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Funding of Public Research and Development: Trends and Changes

by
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1. Introduction

This paper describes trends and practices in the funding of public research and development (R&D). It is based on a study which was carried out by the OECD's Directorate for Science, Technology and Industry. The study dealt with several aspects of the governance of public research such as the structures of science systems, priority setting issues, funding and the management of human resources.[1] The paper provides a picture of the structures and schemes for the funding of public R&D, the development trends, and the changes as well as the reasons for such changes in OECD member countries.[2]

2. Funding levels

The following graphs (see Figure 1) show that – apart from Switzerland – all countries have increased government funding for public sector research over the last few years. These are figures for 2000/01 or closest available year.

While sizeable in absolute terms, increases in funding for public sector research have only kept pace with the expansion of OECD economies. As a share of gross domestic product (GDP), funding for R&D in universities and other public research institutions (PRIs) remained essentially flat at 0.61%

Figure 1. **Development of government funding for public sector research**

Millions 1995 USD

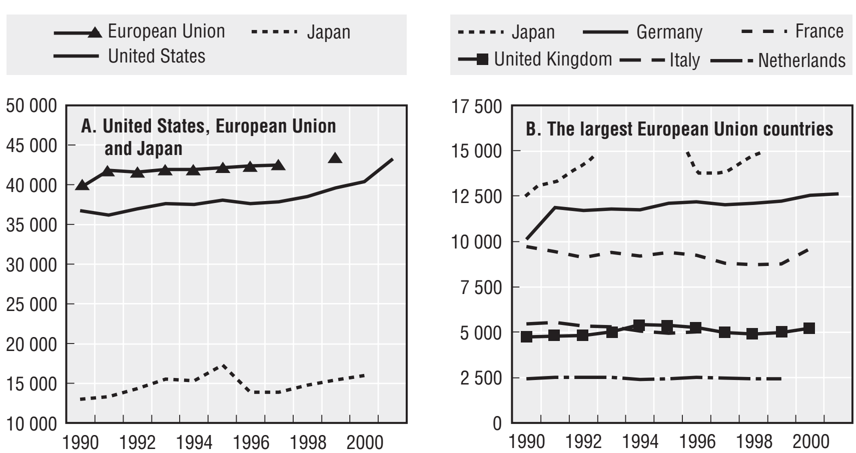
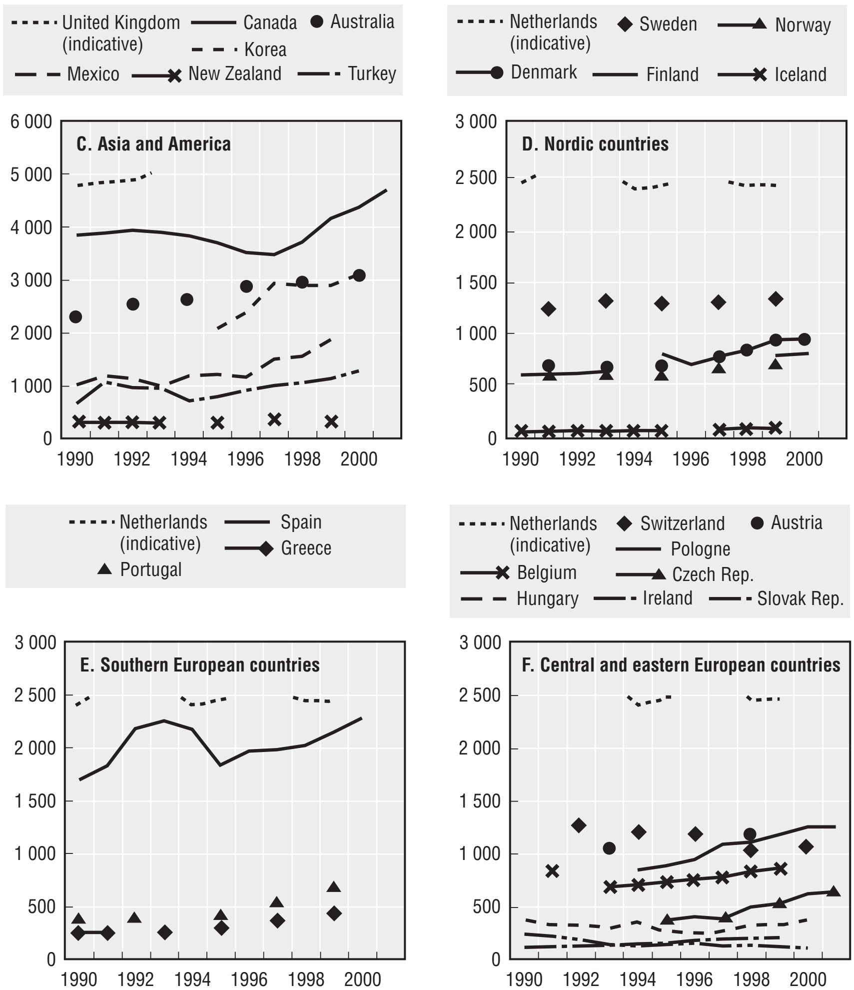


Figure 1. **Development of government funding for public sector research** *(cont.)*

Millions 1995 USD



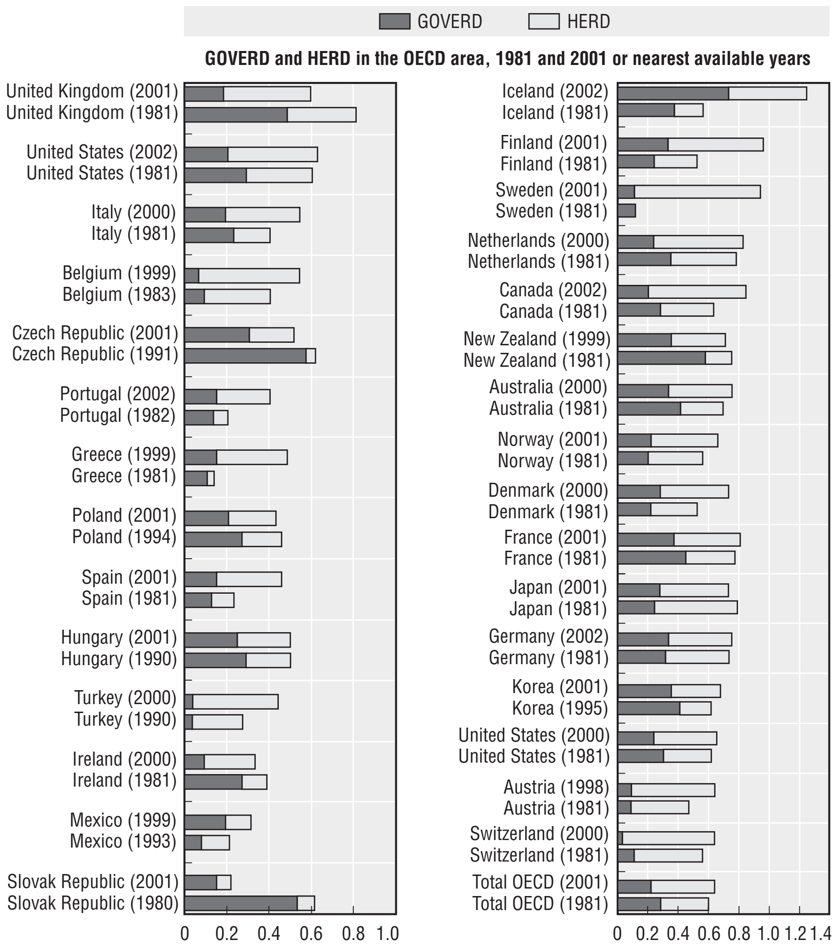
Note: The series for Japan (in the second figure), the United Kingdom (in the third figure), and the Netherlands (in the last three figures) are indicative to highlight the change in the scales on the left side of the graphs.

