results for publications. The incentives for researchers were noted as a contributing factor; staff may obtain some revenues from patent royalties and company contracts, but these outputs are not usually counted towards internal promotion. Scientists thus tend to devote their time to basic research. The study suggested the structural characteristics of Spanish firms and public administration, together with the research nature of many CSIC research areas, also favoured publications over patents and other IPR-related outputs.

In its context note, the Netherlands noted that its PRIs' scientific publications in international journals had remained at a fairly constant level from 1990 to 2006, at around 12% of the national total (Steen, 2008). However, the scientific impact of these publications, based on citation scores, had risen. The 2003-06 average citation score was 1.51 (compared to 1.34 for the Netherlands as a whole). For the scientifically-oriented institutes, there was also significant output of monographs, dissertations, book contributions and other professional products. The number of patent applications to the European Patent Office by non-university public institutions in the Netherlands had also risen.

While not focused on the issue of research commercialisation, the country context notes, survey and case studies have generated a number of observations that are relevant when considering PRIs' research outputs. Recalling from previous chapters, in many cases, the rationales and aims of PRIs included supporting the growth and productivity of industry; enhancing links between science and industry was also a common goal. Surveyed PRIs noted strongly collaborative relationships with firms, and the study found increased involvement of industry in PRIs in general (via, for instance, new structures and funding mechanisms). While some countries felt links could be improved, PRIs link to industry in a variety of ways, from informal exchanges to joint projects. Altogether, the evidence suggests that there are many different connections between PRIs and industry; commercialisation of PRI research results is only one channel for knowledge transfer and different PRIs are likely to have different approaches. Incentives for commercialisation and indicators of PRI performance must be set in the context of this heterogeneity (similar arguments have been made regarding university-industry linkages and commercialisation – see Gulbrandsen *et al.*, 2011).

Evaluation results

Evaluations of individual PRIs, PRI policies and public research systems can provide further insights into PRIs' performance and outputs. Such reviews often identify areas for improvement and can highlight where certain governance, funding or organisational arrangements may be deficient. Evaluations are clearly case-specific – each PRI has different features and the context in which they operate, and the problems and issues they encounter, are not necessarily the same. Nevertheless, assessments of PRIs' performance can often provide some pointers for other countries who may be considering similar structures or experiencing similar issues. For the purposes of this report, evaluations may yield some information on how the ongoing changes to PRIs have been reflected in their performance.

This section presents the results of an earlier RIHR review of selected evaluation exercises, as well as some more recent evaluations at the institution- and system-levels. It uncovers several reoccurring themes, including the difficulties in establishing governance and funding structures that deal appropriately with multiple stakeholders and complex environments, the challenges in establishing and maintaining industry links and diffusing research results to this community, and the ongoing need for clear missions and purposes.

RIHR evaluation review

In 2009, RIHR reviewed a selection of PRI evaluations, to compare and contrast methodologies, highlight lessons learned regarding both PRI policy and evaluation processes, and discuss how evaluation results were used in practice (OECD, 2009). The

evaluations were selected on the basis of delegates’ suggestions and did not represent a comprehensive review of all recent evaluations undertaken in member countries. However, they revealed some interesting issues and suggestions on how to improve PRIs and their activities, and can give some insight into how well PRIs are performing (Box 6.2 contains a list of the evaluations studied).

Box 6.2. RIHR’s work on PRI evaluations

The RIHR’s work on PRI evaluations analysed 12 reviews, as follows:

- **Australia:** CSIRO: cost-benefit analyses (CSIRO, 2006); CSIRO Preventative Health Flagship (ACIL Tasman, 2006); Rural Research & Development Corporations (CRRDCC, 2008)
- **Czech Republic:** R&D financed from public resources (Research and Development Council, 2008)
- **Greece:** Public Research Institutions supervised by the General Secretariat for Research and Technology (GSRT, 2008)
- **The Netherlands:** Leading Technological Institutes (Technopolis, 2005)
- **Sweden:** Competence Centres Programme (1) (Alemany *et al.*, 2004); Competence Centres Programme (2) (Arnold *et al.*, 2004); Industrial Research Institutes (Arnold *et al.*, 2007)
- **United Kingdom:** Intermediate Research and Technology Sector (Oxford Economics, 2008); Knowledge Transfer Activities in Public Sector Research Establishments (Technopolis, 2006); Sustainability of Public Sector Research Establishments (Davidson, 2008)

Source: OECD (2009).