Source: OECD.

between 1981 and 2000 at the OECD level, although considerable variations exist across countries. While the larger OECD member countries tended to see declining levels of funding for R&D in universities and other PRIs as a share of GDP, many others (including Austria, Canada, Portugal, Spain and the Nordic countries) posted significant gains (Figure 2).

Figure 2. **Total funding of R&D in the public sector, 1981 and 2001**[1]

Percentages of GDP



1. Includes funding from the public and private sectors.

Source: OECD, Main Science and Technology Indicators Database, May 2003.

As regards the future development of R&D funding in the public sector, nearly all countries reported that they will increase their funding for research in the years to come. Denmark is an exception: it reported a sharp increase of 30% until 1999, and now intends to decrease research funding by 25-30% between 2000 and 2005. Most recently, however, other countries have announced that – in view of budget difficulties – they cannot completely fulfil commitments made for increased funding of universities or major research organisations (Germany, Italy). Naturally, this has encountered major opposition from the scientific community which argues that research funding should not be regarded as a subsidy but as an investment in the future that therefore, in the interest of future economic growth, should not be cut.

In those countries that envisage increases, these are mostly fed into special programmes or new funding instruments such as centres of excellence (discussed later in this article), all funded on the basis of competitive approaches. As a rule, only a small amount of increases (mostly related to salaries and overhead costs) is spent on institutional funding of research institutions that comes without strings attached. This has caused major concerns in fields of research that are not high on the priority lists. Funding for them might stagnate or even be reduced, although advances in knowledge generation might be forthcoming.

3. Funding structures

The largest share of income for universities and other PRIs comes from government sources (either federal or state/provincial). It is either provided directly by the ministries involved in the funding and managing of such institutions, or funding is delegated to intermediary agencies such as research councils.

In principle there are two different ways of funding research in the public sector. These are normally categorised as "institutional" funding and "project" funding. Institutional funding refers to block funds that governments or funding agencies allocate to research-performing institutions annually. Institutions are free to use these funds in any way they see fit, as the funds do not come with strings attached. Basic research is normally funded by this mechanism. Project funding is normally granted when research performers apply for grants from competitive funding programmes of public research funding agencies, usually research councils. This includes funding through the "responsive mode", since application grants need to be made in order to obtain funding through this mechanism. Contract funding of public sector research from business or private non-profit organisations also falls into this category because funding is for specific projects. A third funding mechanism, which is also based on competitive criteria, is through special programmes either to advance specific research sectors or to promote excellence in general.

3.1. Institutional funding

Institutional funding for universities and PRIs can take different forms, though in most countries it is based on numbers of students or research units (*e.g.* chairs in Japan) for universities. Most OECD member countries claim that research funding comes without strings attached (one exception being Korea), and that the institutions have free reign in using the funds. However, several factors must be taken into consideration. While it is true that institutions can freely distribute these funds internally, the funding depends on overall science policy objectives and strategies established by funders, and utilisation of these funds is tied to overall legislation and regulations (in particular with regard to salaries). Many countries have introduced performance-based criteria for institutional funding. The United Kingdom, for example, is well ahead in doing this: funds are allocated to institutions on the basis that they can prove their strength in research by undergoing a peer review process, and there are periodic research assessment exercises. In some countries (*e.g.* Portugal) free disposal of funds is also limited by the fact that the funds are barely sufficient to cover basic salaries and equipment. In addition, it is difficult to define precisely what share of institutional funding goes into research since funding is normally for teaching and research. Some countries, however, separate funding for teaching and research (Denmark, Korea) or pay separately for undergraduate studies (Sweden).

3.2. Project funding

The call for greater accountability is obviously leading to a change in the mechanisms used by governments to finance R&D in the public sector. Government funding for academic research is increasingly mission-oriented, contract-based and dependent on output and performance criteria. Funding instruments are becoming increasingly competitive. Long-term institutional funding is on the decline. Fixed-term contract funding, funding for specific research programmes requiring networking between institutions and interdisciplinary research, is increasing.

In their responses to the questionnaire for the OECD study, most countries made a general statement to the effect that institutional funding for research institutions has decreased and a larger part is now coming from competitive funding instruments such as grants and project funding. Quantitative evidence is still scarce, but some countries have provided data (Table 1). These data clearly show that there is a tendency to decrease institutional funding in relative terms and to increase the share of more competitive types of funding.

For project funding, public funds are granted on the basis of applications that are submitted in response to a call for tender. Evaluation procedures are usually based on peer review. This is viewed as being similar to business funding of university R&D, which also tends to be contract-based, with specific objectives, deadlines and interim milestones. Such practices have been common for federal funding of university R&D in the United States but are being used more frequently now in Europe and Asia, especially with new (versus existing) funds (see Section 4 on new funding schemes). By tying funding to specific objectives, increased project funding is expected to overcome rigidities in the discipline-based research system of the higher education sector in many OECD member countries and to enable funding of interdisciplinary and emerging areas that reflect national priorities.

Table 1. **Trends in institutional and competitive funding in selected OECD member countries**

Per cent

	1996	1997	1998	1999	2000
Canada					
Universities					
Institutional funding	51.8	51.6	49.0	46.1	43.4
Grants and contracts	29.8	29.5	31.1	33.9	36.7
Czech Republic					
Universities					
Institutional funding	–	–	–	80.2	75.2
Targeted funding (grants)	–	–	–	19.8	24.8
PRIs					
Institutional funding	–	–	–	42.5	41.7
Targeted funding	–	–	–	57.5	58.3
Finland					
Universities					
Institutional funding	–	52.0	–	47.0	–
Grants	–	19.0	–	24.0	–
Contracts/projects	–	18.0	–	19.0	–
PRIs					
Institutional funding	–	50.0	–	43.0	–
Grants	–	7.0	–	9.0	–
Contracts/projects	–	24.0	–	27.0	–
United Kingdom					
Universities					
Institutional funding	37.3	36.2	35.1	35.1	34.8
Grants and contracts	62.7	63.8	64.9	64.9	65.2

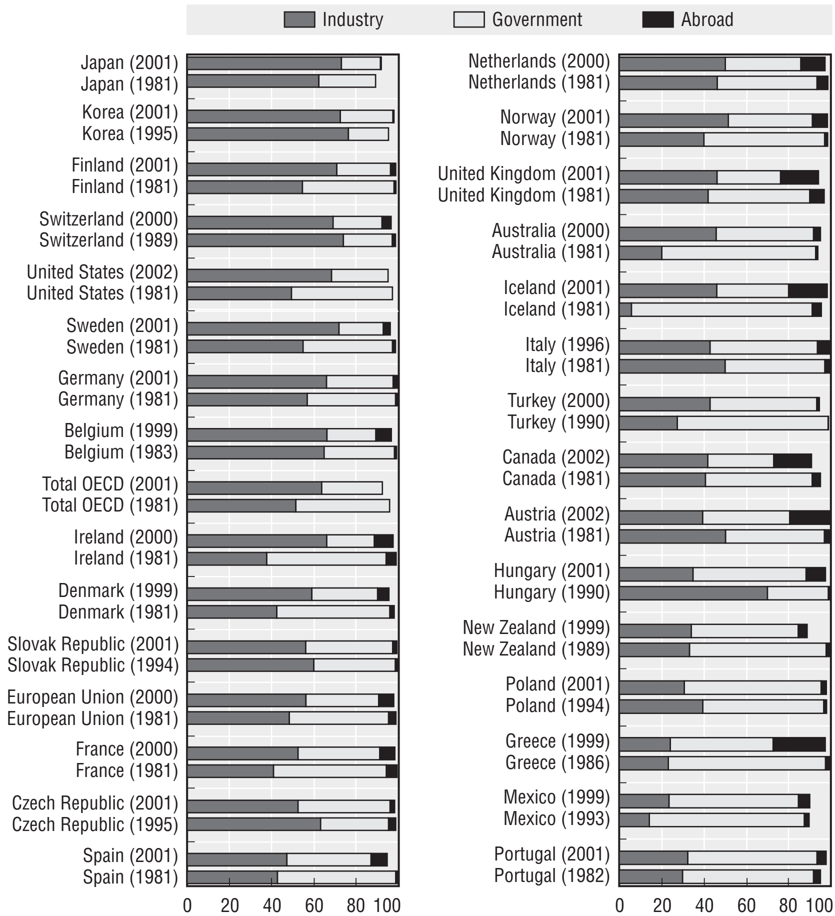
Source: OECD.

3.3. Business funding for public sector research

Regarding global R&D expenditures, the relative role of the different sectors has changed over the last 20 years. Though the structure of performance and funding shows cross-country differences, an aggregate trend can be identified (Figure 3): an increase in R&D financed and performed by business (respectively shifting from 50% and 66% in 1981 to 63% and 69% in 2001) and a decline in the public sector's share in financing (down from 45% in 1981 to around 30% in 2001) and performance (stable at 17% in higher education, but down from 15% to 11% in other public institutions). The increasing share of business funding for global R&D has also led to increased business funding for universities (Figure 4) and PRIs, though there are notable differences with regard to this aspect between countries.

Figure 3. **R&D funding in the OECD area, 1981 and 2001 or nearest available years**

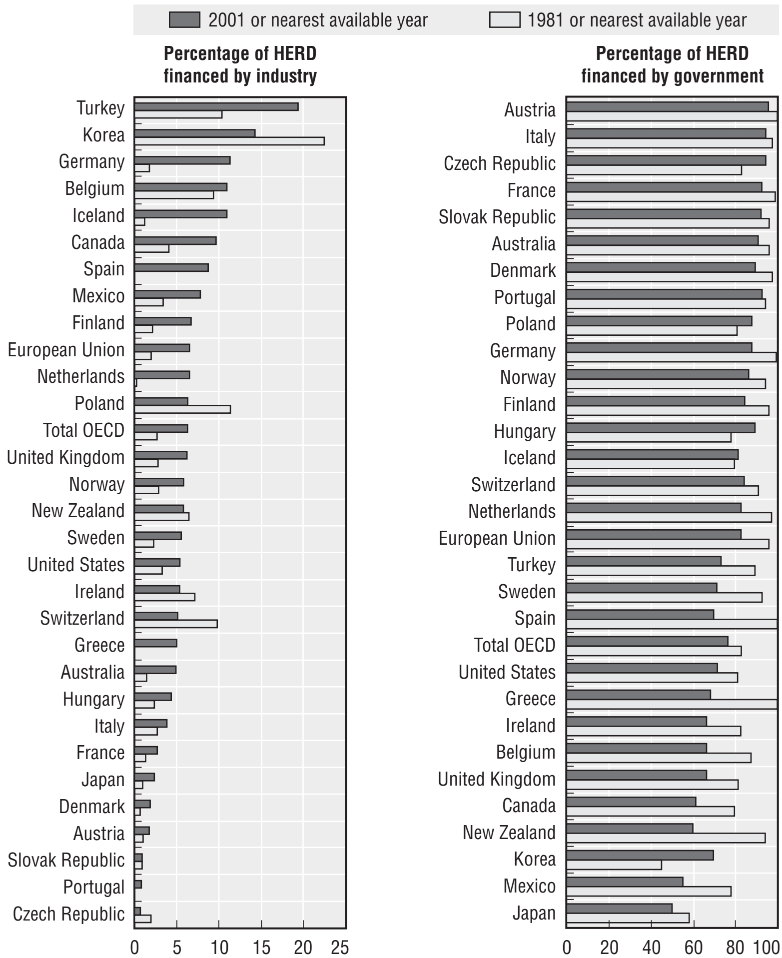
As a percentage of global R&D expenditures



Source: OECD, Main Science and Technology Indicators Database, May 2003.

An analysis of funding flows into the public sector has shown that financial support for public sector research from business has increased in many countries, in particular in the big "spender" countries. Though numbers are still small, the percentage increases are quite remarkable in some countries: in Canada business support for higher education increased by more than 50%; in Finland business support for higher education increased by 40% and by 36% for PRIs; in France business support for PRIs increased by about 80%; in Germany business support for higher education increased by 40% but decreased by 55% for PRIs; in Iceland business support for PRIs increased by a factor of 3.5; in Italy

Figure 4. **Funding for higher education R&D**



Source: OECD Science and Technology Databases, May 2003.

business support for PRIs increased by about 40%; in Mexico business support for higher education has gone up by a factor of 1.2 and has more than tripled for PRIs; in the Netherlands business support has increased for both higher education (26%) and PRIs (18%); in the United Kingdom business funding for PRIs has gone up by a factor of 1.4 and for higher education it has increased by 27%; and in the United States business funding for higher education has increased by 25%. In Japan, business support for higher education and PRIs has slightly increased, but is still small in numbers.

Korea is an exception as regards business funding for the public sector. Business support has decreased both for higher education (by 24%) and for PRIs (by a factor of 1.5). It should be noted, however, that the decrease of business support for higher education in Korea was compensated by funding from government, which increased by about 100%.

Absolute numbers of business funding for the public sector are still small. However, for the receiving institutions, the inflow from business in some cases already presents a considerable part of their income (more than 10% in Belgium, Canada, Finland, France, Germany, Iceland, Ireland, Korea, the Netherlands, Norway, Poland, Slovak Republic, United Kingdom). The statistical material analysed does not convey information about the type of research funded by business. Experts' views differ on whether business funding goes into basic or more applied research.

3.4. Funding from other sources

Other sources of funding, mostly the income sources of the institutions themselves (tuition fees, income from endowments, patent licensing fees), also play a role in some countries. For example, 5% or more of available funding for higher education is financed by such income sources in Canada, France, Japan, Korea, Mexico, Poland, Spain and the United States.

Research institutions are increasingly seeking such external sources of funding, and have therefore embarked on programmes to increase income from patent licensing fees, endowments, private sponsorship or alumni contributions. Such income would give them more flexibility in a funding environment where less money than before comes without strings attached.

Discussion about tuition fees is therefore important in some OECD member countries. While some have a long-established tradition of collecting tuition fees in the higher education sector (United Kingdom, United States) and some countries are not at all considering them (Nordic countries), this is subject to discussion – sometimes very controversial – in others (Australia, Austria, Germany). In a nutshell, discussion mostly focuses on two arguments: those in favour of tuition fees claim that the working class is paying the education for the upper middle classes since the student body mostly consists of young people from the latter layer of society, and that this is unjust since the middle classes should pay for their own education; those against tuition fees claim that young people from the working classes would be discouraged from entering higher education institutions if they had to pay.