The evaluations were pitched at a variety of levels (*e.g.* sector-, institutional-, programme-level) and were mostly undertaken by consultants. Only a third of the evaluations were prescheduled and part of the ongoing operations of the PRIs, while around half could be categorised as mid-term or “check-up” assessments. Impact or value added was the most common evaluation question to be explored, followed by scientific outputs. The most common evaluation methodology was qualitative assessment, relying on interviews and questionnaires to stakeholders. Some evaluations used indicators to inform their assessment of performance; these were generally “backward looking”, in that they summed up past performance but did not attempt to judge potential future impacts of PRIs’ completed research activities.

Most of the evaluations judged that the sector, institute or programme/project in question had been of value or had performed adequately. However, the evaluations generally did not explicitly address whether there was an ongoing rationale for government support. It is difficult to construct a counterfactual (*i.e.* asking “what would otherwise happen?”) to assess whether PRI policies are generating net benefits. But it is possible that, rather than remedying a market failure (*i.e.* too little research), government support of PRIs could crowd out private sector research initiative. For example, one evaluation suggested that multinational firms may become less willing to finance fundamental R&D, as they can increasingly choose between competing offers from PRIs in different countries and regions. Another evaluation cited evidence from business participants that they would continue to work with the local knowledge infrastructure irrespective of whether centre funding continued.

Many evaluations pointed to the difficulties PRIs had in meeting the expectations of all their stakeholders. This is becoming more acute as the environment becomes more complex and numbers of stakeholders grow. The evaluations showed that governments, PRI researchers, academic partners and industry partners can have different expectations

of and objectives for the activities undertaken by PRIs. This could be one reason why initiatives fail or produce suboptimal results, from the point of view of governments. For instance, one evaluation found that the research undertaken by the PRI was no more fundamental than that done in other collaborations; yet increased fundamental research was the justification for the high level of government funding provided. Another evaluation highlighted that internal budgetary goals and funding pressures led to more short-term hiring, which seemed at odds with its goal of sustainability. This suggests a better understanding of stakeholders' motivations and likely behaviour may be useful for judging the likely outcomes of various PRI policy measures.

Related to this, the evaluations suggested that setting research agendas was a difficult balancing act for PRIs with industry links. The degree to which PRIs undertook fundamental research, and received core/capability funding to do so, had to be set against the needs of other stakeholders who had different time horizons and priorities. To help improve processes and outcomes, the evaluations suggested PRIs receive some un-earmarked core funding (on a multi-annual basis) for strategic activities, and focus agenda-setting on the overall portfolio of research, rather than individual projects, so as to promote synergy and multi-disciplinarity and allow for a longer-term research focus. Another suggestion to promote a strategic research approach and balance the influence of large stakeholders was to allocate core funding at a higher (*i.e.* more aggregated) level in the institution. The involvement of top scientists to evaluate the scientific value and relevance of proposals and to evaluate project progress was recommended.

A lack of flexibility in research agendas and stakeholder investments was identified in some evaluations, with concerns about “lock-in”. Several evaluations suggested the right balance had not yet been found between the continuity of longer-term funding commitments and the ability to change research activities along with changing priorities and interests. Some industry stakeholders also commented that governance and decision-making processes did not enable them to inject new ideas and perspectives during an initiative's lifetime. However, there was no clear answer to the “right” amount of flexibility; the approach will likely differ on a case-by-case basis, depending on research fields and policy goals.

Dissemination strategies were considered inadequate in several cases, and evaluations identified the need for specific activities to stimulate “valorisation”. Institutes did not always consider how their results would be converted into further research advances or innovations and underestimated the need for explicit efforts to promote knowledge transfer. However, suitable approaches would differ according to the goals of the institute – creating “value” through commercialisation may not be appropriate for PRIs with the explicit goal of serving industry. Evaluations also noted the importance of industry's absorptive capacity to utilise research results. Some PRIs directly engaged with firms to demonstrate research results and build capacity for future knowledge transfer.