While Germany passed a law in 2002 which guarantees that no tuition fees will be collected for first-time students, Australia successfully introduced tuition fees in 1989 and Austria also introduced tuition in 2001 (see Box 1).

Box 1. **Tuition fees: two examples**

Australia introduced the Higher Education Contribution Scheme (HECS) in 1989. This was a radical change at the time which was at first strongly opposed since it seemed to repudiate a commitment towards free university education. However, it was accepted quite rapidly, and changes proposed to HECS during a review of the higher education system in 1999 were not pursued.

Under HECS, students contribute to the cost of their tuition, while the Commonwealth pays the major part of tuition costs (75%). Most students have the option of obtaining a loan to cover the cost of their contribution. This loan is indexed to maintain its real value but is otherwise interest-free. Repayments are income-contingent and are directly deducted by the Australian Taxation Office. During its ten years of existence, the scheme has become much less generous from the students' perspective (higher fees, higher rates of repayment, lower income thresholds) but this has not caused major opposition. Evaluations of the system have shown that the fact that higher education has to be paid for has hardly any influence on enrolment figures (Edwards, 2001).

Austria first introduced tuition fees for the second semester of 2001. This was strongly opposed by large groups of society. Main arguments were that enrolment would drop markedly, that student numbers would drop since those enrolled but not really following any courses or taking any exams would drop out, and that although student numbers might drop, numbers of graduates would increase since students would finish their studies earlier than before.

Figures clearly show that the introduction of tuition fees led to a considerable drop in student numbers: from roughly 220 000 until 2000 to 175 000 in 2001. This decrease in student numbers of about 20% from 2000 to 2001 might be due to the fact that inactive students dropped out of the system. The number of enrolments dropped by 14% from 2000 to 2001, whereas numbers of graduates increased, the latter being a positive effect. In the 2002 winter term, enrolment increased again by 10%.

As shown in the previous sections, government still provides the major share of funding for higher education institutions and – to a large extent – for PRIs as well. Higher education receives the largest share of funding in many countries, since it is the most important research performer in the public sector. However, in some countries there is a balance between the two main sectors of public R&D, and in some countries PRIs even play a more important role in terms of performance (Table 2).

Table 2. **Main funders and performers of R&D in the public sector**

Categories of main R&D funders	Categories of main R&D performers
Government All countries	***Higher education*** Austria, Belgium, Canada, Denmark, Finland, Greece, Ireland, Israel, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States
10% or more of available funding for either higher education or PRIs from business Belgium, Canada, Finland, France, Germany, Iceland, Ireland, Korea, Netherlands, New Zealand, Norway, Poland, Slovak Republic, Turkey, United Kingdom	***Government (PRIs)*** Czech Republic, Hungary, Iceland, Slovak Republic
5% or more of available funding for either higher education or PRIs from private non-profit sources Australia, Canada, Denmark, Israel, Netherlands, Sweden, United Kingdom, United States	***Balance between higher education and government*** Australia, France, Germany, Korea, Mexico, New Zealand, Poland
5% or more of available funding for higher education, self-financed Canada, France, Ireland, Israel, Japan, Korea, Mexico, New Zealand, Poland, Spain, Switzerland, United States	

Source: OECD.

4. New[3] funding schemes

The requirements for increased accountability of public funds, increased flexibility of research institutions to adapt to changing environments, and a better inclusion of socio-economic objectives into the research agenda have led most countries to include changes in their research funding schemes in their science policy reform kit. Only two countries (United Kingdom and United States) report that they did not introduce new funding mechanisms, schemes or systems recently (Table 3).

The reasons which are most frequently quoted for adopting new methods are increasing excellence and quality of research, encouraging interdisciplinary research, overcoming institutional and structural rigidities, facilitating networking between different institutions and promoting young researchers.

In most cases, more flexible and competitive funding mechanisms are attached to new and specific programmes that address specific priority subjects defined by governments or research councils. In some cases such programmes aim to support and strengthen research, in particular basic research (Canada, Korea, Italy, Norway).

Many governments also try to reduce the percentage of "funding without strings attached" for PRIs or to introduce more performance-based approaches for institutional funding. Even countries where universities could always rely on the main part of their funding being provided without requests for

Table 3. **New funding schemes and programme instruments**

Shift to more performance-based and competitive funding programmes	Promotion of co-operation with the private sector	New centres of excellence	New foundations/funds (established with public money)	New problem-oriented research programmes
Australia	Australia	Australia	Canada	Canada
Austria	Austria	Austria	Denmark	Czech Republic
Canada	Belgium	Canada	Hungary	Denmark
Czech Republic	Canada	Czech Republic	Norway	France
Germany	Denmark	Denmark	Sweden	Germany
Hungary	Finland	Finland		Hungary
Japan	France	Hungary		Iceland
	Hungary	Japan		Italy
	Iceland	Korea		Japan
	Italy	Netherlands		Netherlands
	Japan	Norway		Norway
	Netherlands	Switzerland		Portugal
	Norway			Sweden
	Portugal			Switzerland
	Switzerland			

Source: OECD.

accountability are now changing their approach. While countries are not going as far as the United Kingdom, many of them increasingly submit their universities to regular research assessment exercises (Box 5) and they still try to introduce performance-based criteria for funding (*e.g.* not simple student numbers but graduates, completion of doctorate training, etc.) or they enter into performance agreements with their institutions, which have to be regularly reviewed and renewed (Australia, Finland, Denmark, Iceland). In introducing performance-based funding approaches, governments try at the same time to give more autonomy and flexibility to research institutions for use of the funds received. Some examples: let them decide how much should go to teaching and how much to research (Denmark), give them the possibility of carrying over funds from one budget year to another (Germany).

In most countries the measures described above will not lead to increased funding for research institutions, but perhaps funds will be used in different ways. Canada is an exception. It reports having “introduced a host of new funding mechanisms and agencies in the recent past that have changed how university research is funded in Canada. When these initiatives reach steady state, this may translate into a minimum of 50% increase in sponsored research expenditures in universities and hospitals”.

4.1. Examples for new or changed funding schemes

4.1.1. Support for research in interdisciplinary priority areas

In France, a new scheme was established in 1999 to create incentives for research in priority areas. The new fund (*Fonds national de la science*, FNS) was created to finance support for research projects that call for inter-institutional and interdisciplinary collaboration. It is designed to encourage the establishment of emerging fields of research, new research teams, networks of public laboratories and public-private partnerships. Under this programme, funds are allocated on the basis of peer review for a period of four years. The programme also includes special support for young researchers beginning their careers by giving them funds to establish their own research groups. However, the programme funds must be allocated to projects relating to government-defined priority areas. In 2000, a large proportion of the funds went to genome research, but work on AIDS, microbiology and the social and human sciences was also funded. In 2001, the life sciences were again a priority area, but money was also spent on research relating to GRID computing and remote sensing, as well as on co-financing regional research initiatives. A similarly structured public-private partnership programme (*Fonds de la recherche technologique*) supports pre-competitive technology development and innovation in priority areas.