The evaluations also drew attention to some PRI design and management issues that are relevant to the trends observed in previous chapters. In particular:

- Large industry players considered some PRIs to be too small to make a significant contribution to their research agenda and preferred larger entities with greater access to experienced researchers. The evaluations noted some evidence that PRIs were increasing their scale, and suggested this also helped them to deal with volatile customer demand. These observations accord with the trends shown in previous chapters of institute growth and widening of research scopes.

- Evaluations noted the importance of clarity in business models and in lines of accountability and responsibility. With the wide range of possible governance arrangements (as was also revealed in Chapter 4), all participants need to be clear about who takes decisions and bears risks. One example noted that longer and more complex lines of management led to difficulties in infrastructure investment decisions (RIPSS Steering Group, 2005).
- Evaluations highlighted a lack of serious internationalisation strategies in PRIs, despite much discussion of globalisation. It was suggested that for those PRIs with funding coming mainly from individual countries or subsets of countries, there was little external incentive for internationalisation. In addition, some PRIs may have found it difficult to develop strategies within decentralised governance structures.

Analysis of the evaluations highlighted that these exercises are now taking place in a more complex environment and are being subjected to new demands. Ensuring that evaluation approaches can take account of overlapping roles and responsibilities of stakeholders, multi-disciplinarity, globalisation and more complex funding arrangements is essential to ensure evaluations gather the right information, tackle the pertinent questions and remain a useful tool for policy-makers. In addition, planning for appropriate data and information to be regularly collected over time ahead of evaluations will enable a higher-quality assessment of PRI performance.

Other evaluation exercises

In addition to the general evaluations described above, there are also evaluations that seek to explicitly link PRI policy changes to their impact. The evaluation of Denmark’s university reforms, particularly the merging of nine PRIs into universities, is an example of this type of evaluation (Box 6.3). It provides some interesting early insights into the results of major changes to organisational structures and governance arrangements of PRIs. The mergers aimed to further strengthen the university sector’s global competitiveness, by concentrating research capacities and improving “critical mass”. They also aimed to help universities better serve society, including by contributing to economically relevant innovations in the private sector. They sought to stimulate research synergies between previously separate sectors, “fertilise” universities with practice-oriented research (and increase connections between universities and the private and public sectors), and increase research resources for education.

Given the recentness of the changes (the mergers took effect from 1 January 2007), the review panel was not able to give a comprehensive view of their effects. Academic staff had not yet experienced any particular impacts on their research, although they believed the mergers had strengthened pre-merger research collaborations, created new intra-institutional co-operation structures, and led to new intra-university funding initiatives. The review panel suggested that mergers have acted as “change drivers”, and noted some initial positive effects, such as new study programmes. Looking ahead, the panel recommended that the government consider whether the new “map” of universities and research is serving the interests of society and whether further mergers are desirable. It also recommended a debate on individual university profiles and what type of diversity should exist – in particular, whether universities should have agreed specialisations or should compete. Proposals for developing strategies on EU funding and industry collaboration were also put forward.

Box 6.3. Danish university reforms – background

The Danish university sector has undergone substantial reform in recent years. Reform has come in two stages; first, the 2003 University Act, which addressed university autonomy and codetermination; and second, the 2007 merger process, which saw 9 PRIs (government research institutions, or GRIs, in Danish terminology) integrate into universities, as well as several universities merge with each other. Both reforms aimed to strengthen the global competitiveness of Danish universities and were set in the context of Denmark's Globalisation Strategy. Altogether, the reform package aimed to provide universities with an enhanced capacity for strategic prioritisation across activities (education, research and knowledge transfer) as well as with an enhanced ability to meet demands of society.

The GRIs were integrated into the universities in the form of faculties, departments or professional units, with effect from 1 January 2007. The Technical University of Denmark integrated Risoe National Laboratory, the Danish Institute for Food and Veterinary Research, the Danish Institute for Fisheries Research, the Danish National Space Centre and the Danish Transport Research Institute. Aarhus University merged with the Danish Institute of Agricultural Sciences and the National Environmental Research Institute. The University of Southern Denmark took in the National Institute of Public Health, while Aalborg University took in the Danish Building Research Institute. Four GRIs remained independent; these were the National Research Centre for the Working Environment, the Danish National Centre for Social Research, the Kennedy Centre and the Geological Survey of Denmark and Greenland.

The framework for the evaluation of Denmark's university reforms was outlined in the Danish Parliament's resolution V9 of 16 November 2006. It noted that the purpose of the mergers were more education, greater international impact of research, more innovation and collaboration with industry, the attraction of more research funding from the EU, as well as a continued competent service in the area of government commissioned research.

The review team found difficulties in assessing the effect of mergers on the international impact of Danish research, as "impact" was not adequately defined. The panel noted that Danish universities already performed well in terms of scientific article outputs, impact and productivity and scored well on institutional rankings. They recommended greater clarity be given to the research targets of universities, and the role, profile and mission of each entity. They questioned whether universities should have mutually agreed profiles and roles, or whether there should be more open competition between them.

The review panel found Danish participation in EU Framework Programmes to be high in some areas, but low in others, and the involvement of Danish researchers in project co-ordination was low overall. Various reasons were put forward for this, and the panel suggested there was a gap between political expectations and the "on-the-ground" capacities and actions of researchers with respect to the importance of EU funding. The panel recommended that the government clarify its arguments for emphasising EU funding and develop strategies and targets to promote it.

The panel made some initial observations about the impact of the mergers on education, noting that other policy reforms had been introduced over the past few years and that disentangling impacts was difficult. Some new study programmes and subjects had been offered, and there were examples of new interdisciplinary programmes, although these were still limited in scope. Researchers from the merged PRIs had become involved in teaching (additional teaching-oriented training for these researchers was suggested), and there was some increase in foreign student numbers. Several universities had established new PhD schools and PhD student numbers had increased. The panel recommended that the government consider providing funds, on a one-off basis, for planning and piloting new programmes.

To investigate the change in universities' relationship to the business sector, the panel looked at the share of university research funded by private companies. This was low, and while some reasons for this were proposed, the panel judged that there was a lower level of university-industry collaboration in Denmark than in comparable countries. They recommended developing a strategy to intensify relationships, and also proposed a tax deduction to encourage Danish companies to contribute funding.

The panel also considered whether the four currently un-merged PRIs ought to join with universities. While the PRIs themselves preferred the status quo, the panel suggested that mergers could take place if there was a good match with a university and if merging would contribute to critical mass, research synergies and stronger connections with industry. It recommended the government reconsider the integration of these four entities.

Source: Ministry of Science, Technology and Innovation (2009).

While the Danish evaluation provides a perspective on systemic policy changes already implemented, other evaluations may review PRIs in order to recommend such policy changes. For example, in October 2009, New Zealand’s Ministry of Research, Science and Technology¹ established the Crown Research Institute Taskforce, with a mandate to investigate how New Zealand’s PRIs (the Crown Research Institutes or CRIs) could best deliver on national priorities and respond to user needs.

Through its examination, the Taskforce found that CRIs’ capabilities were nationally relevant and unlikely to be provided by other research entities such as universities (Crown Research Institute Taskforce, 2010). However, the Taskforce concluded that current funding, ownership and governance arrangements were impeding CRIs’ performance, by creating unclear objectives, multiple lines of accountability, over-reliance on competitive contracts and disincentives for collaboration. Some of these issues were also raised in an earlier OECD review of New Zealand’s innovation system (OECD, 2007).

Box 6.4. Review of New Zealand’s Crown Research Institutes

New Zealand’s Crown Research Institutes (CRIs) were formed in 1992-93 from existing government research laboratories and funding streams. Their creation aimed at consolidating national scientific capability around key aspects of New Zealand’s economic, environmental and social requirements. In 2009 there were eight CRIs, representing a quarter of New Zealand’s total research expenditure. A Crown Research Institute Taskforce reviewed the CRIs in late 2009 and recommended a number of specific actions to improve their impact on the New Zealand economy. The actions included:

- Clarifying the exact role each CRI should play in delivering benefits to New Zealand and recognising the distinct role of each CRI relative to other research organisations, via a Statement of Core Purpose.
- Allocating a more significant proportion of CRI funding on a long-term basis to support the delivery of core purpose activities.
- Consolidating core purpose funding into a single contract to reduce compliance costs.
- Putting less emphasis on contestable processes as a performance driver and more emphasis on holding CRIs accountable for delivering on their Statement of Core Purpose.
- Setting aside a tranche of funding for major national collaborative challenges to encourage new multi-disciplinary areas of work.
- Increasing CRI accountability, by strengthening board accountability, measuring CRIs against more balanced and comprehensive performance indicators (including financial viability as opposed to profitability), increasing use of independent expert science panels, and making a tranche of core funding “at risk” against milestones.
- Combining CRI investment, ownership and policy responsibilities into one entity.
- Developing a national research infrastructure strategy to rationalise and ensure open access to major research infrastructure.