Another example where priority setting is backed up by additional funds is a new funding instrument in the Netherlands. Here, virtual institutes called Leading Technological Institutes (LTIs) are funded. They aim to involve industry more in basic research and to facilitate transfer of research results to innovation. Within the framework of this system, business would take the initiative to establish virtual institutes and public research institutions would respond to such initiatives. Once these virtual centres have been established, researchers from different research institutes and universities will carry out strategic research formulated together with the partners in industry. The government's role in this scheme is to match funds earmarked by industry and to facilitate co-operation between the private sector and public institutions. Currently, there are four such LTIs: in food sciences, metals research, polymers and telematics. An example of a temporary structure to stimulate important interdisciplinary research in the Netherlands is the government-financed Genomics Programme, but the four central research themes were identified jointly with industry and options for co-financing of research by industry which fit the EU Support Requirements are being developed.

4.1.2. Public foundations/funds

Increasingly, public foundations are being set up to distribute research funds. Sweden established five such foundations in 1994, and funding started in 1997. The capital stock of these foundations is based on the former Employees'

Monetary Fund.[4] The resources are allocated to the following priority areas: strategic research, environmental research, research on caring and allergies, regional support and information technology, and internationalisation. These foundations distribute roughly 10% of total public funding for research in Sweden; this is of the same order of magnitude as the funds distributed by the Swedish Research Councils. These foundations are presently undergoing restructuring which might result in a decrease of available funding. On the one hand, these foundations were only planned for a period of ten years but now will be turned into permanent funding agencies, which means that funds have to be spread more thinly. On the other hand, the foundations lost money by investing in stocks, which will also lead to reduced funding at least for the next few years. Also, the foundations came under criticism when being evaluated by the Swedish Royal Academy of Sciences in 2001. An example is the Knowledge Foundation (KK), which was established with the aims of supporting exchange of knowledge between universities, research institutes and industry, supporting research at smaller university colleges and facilitating the use of information technology. This has been carried out via three programmes. However, the programme for research at university colleges failed to raise sufficient interest from local industry. It has also been difficult for the colleges to continue the funding after the external funding was terminated. The Royal Academy therefore suggested that the programme be more strongly directed towards research and graduate education since the interest from industry was relatively weak. It also recommended longer funding periods.

The Hungarian Government established a foundation in 1992 (the Bay Zoltán Foundation for Applied Research). Its purpose is to carry out efficient applied technological and scientific research and development. One of its major objectives is to establish an intellectual basis for an emerging small and medium-sized Hungarian business sector. Other objectives include the establishment of demonstration centres for teaching modern industrial and agricultural methods and the training of researchers, supplementing the universities' PhD programmes. The foundation operates as a non-profit organisation. It obtains its financial resources from the interest on financial investments from a fund first established by the government and from R&D and service contracts with business, and from international funding programmes (Bay Zoltán Foundation for Applied Research, 2000).

In Norway, there is general political agreement to substantially increase investments in research in order to reach at least the OECD average (as a proportion of GDP) by 2005, by increasing both public and private funding. Since the increase can only partly be financed from the national budget, the government decided to create the Fund for Research and Innovation. The Fund is intended to secure comprehensive, stable and long-term public financing of research that cuts across sectors and long-term basic research in general within the four national priority areas: marine research, ICT, medicine and health care, and research at the intersection of energy and environment. The capital is placed with Norway's Central Bank, *Norges Bank*, at fixed interest. Since the creation of the fund, more capital has been added thus increasing its yield. Income from the fund (NOK 525 million in 2002 and NOK 793 million in 2003) was – up to 2001 – distributed by the Research Council of Norway according to government guidelines. This changed with the 2002 budget. Now, one-third of the funding is channelled directly to higher education institutions, and two-thirds are still distributed by the Research Council. The Research Council, for instance, uses its part to fund the new Centres of Excellence scheme. Thirteen new centres were created in 2002 based on international peer review as was a functional genomics programme.

The Canada Foundation for Innovation (CFI) is an independent body created in 1997 with an initial endowment of CAD 800 million. It has now been extended to 2010, and its total budget is CAD 3.15 billion. The foundation funds research infrastructure in universities, hospitals, colleges and non-profit research institutes. The CFI covers 40% of infrastructure project costs, the remainder being covered by universities, the private sector or other government departments (provinces in particular). The extension and the new investment made available provide the stability that universities and research institutions need to make further progress in planning their research agendas.

4.1.3. Centres of excellence

Austrian K-plus centres are funded by a government programme and set up after thorough evaluation of the position and quality of the partners in their scientific and/or economic field and the prospects for becoming a centre of excellence. These centres involve the collaboration of several partners to develop co-operation between science and industry, stimulate pre-competitive R&D and perform long-term research. The centres, of which there are 12 at present, are established through a competitive selection process based on a bottom-up approach. At regular intervals, the TIG (*Technologie-Impulse-Gesellschaft*), acting as programme manager, launches calls for proposals (similar to those for the EU Framework Programme), with government money set aside for funding. Proposals are not restricted to specified areas or types of submitting bodies, so that research groups can be formed from science as well as industry in a bottom-up manner. These groups submit brief proposals describing their research programme and the involved partners; proposals are then examined by special funding agencies that work closely with the TIG. Applicants that pass this first evaluation are invited to submit a full application, which is assessed on the basis of scientific and economic competence, possible economic benefit for Austrian companies as well as the general quality of the proposal. Final decisions are based on recommendations by an independent body of experts to the minister of technology.

The Czech Republic introduced a programme in 2000 for the establishment of "research centres" for a five-year funding period. This programme has several objectives: creating strong research environments by concentrating research capacity in selected research areas and on selected topics (critical mass), increasing excellence and research quality, supporting collaboration between different research teams, and supporting young researchers. The centres should also link up with other European research institutions, develop co-operation with local groups in business and society at large, and enhance Czech participation in European programmes. These centres are directed towards basic research as well as towards applied research. So far three such centres have been selected through a call for tender.

Finland adopted a strategy to establish national centres of excellence in 1995. Its aim is to provide the framework for the development of high-quality, creative and efficient research environments in which research of international quality can be carried out. A Finnish centre of excellence is defined as "a research and researcher training unit comprising one or more high-level research teams with shared, clearly defined research goals and good prospects for reaching the international forefront in its field of specialisation. Centres of excellence are selected for a term of six years on a competitive basis, with evaluations provided by international experts" (Academy of Finland, 2000). For 2000-07, 26 such centres have been selected for funding. Many of their programmes and projects are co-funded from several sources, including industry.

Japan launched a new university resource allocation prioritisation scheme called the 21st Century COE Programme in 2002. The aim of this programme is to promote research units of world-class excellence in selected fields. The fields supported in 2002 were life science, chemistry and material sciences, information, electrical and electronics, humanities and interdisciplinary subjects. Each research unit that is selected as a centre of excellence will be allocated resources around JPY 100 to 500 million for five years. In November 2002, 113 research units at 50 institutions were selected out of 464 applications from 163 institutions.

4.1.4. New approaches in funding for public research institutions

The reform of public research institutions has been an important part of government efforts to strengthen the science base and increase the contribution of government-funded research to meeting societal needs. Changes in funding modes are one of the major instruments for such reforms. One approach has been to introduce more competitive funding mechanisms for public research institutions.

In Germany, public institutional funding for the Helmholtz Association laboratories is giving way to more programme-oriented funding in an attempt to better link the labs to industrial needs and improve the quality of their output (Box 2).

In Japan, since 2001, government-funded agencies have been progressively changing their status to that of Independent Administrative Institutions (IAIs) or National University Corporations as part of the government's overall restructuring. This is a government-wide approach, affecting research organisations along with organisations with other purposes (*e.g.* museums). The effect will be to considerably reduce the number of civil servants, as this has historically been the status of staff of such agencies. The move to IAI status is generally presented in terms of the anticipated benefits of greater autonomy for the institution with regard to flexibility of management and financing. The implementation of the policy appears to be quite systematic, taken at a steady pace, and with due attention being paid to the special requirements of certain organisations such as universities.