Some of these actions have now been taken, notably the creation of the Ministry of Science and Innovation from a merger of the former policy and funding bodies. Work is continuing to implement the remaining recommendations.

Source: Crown Research Institute Taskforce (2010).

1. Now the Ministry of Science and Innovation.

The Taskforce recommendations aimed to encourage CRIs to take a longer-term perspective, co-operate with complementary parts of the national and international innovation system, and transfer their knowledge to users. The key actions proposed included setting clear Statements of Core Purpose and raising the share of core purpose funding, and balancing this with strengthened board accountability and comprehensive performance assessment (Box 6.4). The company legal structure for CRIs was recommended to be maintained, but with a goal of encouraging efficient management, rather than for-profit commercial business activity. Implementation of the key actions and recommendations is now underway.

Some recent evaluations have investigated the performance of newer types of PRI. For example, Norway recently evaluated its 14 centres for research-based innovation (SFI), which were started in 2007 (Research Council of Norway, 2010). The SFIs were intended to promote innovation by supporting longer-term industry-oriented research and better connecting enterprises and research groups. They were based on experiences with similar types of centres in Europe, North America and Australia and were a new experiment for Norway. The evaluation formed a “midway” review, and its outcomes provided evidence for decisions about ongoing funding. The review teams generally concluded that the centres were successful. Their staff members were of high calibre, they received good support from their host universities as well as industry partners, their research had demonstrably aided industries and organisation in the public sector, and some have fostered increased research co-operation across institutional borders.

Some weaknesses were identified, related to visibility, peer review, management and forward planning. The review team found that the external visibility of some SFIs was obscured by certain practices, such as identifying centres as projects at host institutions rather than distinct operating units, and not identifying centre affiliation on scientific publications and conference reports. It also suggested SFI-related material was insufficiently visible on the Research Council of Norway website. Not all SFIs had an international scientific advisory board providing regular peer review. On management, the reviewers found that boards would benefit from greater independence of chairs, and management teams required better structure and more formality so as to ensure participation of scientists and user partners in project planning and monitoring. Given the significant resources so far dedicated to the centres, the review team also believed better strategic planning was required for the period beyond current funding commitments. To address these issues, the review team made a number of recommendations, including that Board chairs should be selected from user partners, and that guidelines be developed for presentation of affiliations and for peer review.

Challenges ahead

The evidence presented above on PRIs' outputs and performance, combined with the issues raised in previous chapters on operational features, activities and linkages, clearly paints PRIs as continually evolving entities. Though institutes are maintaining or increasing their research outputs, they are continuing to identify areas for improvement, particularly in establishing governance and funding structures that deal appropriately with multiple stakeholders and complex environments, establishing and maintaining industry links and diffusing research results to this community, and setting clear missions and purposes. Governments are seeking policy instruments and settings that can boost these institutes' effectiveness in providing research and other services to fulfil their missions and contribute to a stronger national innovation system.

The survey and case studies further confirm that the process of change and continual improvement is unlikely to recede. PRIs face ongoing challenges and must regularly review whether their structures and processes are adequate for the task. Results from the institute-level survey help to pinpoint the key themes that will potentially spur change in PRIs in the future. Institutes responding to the survey frequently noted “increasing scientific impact”, “increasing the degree of internationalisation”, “recruitment and retention of highly qualified personnel” and “increasing contract research” as their main challenges in the next five years. Table 6.2 lists the top 3 responses from institutes for each country, ranked according to the share of responses for each “challenge category”. It reveals commonality across countries, in that their PRIs all appear to be facing similar issues, although with some differences in the urgency of each of these challenges. For example, recruitment was the most frequently noted challenge in Norway, while it was third-ranked in Austria (and lower-ranked in Italy). Additionally, analysis from Austria suggested there were some differences in the views of institutes in different sectors. Austrian PRIs in the Frascati higher education sector most frequently selected increasing scientific impact as a main challenge, while those in the government sector regarded organisational development as a bigger challenge.