5. Support for basic research

Overall, the trend in basic research funding in OECD member countries is difficult to define since only 15 countries reported data on this for the period after 1996. Also, in many cases data may be distorted since countries tend to label basic research according to the institutions where the research is carried out, although these institutions – while originally dedicated to basic research – may also perform other types of research (*e.g.* research carried out in universities or institutes of academies of sciences is always defined as basic research).

Available data show that funds invested in basic research have remained relatively stable over the last decade and have not been affected to a large extent by reductions in government R&D funding (Figure 5). However, there are countries in which the relative share of R&D expenditures devoted to basic research increased, and countries whose relative share decreased between the early 1980s and late 1990s.

It is quite clear to countries that they have to maintain strong support for basic research in order not to lose, or even still to establish, a strong science base. This support can take very different forms. Most OECD member countries provide this support as institutional funding to institutions of higher education or to special institutions for fundamental long-term research (*e.g.* CNRS in France, institutions of the academies of sciences in countries in transition, or institutions of the Max Planck Society in Germany). In this case, the institutions are totally autonomous in managing such funds. Other countries provide contract-based funding for such research which comes without strings attached. Some countries have introduced programmes

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Box 2. **Reforms of the German Helmholtz Association laboratories**

Between 1956 and 1992, Germany established 16 public laboratories that are non-university research institutions (other than Fraunhofer or Max Planck institutes) and are jointly funded by the federal and *Länder* governments. These laboratories had 23 000 employees in 2001 and received about DEM 3 billion a year in institutional funding, the equivalent of 25% of all public R&D funding.

In 1995, these laboratories organised themselves in an umbrella organisation, the Helmholtz Association of National Research Centres (*www.helmholtz.de*), but they were still criticised for a lack of inter-institutional co-operation and flexibility in their research approaches. Evaluations showed that their potential and resources were not being used efficiently. It was therefore proposed to gradually move away from institutional to programme-oriented funding that would allocate resources to inter-institutional thematic research programmes to be evaluated externally, in line with international standards.

Under the new system introduced on 1 January 2002, the government sets research priorities in consultation with the science community, the business sector and the laboratories concerned. Programme portfolios, running over several years and defining clear interim milestones, the share of work and budget of the institutions involved, are established for each project within these programmes. Research proposals submitted on this basis are evaluated *ex ante* by an international evaluation team. Of the total Helmholtz Association budget, 80% is allocated to laboratories on a competitive basis and linked to the defined programme areas (*i.e.* energy, earth and environment, health, key technologies, structure of matter, transport and space). The remaining 20% supports work to follow up on promising advances made within the defined programme areas as well as in other fields selected by the laboratories. The government anticipates that this reform will produce several benefits:

- more focused allocation of R&D funds with greater transparency in priority setting, selection of research proposals and allocation of funds;
- improved planning owing to the fixed-term nature of the programmes;
- greater competition for resource allocation, which should also result in increased networking between institutions and improved international collaboration;
- strengthening of scientific excellence, promotion of interdisciplinary research and co-operative research with industry.

Box 3. **The scope of basic research: how the issue should be reframed**

The notions of "basic research" and "applied research" have been standard elements of the policy maker's toolkit for many years. The dissociation of pure science from practical applications so far has been the basis for defining basic research, including the OECD *Frascati Manual*.[1] However, the blurring of the boundaries between basic and applied research, and the impact of this phenomenon on priority setting and funding decisions in the public and private sectors, have posed difficulties for policy makers.

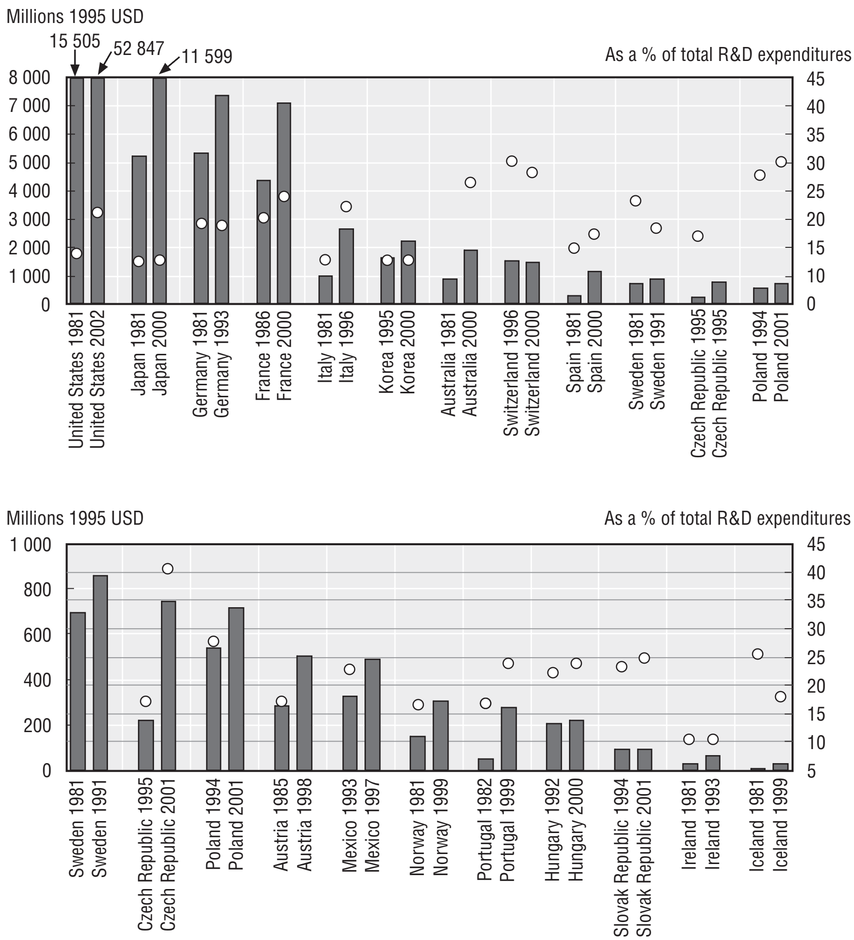
During the course of the project on steering and funding of research institutions, the usefulness of the notion of basic research for actors involved in science systems has been scrutinised.[2] This included re-examining the definition of basic research in the *Frascati Manual*, and it was concluded that the definition was not sufficiently operational for science policy-making purposes. Though views with regard to a new definition of basic research vary widely, there is an understanding that such research has both components: pure curiosity-driven work without a particular use in mind, and use-oriented work.

The 2002 edition of the *Frascati Manual* acknowledges the difficulties involved in categorising research as being basic or applied research or experimental development. It stipulates, however, that it is better to collect data about research expenditure in these categories until some better classification is found than to abandon them. This is perfectly valid for statistical purposes; however, to analyse science policy, basic research has to be defined as including use-oriented components as well.

The reality is that both components have been pursued in the public as well as the private sector, but with differing degrees of emphasis. For public sector research, the central issue is how to achieve an optimum balance taking into account current changes at the research frontier as well as the needs of the private sector. A balance needs to be struck between short-term *vs.* long-term research, knowledge generation *vs.* application, and uncommitted funding *vs.* project/contract funding. Therefore, the key question is not to find a new conceptual definition for basic research, but to define its scope sufficiently broadly to cover the whole range of research types needed to establish a sound body of knowledge to achieve socio-economic advances. This implies that policies for public sector research need to complement private sector research in the public interest and to define research priorities, research agendas and funding instruments accordingly.