Table 6.2. Institutes’ main challenges in the next five years – survey evidence

	Challenge – rank 1	Challenge – rank 2	Challenge – rank 3
Austria	Increase scientific impact	Organisational development	Recruitment and retention of highly qualified personnel
Italy	Increase scientific impact	Increase contract research	Increase degree of internationalisation
Norway	Recruitment and retention of highly qualified personnel	Increase degree of internationalisation	Increase scientific impact
Poland	Increase contract research	Increase scientific impact	Increase degree of internationalisation
Slovenia	Challenges included increasing degree of internationalisation, increasing scientific impact, increasing contract research and increasing industry impact		

Notes: This table is based on responses to question 21 of the RIHR survey. The results shown are drawn from an aggregation of institute responses in each country. Institutes could choose multiple responses. Rankings were established according to the share of responses received by each challenge category. Response rate for this question: Austria: 72%; Italy: 41%; Norway: 90%; Poland: 99%. Statistics for Slovenia were not supplied. See Annex 3.A for further details on characteristics of the survey data.

Source: Survey reports supplied to the OECD Secretariat.

Similar areas were highlighted by PRIs in the case studies. PRIs were asked whether there were needs or prospects for change across several facets of their operations – missions, activities, organisational structure, funding and external linkages. In many cases, the PRIs pointed to (in some instances, large) expected alterations in their operations:

- Half of the PRIs described likely factors that would push changes in their missions or rationales in the near future. They pointed to changes in the operational and policy environment, including longer-term changes in priorities around climate change and resource depletion. One PRI noted that its multi-functional research assignment implied constant flux in roles and functions, while another expected its ambitions to become an internationally-recognised institute would result in important mission changes.

- Three-quarters of the case study PRIs expected changes in their activities. Changes in market/customer demands were the likely driver of such change – PRIs mentioned changes in governments' technological demands and related policies, new demands in the marketplace, an increased focus on technology transfer and dissemination activities, calls for an increased industry focus, and plans to be more international. Progress in science and technology was also considered to be a factor in changing activities, and several PRIs mentioned the desire for more multi-disciplinary activities.
- Several PRIs noted that changes in activities would likely lead to changes in governance and management practices (*e.g.* human resource plans) or to organisational structures (*e.g.* new groups to administer technology transfer, and new spin-offs using PRI-created technologies). One PRI noted that a more customer-based perspective in the public sector would likely lead to governance changes. Two PRIs explicitly mentioned possible mergers and consolidation. Changes to legal instruments, and ongoing accumulation of experience, were also considered to be potential drivers of structural change.
- More than half of the case study PRIs expected future changes in their funding arrangements. Several noted their expectations for a diversification of sources, particularly an increase in external financing (*e.g.* via joint projects, EU programmes, regional funds, *etc.*). At the same time, several also expected increases to their public institutional funding, to help boost their mid- to long-term research activities. Performance-funding arrangements were expected to affect the financing of some PRIs. One PRI noted that it may itself play a new role as a funding agency.
- Almost all the PRIs mentioned their expectations (or, the necessity) for increased international links in the future, as a result of ongoing globalisation, cross-country research themes (*e.g.* climate change), the need to gain access to sophisticated and expensive instrumentation, and ambitions to play a leading role internationally. Some foresaw more international laboratories, research bases and joint centres. Several mentioned increasing the numbers of foreign scientists and personnel exchanges. Increasing links to developing countries were noted by several PRIs

Shaping a policy agenda – key points and future directions

The wealth of material gathered by the RIHR project on the transformation of PRIs shows that this sector has undergone much change in recent years and is consequently populated by a diverse range of institutes. As highlighted by the institute-level survey, organisational change has frequently stood out as a major change for PRIs, and new strategic directions have been a notable driver of their evolution. In practice, change has frequently manifested itself as an expansion of PRIs and their activities.

While evaluations of PRI performance are often positive overall, they have uncovered several reoccurring themes, including the difficulties in establishing governance and funding structures that can cope well with multiple stakeholders and complex environments, the challenges in establishing and maintaining industry links, and the ongoing need for clear missions. Survey evidence revealed that publications and dissemination efforts have increased over time for PRIs, although more industry-related outputs have tended to stay the same. This situation was generally confirmed by the case studies and country context notes.