1. OECD *Frascati Manual* definition: "basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts without any particular application in view."
2. Workshop on Policy-relevant Definitions and Measurement of Basic Research, Oslo, Norway, 29-30 October 2001. Proceedings available at *www.oecd.org/sti/stpolicy*.

Figure 5. **Basic research in the OECD area, 1981 and 2001**



Source: OECD, Science and Technology Databases, May 2002.

which encourage industry to engage in science-industry relations (*e.g.* the Netherlands, with its funding for leading technological institutes). An overall trend is that institutions dedicated to basic research are increasingly looking for partnerships with industry and are more and more committed to a rapid transfer of research results to application.

The increasing demand for greater relevance of research makes it more difficult for research funders and performers to balance mere knowledge generation with contributions of research for solving societal problems. Increased funding of public research from industry and – alongside this – an increasing influence of industry on research agendas call for more economic relevance of

Box 4. **The Max Planck example**

Germany's Max Planck Society for the Advancement of Sciences (MPG) is an example of good practice for the funding of basic research outside the higher education sector. Its research institutes carry out basic research in all fields of science. The MPG focuses on new and promising research that universities have difficulties accommodating sufficiently, either due to the fact that the interdisciplinary character of such research does not fit into the universities' organisational framework or because the costs for personnel and facilities go beyond the universities' resources. Other research is performed in joint projects between the Max Planck Society and universities. Such co-operation will be intensified in the future.

The public sector supplies 95% of the MPG's funding and only 5% comes from other sources (members' contributions, donations, own income). Public money comes without any strings attached. The Society is completely autonomous in choosing its research priorities, managing its staff, etc.

A good example of a modern MPG institute that responds to the demand for more societal and economic relevance and interaction with other players in the science system is the Max Planck Institute for Biochemistry in Martinsried. Working in the field of biotechnology, the institute has gone beyond purely basic research and is now also engaging in medical-oriented work. The institute co-operates in this area with the pharmaceutical industry at national and international level. By 2002 it had concluded 27 such co-operation contracts.

There are other indicators of close co-operation with the private sector and of the rapid transfer of research results to innovation. Until May 2002, 15 spin-off companies were established by staff of the institute. Between 1997 and 2002, 32 new licensing contracts for inventions patented at the institute were concluded; a total of 76 such licensing contracts presently exist.

The institute also closely co-operates with universities. It engages in researcher training, has an extensive programme for graduates and has established special research groups for young scientists (MPG, 2002).

research activities. Also, increases in competitive funding levels relative to institutional funding can affect institutions' capacity to conduct basic research as well as their science infrastructure investments. Such effects could be negative if public funding did not take account of the full costs incurred.

5.1. The United Kingdom example

In the United Kingdom, competitive funding of university research relative to institutional funding has increased rapidly in recent years. This trend is giving rise to major concerns. Funding from the Higher Education Funding Councils (HEFC) enables higher education institutions (HEI) to conduct research that is not supported by others. As the proportion of "project" funding increases, research work funded with such funds consumes the staff time and infrastructure funded by HEFCs. The situation is aggravated in research areas where the proportion of HEFC funds accounts for a much smaller portion of total research, notably in biomedicine. There are indications that in this area the widening distortion between "project" and "institutional" funding is resulting in a "squeezing out" of some forms of long-term basic research. Although research councils do fund basic research through "responsive" mode funding, this cannot necessarily replace HEFC funding since the research council funding through this mode may fail to support research at the cutting edge, as research council peer review committees may encounter too much time lag to be responsive to research needs at the real frontier. Also, different types of funding may induce different behaviours on the part of the researchers, *i.e.* the basic research that researchers undertake with research council funding and with HEFC funding could well be different.

Another concern is that the relative reduction in funding through the HEFC stream of the dual funding system and the increasing grant funding has resulted in inadequate funding of university research infrastructure. Research Council (RC) funding of university research, as well as funding by charities and industry, only covers the direct costs of research. Remedial investments are needed in generic institutional infrastructure (buildings, plants and services, IT networks and libraries), in the minimum level of research equipment and facilities to attract external funding (the "well found laboratory"), and in improvements in advanced scientific equipment to maintain infrastructure for world-class science. In response, the British Government has decided to allocate a major part of the annual science budget increase to boost university infrastructure. It recently announced that it will institute a dedicated earmarked capital stream for university science research infrastructure (HM Treasury, 2002). Also, the UK research-funding bodies (government, RCs and HEFCs) agree that grant funding of university research should move toward covering the full costs of research. The HEFCs, with the encouragement of their sponsoring bodies, are working to help HEIs develop a standardised methodology for assessing the full costs of research, which is needed to move toward covering full research costs by the grant funders.

6. Evaluation and assessment

The intention to implement major changes in their approach to funding R&D has incited some countries to review either their science system as such, or a whole area of the science system such as universities or public labs before introducing new schemes. In many countries certain research areas, disciplines or institutions have been evaluated or are regularly evaluated. Traditional evaluation procedures such as *ex ante* peer reviews for grants and projects are used in nearly all countries. Some countries have introduced ongoing measurements of performance, sometimes in the form of periodic assessment reviews. *Ex post* evaluation of projects is less frequent.

Table 4. **Evaluation procedures related to funding**

Ex ante	Ongoing and *ex post*	*Ad hoc* procedures	Sophisticated procedures (for whole programmes or institutions) in place or under development
Australia	Australia	Belgium	Australia
Austria	Canada	Hungary	Austria
Belgium	Czech Republic	United Kingdom	Canada
Canada	Finland		Czech Republic
Czech Republic	France		Denmark
Denmark	Germany		Finland
Finland	Hungary		France
France	Iceland		Germany
Germany	Italy		Mexico
Hungary	Korea		Netherlands
Iceland	Netherlands		Norway
Italy	Norway		Sweden
Japan	Portugal		Switzerland
Korea			United Kingdom
Mexico			
Netherlands			
Norway			
Portugal			
Sweden			
Switzerland			
United Kingdom			
United States			

Source: OECD.

It is difficult to get a clear picture of the criteria on which evaluations are based. Scientific excellence still seems to be the most important criteria using the "classical" indicators such as the number of publications, citations, patents, prizes and awards. This might evoke the question of measuring productivity *vs.* quality. Public-private partnerships, networking and mobility of researchers so far are not well integrated into a set of criteria. However, there are attempts to change this: the Czech Republic reports that meeting socio-economic demand has been included as a criterion in its evaluations, and Germany is asking for an *ex ante* "utilisation plan of research results" for its project funding. New evaluation schemes still have to be defined for new funding schemes to fit their objectives.

Box 5. **The United Kingdom Research Assessment Exercise (RAE)**

The Research Assessment Exercise[1] aims to improve research performance of higher education institutions (HEIs) by assessing and rating the research performance of university departments and institutes and selectively funding those that perform the best. The RAE is conducted jointly by the four Higher Education Funding Councils (HEFCs) on a UK-wide basis. The most recent exercise took place in 2001.

In the exercise, HEIs are invited to submit their research activity for assessment. The submitted information goes through peer review assessment of research quality by specialist panels that base their judgment on specified criteria and working methods. The scope of research activities subject to assessment is broad. Basic, strategic and applied research are given equal weight, and all forms of research output are treated on an equitable basis. The assessment gives a rating of one to five stars to each academic unit, with five stars being the highest. The HEFCs all allocate research funding on the basis of these ratings, using slightly different allocation methods. In all cases, the allocation of funding is highly selective, although the precise degree of selectivity varies between the HEFCs. In England, for example, the highest rating of five stars attracts four times as much money as the lowest rating, and in 2001/02, 75% of HEFCE research funds were allocated to 25 higher education institutions.