Ongoing evolution in the form and function of PRIs is thus to be expected; the process of change and improvement is unlikely to cease. Surveyed institutes identified “increasing scientific impact”, “increasing the degree of internationalisation”, “recruitment and retention of highly qualified personnel” and “increasing contract research” as their main challenges in the next five years. Similar issues were identified in the case studies, with PRIs especially expecting changes in their activities, international linkages and funding arrangements.

Altogether, the information and evidence presented in this report point to a policy agenda for PRIs centred on ensuring the relevance of PRI activities, shaping government funding to support PRI goals, enabling linkages (domestic and international) and bolstering human resources. These issues are not self-contained – arrangements in one area influence another (*e.g.* international linkages may influence funding sources). This highlights the importance of embedding focused slices of policy analysis within a “bigger picture” of PRI systems as a whole. In addition, further evaluation evidence would be a valuable input into analysis of how PRIs can be better designed, implemented and managed. Picking out the main policy challenges and key considerations and insights that arose from the country context notes, case studies and survey yields the following potential roadmap for PRI policy analysis:

A. Ensuring the relevance of PRI activities

Concerns about increasing scientific impact, and changing missions and activities, are broadly about ensuring that PRIs remain relevant to user needs, be they of government, other PRIs, higher education establishments, industry or wider society. Effective steering and governance is central to this, and analysis in the previous chapters identified this as one of the most important issues that will test and change PRIs in the future. But steering and governance is increasingly difficult – the methods that governments use to task PRIs with missions and roles are operating in ever more diverse environments, with multiple stakeholders and multiple sources of funding.

Analysis of PRIs’ research activities shows the possible difficulties in steering. PRIs follow predominantly public-oriented missions and, in most countries, undertake a significant amount of applied research, although the fields of study attracting the highest share of government expenditure (as well as the absolute amounts of spending) differ widely. By socio-economic objective, the categories of “agriculture” and “health and general advancement” frequently appear as important areas of spending in many countries’ government sectors. In contrast, survey data showed that the field of “engineering and technology” was frequently judged by PRIs as a “very important” activity. These observations highlight that although PRIs as a group have public goals, many PRIs face pressures to provide research relevant to a wide range of stakeholders, including industry. Governments should question whether the research priorities they envisage for their PRIs are the same as those envisaged by PRIs themselves. While governments continue to express their desired directions for PRIs via funding, regulations and senior appointments, if not direct management and ownership, there is a question as to how clear this direction is and how closely it can be followed, especially when PRIs have numerous other interests to satisfy. The country-level evidence showed PRIs often pursue multi-faceted missions and rationales, and that decision-making is predominantly considered the domain of internal management, rather than public authorities. The observations also underline the importance for countries of assembling better data and information to underpin policy, as some of the differences in results are due to the wider

sample of PRIs used in the RIHR study. Policy decisions may need to consider the broader range of PRIs that now exist and that are not captured in traditional statistical indicators.

Evaluation is one (often underused) way for governments to learn about the impacts of different choices for organisational and operational designs. The report has described numerous structural changes to PRIs. Growth in institutes and research groups, sometimes undertaken via mergers, has been a common occurrence, and in some instances has been driven by a search for increased critical mass. Taking stock of the impact of these changes and learning lessons from them is important, especially since every change of this nature has financial implications. Higher priority should be given to scheduling evaluations and assessments of performance that explicitly attempt to trace the effects of structural and management changes on outcomes (and comparing these to *ex-ante* goals). Further evaluation of the increasing number of PRIs with business-like operational models against their stated goals of increased autonomy, collaboration and responsiveness to stakeholders (as well as against desired research priorities) would be one valuable area to progress. Testing and evaluating different methods of gathering, co-ordinating and operationalising key stakeholders' inputs to target-setting would also yield important information for policy making, as would assessments of the effectiveness of the performance agreements and contracts that some countries have established with their PRIs.

At the same time, governments need to recognise the trade-offs often inherent in their visions for PRIs. Pursuing greater collaboration with industry and other stakeholders, increasing the reactivity of PRIs to the needs of these players, and raising the steering power of these stakeholders via their funding contributions, necessarily reduces the influence of governments over PRIs and their research priorities.

B. Shaping government funding to support PRI goals

Funding is another key issue and an area where PRIs have already encountered challenges. The use and effects of competitive funding, the desire for autonomy, the role of core “no strings attached” finance, the challenge of attracting foreign funds as part of internationalisation efforts, and the ability to meet the cost of major equipment and infrastructure needs – these concerns confront PRIs and policy makers, and demand funding instruments that can balance short- and long-term goals and the requirements of different users, guard research quality and ensure the sustainability of PRI activities. PRIs are generally experiencing an increase in industry funding and also income from abroad (although from a lower base). There were strong increases in public competitive funding and private contract income for PRIs participating in the survey. Overall, PRIs now have a diverse set of funding sources; furthermore, these differ across institutes and across countries.

There is a need to continue analysing how different government funding instruments impact on PRI behaviour and performance, especially in research and service provision, but also regarding their longer-term investments in infrastructure and equipment. A number of governments still make strong use of institutional (or “block”) funding, where PRIs may have more choice over the way funds are spent. This suggests mission and priority setting is important, but it also raises questions over how allocation of institutional funding can be used to shape PRI behaviour. Some work has been done on performance-based funding in tertiary education institutions, and the OECD's RIHR group will continue to examine different public funding tools at the cross-country level.

There is also a need to examine the impacts of competitive project funding on PRIs, clearly identifying the goals sought by policies requiring PRIs to seek this type of funding.

More broadly, policy makers need to consider the relative role of PRIs in the public research arena. There has been a clear shift in the funding mix for public research over time, with the higher education sector increasing its share of public R&D expenditures. At the same time, PRIs continue to be an important source of new knowledge and a central actor in the linkages across innovation systems. In addition, the data re-tabulation described in Chapter 2 showed how the picture of a country's PRI sector can change when the analysis includes relevant business sector entities and excludes non-R&D-focused government sector entities. Future funding decisions need to consider how various instruments (new forms of competitive funding, for instance) will affect the division of funding between PRIs and other research providers and the potential impact of this funding mix.

C. *Enabling linkages*

Enabling a level of linkages and internationalisation that supports PRIs activities is another challenge. The vast majority of PRIs have (predominantly collaborative) links to other players, but there is a sense that the research and outputs they produce could be better used and that stronger linkages would assist in achieving this. Cross-sector funding of research is one method of linking; national-level data show industry funding of government sector R&D is low on average in the OECD (although the share may be higher when the full range of entities considered to be PRIs is taken into account). Data also show a low percentage of innovative firms collaborating with PRIs. The survey results revealed that PRIs are interested in pursuing knowledge transfer and dissemination, yet linkages are driven more by knowledge acquisition than knowledge exploitation.

The degree of internationalisation has increased across a number of facets for many PRIs, with institutes increasing their country links, joint research projects and participation in international committees. Increased linkages are being pushed both by PRIs' need to access knowledge and their governments' aspirations for PRIs' performance. Geographically proximate countries appear to be the main partners and case study evidence underlined how linkages develop over a long time. The main methods of linking differ by partner and by country, but personal interactions are crucial. The survey results, for instance, showed that joint positions and regular meetings were the top linkage method between PRIs and universities; they were also important linkage methods with firms, alongside joint projects and training.

However, the role for policy in further stimulating linkages is not clear. Given the wide variety of linking methods and the differences across countries and PRI partners, as well as the evolutionary nature of collaboration, there is a question of what policy can do to improve the situation. Expectations cannot be uniform across PRIs either; for instance, large entities, those with multiple research areas, and those with more intensive academic orientations tended to have more diverse international linkages. Action on linkages and internationalisation may need to focus on how steering and funding arrangements impact on PRIs' incentives for collaboration and competition with other entities.

D. Bolstering human resources

Finally, human resources, as a key input to PRI activities, may also require policy attention. Countries have seen a rebalancing of R&D personnel towards a greater share of researchers, and many institutes play a role in researcher training and development. Some PRIs have experienced recruitment difficulties, related to specific groups or skills, while others faced difficulties due to wider labour market regulations. Institutes are also challenged in their recruitment of foreign staff. Internally, establishing systems of staff motivation and reward that support the research outputs foreseen by PRIs' missions may be a challenge for some institutes. Analysis on human resource issues could focus on the role of policy in supporting researcher training efforts, the desirable balance of research and technical personnel, analysing the effects of internal incentive systems on research outputs, and assessing the scope for change in wider labour market regulations.

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Public Research Institutions

MAPPING SECTOR TRENDS

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