RAE has stimulated HEIs to improve their research performance. In the most recent exercise, the percentage of higher-ranking units (rating of four stars or above) across the United Kingdom as a whole increased from 43% in 1996 to 65% in 2001, and lower-rated units (rated one or two stars) decreased from 24% to 6%. Also, 55% of active research staff in UK HEIs now work in the highest-ranking units (5 and f5*) compared to 31% in 1996.

The funding councils now consider that the exercise has fulfilled its original mission of improving the research performance of the HEIs to a desirable level. It was even "too" successful in doing so, since – as it was undertaken in the context of slowly increasing funds for research (HEFCE in particular) – it was found that the funding levels for higher-performing institutions could no longer be sustained.

For the HEIs, the exercise has become an increasingly resource-intensive process, taking up staff resources as well as involving long-range planning and strategies. Compared to the amount of effort that needs to be put into the process, with the slow increase in the absolute funding levels, some observers assess that RAE has come to the point of "diminishing returns" (Geuna and Martin, 2003).

1. Details of the Research Assessment Exercise are provided on the Higher Education and Research Opportunities (HERO) site: *www.hero.ac.uk/rae*.

6.1. Examples for evaluation and assessment

In **Canada**, evaluation is used to provide periodic assessment of programme effectiveness, impacts (intended and unintended), and alternative ways of achieving expected results. Depending on the need, evaluation studies can be conducted soon after the initial implementation of a programme to assist in making adjustments to programme delivery, or later in the life-cycle of the programme where the focus is on demonstrating the accomplishments and results of the programme. Basic programme evaluation issues (the criteria upon which programmes are evaluated) include the following:

- Continued relevance: to what extent are the objectives and mandate of the programme still relevant?
- Programme results.
- Achievement of objectives: to what extent were they met as a result of the programme?
- Impacts and effects: what outcomes, both intended and unintended, resulted?
- Cost effectiveness: are there more cost-effective ways of carrying out the programme, are there more cost-effective alternative programmes that might achieve the objectives and intended results?

In addition to periodic evaluations, the Natural Sciences and Engineering Research Council (NSERC) also engages in performance measurement activities. Performance measurement is the ongoing monitoring of the results of a programme; it differs from evaluation in that measurements of key indicators of performance are collected on an ongoing basis. Performance measurement activities feed into the evaluation process by providing the historical data upon which conclusions relating to programme performance and effectiveness in evaluations are based. NSERC tracks information on a variety of indicators relating to, for example, the excellence of its grantees and the technological and economic impact of NSERC-funded research. Specific examples of a few of the key indicators that NSERC tracks for performance in these areas include the following:

- awards and prizes;
- membership on editorial boards of journals and boards of professional societies;
- funds leveraged from other sources;
- patents;
- publications (number and impact);
- start-up companies.

The evaluation activities of the **Australian Research Council** (ARC) are quite comprehensive, as outlined below:

- Measuring its performance each year in its annual report against key performance indicators identified in its strategic plan.
- Monitoring the outcomes of individual research projects based on final reports provided by the researchers involved. Researchers with ARC funding are required to provide a final report within six months of project completion. The report includes information on the benefits expected to arise from the work as well as the results of the work and the outputs (*e.g.* publications).
- Monitoring the efficiency and effectiveness of the ARC's programmes in achieving their objectives. Activities in this category are currently under review, but in the past they have included evaluation of individual programmes as well as evaluations across programmes, for example, an evaluation of biological science research funded by all ARC research programmes.
- Monitoring the status of or developments in the national research effort, for example, through discipline research strategies and other benchmarking studies. The conduct of discipline research studies has enabled research communities to commission or develop research strategies for their disciplines. The aim of these studies is to enable all stakeholders in a discipline, including those who use research and research training graduates, to participate in developing longer-term goals for the discipline and a strategy for achieving the identified goals. Benchmarking studies enable the comparison of Australia's performance against relevant indicators with international achievements. In 2000, for example, the ARC and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) published the results of a study they had commissioned to investigate the linkages between public science (as represented by papers published by university and public research institutions) and private industrial technology (as represented by patents). The ARC completed a benchmarking study of research commercialisation activities in Australian universities in 2002.

7. Conclusions

R&D funding is one of the major instruments for steering the science system, and many OECD governments have embarked on reforms of their funding system to respond to the new demands and challenges highlighted above. All countries have enhanced strategic thinking in the development of their funding policies and mechanisms in the sense that increased attention is paid to the broader social and economic environment in which research policies are designed, and to the evolving patterns of relationships between stakeholders involved in the funding and performing of research.

Each OECD member country has a tradition of its own with regard to R&D funding. However, there are some trends and approaches common to all countries, and reforms in general go in the same direction. The first of such trends concerns the volume of R&D funding. This is generally increasing in OECD member countries. Overall, public R&D funding is increasing to a much lesser extent than private funding. For public sector research, this trend is not so obvious in all countries, although business funding of public research is also increasing, giving rise to new relationships between funding sources and research performers. In this context it is particularly important that funding measures are being designed which allow public and private funding to complement each other in a way that ensures increasing returns on public investments for both sectors. New funding from public sources is usually attached to specific priorities, new interdisciplinary research programmes, or new funding schemes such as centres of excellence or public funds and foundations.

In order to broaden the base of their financial resources, public research institutions (PRIs) are also increasingly looking for new sources of funding, including private charitable foundations, university tuition fees in some countries, and the attempt to include overhead costs for research funded with grants and contracts.

A second important reform approach relates to changes in the allocation of funds. The proportion of funds distributed through competitive grant schemes is increasing relative to institutional funding in the public sector. Also, the use of institutional funds by public research institutions and even universities is increasingly evaluated with measurable performance indicators.

In designing new funding schemes, the involvement of stakeholders beyond the directly concerned research funders and performers is of increasing importance. Independent advisory bodies or research councils with representatives from government, the scientific community, business and society at large play an increasing role in the decision processes relating to the funding of public sector research.

More flexibility, more accountability and – in particular – the relative decrease in institutional funding and increase of funding based on competitive approaches as well as the increased role of business funding for the public sector may give rise to some concerns about support for long-term and fundamental research as well as about support for some research areas not high on the priority lists of policy makers (*e.g.* humanities). Countries will have to address these questions when shaping policy responses for R&D funding.

Notes

1. The complete report of the study, *Governance of Public Research – Toward Better Practices* (OECD, 2003a), is available from the OECD online bookshop. Case studies of selected countries (OECD, 2003b) are available on the OECD site: *www.oecd.org/sti/stpolicy*.
2. The following countries participated in the study: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Iceland, Italy, Japan, Korea, Mexico, Netherlands, Norway, Portugal, Sweden, Switzerland, United Kingdom, United States.
3. "New" does not imply that such instruments have not been applied anywhere before; it means that the schemes or instruments are new to the countries mentioned, or that additional such instruments and programmes are introduced by the countries mentioned.
4. This is specific to Sweden. During the many years of social democratic government, every employee had to pay into such a fund and the money was earmarked for public tasks. After a change of government in the early 1990s, employees no longer had to contribute to the fund, and the accumulated capital was used to establish the research foundations.

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